Tax Credits to Startups?

Thomas Astebro[1], **Tomasz Kamil Michalski**[2]

[1]HEC Paris, and ION Management Science Lab, Paris
[1]HEC Paris

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Abstract

We examine how a general tax credit in France causally affect startups' investments and growth. As tax credit exposure increases, investment in all types of capital increase on both margins for startups but not for established firms. Startups that are fully tax credit exposed increase their growth of investment by approximately 30% compared to non-exposed established firms. Liquidity constraints might explain the greater sensitivity in startups to the tax credit. Indeed, we find that startups are approximately 23% more illiquid than established firms. There are multiplicative effects of the tax credit for the most illiquid startups as they finance further investments partially with issuing more equity, increasing debt, and obtaining more trade credit. The tax credit plus the combined financing boost allows illiquid startups to increase sales, value added and labor productivity without any rent capture observed. Our evidence suggests that tax credits should be limited to firms that are growth oriented and we find these among young and financially constrained firms.

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Correspondence: Astebro: HEC Paris and GREGHEC. Email: astebro@hec.fr; Michalski: HEC Paris and GREGHEC. Email: michalski@hec.fr. The authors wish to thank Viral Acharya, Francesco D'Acunto, Marc Cowling, Clement De Chaisemartin, Daniel Elfenbein, Johan Hombert, Xavier Jaravel, Ramana Nanda, Jose Penalva Zuasti, Fabiano Schivardi, Carlos Serrano and Paolo Surico for valuable discussions.

1 Introduction

Governments regularly subsidize investments by firms. For example, the U.S. spent about $47 billion in 2015 on local business tax incentives alone, about three times the amount they spent in 1990 (Bartik, 2020). There are at least two arguments used to support such measures. Firms may underinvest compared to what is socially optimal, perhaps because some private returns are partially appropriated by competitors. Firms may also face financial frictions or barriers to entry which makes it too costly or impossible for them to invest at optimal levels. There is ample evidence, however, that government and local schemes to stimulate capital investments for many reasons often fail (see e.g. Lerner, 2009; Acs et al., 2016; Criscuolo et al., 2019).

Since general subsidies to stimulate firms' investments often fail, the public may instead target specific industries or classes of firms. In this respect, place-based policies have only found limited impact (Bartik, 2020). A focus on specific industries, so-called industrial policies, have had a resurgence, trying to emulate for example the successful South Korean industrial support policies for their domestic steel and shipmaking industries in the 1970s or the Japanese support of their early cotton-spinning industry in the late 1800s (for a review of this literature, see Juhász et al., 2023). There are also policies targeting specific investment classes, such as support for innovation and R&D, where there are well known market failures (Lerner, 2009), and reasonably good evidence that for example R&D tax credits are generally effective (Bloom et al., 2019). A third opportunity is to support the creation and growth of new firms. This article focus on this third alternative and compare the effectiveness of investment subsidies for startups compared to established firms in France.

Startups are considered those firms from which most new technologies and business opportunities typically originate (Schumpeter, 2013). Some researchers go even further and claim that "A country cannot be great over a sustained period without a steady flow of great new firms" (Klepper, 2015, p. 62). This claim has strong empirical backing (Decker et al., 2014), as well as plenty of anecdotal evidence support. Many countries therefore strive to create competitive sectors through subsidies to startups (Howell, 2017).

Startups are considered to be financially constrained, especially when it comes to obtaining bank credit (Evans and Jovanovic, 1989). Maybe surprisingly then, startups typically rely heavily on bank debt as a source of capital (Åstebro and Bernhardt, 2003; Robb and Robinson, 2014). Consequently, a series of articles has shown that increases in collateral or relaxation of credit constraints positively impacts startups. For example, when house prices increase, entrepreneurs may refinance their house with a second mortgage, and that appears to increase entrepreneurial activity and firm growth (e.g. Adelino et al., 2015; Schmalz et al.,

2017; Kerr et al., 2022).[1]

There is less work on how other types of financing may release financial constraints for startups. And to date, it is still unclear how large financial constraints are for startups, how damaging they are in limiting investment and firm growth, and whether government policy may be able to alleviate such constraints. Furthermore, while theory indicates that operations will become more efficient as financial constraints are released Evans and Jovanovic (1989), there is little empirical research on the impact of releasing financial constraints on operations for startups.

The policy we study, the French CICE tax credit introduced in 2013 ("le Crédit d'Impôt pour la Compétitivité et l'Emploi", provided a liquidity boost and could be applied to a wide variety of purposes. It addressed all firms for "improving their competitiveness, in particular through efforts in terms of investment, research, innovation,..." and, importantly, was based on the size of the eligible wage bill and not on the tax paid or some firm-level financial indicators that could favor e.g. more profitable firms. The scope of the program was substantial, representing up to one percent of GDP. Prior assessments estimate that it failed to have any measurable effect on the average participating firm (Carbonnier et al., 2022; Gilles et al., 2018), which we confirm in our study.[2] However, if financial constraints prevent the scale-up of new firms, startups may be more forcefully affected than the average firm. As the tax credit did not target any specific investment or firm category we can compare impacts on financially distressed versus other firms, and impacts on start-ups versus other firms. In addition, our results will reveal which quantities (investment, employment, trade credit, etc.) appear most constrained for startups as they react to the tax credit. The flexibility may, however, also attract various rent seeking, and we investigate that as well.

Studying their liquidity and leverage ratios we find that startups indeed appear more financially constrained than established firms. Potentially for this reason, growth of plant, property and equipment (PPE) investment increases by 38 log-points, or approximately 46%, for startups with full exposure to the tax credit, compared to no exposure. There are multiplicative effects of the liquidity boost from the government as illiquid startups in

[1] Kerr et al. (2022), however, estimate the housing collateral channel to be just a tenth or less of entrepreneurial entry associated with house price increases, suggesting that other financing channels associated with house price increases are operative and may even be more important.

[2] The French may not be worse than other governments in this respect. In one apparently successful French policy, Barrot et al. (2021) show that a Loan Guarantee Program that offered a public guarantee for French small and medium-sized enterprises (SMEs) to roll over and extend their short-term debt during the financial crisis during 2008-2010 had a sizeable impact on workers' employment and earnings trajectories, and the program was revenue-positive for the government. Another successful French policy targeting startups allow entrepreneurs to use unemployment insurance towards salary for new business owners (Hombert et al., 2020).

particular appear to finance these investments partially with issuing more equity, obtaining more debt, and also receiving more trade credit. The tax credit appears to increase the return on investment and lead to "crowding in" of capital from the three sources. This suggests two new channels in addition to the traditional bank lending channel. Furthermore, the liquidity position is improved for startups with the poorest liquidity with greater exposure, suggesting that the policy was used in a flexible way depending on firm conditions. On top of this, startups that are exposed by the CICE tax credit and are in the lowest quartile of liquidity also increase employment, sales and value added in comparison to non-affected startups. Overall, we find evidence that the CICE tax credit relaxed several resource constraints that startups typically are subject to.

For the exposed startups, we don't find any apparent crowding out of other investments, or insider capture effects, neither to shareholders, nor employees. In fact, dividend growth decreases while average wages go down slightly and profits are unaffected. The lack of rent capture might be due to that firms were required not to take out the credit in profits, and could not increase salaries to the top earning employees, which are otherwise two clear capture opportunities.

Our finding that investment responds so much more strongly to the tax credit among startups than among established firms is best understood as a firm-level analogue of the marginal propensity to consume (MPC), the statistic that has organized the household literature on fiscal transfers since Johnson et al. (2006) and Parker et al. (2013): liquidity-constrained households spend a much larger share of a windfall than unconstrained ones, and this heterogeneity is central to how demand shocks propagate in heterogeneous-agent New Keynesian (HANK) models. The firm-side counterpart, a marginal propensity to invest (MPI) out of an exogenous cash-flow shock, has been estimated far less often, and almost always out of monetary policy shocks rather than fiscal transfers, by separating firms into financially constrained and unconstrained groups (Ottonello and Winberry, 2020; Jeenas, 2023; Cloyne et al., 2023a; Crouzet and Mehrotra, 2020; Gnewuch and Zhang, 2025). We contribute to this literature by estimating an MPI out of a tax-based, rather than monetary, shock, one that is directly denominated in euros received by the firm. To interpret the economic magnitude of this heterogeneity and to ask whether it matters for aggregate outcomes which firms receive a targeted subsidy, in Section 2 we enlarge our contracting model of the firm along the lines of the tractable heterogeneous-agent New Keynesian (HANK) framework of Bilbiie (2025) and its extension to capital and investment heterogeneity in Bilbiie et al. (2022). Aggregating investment across a mass of constrained (startup) and unconstrained (established) firms, in the same way that these papers aggregate consumption across hand-to-mouth and unconstrained households, yields a model-based prediction that the aggregate

investment response to the credit is governed almost entirely by the share of constrained firms and their MPI, and delivers a simple, model-consistent calculation of how many euros of investment one euro of CICE credit generates when directed at a startup relative to an established firm.

This introduction is followed by a brief literature review, our theoretical framework, a presentation of the French tax credit, and data description. We then discuss the econometric specification which follows the triple-difference method and where we instrument for tax credit eligibility. We present the regression results displaying causal impacts of the tax credit on startups and established firms in Section 5. We then conclude.

1.1 Related Literature

Financial constraints may have a large impact both on which projects that firms can undertake and on general business and economic development. The relationship between financial constraints and firm growth has traditionally been examined through the sensitivity of investments to cash flow (e.g. Fazzari et al., 1988; Blanchard et al., 1994; Lamont, 1997; Alti, 2003; Rauh, 2006; Faulkender and Petersen, 2012), but typically only for large publicly listed firms. Consistent with financial frictions affecting firms cash management behavior, Almeida et al. (2004) find that financially constrained firms appear to hoard cash out of cash flow, and save more in recessions to be better prepared for future liquidity needs. Acharya et al. (2012) show that the precautionary motive to hoard cash is related to higher credit risk while cash holdings connected with non-credit risk factors lowers it.

Our paper is also related to a small but growing literature that estimates a firm-level marginal propensity to invest (MPI) by explicitly separating constrained from unconstrained firms, the corporate-finance counterpart of the household marginal propensity to consume (MPC) documented since Johnson et al. (2006) and Parker et al. (2013). This literature has so far studied almost exclusively monetary policy shocks: Ottonello and Winberry (2020) find that low-default-risk firms drive most of the aggregate investment response to monetary shocks and rationalize this with a heterogeneous-firm New Keynesian model; Jeenas (2023) shows that firms with low balance-sheet liquidity cut investment disproportionately following monetary tightening, even among firms with similar leverage; Cloyne et al. (2023a) document that young, non-dividend-paying firms adjust investment and borrowing far more than old, dividend-paying firms because their debt is more sensitive to collateral values; and Crouzet and Mehrotra (2020) and Gnewuch and Zhang (2025) show that such size- and age-related heterogeneity shapes the aggregate transmission of monetary policy through the distribution of firm-level investment rates. We are not aware of comparable MPI estimates out of a fiscal,

tax-based cash-flow shock of the kind we study, which has the advantage of being directly denominated in euros received by the firm rather than in a change in the cost of capital. On the theory side, this heterogeneity in investment responses is the natural firm-side analogue of the heterogeneity in consumption responses that motivates the heterogeneous-agent New Keynesian (HANK) literature; we build in Section 2 on the tractable HANK framework of Bilbiie (2025) and its extension to capital and investment heterogeneity in Bilbiie et al. (2022), aggregating firm-level MPIs in the same way that these papers aggregate household MPCs, and relate this also to Kaplan et al. (2018).

As the French tax credit was possible to use for any purpose, except to bolster wages for top employees or raise profits, we situate our study within the literature on evaluations of reforms to tax credits in general. There is some evidence that some specific tax credits to firms have positive effects, including capital gains tax relief, accelerated investment depreciation, R&D tax credits, and corporate tax cuts (Cummins et al., 1994; Hall and Van Reenen, 2000; Zwick and Mahon, 2017; Curtis and Decker, 2018; Freedman et al., 2023), although results varies. While firm-specific tax incentives at the state and local level do not seem to increase economic growth much (Slattery and Zidar, 2020), R&D tax credits stand out as appearing to be the most successful tax credit (Bloom et al., 2019).

Most evaluations of tax cuts or credits, summarized in Cloyne et al. (2023b) and Kennedy et al. (2022) examine effects on the average firm, rather than on financially constrained firms.[3]

Relevant from this literature for our study is that tax cuts appear to produce differential responses across firms in the same jurisdiction. For example, Cloyne et al. (2023b) show that goods producers increase their capital expenditure and employment in response to an increase in investment tax credits, but companies in the service sector mostly use tax windfalls to increase dividend payouts, while Zwick and Mahon (2017) show that small firms and financially constrained firms respond much stronger to a change in invest write-offs than large and unconstrained firms. Another set of related articles examine the impact of R&D tax credits and find differential responses to those by firm size: smaller firms are much more responsive to R&D tax incentives than larger firms.[4] Closest to our study may be Zwick and

[3]See for example House and Shapiro (2008), Zwick and Mahon (2017), Ohrn (2019), Garrett et al. (2020), Curtis et al. (2021) on the U.S. "bonus" depreciation policies;Yagan (2015) on dividend tax reforms; Goodman et al. (2021) on the 2018 reforms to U.S. Section 199; Ohrn (2018) and Dobridge et al. (2021) on the U.S. Domestic Production Activities Deduction; Kennedy et al. (2022) on the 2017 Tax Cuts and Jobs Act; Giroud and Rauh (2019) and the review by Slattery and Zidar (2020) on effects of U.S. state and local level taxes.

[4]See for example Wallsten (2000); Lach (2002); Görg and Strobl (2007); Bronzini and Iachini (2014); Appelt et al. (2016); Howell (2017); Criscuolo et al. (2019)

Mahon (2017) and Edwards and Todtenhaupt (2020). The latter study finds that a capital gains tax reduction increases the amount of investment in start-up firms per funding round by about 12%.

The literature on the effects of tax credits does not form strong agreement. For example, Yagan (2015) and Goodman et al. (2021) find no discernible effects, while Giroud and Rauh (2019), Curtis et al. (2021), Dobridge et al. (2021), and Kennedy et al. (2022), find positive elasticities for tax cuts on investments and employment.[5]

There is a much smaller literature that causally identifies the role of financial constraints on the effectiveness of governmental investment subsidies for startups. Related literature shows that startup activity has been found affected by banking deregulation (Kerr and Nanda, 2009; Zarutskie, 2006), where deregulation proxy for relaxed constraints. We examine alternative financial mechanisms to bank lending and retained earnings, in particular voluntary dividends cuts, equity increases and trade credit. While the equity channel is rather underresearched (although see Edwards and Todtenhaupt, 2020), the trade credit and bank lending channels have been investigated more. For example, negative investment effects of liquidity shocks to trade credit demanded from small but established suppliers are shown in Murfin and Njoroge (2015). If suppliers have an informational advantage to anticipate or observe the increased firm liquidity faster than banks, they can increase trade credit provision (see e.g. Biais and Gollier, 1997).[6]

2 Theoretical Framework

We first adapt Holmstrom and Tirole (1997) to fix ideas on the impact of the CICE policy at the level of the individual firm, deriving the marginal propensity to invest (MPI) of a financially constrained entrepreneur out of an unanticipated tax windfall and contrasting it with the (zero) response of an unconstrained firm. We then aggregate across the two types of firms in Section 2.4, in the spirit of the heterogeneous-agent New Keynesian (HANK) literature that aggregates household-level marginal propensities to consume, to obtain a

[5]One needs to be careful in comparing the impacts of these different policies to each other. Dividend taxes and more narrowly targeted corporate tax deductions and credits should have different effects than the more general corporate income tax (Auerbach, 2002; Hassett and Hubbard, 2002).

[6]There are few theories of trade credit offered to or demanded by firms linked directly with liquidity or firm cash flows, and their predictions differ. For example, a prediction in Cunat (2007) is that a firm with a positive liquidity shock would obtain less trade credit supplied except in cases with large liquidity shocks improving the value of maintaining credit relationships for the supplier where the impact should be the opposite. In some models there is a weakly decreasing relationship between the share of trade credit and the extent of wealth (that can be reinterpreted as cash flow) or credit constraints such as Burkart and Ellingsen (2004) or Fabbri and Menichini (2010).

simple model-based prediction for the economy-wide investment response to the tax credit, and a back-of-the-envelope calculation of the investment generated by one euro of credit directed at a startup relative to an incumbent.

We develop two models of the individual firm's problem, of which the bank lending version is featured. The two models differ only marginally, and predictions from the two are qualitatively similar. A sketch of the equity investment version is located in the Appendix.

An entrepreneur (firm) has capital k invested in a project with a concave yield $f(k)$. She meets a bank (investor) that can provide funding competitively through debt (equity) financing, seeking a market return rate R_f. There is a moral hazard problem: the entrepreneur needs to exert effort e to increase the probability of success of a project $p(e)$. We analyze the effect on the optimal contract of the unexpected introduction of the CICE policy as a reduction on taxes on profits t. Proofs and a specialized version of the model with closed form solutions are exhibited in Appendix A.3 and A.5.

2.1 Setup

Production. Each entrepreneur has a project that yields $Af(i)$ if it is successful on an invested amount i. The production function f is strictly concave ($f' > 0$ and $f'' < 0$) while $A > 0$ is a productivity parameter. Each entrepreneur has to exert unobserved effort $e > 0$ to increase the probability of project success $p(e)$ (with $0 \leq p(e) \leq 1$ and $p'(e) > 0$). The costs of exerting effort $\psi(e)$ are convex with $\psi'(e) > 0$ and $\psi''(e) \geq 0$. The production, project success probability, and effort cost functions are common knowledge. If the project fails (with probability $1 - p(e)$), it yields zero. There is limited liability. The bank may lend by securitizing some business assets, but since this is a start-up, there is no recoverable scrap value, so nothing is repaid to the bank in case of project failure.

Timing. An entrepreneur with a production function $Af(\cdot)$ and irreversibly invested capital k is matched with a bank. We can interpret this as a firm that has some liquidity on hand k but observes a sudden investment opportunity. Both observe the rate of the CICE tax t on profits, and the bank can verify costlessly the level of capital already invested k. The two play a sequential game. The bank propose a take it or leave it offer of a loan at a rate r to the entrepreneur. The entrepreneur observes r and decides how much to borrow b and how much unobserved effort e to exert in the following production phase. After production the loan is repaid in full in case the project is successful; if it fails, the bank obtains 0. There is limited liability of the entrepreneur who claims the residual after the loan repayment.

CICE. There is a proportional tax t on profits levied on successful projects. Introducing CICE will lead to a decrease in t for affected firms.

2.2 Solution

The game is sequential, solved by backward induction.

Firm. The entrepreneur observes r and chooses how much funds to borrow and how much effort to exert to maximize utility.

Bank. In proposing r, the bank understands that the entrepreneur will choose jointly b^* and e^* to maximize utility. Since the cost of capital for lenders is constant at R_f and the offer is competitive, the bank will charge $r = \frac{R_f}{p(e^*)}$, the risk-adjusted interest rate.

2.3 Debt financing case

The CICE is a tax levied on profits and debt offers a tax shield. The entrepreneur maximizes

$$\max_{e,b} p(e)(1-t)(Af(k+b) - rb) - \psi(e) \tag{1}$$

The first order conditions are with respect to b

$$Af'(k+b^*) = r \tag{2}$$

and with respect to e if an interior solution

$$p'(e^*)(1-t)(Af(k+b^*) - rb^*) = \psi'(e^*) \tag{3}$$

Normalize $R_f = 1$ and set $q(e) = \frac{\psi'(e^*)}{p'(e^*)}$ where $q'(e) > 0$ and $q''(e) > 0$. Reworking eqs. (2-3) we obtain a system of two equations[7] that implicitly define e^* and b^*

$$p(e^*) - \frac{1}{Af'(k+b^*)} = 0 \tag{4}$$

$$(1-t)A(f(k+b^*) - b^*f'(k+b^*)) - q(e^*) = 0 \tag{5}$$

Using the implicit function theorem, we obtain under reasonable technical conditions that the optimal effort is increasing $\frac{\partial e^*}{\partial k} > 0$ while the borrowed amount is decreasing in the entrepreneur's initial capital (liquidity on hand) $\frac{\partial b^*}{\partial k} \geq -1$.[8] The latter implies that total investment $\frac{\partial (k+b^*)}{\partial k} = 1 + \frac{\partial b^*}{\partial k} \geq 0$.

[7] If $f(k) = k^\alpha$ we can solve for b^* as a function of e^* directly and express e^* in terms of an implicit function of one variable. Moreover, If $k = 0$ we can use the second equation to obtain $b^* = \left(\frac{q(e^*)}{(1-t)A(1-\alpha)}\right)^{\frac{1}{\alpha}}$.

[8] Given our assumptions there may be an optimal scale of the project. Beyond some level of k the optimal effort level may be such that $p'(e) = 0$ and the optimal investment is constant even if k increases.

The exerted effort increases with an increase in CICE as CICE causes the tax to fall $-\frac{\partial e^*}{\partial t} > 0$ and so does the borrowed amount $-\frac{\partial b^*}{\partial t} > 0$. This implies that total investment as a function of tax: $-\frac{\partial (k+b^*)}{\partial t} = -\frac{\partial b^*}{\partial t} > 0$. We can also derive results on the impact on sales: $-\frac{\partial [p(e)Af(k+b)]}{\partial t} > 0$. Further characterizations of the problem are feasible using specific assumptions on $f, p(e), q(e)$, examples are given in the online Appendix.

A key modeling objective is to understand the differential effect of CICE on firms with different levels of capital k. Therefore, compare an unconstrained firm with a high initial k where the optimal choice entails $p(e) = 1$ with that for a constrained firm with low k so that $p(e^*) < 1$. For an unconstrained firm, there is no wedge in optimal investment from CICE, apparent from the first order condition, eq. (2), and $R_f = r$. But for a constrained entrepreneur with a low k, $-\frac{\partial b^*}{\partial t} < 0 = \frac{\partial b^*}{\partial t}|_{unconstrained}$.

2.4 Aggregation, Firm Heterogeneity, and the Marginal Propensity to Invest

The comparative statics above are stated at the level of an individual entrepreneur. They imply a firm-level *marginal propensity to invest* (MPI) out of the tax credit, $\text{MPI}^j \equiv -\partial (k + b^*) / \partial t$ for firm type j, that is zero for an unconstrained firm ($p(e^*) = 1$) and strictly positive for a constrained firm ($p(e^*) < 1$). This object is the direct firm-side counterpart of the household marginal propensity to consume (MPC) that has organized the household literature on fiscal transfers since Johnson et al. (2006) and Parker et al. (2013), and it lets us ask the same aggregation question that the heterogeneous-agent New Keynesian (HANK) literature asks of households: does it matter for aggregate outcomes *which* economic units receive a given windfall, or only how large the windfall is in total?

Estimates of an MPI are considerably rarer than estimates of the MPC. Existing evidence on differential investment responses across constrained and unconstrained firms comes almost exclusively from *monetary* policy shocks: Ottonello and Winberry (2020) and Jeenas (2023) show that low-leverage or high-liquidity firms respond most strongly to interest rate surprises, while Cloyne et al. (2023a) document that younger, non-dividend-paying firms adjust capital expenditure and borrowing far more than older, dividend-paying firms following a monetary shock, and Crouzet and Mehrotra (2020) and Gnewuch and Zhang (2025) show that this size/age heterogeneity in investment responses matters quantitatively for the aggregate transmission of monetary policy. Our setting complements this literature by measuring an MPI out of an exogenous, tax-based cash-flow shock rather than a change in the cost of capital, and by exploiting a policy that, unlike a change in the policy rate, is directly denominated in euros received by the firm; this makes possible the euro-for-euro comparison

between startups and established firms we develop below.

To translate the individual-firm comparative statics into an aggregate, model-based prediction we adopt an aggregation logic directly analogous to the tractable HANK models of Bilbiie (2025) and Bilbiie et al. (2022). There, a unit mass of households is split into a fraction λ of constrained, "hand-to-mouth" households with a high MPC and a fraction $1-\lambda$ of unconstrained "savers" whose consumption is pinned down by a frictionless Euler equation; aggregate consumption dynamics, determinacy, and the size of fiscal multipliers all depend on λ and on the cyclicality of the constrained households' income, summarized by their income elasticity to aggregate income, χ — the same basic "indirect effects" logic that Kaplan et al. (2018) show is central to the transmission of monetary policy in quantitative HANK models. We map this structure onto firms: a unit mass of firms is split into a fraction λ of financially constrained firms (empirically, the startups in our sample, with $p(e^*) < 1$) and a fraction $1-\lambda$ of unconstrained, established firms (with $p(e^*) = 1$). Aggregate investment is

$$I_t = \lambda I_t^H + (1-\lambda) I_t^S, \tag{6}$$

where H ("hand-to-mouth") denotes the constrained, startup-type firm and S ("saver") the unconstrained, established-type firm, echoing the H/S notation of the household HANK literature. Differentiating (6) with respect to an economy-wide, uniform change in the tax credit τ_t gives the aggregate MPI

$$\frac{dI_t}{d\tau_t} = \lambda \,\mathrm{MPI}^H + (1-\lambda)\,\mathrm{MPI}^S = \lambda \,\mathrm{MPI}^H, \tag{7}$$

since $\mathrm{MPI}^S = 0$ by the unconstrained firm's first-order condition (2). Equation (7) is the exact investment-side analogue of the "New Keynesian Cross" logic in Bilbiie's TANK/HANK models: just as aggregate consumption there is governed entirely by the mass and MPC of hand-to-mouth households, aggregate investment here is governed entirely by the mass and MPI of financially constrained firms. It immediately implies that a policy of *targeting* the credit at constrained startups rather than spreading it uniformly across all firms delivers a strictly larger aggregate investment response for a given fiscal outlay, since it raises the effective λ applying to MPI^H while economizing on transfers to firms with $\mathrm{MPI}^S = 0$.

Equation (7) also understates the full response whenever the credit crowds in other sources of finance, as we document empirically in Section 5.2. Because a marginal euro of credit relaxes the constrained entrepreneur's pledgeable income, it lowers the risk-adjusted rate r charged by the bank (Section 2.3), which raises both effort e^* and borrowing b^*, and, in the extended version of the model with trade credit sketched in Appendix A.5,

additional trade credit c^*. Writing the euro amount of credit received by a firm as $\tau = -\Delta t \times W$, where W is the eligible wage bill, the total investment response per euro of credit for a constrained firm is $\text{MPI}^H_\tau \equiv dI^H/d\tau = \text{MPI}^H/W^H > 0$, which exceeds the direct liquidity injected per euro whenever debt, equity, or trade credit respond positively to the credit, while $\text{MPI}^S_\tau = 0$ for an unconstrained firm regardless of W^S. This is the firm-side counterpart of the amplification that cyclical income inequality generates for aggregate demand in Bilbiie (2025), that capital-income redistribution generates for consumption in Bilbiie et al. (2022), and, more generally, of the amplification through repeated rounds of income and spending responses formalized by the "intertemporal Keynesian cross" of Auclert et al. (2024): heterogeneity in the marginal propensity to respond, combined with a concentration of the shock among high-MPI/high-MPC units, amplifies the aggregate effect of a demand shock relative to a representative-firm (or representative-household) benchmark.

A simple calculation: one euro of CICE to a startup versus an incumbent. To illustrate the quantitative content of (6)–(7), we combine the model with our reduced-form estimates from Section 5.2. There, a startup with full exposure to the tax credit increases the growth rate of its PPE investment by 30–46 log points relative to a non-exposed established firm, while the average established firm shows no discernible investment response to its own exposure ($\hat{\beta} = 0.058$, s.e. $= 0.045$). Consistent with the model's prediction that $\text{MPI}^S = 0$, we treat the established-firm response as a precisely-estimated zero. Let I^H_0 denote the average pre-reform annual PPE investment of a startup (Table 2) and $\tau^H \approx$ €12,000 the average CICE exposure of a startup (Section 3). The model-consistent, back-of-the-envelope euro-for-euro impact of the credit on startup investment is

$$\frac{\Delta I^H}{\tau^H} \approx \frac{I^H_0 \times (e^{0.38} - 1)}{\tau^H} \approx \frac{0.46 \times I^H_0}{\tau^H} \approx \text{[to be updated with } I^H_0 \text{ from Table 2]},$$

euros of additional investment per euro of credit, compared with approximately zero for an established, unconstrained incumbent, whose extra euro of credit instead shows up in Section 5.2 as higher liquidity, debt repayment, or dividends rather than as new investment. Put differently, redirecting one euro of CICE from an established firm to a constrained startup is, in the model, equivalent to multiplying the investment impact of that euro by a factor on the order of $I^H_0/\tau^H \times 0.46$, purely as a consequence of firm heterogeneity in the MPI — the corporate-finance analogue of the amplification that targeting transfers at high-MPC households generates for consumption in household HANK models.

3 The CICE Tax Credit

After François Hollande won the Presidential election in 2012, the new socialist government signaled that it considered measures to stimulate the economy and increase employment and incomes for the poorer strata of the society. The announcement of a new business tax credit in late Fall 2012 therefore came as a surprise.[9]

The Tax Credit for competitiveness and employment, "le Crédit d'Impôt pour la Compétitivité et l'Emploi" (CICE) was announced on 6 Nov 2012 and took effect on January 1st, 2013. It was a major reform intended to aid all French firms both to reduce unemployment in the economy and increase firm competitiveness. Starting from a projected initial amount of more than 10 billion euros in 2013, the aid reached nearly 20 billion euros each year between 2014 and 2016, or approximately one percentage of GDP. It was a measure comparable in magnitude to general exemptions from social security contributions.

CICE was a general tax credit. It potentially affected all domestic companies, as long as they employed at least one person and were not part of the public administration. Few conditions of use were imposed.[10] The only restrictions were that the tax credit can "neither finance an increase in the share of distributed profits, nor increase the remuneration of persons exercising managerial functions in the company".

CICE was in the form of a deduction on taxable income. The CICE was charged at the time of liquidation of the balance of corporate tax. The credit is available for 3 years towards any taxes levied in those years, with the balance of unused credit paid to the firm in the 3rd year. However, four sets of firms could claim the full credit immediately and without first deducting the amount from taxes owed. Those were SMEs, new firms, young innovative firms, and firms in financial distress. Other firms were also able to directly use the expected tax credit to obtain additional financing by transferring the expected credit to a financial institution.[11] Many U.S. job creation tax credits work in the same way. They are refundable, meaning they can exceed the firm's state corporate income tax liabilities (see Bartik, 2020).

The size of the credit was conditioned on the size of the wage bill for lower paid employees. Aid was uniform, with a tax credit of 4% in 2013, increased to 6% from 2014,

[9] A Google trend search on the term "CICE" (Figure A4) and alternate acronyms revealed a random pattern of mentions before the introduction of the reform.

[10] According to article 244 quater C of the French general tax code, which defined the CICE, it was for companies to finance "improving their competitiveness, in particular through efforts in terms of investment, research, innovation, training, recruitment, prospecting for new markets, ecological and energy transition and the reconstitution of their working capital" .

[11] For details see ESTAT/D-2/FL/LFO/LPU/mhci D(2013) 3053127

on all salaries paid that were below a maximum limit of 2.5 times the minimum wage.[12] Wages above 2.5 times the minimum wage "2.5 × SMIC" were exempt from the credit. As firms' wage distributions differ there is no fixed threshold to form a discontinuity around.[13] The total amount of the credit differs across companies depending on their within-firm wage distribution. CICE was transformed in 2019 into a general and permanent reduction of social security contributions.

We calculate the exposure to the tax credit for the average startup and the average established firm to be almost 12,000 and 35,000 euros, respectively. This comes to approximately 1,000 euros per employee in start-ups, and 1,100 euros in established firms. The credit exposure was therefore substantial.

Several evaluations of the program have been conducted, but none focusing on startups. Notably, Carbonnier et al. (2022) and Gilles et al. (2018) both performed impact evaluation of the CICE tax credit on employment and wages (among other) on the average firm and found small effects that appear not motivated by the cost of the disbursed tax refunds.

4 Data, Descriptive Analysis, Econometric Specification

4.1 Data Construction

We use the French administrative data "DADS-Postes" from INSEE (the National Institute of Statistics and Economic Studies) for the period 2010 to 2014. These include establishment- and firm-level linked individual employees' wages, hours worked, occupation, age and employment contract characteristics. Data are available separately for each year vintage with each such panel of firms containing the preceding year's data as well. This allows us to construct a panel dataset at the establishment- and firm-level but not worker-level, as anonymized employee identifiers vary across yearly vintages.

Following established tradition when using registry data we define startups as firms that are less than or equal to five years old (see e.g. Decker et al., 2014) as of 2012.[14] Older firms are called "established". In the analysis of startups we further restrict attention to

[12] The national minimum wage was 9.43 EUR/hour or 1,430 EUR monthly as of January 1st 2013.

[13] The threshold corresponds to a little more than 3,575 euros gross monthly in 2013. Note that the threshold of 2.5 × SMIC is a high threshold in the French distribution of wages. According to data published by INSEE and from the DADS, this threshold is between the 8th and 9th deciles of the wage distribution.

[14] Given the methodology that we need to implement (see Section 4.4), this means that effectively we study startups that were founded between 2008 and 2011.

firms with more than 3 employees to observe meaningful changes in either hours worked or average wages. Based on information contained in separate datasets[15] we reclassify as established the following types of firms even if their founding date is between 2008 and 2011: (i) firms with more than 100 employees at inception (to avoid capturing mergers); (ii) firms that are continuing activity of some earlier entity — an establishment or firm — possible spin-offs, renamed or reorganized firms and (iii) any newly registered company that is owned by another (with at least a 10% stake, or more) in the year of founding.

We use the Fichier des données Annuelles et RElatives data set from the INSEE to obtain firm-level balance-sheet and income statement data to calculate such quantities as firm investments, leverage, liquidity, dividends, retained earnings, equity, debt, profits, cash flow, and accounts payable on all firms.

In this article we do not rely on an explicit measure of financial constraints to infer treatment effects. Instead, we rely on comparing outcomes between startups and established firms, and noting that if startups are financially constrained their reactions would be greater from those of established firms given random access to a tax credit. Nevertheless, it is still of interest to try and independently observe indicators of financial distress and how distress differ across startups and established firms. Several alternative measures of financial distress for listed firms have been used in the literature, such as payout policy, asset size, bond ratings, commercial paper ratings, and the multiple measure index by (Kaplan and Zingales, 1997). The first four measures seem to agree with each other while the "KZ index" appears to measure something else (Almeida et al., 2004). As we use a combination of listed and unlisted firms and register based data, most of these alternative measures are not available to us, or are imperfect because of our focus on startups. Since the CICE tax credit is a liquid cash payout, we use the short term (also called the quick ratio) and medium term (the current ratio) cash position, to indicate the degree to which firms are liquidity constrained. As a complement and measure of access to debt financing, we compute the ratio of debt over assets, and retain firms with leverage below 2.5.

To examine firm growth and wages, we use the entire universe of payslips, and clean the data. At the worker level, we discard observations that deliver abnormally low average wages.[16] We use incorporated private firms that had yearly hours worked above 1,680 hours, equivalent to at least one employed worker. We drop firms with the 0.1% lowest and highest average wages to limit data errors and those with wages below 95% of the minimum wage.

[15] "Liens de succession" (part of firm registry SIREN database) and "Base de donnees sur les liasons financieres" (LIFI), both from the INSEE for the years 2008-2011.

[16] We discard wages below 25% of the legally imposed national minimal wage. A wage below 25% would be disallowed typically even for apprenticeship or internship hourly pay.

We disregard sectors active in agriculture or extractive industries (NACE 2-digit sectors with codes lower than 10) and temp agencies (NACE sector 78). Using accounting data, we remove firms with negative total assets or liabilities, and those that report negative PPE, debt, retained earnings or dividends. Summary statistics for the main sample are given in the Appendix, Table A6. More detailed sample statistics broken up by 2012 and 2013 are given in the Appendix, Tables A7 and A8.

Firm growth is captured by the total number of hours worked in the firm and by sales. The benefit of hours worked is that it is a very precise number computed from payslip data, and it does not suffer from being affected by product-market prices and markups charged by firms. The drawback is that firms that produce capital goods may have output growth that significantly differ from hours worked. Furthermore, French firms are known not to adjust employment quickly to changing economic conditions due to strict labor laws. We therefore also include sales as a secondary measure of firm growth.

The share of the wage bill that is eligible for CICE is calculated using the entire universe of employment contracts within the firm, as stipulated in the law. The distribution across firms of the share of the wage bill that is eligible in 2013 is shown in Figure A2.

4.2 Data Description

We begin with Table 1 describing the basic growth patterns in investment, hours worked, and wages during the three-year period 2011 to 2013, being the two years prior and the first year after the reform was implemented. We do not analyze years beyond 2013 as firm behaviors then are in expectation of receiving the credits.

The median sample growth in plant, property, and equipment (PPE) investment was -25.7% during 2012-2013, while it was -24.6% during 2011-2012. Hours worked, a measure of firm growth, fell by 0.3% for the median firm during 2012-2013 and increased by 0.9% during 2011-2012. Average wages grew by 1.8% during 2012-2013 for the median firm, while their growth was 2.2% during 2011-2012.

These firm-level data make clear that France's economic activity is weak in the period 2011-2013, with median firm investment falling in both periods on a year to year basis, and weak growth of both hours worked and average wages. In fact, the country barely avoided a recession during these two years. Appendix Table A9 exhibits the main yearly macroeconomic figures. Our econometric specification accommodates for changes in general economic conditions, as discussed in Section 4.4.

Most startups had a difficult time in the 2011-2013 economic environment. Startup investment growth was particularly hard hit. The median startup suffered a large decline

in investments, and much larger declines than for the median established firms. However, median startup hours worked grew by 9.2% and 1.5% in the two years respectively, which was more than for the median established firm, while wages grew by about the same rates as other firms during the same periods. In all, both 2012 and 2013 were difficult years for startups.

Startups typically exhibit an up-or-out growth pattern (see e.g. Eslava et al., 2019). Most startups fail, the median startup typically does not grow, while a few instead experience tremendous growth compared to established firms. We illustrate this up-or-out pattern by examining the distributions of growth in Table 1. First, while the third quartile of startups experienced growth in investments, their investment growth was still much less than for established firms in that quartile. For wages, the distributions between startups and established firms match each other rather well. However, when it comes to hours worked, the picture is quite different. The median startup grows at approximately the same rate as the median established firm, but at the third quartile startups output growth clearly outpaced that of the established firms. For the 2011-2012 period the difference in growth rates between startups and established firms was a factor of three at the third quartile, and by 2012-13 the difference was still approximately 80%. This illustrates the up-or-out pattern rather well, the upper end of the distribution of startups grow at a much more rapid pace than established firms at the same point on their respective distributions.

What is worrying then, is that growth of investments in startups are significantly lagging behind their growth in established firms. In sum, investments were held back in startups during 2013 due to the weak economy, and in particular were stymied for the fast-growing startups that we think are the main creators of wealth for the nation.

Table 1: Growth rates at the median and 3rd quartile

Item	Year	All firms	Startups	Established firms	All firms	Startups	Established firms
Change in:			median			3rd quartile	
gross investment rate	2011-2012	5.1%	11.2%	5.0%	16.4%	46.4%	15.3%
	2012-2013	4.1%	6.8%	4.0%	13.5%	28.9%	12.8%
Growth rate of:			median			3rd quartile	
PPE investment	2011-2012	-24.6%	-44.2%	-23.1%	94.4%	51.1%	98.0%
	2012-2013	-25.7%	-30.5%	-25.4%	90.0%	71.0%	91.6%
hours worked	2011-2012	0.9%	9.2%	0.5%	9.7%	30.9%	8.7%
	2012-2013	-0.3%	1.5%	-0.4%	6.8%	14.7%	6.4%
average wages	2011-2012	2.2%	2.8%	2.1%	6.2%	7.9%	6.1%
	2012-2013	1.8%	2.0%	1.8%	5.7%	6.6%	5.7%

We now compare the subsample of startups and established firms along some key dimensions in Table 2. There are important differences between these two types of firms.

Panel A shows the median values in levels. The median startup is on average much smaller (11.5 workers) than established firms (31.2 workers) and has much lower equity and debt positions. The median startup is also less liquid, as their quick ratio is 1.37 vs. 1.78 for established firms. Their operating efficiency is lower than established firms, 175k vs. 232k Euros in sales per worker. They also pay lower average wages.

Regarding their investment levels, they have substantially less capital per worker, but yearly PPE investment as a share of total assets is higher. That is, they invest more as normalized by their assets, but are more labor intensive than established firms.

In Panel B we show the growth rates of startups and established firms for the median firm in each group. The median growth of employment, sales per worker, average wages and capital per worker is higher ins startups than for established firms. Startups also observe a much faster equity growth as they are starting from substantially lower levels than established firms. These are all consistent with higher growth rates for startups, reflecting the up-or-out pattern previously mentioned. However, median growth of PPE investment among startups is much lower than for established firms, with yearly declines of 47.8% in comparison to 25.4% for established firms. Startups are also decreasing their total debt levels faster than established firms. Overall, as may be expected, startups are more severely affected than established firms by the weakening economy.[17]

Table 2: Comparison of startup and established firms' characteristics

Item	Units	Panel A. Levels, startups and established firms 2011-2013, mean		Panel B. Growth rate, startups and established firms 2011-2013, median	
		Startups	Established firms	Startups	Established firms
Number of employees	count	11.5	31.2	4.9%	0.0%
Average wage	euros / hour	15.1	16.3	2.4%	1.9%
Operational efficiency: sales per worker	1,000 EUR	175.5	231.8	1.0%	0.1%
PPE investment / Total Assets	share	0.05	0.03	-45.1%	-25.8%
Liquidity: quick ratio	ratio	1.37	1.78	0.0%	0.0%

4.3 Are startups more financially constrained than established firms?

In this section we employ three accounting measures to indicate the possibility that a firm is financially constrained. The literature on financial constraints is littered with various attempts at measuring financing frictions, some more successful than others. Since our firms

[17] Mean log-growth rates exhibit very similar patterns.

consist of a combination of both public and (a majority of) private firms, we cannot rely on measures that are applicable only to public firms. Our measures are therefore based on accounting data, and the main construct of financial constraints is short term cash liquidity, the so-called quick ratio, recorded in the pretreatment period. To support interpretations, we also include measures of medium term liquidity and leverage, all measures assessed in 2011, two years prior to treatment. We perform regression analysis to remove effects of eligibility for treatment, firm location, industry, firm size and firm running age to focus on the dichotomy of firms less than five years old, or established firms. Results are exhibited in Table 3.

Table 3: Liquidity and leverage for startups versus established firms in 2011

	quick ratio	current ratio	leverage
Startup	-0.1310***	-0.1425***	0.0897***
	(0.0465)	(0.0474)	(0.0073)
Share of eligible CICE wages in 2011	-1.0573***	-1.0483***	0.0430***
	(0.2008)	(0.2182)	(0.0099)
Observations	352545	352545	352545
$R\hat{2}$	0.0110	0.0139	0.1704

Notes: Quick ratio = cash, cash equivalents, marketable securities, and accounts receivables / total current liabilities. Current ratio = current assets / current liabilities. Leverage = debt / assets. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. The variable "Share of wages eligible for CICE in 2011" was calculated applying the 2013 CICE rules to 2011 data. 2-digit NACE fixed effects, 5 city size indicators, log of firm hours, firm age, and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

In column 1, we show the cross-sectional correlations between short term liquidity, an indicator variable that a firm is a startup and other control variables. We use a log-linear regressions with the transformation $log(Y + 1_{f,t})$, where t is in 2011. Results are consistent with the hypothesis that startups are more financially constrained than established firms. Controlling for industry fixed effects and other variables, Column 1 of Table 3 shows that short term liquidity is lower in startups by 0.13 than in established firms. Given that the average quick ratio in the sample is 1.70, this represents a difference of 7.7% from the average. Startups in our sample have an average quick ratio of 1.37, while established firms have an average of 1.78. To support the interpretation that startups are more likely to be financially constrained than established firms we also present estimates for medium term liquidity as well as leverage in Columns 2 and 3. The measures show that startups are more illiquid also in the medium term (the current ratio) and have higher debt levels than established firms. The second row shows that firms with higher pre-treatment exposure to treatment are also more illiquid and more indebted.

Figure A3 in the Appendix shows the distribution of various financial indicators among startups and established firms. The graphs illustrate that startups have a worse financial position compared to established firms. Startups have lower liquidity, higher leverage, lower equity, almost none of the startups distribute any dividends, and they have lower accounts payable (lower trade credit from suppliers).

4.4 Econometric Specification

Since all French private firms are eligible for the tax credit one cannot create a control group of comparable non-eligible firms. We instead follow past practice (Gilles et al., 2018; Carbonnier et al., 2022) and compare firms that were treated with a pseudo-control group. The pseudo-control group represents those firms with a different level of eligible wages for credit than the treated firm. We estimate an intensity of intent-to-treat parameter represented by the share of wages that are below the eligibility cutoff of 2.5×SMIC as of 2013 that is, further, instrumented by the firm-level eligible wage share in 2011 constructed according to the CICE rules. The distribution of CICE exposure among startups and established firms is given in Figure A2 in the Appendix.

In our base regressions we use the difference-in-differences with first-differenced dependent variable methodology (popularized by e.g. Khandelwal et al., 2013). For each firm we take the first difference of the dependent variable between two consecutive years (2013-2012 and 2012-2011) and run a difference in differences regression. This controls for the possibility that treated and control firms have different linear growth paths prior to the treatment period (see e.g. Mora and Reggio, 2015).

One of the virtues of this methodology is that it controls for "typical" growth behavior differing between startups and established firms. For example, a finding in a regular difference-in-differences regression that treated firms react to a tax credit might be confounded with the effect of a particular firm characteristic that is not controlled for properly. The triple-diff methodology controls for whether there is an effect over and above any "regular" behavior exhibited in pre-treatment periods that is different. For example, perhaps startups grow faster in terms of employment than established firms on average. With a "triple difference" approach we are going to capture how sensitive firms are to the CICE reform in their growth path, and difference out standard firm-fixed effects in general (i.e. the initial productivity composition). Another virtue of this method is that for startups, it is difficult to observe a long enough pre-trend to establish visible parallel trends. Startups are by definition younger than five years. More than two-fifths of our sample are one and two years old. The pre-trend for these firms is meaningless, and the triple-diff instead allows

us to account for typical growth path differences between startups and established firms. In addition, we add different firm-level controls in the regression, permitting to control for separate growth rates for firms with different characteristics.

Our base regression, estimated by first differences is the following:

$$\Delta(Y_{f,t}) = \alpha + \beta_1 D_Startup + \beta_2 CICE_share + \beta_3 D_Startup \times CICE_share + \cdots \quad (8)$$
$$+\gamma Controls + \delta_s + \epsilon_{ft}$$

where Δ is the difference operator for the dependent variable between two time periods, $t = \{2013 - 2012, 2012 - 2011\}$, Y is the dependent variable at the firm level f, *D_Startup* is a variable indicating whether the firm is a startup, *CICE_share* is the share of the wage bill eligible for the CICE tax credit (a continuous variable between 0 and 1) as of 2012 and *D_Startup* $\times$ *CICE_share* is the interaction between being a startup and the intensity of treatment. Controls include various variables at the firm level including firm age and size in 2011. We also include 2-digit NACE sector level fixed effects δ_s. We cluster errors by sector and firm age.

A discussion of this methodology is in order, and we will use the example of investment growth. Coefficient interpretations are as follows. The estimate of α captures the overall (period) effect on the dependent variable, e.g. how investment grows between 2013-2012 in comparison to 2012-2011 for example due to macroeconomic effects. The coefficients β_1 and β_2 show the changes in investment growth among startups and firms eligible for the CICE tax credit, respectively. Our parameter of interest is β_3 which measures the reaction of the treated startups to the intensity of the CICE tax credit. The first differences estimator difference out firm fixed effects from the equation.[18] By including various controls and sector level fixed effects we allow firms with different characteristics to react differentially between the pre- and post-treatment periods. For example, δ_s captures any differential evolution of the dependent variable at the sectoral level, e.g. sectoral investment paths due to sectoral growth spurts. When these are included in our regressions, α is subsumed. None of these fixed effects are reported.

To alleviate concerns of endogeneity, specifically that the wage bill composition is adjusted to benefit from the reform, we instrument the post-reform tax credit exposure in

[18] As a reminder, for example the following should give equivalent results on the effect of CICE on the dependent variable: first differences estimate of $\Delta Y_{f,t} = a + bCICE_share + epsilon_{f,c,p,t}$ and OLS of $\Delta Y_{f,t} = \alpha + \beta_1 D_period + \beta_2 CICE_share + \beta_3 D_period \times CICE_share + \delta_f + \varepsilon_{f,c,p,t}$ where *D_period* is the treatment period indicator and δ_f is a firm fixed effect. In other words, asymptotically, $b = \beta_3$. The first specification is more efficient as it avoids thousands of fixed effects and permits also a more compact presentation of results.

2013 with the 2011 exposure, in line with the practice in the tax literature (Auten and Carroll, 1999). All results presented are with the instrumented tax credit exposure.[19]

We calculate various firm growth measures. Computing the growth for some quantities is associated with some challenges. Growth rates based on the difference in the natural logarithm of variables allow us to calculate growth rates for firms that have positive values of the studied variables – the intensive margin. But for many firms, and especially startups, some quantities are often zero (e.g. dividends, retained earnings), which complicates the analyses. A different option is to calculate the log of the value adding one so that the logarithms of zeros are defined, and then use the difference operator. This method, however, may introduce biased estimators, especially when quantities are close to zero, such as for various accounting fractions (see Bellégo et al., 2022). As an alternative, we therefore calculate growth rates as in Davis et al. (1996) [DHS]. The DHS measure allows us to capture growth in the studied quantities even if some items in one of the periods are zero. DHS growth rates are bounded between -2 and +2. Such growth rates jointly measure both the intensive and extensive margins of change. When presenting results we note when we use log-growth or DHS measures in the bottom of the Table. In the Appendix we present results with alternative specifications.

5 Results

5.1 Does the tax credit change the financial position of startups?

The first item to investigate is whether the CICE tax credit appears to have any impact on a firm's liquidity and financial position. As displayed in Table 4, higher exposure to tax credits implies stronger growth in liquidity for the established firms but not for the startups, as indicated by the coefficients in the first and second row in the first two columns. Note that these estimates are with DHS, and so may be only approximated with percentages. Fully exposed established firms grow their short term cash buffer by 0.7%, while the growth in the cash buffer for the average startups is 0.25% (0.0073-0.0045)*100, but it is not significantly different from zero. There is no effect of tax credit exposure on debt holdings. That is, the established firms seem to hoard the cash they obtain from CICE.

We next focus on the firms that are in the bottom quartile of the liquidity distribution pre-treatment. Regressions indicate that for the most illiquid startups, full tax credit exposure has a positive effect with 4.1% on the growth of liquidity compared to other less

[19] Strictly speaking, we instrument the value of $CICE_share$ and $D_startup \times CICE_share$ by their 2011 values. Non- instrumented regressions and first-stage regressions available upon request.

illiquid startups. The total effect compared to a non-exposed, less illiquid established firm is 1.7% ((0.0167-0.0401+0.0406)*100). The alternative measure of illiquidity, the current ratio, confirms these results. The debt position continues to be unaffected by the tax credit also for the most illiquid firms. Note that the regressions show that in the absence of the tax credit, the cash positions of the illiquid startups would deteriorate, given the slowdown in the economy. The tax credit allows these most illiquid startups to just barely keep up their liquidity position from before the slowdown. This is consistent with Almeida et al. (2004) who find that financially constrained firms appear to hoard cash and save more in recessions.

It appears that the tax credit slightly improves startups' liquidity position in comparison to established firms but only for those startups that are most illiquid. We will explore the reasons for these differences in depth in subsequent analysis. One preliminary interpretation of these results, which is consistent with our model as well as the model of for example Evans and Jovanovic (1989), is that most startups prefer to invest available cash, rather than to improve their financial position, because they are financially constrained in their operations and therefore have a high return on investment. However, for the most illiquid startups they might need to "weather the storm" and refill their cash position to avoid bankruptcy (Almeida et al., 2004). We next examine how the tax credit impacts investments.

5.2 Effects of the tax credit on investments in startups versus established firms

In Panel A of Table 5 we study the net investment rate.

In Panel A in Table 6 we investigate changes in log-growth rates of investment in tangible capital (plant, property and equipment, PPE) and the resulting log-growth rates of capital per worker due to the CICE reform. For ease of exposition, the effect of the CICE exposure is interpreted for a firm that is fully eligible, compared to one that is not eligible. In the triple-difference setting, coefficients are interpretable as differences in log-points, which will be approximately close to percentage points for changes that are small enough.

Column 1 shows that the tax credit exposure had no effect on average firm investments: the coefficient is 0.058, with a standard error of 0.045. This means that on average there is no discernible difference in the response between firms that are exposed to the CICE reform and those that are not.

In column 2 we add the distinction of whether a firm is a startup or not, and the interaction between startup status and the instrumented CICE exposure. Startups have lower investment trajectories than established firms in the studied period, roughly by 1/6 (15.5 log-points lower than established firms), but not significantly so. However, star-

Table 4: Impact of treatment exposure on liquidity and leverage growth

	Full sample			Lowest quartile in terms of quick ratio		
Change in:	quick ratio	current ratio	leverage ratio	quick ratio	current ratio	leverage ratio
CICE exposure (IV)	0.0070***	0.0052***	0.0085	0.0167**	0.0092	-0.0158
	(0.0017)	(0.0017)	(0.0053)	(0.0073)	(0.0073)	(0.0105)
D_Startup	-0.0045	-0.0024	0.0010	-0.0401***	-0.0366***	-0.0391*
	(0.0042)	(0.0033)	(0.0088)	(0.0120)	(0.0121)	(0.0231)
D_Startup × CICE exposure (IV)	0.0040	0.0004	-0.0110	0.0406***	0.0338***	0.0320
	(0.0052)	(0.0038)	(0.0100)	(0.0141)	(0.0128)	(0.0244)
Observations	350635	350668	323853	87577	87591	82823
KP statistic for underidentification	17.2	17.2	17.4	9.0	9.0	8.9
p-value of KP statistic	0.000	0.000	0.000	0.003	0.003	0.003
KP F statistic for weak identification	2105.4	2105.2	2305.8	1192.9	1195.8	1266.0
growth measure	DHS	DHS	DHS	DHS	DHS	DHS

Notes: Quick ratio = cash, cash equivalents, marketable securities, and accounts receivables / total current liabilities. Current ratio = current assets / current liabilities. Leverage = debt / assets. CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level. DHS values ranges from -0.5 to +0.5 and a coefficient can be approximated as a percentage.

tups that are fully tax credit exposed experience an increase in investment growth by 41.6 ((0.3804+0.0351)*100) log-points compared to startups that are not exposed, fully overshadowing the drawback to investment growth implied by being a startup. The overall increase in investment for startups that are fully tax exposed is 25.1 log-points compared to established firms not tax exposed (the sum of the coefficients on CICE exposure, startup dummy and the interaction term). This suggests that startups boosted their investment growth as a result of the CICE tax credit by $exp(0.26)$, or close to 30%. Including firms where investment was zero in one of the studied years[20] or normalizing investment by total assets does not quantitatively change these results (columns 1 and 3 of Table A1). Examining total investment, which includes investments in intangibles, also does not qualitatively change results (column 3). However, the regressions suggest that the tax credit mostly affects investments in hard capital (PPE).

In summary, there is a positive and substantial robust effect of the tax credit on growth of investment in young firms while there is no effect on growth of investment in the average

[20]More precisely, in this case we calculate the log-growth rates of (value of investment in euros + 1).

firm older than five years. Our results indicate that the CICE tax credit helped startups to weather weak economic conditions in the period 2012-2013, allowing eligible firms to increase their investment growth, outpacing investment growth in established firms.[21] Recall that this happens in an economic environment where startups have to curtail their investments.

A question that immediately arises is whether firms shift their production function along the margin of capital/labor ratio or not when they get access to the tax credit.

The tax credit is input factor neutral. No particular firm action either in terms of hiring or investment was directly targeted. We might therefore expect that firms would expand capital to labor neutrally if they operate on the efficiency frontier. However, if firms are capital constrained, then the result of increased access to cash would have a capital deepening effect.

This is precisely what is observed for startups, as documented in the last column of Table 6. The fully eligible startups shift up the growth of their capital-to-labor intensity by approximately 9.1% as a result of the tax credit. Further, the CICE tax credit more than compensates for the reduction in the capital to labor ratio that occurs for startups that are not tax eligible during the period of overall weak economic activity. For established firms, on the other hand, their capital to labor ratio increases slightly by 1.9%.

5.3 Effect of the tax credit on investments in financially constrained firms

We now explore the potential role of financial constraints in the investment response by startups and established firms. To this end, we use the three different financial indicators: short and medium term cash liquidity (quick and current ratios), and debt (leverage). In Panel B Table 6, we single out the firms in the lowest quartile of short term liquidity and rerun the regression specified for Panel A.[22]

First note that as in panel A describing the average startup vs the average established firm, the investment rate is lower for illiquid startups (-0.22 log points) than illiquid established firms, although the coefficient is not significant, the latter reflecting high variance among the startups in their investment response. The deceleration in investment occur both among startups and established firms and is a reflection of the impact of the weak economy

[21] As a benchmark, Curtis et al. (2021) and Giroud and Rauh (2019) estimate similar sized (small) effects for the average firm after their studied policy interventions, while Yagan (2015) and Goodman et al. (2021) estimate investment elasticities close to null for the average firm.

[22] Alternative regressions where we introduce a triple interaction between CICE exposure, the startup indicator, and the linear running variable of three alternate measures of financial constraint are presented in the Appendix.

in 2013, as discussed in the previous section reporting descriptive statistics.

Panel B then indicates that higher financial distress results in higher impact on investment growth for a euro spent on the tax credit. Liquidity constrained firms invest more the higher their tax credit exposure, independent of whether they are startups or established firms. The average growth in PPE investments is 32 log points for a fully exposed firm that is the lowest quartile of liquidity. Let us now look at the response for startups that are not in the lowest liquidity quartile. Startups that are fully tax credit exposed experience an increase in PPE investment growth by 71.6 (0.2871+0.4291)*100 log-points compared to startups that are not exposed. Startups also experience higher investment growth in total investment, although at a lower rate than PPE, and their capital deepening growth increases by 24.3 ((0.2183+0.0252)*100) log points compared to startups that are not exposed. Results are similar when using the current ratio as a measure of financial distress, while debt leverage indicates no significant reaction to the CICE tax credit exposure for the most indebted startup firms, although the overall response pattern is similar as for the other two measures of financial distress.[23]

In this subsection we conclude that the average eligible startup but not the average established firm react to the greater access to the tax credit by increasing capital investments. Both startups and established firms increase increase their capital to labor ratio as a response to the tax credit, but startups do so five times more. When examining reaction among financially distressed firms, both distressed startups and distressed established firms react stronger to the tax credit than non-distressed firms, but distressed startups react even more in PPE investments and in capital deepening. Without the tax credit the startups' investment growth would have significantly reduced.

5.4 Financing investment: how different financing channels react to the tax credit

There have been two traditional channels of startup financing investigated in the past: bank lending and retained earnings. The bank lending channel has been well established for startups (see for example Adelino et al., 2015; Schmalz et al., 2017; Kerr et al., 2022). The literature on the retained earnings channel has already been cited and discussed (see e.g. Fazzari et al., 1988).

It is possible that both bank lending will improve and retained earnings increase as the tax credit produces a cash injection. One mechanism could be that the default probability

[23]Results presented in the Appendix.

goes down, increasing bank lending. Another could be that taxes are reduced so the financial (but not economic) returns go up, increasing retained earnings. These increased sources of financing may then each in turn affect investments. However, given that the reform is a general tax credit there might also be other actors that respond to the cash injection and crowd in to finance investments. In particular, since Kerr et al. (2022) estimate the collateral channel to be just a tenth or less of entrepreneurial entry associated with house price increases, other channels than bank lending may be more important.

We explore the two traditional channels debt and retained earnings. We also examine less investigated, although plausible channels; increases in equity, accounts payable, and cuts to dividends. Given that retained earnings and dividends can be zero for many firms, we use the DHS growth measure across all our regressions in this table. Coefficients from this formula share some useful properties of log differences and can be interpreted directly as percentages if not too large. We use log points to describe effect sizes unless otherwise indicated.

Panel A of Table 7 shows the impact of tax credit exposure on several potential financing channels for startups and established firms, respectively. First, recall that the year 2013 involved weak economic conditions in the overall economy, with a meagre 0.7% growth of GDP, and negative growth in investments for both startups and established firms, but much more of a contraction for startups (see Table 2).

The tax exposure appears to have positively affected a number of financing channels. There is a positive impact of higher tax credit eligibility on retained earnings, debt growth, and equity growth, while dividends are reduced as a function of higher tax exposure for the average firm. Moving on to examine the startups, they shrink retained earnings, dividends, debt, equity, and trade credit during the period more than the established firm, all these retrenchments likely being a function of the slowdown in the economy affecting startup financing more harshly in a number of ways. Finally, examining how the tax credit exposure manifests itself for startups, the only significant effect is a shrinkage in dividends for higher tax exposed startups. That is, from the perspective of the typical startup, the tax credit seems not to have affected additional financing possibilities over and beyond the general positive impacts on debt, equity and retained earnings. However, there is a lower take-out of dividends in startups the greater the tax exposure, suggesting that inside shareholder choose to move dividends towards making investments instead.

We have previously documented large increases in investment in property, plants, and equipment for all firms but in particular for eligible startups, indicating that additional financing in startups may come from some channels that are complementary to the tax credit. But Panel A only revealed existing shareholders in startups reacting positively by curtail-

ing dividends the higher the tax credit exposure. We now investigate whether financially distressed startups may behave differently in raising external funds. Results are reported in Panel B.

Indeed, Panel B of Table 7 shows that in firms within the lowest quartile of liquididty, indicating firms the most likely to be financially distressed, there are three external financing channels that react positively to the increased tax exposure: debt creditors, equity holders, and trade creditors.

First, debt increases by 6.2 log points more in financially distressed firms that are fully exposed to the tax credit, compared to startups not exposed. Second, equity grows with about the same amount, 6.8 log points. Finally, accounts receivable also increases and the growth is 4.1 log points, all effects indistiguishable from each other, but all significantly different from zero. [24]

One potential explanation for the response by equity holders is that the tax credit might increase the returns from capital invested in illiquid startups at the margin, thus inducing equity holders to invest more in these firms. In other words, the tax credit allow for private capital to crowd in for illiquid startups as the tax burden is reduced. A potential explanation for the response by debt and trade creditors is that the risk of default is decreased with the tax credit liquidity infusion.

In sum, we find three important channels that illiquid startups use the tax credit for to boost investments. First, equity holders reduce their dividends and increase their equity. Second, suppliers provide more trade credit. Third, creditors provide more debt. The three channels seem to respond in about equal measures.

5.5 Firm growth and other related outcomes

We next investigate whether the reform has an impact on sales, hours worked, value added, labor productivity, and pre-tax profits. Results are given in Table 8. First, it should be noted that given the weak economic activity in the period, startups' growth pace declines in comparison to that of established firms in terms of hours worked, sales, value added and value-added per worker. However, it also appears that the growth in sales (column 3) increases for startups eligible for the tax credit in comparison to startups that cannot use the tax credit at all while average wages decline (column 1). Hours worked are not affected

[24] Notice also that the established firms that are in the lowest illiquidity quartile do not experience any changes in their additional financing. Since the mean firm does experience both a growth in debt and equity, as reported in Panel A, it must be that established firms with higher levels of liquidity are those that obtain additional financing from these channels.

by the tax subsidy (column 2), and neither is value added (column 4), nor labor productivity (column 5), or pre-tax profits (column 6).

However, when examining the financially distressed firms a somewhat more energetic response appears from the startups to the tax credit exposure. When we single out those firms that are in the lowest quartile of liquidity and present the same firm growth regressions in Panel B, sales, value added, and labor productivity all increase significantly with tax credit exposure. The sizes of the coefficients are remarkably large. Sales grows by 37.5%, value added expands by 41.1%, and productivity grows by 37.6% for illiquid fully exposed startups compared to non-exposed illiquid startups. All effects are statistically significantly different from zero. Note that in the absence of the tax credit exposure these firms would have had these outcomes reduced by about the same amounts.

Altogether, it appears that in the short run, and as a function of the tax credit, startups increase capital investments, deepen their capital, raise additional equity, debt, and trade credit, reduce dividends, and this is correlated with expanding startups, as observed from the analysis. Financially distressed startups invest even more, and raise even more outside debt, equity, and trade credit as a function of increased tax exposure, and, potentially as a result of these investments, they grow sales, value added and labor productivity by a large amount. It is comforting to note that the startups do not use the additional tax credit to share rents with incumbent workers, something that has been noted to happen in other settings (see e.g. Howell and Brown, 2022), and neither do they share rents with owners through increased profits. A number of alternate calculations of profit growth are provided in Appendix Table A5, none providing a different conclusion than that based on Table 8.

Table 5: Change in year-on-year in the gross and net investment rates in PPE

Panel A. Full sample results				
Change in:	Gross investment rate	Gross investment rate	Gross investment rate	Net investment rate
CICE exposure in 2013 (IV)	0.0040	-0.0007	0.0056	0.0020
	(0.0041)	(0.0046)	(0.0044)	(0.0048)
D_{Startup}		-0.1035***	-0.0940***	-0.1148***
		(0.0225)	(0.0225)	(0.0225)
$D_{\text{Startup}}\times$ CICE exposure in 2013 (IV)		0.0666***	0.0581**	0.0848***
		(0.0256)	(0.0247)	(0.0259)
Observations	343656	343656	343049	345387
KP statistic for underidentification	16.1	17.2	17.0	17.2
p-value of KP statistic	0.000	0.000	0.000	0.000
KP F statistic for weak identification	4823.2	2075.8	2056.2	2084.8
Controls				
2-digit NACE FE	x	x	x	x
Log-percentage distance to 4-digit NACE median PPE			x	
Panel B. Results for firms in lowest quartile in terms of the quick ratio in 2011				
Change in:	Gross investment rate	Gross investment rate	Gross investment rate	Net investment rate
CICE exposure in 2013 (IV)	0.0223*	0.0151	0.0237*	0.0051
	(0.0132)	(0.0113)	(0.0130)	(0.0125)
D_{Startup}		-0.1192***	-0.1081**	-0.1495**
		(0.0458)	(0.0458)	(0.0710)
$D_{\text{Startup}}\times$ CICE exposure in 2013 (IV)		0.0959*	0.0821	0.1403*
		(0.0502)	(0.0500)	(0.0769)
Observations	85,471	85,471	85,343	85,801
KP statistic for underidentification	7.9	9.2	9.1	9.5
p-value of KP statistic	0.005	0.002	0.003	0.002
KP F statistic for weak identification	3140.9	1057.5	1060.0	1041.6
Controls				
2-digit NACE FE	x	x	x	x
Log-percentage distance to 4-digit NACE median PPE			x	

Notes: The gross investment rate is the ratio of investment in year t and PPE in year $t-1$; net investment rate is the growth rate of PPE, CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age runnning variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table 6: Change in year-on-year log-growth in investment and capital per worker

Panel A. Full sample results				
Change in:	PPE	PPE	total investment	capital per worker
CICE exposure (IV)	0.0576	0.0351	0.0074	0.0189***
	(0.0446)	(0.0451)	(0.0417)	(0.0064)
D_Startup		-0.1555	-0.0182	-0.0659**
		(0.1101)	(0.1181)	(0.0311)
D_Startup × CICE exposure (IV)		0.3804***	0.2619*	0.0910**
		(0.1409)	(0.1427)	(0.0362)
Observations	237993	237993	261582	348034
KP statistic for underidentification	17.2	18.8	18.5	17.2
p-value of KP statistic	0.000	0.000	0.000	0.000
KP F statistic for weak identification	6717.1	2703.7	2544.1	2124.0
Growth measure	log-growth	log-growth	log-growth	log-growth
Panel B. Results for firms in lowest quartile in terms of the quick ratio in 2011				
Change in:	PPE	PPE	total investment	capital per worker
CICE exposure (IV)	0.3205***	0.2871**	0.1769**	0.0252
	(0.1233)	(0.1255)	(0.0809)	(0.0190)
D_Startup		-0.2196	0.1905	-0.1869*
		(0.2269)	(0.3728)	(0.1012)
D_Startup × CICE exposure (IV)		0.4291*	0.0640	0.2183**
		(0.2478)	(0.3953)	(0.1109)
Observations	54377	54377	60826	86463
KP statistic for underidentification	9.4	11.6	10.4	9.1
p-value of KP statistic	0.002	0.001	0.001	0.003
KP F statistic for weak identification	3143.8	1207.3	1212.2	1135.5
Growth measure	log-growth	log-growth	log-growth	log-growth

Notes: PPE is investments in Plant, Property and Equipment, CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age runnning variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table 7: Financing investment

Panel A. Full sample results					
Change in:	growth of retained earnings	growth of dividends	growth of debt	growth of equity	growth of accounts payable
CICE exposure (IV)	0.0031*	-0.1156***	0.0099**	0.0048***	0.0001
	(0.0016)	(0.0140)	(0.0048)	(0.0018)	(0.0026)
D_Startup	-0.0565***	-0.0326	-0.0035	-0.0151**	-0.0117
	(0.0104)	(0.0278)	(0.0092)	(0.0060)	(0.0074)
D_Startup × CICE exposure (IV)	-0.0161	-0.0825**	-0.0123	0.0082	0.0081
	(0.0113)	(0.0340)	(0.0107)	(0.0068)	(0.0083)
Observations	322201	120844	324505	305220	350637
KP statistic for underidentification	16.9	17.2	17.4	16.9	17.1
p-value of KP statistic	0.000	0.000	0.000	0.000	0.000
KP F statistic for weak identification	2258.9	2931.9	2314.3	2501.5	2132.1
growth measure	DHS	DHS	DHS	DHS	DHS
Panel B. Results for firms in lowest quartile in terms of the quick ratio in 2011					
Change in:	growth of retained earnings	growth of dividends	growth of debt	growth of equity	growth of accounts payable
CICE exposure (IV)	0.0070	-0.1295***	-0.0091	0.0041	0.0010
	(0.0051)	(0.0500)	(0.0108)	(0.0044)	(0.0056)
D_Startup	-0.0337	0.0041	-0.0718***	-0.0709***	-0.0385***
	(0.0289)	(0.0892)	(0.0242)	(0.0168)	(0.0140)
D_Startup × CICE exposure (IV)	-0.0449	-0.1023	0.0627**	0.0676***	0.0410***
	(0.0300)	(0.0956)	(0.0259)	(0.0173)	(0.0138)
Observations	71333	13272	83097	61407	87560
KP statistic for underidentification	8.8	7.1	8.9	7.4	9.0
p-value of KP statistic	0.003	0.008	0.003	0.006	0.003
KP F statistic for weak identification	1233.0	1803.5	1271.1	1857.5	1205.0
growth measure	DHS	DHS	DHS	DHS	DHS

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level. We use the DHS formula for computing growth to be able to include firms reporting zero in one year. DHS values ranges from -0.5 to +0.5 and a coefficient can be approximated as a percentage.

Table 8: Year-on-year log growth in other firm-level outcomes

Panel A. Full sample results						
Change in:	average wages	hours worked	sales	value added	value added per worker	before-tax profits
CICE exposure (IV)	-0.0330***	-0.0026	-0.0026	-0.0166**	-0.0136*	0.0688***
	(0.0052)	(0.0060)	(0.0067)	(0.0070)	(0.0077)	(0.0220)
D_Startup	0.0062	-0.0632***	-0.1306***	-0.1068***	-0.0504*	-0.0118
	(0.0062)	(0.0111)	(0.0274)	(0.0330)	(0.0301)	(0.0700)
D_Startup × CICE exposure (IV)	-0.0148**	0.0076	0.0521*	0.0129	0.0140	-0.0378
	(0.0070)	(0.0130)	(0.0291)	(0.0366)	(0.0324)	(0.0744)
Observations	352545	352545	350427	344955	344164	198337
KP statistic for underidentification	17.2	17.2	17.1	17.0	17.0	16.5
p-value of KP statistic	0.000	0.000	0.000	0.000	0.000	0.000
KP F statistic for weak identification	2083.7	2083.7	2092.2	1965.9	1987.1	2020.9
Panel B. Results for firms in lowest quartile in terms of the quick ratio in 2011						
Change in:	average wages	hours worked	sales	value added	value added per worker	before-tax profits
CICE exposure (IV)	-0.0421***	-0.0025	0.0496**	0.0091	0.0189	-0.0173
	(0.0071)	(0.0157)	(0.0212)	(0.0283)	(0.0241)	(0.0846)
D_Startup	-0.0043	-0.0991***	-0.4283***	-0.4286***	-0.3546***	-0.4739
	(0.0153)	(0.0360)	(0.1187)	(0.1509)	(0.1345)	(0.2936)
D_Startup × CICE exposure (IV)	-0.0035	0.0538	0.3749***	0.3441**	0.3192**	0.4507
	(0.0162)	(0.0380)	(0.1248)	(0.1601)	(0.1426)	(0.3163)
Observations	88137	88137	87502	85456	85098	37137
KP statistic for underidentification	9.1	9.1	9.0	9.5	9.4	8.1
p-value of KP statistic	0.003	0.003	0.003	0.002	0.002	0.004
KP F statistic for weak identification	1189.8	1189.8	1162.2	964.6	955.5	885.5
growth measure	log-growth	log-growth	log-growth	log-growth	log-growth	log-growth

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

5.6 Robustness analysis

5.6.1 An alternative treatment exposure indicator

The main instrument used in this article for causal identification is the pre-treatment tax credit eligibility, measured as the instrumented fraction of all wages in the firm that emanate from employees with a wage below 2.5 times the minimum wage "2.5 × SMIC". A potential critique may be that while pre-determined and instrumented, the allocation to treatment is not random, and that more exposed firms may differ qualitatively in unobservable ways to less exposed firms.

Since all French firms are eligible in principle, we cannot create a control group of non-exposed firms. An alternative identification approach is to examine the response to the tax credit by firms with varying levels of capital intensity across industries, as for example in (Hombert et al., 2020). As an alternative measure of treatment intensity we expect startups in industries with ex-ante higher capital intensity to be more affected by the reform. The simple intuition is that under financial constraints, startups in industries with higher capital intensity, and thus higher capital demands, are more likely to be financially constrained, affecting the speed of their capital accumulation. These firms will therefore react more to treatment and have faster investment growth. Following this intuition, we define industry treatment intensity as the tangible capital (PPE, as previously defined) per hour worked for the median firm out of established firms in each of the four-digit industry levels in the pretreatment period (2011).[25] Each firm from the same 4-digit industry gets this value assigned as its measure of capital intensity. We then rank firms in ascending order by such capital intensity and construct four quartiles of firms labelled Q1 to Q4, with Q4 capturing the most capital-intense firms. Each firm with the same intensity (that is, from the same industry) is assigned to the same quartile. Our identification strategy then simply involves comparing how capital investments changed from the pre- to the post-reform period depending on the treatment intensity quartile to which the firm belongs. The identifying assumption is that absent the reform, changes in log-growth of capital per worker in 2013 would not have been systematically related to our measure of treatment intensity.

Our results are shown in Table 9. Fully-exposed startups that are in the most capital intensive quartiles (Q4, column 4) have investment log-growth rates more than double that of zero-exposed young firms (exp(0.056+0.9051) or 160%) after the introduction of the policy which is more than four times as high an effect as for startups in the bottom quartile (Q1, exp(0.035+0.263) or 35%). It is notable that non-exposed startups in the most capital

[25] We use industries with at least 30 established firms.

intensive sectors have investment growth rates much lower relative to established firms than those in non-capital intensive sectors (even if the estimates are not statistically significant). Using this alternative identification strategy, we find results consistent with the measure that directly determines the size of the tax credit.

Table 9: Change in gross investment rate: by capital intensity in 2011 quartiles.

Change in gross investment rate in PPE	Q1	Q2	Q3	Q4
CICE exposure in 2013 (IV)	-0.0027	0.0006	0.0125	0.0013
	(0.0079)	(0.0105)	(0.0091)	(0.0129)
D_Startup	-0.0985***	-0.1263***	0.0450	-0.2093***
	(0.0314)	(0.0422)	(0.0597)	(0.0670)
D_Startup × CICE exposure in 2013 (IV)	0.0456	0.0770*	-0.0730	0.1970**
	(0.0362)	(0.0456)	(0.0608)	(0.0796)
Observations	84,953	85,339	85,194	84,384
KP statistic	12.2	6.5	7.1	10.5
p-value	0.000	0.011	0.008	0.001
KP F statistic	1490.6	656.2	538.0	510.4

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

5.7 Placebo test

The placebo test examines the response of startups and established firms to tax exposure in a year when the tax credit was not granted. We select the year before the actual implementation of CICE as the placebo treatment year and the year before that as the placebo pre-treatment year. In the main analysis we studied startups that were founded between 2008 and 2011. For the placebo analysis we create a completely new sample, consisting of startups founded between 2007 and 2010.

We re-run the exact same specification as before but for the period 2010-2012, where 2011-2012 is the placebo post-treatment period, and 2010-2011 is the placebo pre-treatment. The treatment effects of instrumented CICE exposure is then null on investment. Results are shown in Table 10.

Table 10: Placebo version of Table 5. Change in year-on-year in the gross and net investment rates in PPE, 2010-2012.

Change in:	Gross investment rate	Gross investment rate	Gross investment rate	Net investment rate
CICE exposure in 2012 (IV)	0.0098	0.0076	0.0159***	0.0006
	(0.0061)	(0.0056)	(0.0061)	(0.0065)
D_{Startup}		-0.0745***	-0.0641***	-0.1098***
		(0.0183)	(0.0186)	(0.0230)
$D_{\text{Startup}}\times$ CICE exposure in 2012 (IV)		0.0269	0.0176	0.0441
		(0.0273)	(0.0262)	(0.0333)
Observations	343679	343679	343004	340530
KP statistic for underidentification	16.1	17.5	17.3	17.5
p-value of KP statistic	0.000	0.000	0.000	0.000
KP F statistic for weak identification	3066.5	1322.8	1309.3	1329.1
Controls				
2-digit NACE FE	x	x	x	x
Log-percentage distance to 4-digit NACE median PPE			x	

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable, firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

6 Conclusion

The French general tax credit put in place in 2013 had no effect on the average firm in the most important respects; it did not increase employment, sales or investments. It cost at least 10 billion Euros in the first year. And our results indicate it might have decreased average wages, value added, and labor productivity, while increasing profits. As such, it might be counted as one of the more expensive yet wasteful French industrial policies. However, using a triple-difference quasi-experimental design, and measuring treatment effects in two separate ways, we find that for startups the subsidy increases investments, lead to greater capital deepening, and also causally positively affect their sales growth. The effects are notable. Startups that are fully tax credit exposed experience an increased investment growth by 46% and increased growth of sales by 5.3% compared to startups that are not exposed. The causal effects are even larger when we, in addition, zero in on startups that are financially distressed. Startups that are fully tax credit exposed and in the bottom quartile of firms in illiquidity experience an increased investment growth by 54%, and increased growth of sales by 45.5%, compared to startups that are not exposed.

We identify liquidity constraints as a plausible reason why startups and established firms react so differently; startups appear more liquidity constrained as indicated by a battery of accounting measures. We also identify two relatively understudied financing mechanisms that mean that the tax credit led to a crowding in of additional capital by the private sector. We find that existing shareholders curtail their dividends in the average startup when tax credits increase, but that there are no changes in debt or retained earnings for the average startup. However, for the most illiquid startups, owners plow in more equity, suppliers increase trade credit, and creditors extend more debt for those that are more eligible to obtain the tax credit.

A quick calculation based on eligible wages paid to obtain the credit show that 11.8 billion Euros in disbursements to established firms in 2013 could have been withheld without any negative effects on the economy in terms of reduced investment, employment, or output, or diminished state income in social security or VAT taxes. For the startup sector, the situation is different. First, the startup sector is much smaller, representing only approximately 7.5% of all firms in the economy or nearly 12% of all wages paid. The cost of the subsidy to startups is therefore estimated to only 0.4 billion Euros. There are immediate gains to the state in terms of added VAT taxes as the startups grow in sales with a CICE tax credit. VAT is typically 20% on sales, and sales growth was estimated to increase by approximately 5% year-on-year for fully exposed startups with the CICE credit. If we consider that firms' investments typically have a payback period of three years, the subsidy returns at least three

times more VAT tax over the next three year. An additional benefit of addressing the startup sector is that there are always new firms arriving each year that have been untreated in the year before and that are likely good candidates for the subsidy. As the startups grow, older firms are likely squeezed out. These dynamics are part and parcel of the creative destruction process identified by Joseph Schumpeter, and the source of industrial renewal and the provision of more innovative products and services.

Economists and policy makers often worry about unintended negative consequences of any industrial policy (see e.g. Lerner, 2009; Acs et al., 2016; Criscuolo et al., 2019). For example, there are policies which only apply to firms above a certain employment size. An unintended consequence of the laudable exception of not having to follow the full 3,000+ page French labor relations regulation for firms smaller than 50 employees is a constrained firm growth in France with a conspicuous bunching of firms maintaining only 49 employees (Garicano et al., 2016). The welfare loss of such well intended regulation are significant.

It is possible that there could be general welfare losses from constraining the tax credit to startups similar in character to those identified by (Garicano et al., 2016). But two facts may mitigate such welfare losses. First, firm age is not as firm size an endogenous choice by its owners. A firm cannot reverse the passage of time, and may therefore only qualify for a start-up subsidy for a limited time duration. Firms may of course try and game the system by reincorporating every fifth year to gain access to the (proposed) tax credit for startups in perpetuum. But such gaming is possible to observe at reincorporation by noting for example whether owners, location, and industry classification remain the same between the old and new firm. In fact, in this study we have eliminated such firms from the pool of startups and moved them over to the established firm group. Second, the alternative of making the tax credit generally available to all firms seems, in comparison, frightfully inefficient.

A second concern is that general tax credits are hard to trace and may be used for rent capture. Lerner (2009) describe a range of such examples and Howell and Brown (2022) estimate how SBIR grants are used to increase incumbent workers' salaries in startups. In order to avoid such rent capture the French tax credit had as its only stipulation that the tax credit can "neither finance an increase in the share of distributed profits, nor increase the remuneration of persons exercising managerial functions in the company". It appears that these conditions were successfully applied. We find no increase in average wages and no increases in dividends for startups that are more exposed to the tax credit.

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A Additional Tables and Figures

Table A1: Change in year-on-year log-growth in investment and PPE: additional measures.

Change in:	Log-growth of (investment in PPE+1)	Log-PPE growth	Log of investment / TA growth	investment growth
CICE exposure (IV)	0.0138	0.0195***	0.0335	-0.0017
	(0.0293)	(0.0048)	(0.0413)	(0.0056)
D_Startup	-0.1052	-0.1322***	-0.0622	-0.0030
	(0.0917)	(0.0306)	(0.1071)	(0.0156)
D_Startup × CICE exposure (IV)	0.3620***	0.0977***	0.3263**	0.0464***
	(0.1225)	(0.0341)	(0.1347)	(0.0174)
Observations	349441	348849	237937	314724
KP statistic for underidentification	17.2	17.2	18.8	17.8
p-value of KP statistic	0.000	0.000	0.000	0.000
KP F statistic for weak identification	2119.9	2106.8	2710.4	2248.0
Growth measure	log-growth	log-growth	log-growth	log-growth

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table A2: Year-on-year log-growth in investment based on financial constraint

Investment growth in PPE	quick ratio	current ratio	leverage
CICE exposure (IV)	0.094	0.150*	-0.330***
	(0.084)	(0.088)	(0.076)
D_Startup	-0.457**	-0.548**	0.319
	(0.188)	(0.214)	(0.295)
D_Startup × CICE exposure (IV)	0.712***	0.824***	-0.053
	(0.199)	(0.270)	(0.448)
Variable	-0.013	0.013	-0.358***
	(0.037)	(0.034)	(0.122)
D_startup × Variable	0.232**	0.240**	-0.551
	(0.100)	(0.115)	(0.429)
CICE exposure (IV) × Variable	-0.050	-0.067*	0.749***
	(0.044)	(0.040)	(0.149)
D_Startup × CICE exposure (IV) × Variable	-0.272**	-0.277*	0.430
	(0.116)	(0.153)	(0.612)
Observations	217186	216524	237993
KP statistic for underidentification	17.74	17.87	18.14
P-value of KP statistic	0.0000	0.0000	0.0000
KP F statistic for weak identification	863.6	988.4	1022.0

Notes: The outcome is log growth of investments in Plant, Property of Equipment. "Variable" is the measures of financial distress indicated in the top row of the column, i.e. quick ratio, current ratio, leverage. CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. Quick ratio = cash, cash equivalents, marketable securities, and accounts receivables / total current liabilities. Current ratio = current assets / current liabilities. Leverage = debt / assets. *D_Startup* is an indicator Variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level. All financial values calculated as of 2011.

Table A3: Financing investment: 1st quartile in terms of quick ratio in 2011

Change in:	growth of retained earnings	growth of dividends	growth of debt	growth of equity	growth of accounts payable
CICE exposure (IV)	0.0070	-0.1295***	-0.0091	0.0041	0.0010
	(0.0051)	(0.0500)	(0.0108)	(0.0044)	(0.0056)
D_Startup	-0.0337	0.0041	-0.0718***	-0.0709***	-0.0385***
	(0.0289)	(0.0892)	(0.0242)	(0.0168)	(0.0140)
D_Startup × CICE exposure (IV)	-0.0449	-0.1023	0.0627**	0.0676***	0.0410***
	(0.0300)	(0.0956)	(0.0259)	(0.0173)	(0.0138)
Observations	71333	13272	83097	61407	87560
KP statistic for underidentification	8.8	7.1	8.9	7.4	9.0
p-value of KP statistic	0.003	0.008	0.003	0.006	0.003
KP F statistic for weak identification	1233.0	1803.5	1271.1	1857.5	1205.0
growth measure	DHS	DHS	DHS	DHS	DHS

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table A4: Liquidity measures: firms with lowest quartile in terms of quick ratio in 2011

Change in:	leverage ratio growth	cash ratio growth	quick ratio growth	current ratio growth
CICE exposure (IV)	-0.0158	0.0015	0.0167**	0.0092
	(0.0105)	(0.0176)	(0.0073)	(0.0073)
D_Startup	-0.0391*	-0.0399	-0.0401***	-0.0366***
	(0.0231)	(0.0296)	(0.0120)	(0.0121)
D_Startup × CICE exposure (IV)	0.0320	0.0437	0.0406***	0.0338***
	(0.0244)	(0.0326)	(0.0141)	(0.0128)
Observations	82823	84708	87577	87591
KP statistic for underidentification	8.9	8.4	9.0	9.0
p-value of KP statistic	0.003	0.004	0.003	0.003
KP F statistic for weak identification	1266.0	1245.8	1192.9	1195.8
growth measure	DHS	DHS	DHS	DHS

Notes: Quick ratio = cash, cash equivalents, marketable securities, and accounts receivables / total current liabilities. Current ratio = current assets / current liabilities. Leverage = debt / assets. CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE, four separate city size fixed effects, log of firm size, firm age running variable and firm age squared included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table A5: CICE exposure and evolution of profit growth.

Change in:	growth of before-tax profits	growth of after-tax profits	log-growth of after-tax profits
CICE exposure (IV)	0.0108**	0.0236***	0.1346***
	(0.0043)	(0.0043)	(0.0268)
D_Startup	-0.0056	-0.0053	-0.0717
	(0.0126)	(0.0129)	(0.0785)
D_Startup × CICE exposure (IV)	-0.0036	-0.0034	0.0410
	(0.0136)	(0.0137)	(0.0877)
Log of firm hours in 2011	0.0038***	0.0077***	0.0367***
	(0.0014)	(0.0015)	(0.0080)
Firm age	0.0005***	0.0008***	0.0039***
	(0.0002)	(0.0001)	(0.0008)
(Firm age)^2	-0.000008**	-0.000012***	-0.000058***
	(0.000003)	(0.000003)	(0.000015)
Observations	198632	213510	213256
KP statistic for underidentification	16.5	16.6	16.6
p-value of KP statistic	0.000	0.000	0.000
KP F statistic for weak identification	2008.9	2339.1	2358.2
growth measure	DHS	DHS	log-growth

Notes: CICE exposure (IV) = Share of eligible 2013 CICE wages instrumented. *D_Startup* is an indicator variable = 1 if startup, else 0. ***, **, and * denote statistical significance at the 1 %, 5 %, and 10 % levels. 2-digit NACE and four separate city size fixed effects included. Errors clustered at the 2-digit sector and age (yearly cohorts) level.

Table A6: Sample statistics

variable	units	count	mean	std. dev.	5th percentile	median	95th percentile
D_startup	indicator	352545	0.075	0.263	0	0	1
Firm age	years	352545	16.11	12.61	2	13	44
Ln (hours worked)	ln of hours	352545	9.821	1	8.677	9.58	11.73
Paris	indicator	352545	0.213	0.409	0	0	1
Large city ¿ 0.5m	indicator	352545	0.158	0.365	0	0	1
Cities 0.2-0.5 m	indicator	352545	0.105	0.307	0	0	1
Cities 0.1-0.2 m	indicator	352545	0.054	0.227	0	0	1
Own equity	1,000 Euros	352545	3217	147040	-47.19	209.4	4351
Debt	1,000 Euros	352545	2502	155616	0	82.63	2104
Total assets	1,000 Euros	352545	11243	526767	162.4	871	15637
PPE + intangible + financial capital	1,000 Euros	352545	7181	443117	27.55	322.1	6511
PPE	1,000 Euros	352545	3235	191433	13.74	178.3	3684
Retained earnings	1,000 Euros	352545	748.2	28537	0	55.81	1520
Dividends	1,000 Euros	352545	267.2	14996	0	0	308.8
Profits	1,000 Euros	352545	328.2	22067	-108.1	31.66	632.2
Output	1,000 Euros	352545	4535	129594	0	594.7	9727
Sales	1,000 Euros	352545	7752	152452	267.5	1117	17926
Value added	1,000 Euros	352545	2020	42457	122.2	437.3	4550
Ln (PPE/hour worked)	ln of PPE/hours	352399	61	960.4	2.103	22.71	141.4
Leverage	ratio	352545	0.526	0.264	0.17	0.495	0.944
Cash ratio	ratio	352545	0.751	2.878	0.002	0.35	2.449
Quick ratio	ratio	352545	1.701	3.666	0.27	1.289	3.942
Current ratio	ratio	352545	2.082	3.761	0.485	1.615	4.576
Share of CICE eligible wage bill, 2011	ratio	352545	0.799	0.252	0.247	0.909	1
Share of CICE eligible wage bill, 2013	ratio	352545	0.805	0.247	0.262	0.915	1

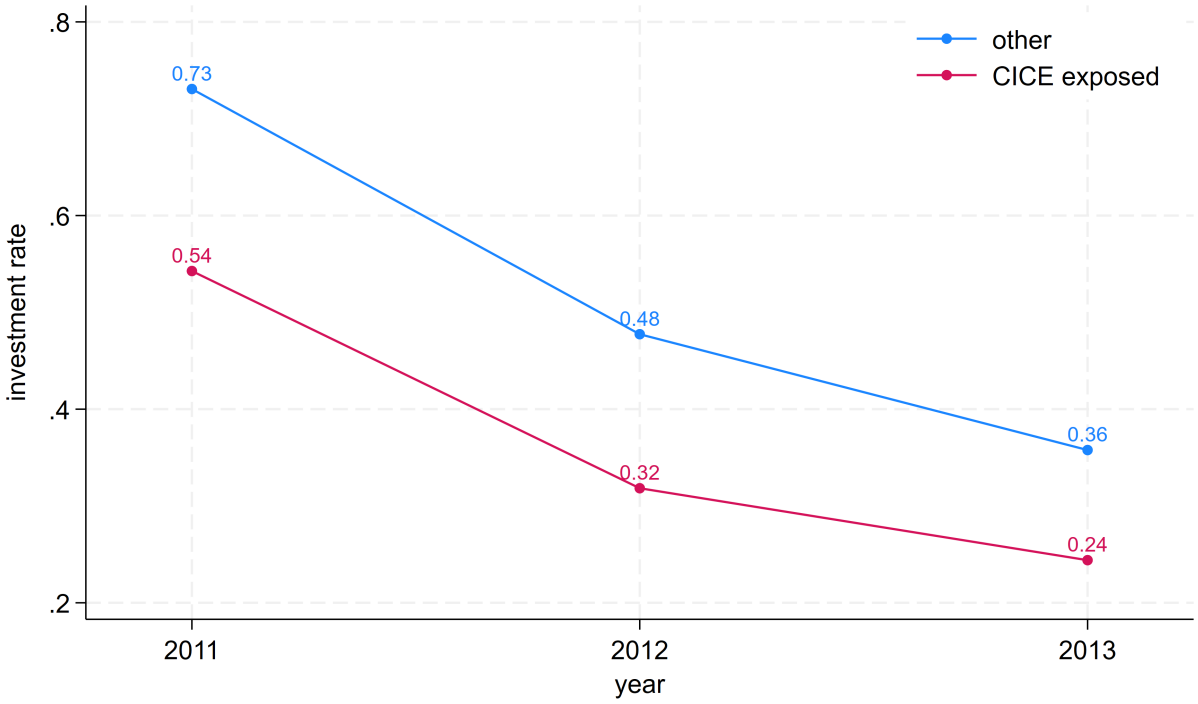
Table A7: Sample statistics of growth of variables, 2012

variable	count	mean	sd	5th percentile	median	95th percentile
gross investment rate	349816	440.6%	1645.2%	0%	5.1%	79.1%
log-growth of investment in PPE	268739	-12.4%	168.8%	-294.9%	-6.1%	266.5%
log-growth of total investment	288906	-14.5%	179.2%	-316.5%	-6.0%	277.4%
log-growth of capital per worker	351438	6.0%	37.2%	-31.8%	3.3%	50.4%
retained earnings growth	323862	2.9%	13.8%	-10.0%	-0.5%	36.0%
dividends growth	138657	1.7%	32.1%	-50.0%	-0.5%	50.0%
debt growth	330827	-0.6%	20.7%	-41.1%	-1.7%	45.1%
equity growth	314698	0.3%	9.7%	-15.6%	0.5%	14.1%
accounts payable growth	351640	-0.1%	12.2%	-19.7%	-0.5%	20.1%
cash ratio growth	345757	-1.8%	21.0%	-42.4%	-0.5%	37.5%
quick ratio growth	351899	-0.4%	8.5%	-14.4%	0.0%	12.4%
current ratio growth	351924	-0.2%	7.2%	-11.8%	0.0%	10.5%
log-growth of average wages	352545	2.0%	9.1%	-11.7%	2.1%	15.2%
log-growth of hours worked	352545	2.5%	19.8%	-23.3%	0.9%	32.2%
log-growth of sales	351636	1.3%	32.1%	-28.7%	-1.1%	34.1%
log-growth of value added	347580	-0.3%	35.0%	-39.1%	-1.4%	39.3%
log-growth of labor productivity	347404	-0.6%	33.0%	-39.5%	-0.5%	35.7%
log-growth of before tax profits	229108	-13.9%	111.0%	-194.9%	-6.0%	151.2%
leverage growth	351955	-0.5%	5.3%	-7.9%	-0.6%	8.1%

Table A8: Sample statistics of growth of variables, 2013

variable	count	mean	sd	5th percentile	median	95th percentile
gross investment rate	348864	32.3%	3485%	0%	4.1%	62.0%
log-growth of investment in PPE	257800	-11.1%	164.4%	-287.0%	-4.3%	264.5%
log-growth of total investment	278742	-11.9%	172.5%	-301.4%	-4.4%	276.2%
log-growth of capital per worker	348113	5.9%	34.3%	-29.0%	3.8%	47.8%
retained earnings growth	326162	2.1%	12.2%	-10.1%	-0.2%	23.0%
dividends growth	131291	-11.1%	33.3%	-50.0%	-5.8%	50.0%
debt growth	329585	-1.7%	20.3%	-42.8%	-2.1%	42.4%
equity growth	310340	1.4%	9.5%	-13.6%	1.4%	15.0%
accounts payable growth	350773	-0.1%	12.1%	-19.7%	-0.2%	19.5%
cash ratio growth	343480	-0.6%	21.0%	-41.0%	0.0%	39.4%
quick ratio growth	350651	0.7%	8.6%	-12.6%	0.3%	13.9%
current ratio growth	350683	0.5%	7.4%	-10.8%	0.2%	11.4%
log-growth of average wages	352545	1.7%	9.0%	-11.7%	1.8%	14.9%
log-growth of hours worked	352545	-1.2%	19.5%	-28.6%	-0.3%	24.5%
log-growth of sales	350594	-1.4%	25.3%	-31.1%	-0.9%	27.5%
log-growth of value added	346430	-2.2%	32.4%	-42.1%	-0.8%	34.1%
log-growth of labor productivity	345697	-0.4%	31.9%	-38.8%	0.1%	36.6%
log-growth of before tax profits	218932	1.0%	116.5%	-174.8%	0.2%	176.0%
leverage growth	350794	-0.8%	5.5%	-8.5%	-0.8%	7.7%

Figure A1: The investment rate for startups that are most exposed to the CICE reform > 25 percentile and others.



A.1 Pretrends for startups between 3-5 years as of 2013

Nearly 75% of startups in our sample are fully exposed to the CICE reform while the rest are somewhat exposed (see Table XXX). With continuous treatment, we need thus to make an arbitrary choice on grouping them into two bins to show how the behave in before the CICE-reform. Moreover, as we look at changes in investment rates, we can include only startups that are between 3-5 years old as of 2013. Startups more exposed (> 25 percentile) to the CICE-reform in 2013 do not show differential investment rate changes between 2012 and 2011 than those that are less exposed, but there is a different outcome between groups that appears in 2013.

A.2 Macroeconomic developments around the studied years

In Table A9 we show the yearly GDP, GFCF (fixed asset acquisitions for production processes minus disposals by resident producers, an aggregate measure of private PPE investment by firms) and bank credit to the private firm sector aggregate growth to give the overview of the economic conditions in the studied period.

There was a marked slowdown of GDP growth in 2012 and 2013 in comparison to

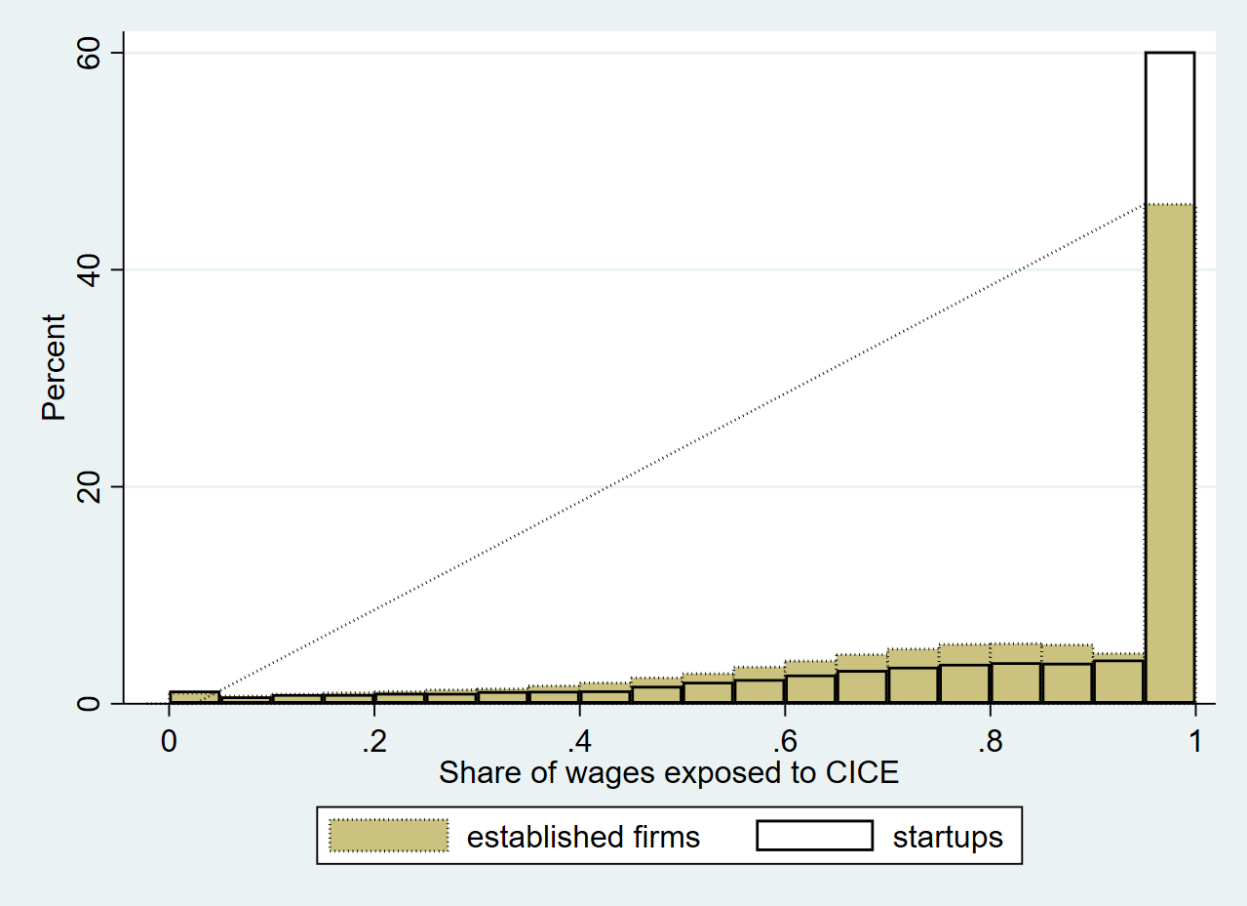
the previous years associated with broader developments in the euro zone area related to the Euro crisis and the European Central Bank monetary policy after the Great Recession. GFCF fell in 2013 in comparison with 2012 by -0.5%. The growth of bank credit was also slowest in 2013 (0.7%). The first year when CICE was operational (2013) thus was in a period of relatively weak economic conditions that would typically most strongly reverberate negatively on startups.

Table A9: Year on year growth of macroeconomic aggregates

Year	Real GDP	Real Gross Fixed Capital Formation	Total Credit to Non-Financial Corporations
2010	1.8	1.8	0.8
2011	2.2	2.2	5.9
2012	0.4	0.2	6.6
2013	0.7	-0.5	0.7
2014	1.0	0.1	4.0
2015	1.0	0.9	6.1
note	seasonally adjusted	seasonally adjusted	not seasonally adjusted

Figure A2: Distribution of the share of wages to CICE exposure in 2013 for startups and non-startups

h!



A.3 Proofs

In this sections we show the proofs from Section 2.

Denote eq. (4) and (5) respectively F^1 and F^2.
The Jacobian determinant is
$|J| = \begin{vmatrix} \frac{\partial F^1}{\partial e^*} & \frac{\partial F^1}{\partial b^*} \\ \frac{\partial F^2}{\partial e^*} & \frac{\partial F^2}{\partial b^*} \end{vmatrix} = \left[p(e^*)q'(e^*) + q(e^*)p'(e^*) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right]\frac{f''(k+b^*)}{f'(k+b^*)}$. $|J| \neq 0$ if $f'' \neq 0$ and $\left[p(e^*)q'(e^*) + q(e^*)p'(e^*) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right] \neq 0$. With $f' < 0$; $p'(e) > 0$ and $q'(e) > 0$ as assumed, $\left[p(e^*)q'(e^*) + q(e^*)p'(e^*) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right] > 0$.
Then

$$\begin{bmatrix} -\frac{\partial F^1}{\partial k} \\ -\frac{\partial F^2}{\partial k} \end{bmatrix} = \begin{bmatrix} -\frac{f''(k+b^*)}{A(f'(k+b^*))^2} \\ -A(1-t)(f'(k+b^*) - bf''(k+b^*)) \end{bmatrix}.$$

$$\begin{aligned} |J_1| &= \begin{vmatrix} -\frac{f''(k+b^*)}{A(f'(k+b^*))^2} & \frac{1}{A}\frac{f''(k+b^*)}{(f'(k+b^*))^2} \\ -A(1-t)(f'(k+b^*) - bf''(k+b^*)) & -(1-t)Ab^*f''(k+b^*) \end{vmatrix} \\ &= \frac{f''(k+b^*)}{(f'(k+b^*))^2}(1-t)b^*f''(k+b^*) + \frac{f''(k+b^*)}{(f'(k+b^*))^2}(1-t)(f'(k+b^*) - bf''(k+b^*)) \\ &= (1-t)\frac{f''(k+b^*)}{f'(k+b^*)} \end{aligned}$$

and therefore

$$\begin{aligned} \frac{\partial e^*}{\partial k} &= \frac{|J_1|}{|J|} \\ &= \frac{(1-t)}{\left[p(e^*)q'(e^*) + q(e^*)p'(e^*) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right]} \\ &> 0. \end{aligned}$$

Since

$$\begin{aligned} |J_2| &= \begin{vmatrix} p'(e^*) & -\frac{f''(k+b^*)}{A(f'(k+b^*))^2} \\ -q'(e^*) & -A(1-t)(f'(k+b^*) - bf''(k+b^*)) \end{vmatrix} \\ &= -(1-t)\frac{p'(e^*)}{p(e^*)} - \frac{f''(k+b^*)}{f'(k+b^*)}\left(p'(e^*)q(e^*) + p(e^*)q'(e^*) - (1-t)\frac{p'(e^*)}{p(e)}\frac{f(k+b^*)}{f'(k+b^*)}\right) \end{aligned}$$

$$\begin{aligned}
\frac{\partial b^*}{\partial k} &= \frac{|J_2|}{|J|} \\
&= \frac{-\left(1-t\right)\frac{p'(e^*)}{p(e^*)} - \frac{f''(k+b^*)}{f'(k+b^*)}\left(p'\left(e^*\right)q\left(e^*\right) + p\left(e^*\right)q'\left(e^*\right) - \left(1-t\right)\frac{p'(e^*)}{p(e)}\frac{f(k+b^*)}{f'(k+b^*)}\right)}{\left[p\left(e^*\right)q'\left(e^*\right) + q\left(e^*\right)p'\left(e^*\right) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right]\frac{f''(k+b^*)}{f'(k+b^*)}} \\
&\simeq -\frac{\frac{p'(e^*)}{p(e^*)}}{\frac{f''(k+b^*)}{f'(k+b^*)}}\frac{\partial e^*}{\partial k} - 1 \\
&= -\frac{p'\left(e^*\right)}{p\left(e^*\right)}\frac{f'\left(k+b^*\right)}{f''\left(k+b^*\right)}\frac{\partial e^*}{\partial k} - 1 \\
&\geq -1
\end{aligned}$$

If $p'\left(e^*\right) = 0$ then $\frac{\partial b^*}{\partial k} = -\frac{\frac{f''(k+b^*)}{f'(k+b^*)}p(e^*)q'(e^*)}{[p(e^*)q'(e^*)]\frac{f''(k+b^*)}{f'(k+b^*)}} = -1$: the firm is operating at the optimal capital level, it doesn't need more funding.

To determine $-\frac{\partial e^*}{\partial t}$ and $-\frac{\partial b^*}{\partial t}$ we need

$$\begin{bmatrix} -\frac{\partial F^1}{\partial t} \\ -\frac{\partial F^2}{\partial t} \end{bmatrix} = \begin{bmatrix} 0 \\ A\left(f\left(k+b\right) - bf'\left(k+b^*\right)\right) \end{bmatrix}$$

We redefine $|J_1|$ and $|J_2|$

$$\begin{aligned}
|J_1| &= \begin{vmatrix} 0 & \frac{1}{A}\frac{f''(k+b^*)}{(f'(k+b^*))^2} \\ A\left(f\left(k+b\right) - bf'\left(k+b^*\right)\right) & -\left(1-t\right)Ab^*f''\left(k+b^*\right) \end{vmatrix} \\
&= -\frac{f''\left(k+b^*\right)}{f'\left(k+b^*\right)}\left(\frac{f\left(k+b\right)}{f'\left(k+b^*\right)} - b\right) \\
&> 0
\end{aligned}$$

$$\begin{aligned}
\frac{\partial e^*}{\partial t} &= \frac{|J_1|}{|J|} \\
&= -\frac{\left(\frac{f(k+b)}{f'(k+b^*)} - b\right)}{\left[p\left(e^*\right)q'\left(e^*\right) + q\left(e^*\right)p'\left(e^*\right) - \frac{f(k+b)}{f'(k+b)}\frac{p'(e^*)}{p(e^*)}\right]} \\
&< 0
\end{aligned}$$

because $\left(\frac{f(k+b)}{f'(k+b^*)} - b\right) > 0$ as $f\left(k+b\right) > bf'\left(k+b^*\right)$.

$$\begin{aligned} |J_2| &= \begin{vmatrix} p'(e^*) & 0 \\ -q'(e^*) & A(f(k+b) - bf'(k+b^*)) \end{vmatrix} \\ &= p'(e^*) A(f(k+b) - bf'(k+b^*)) \end{aligned}$$

$$\begin{aligned} \frac{\partial b^*}{\partial t} &= \frac{|J_2|}{|J|} = \frac{p'(e^*) A(f(k+b) - bf'(k+b^*))}{\left[p(e^*) q'(e^*) + q(e^*) p'(e^*) - \frac{f(k+b)}{f'(k+b)} \frac{p'(e^*)}{p(e^*)}\right] \frac{f''(k+b^*)}{f'(k+b^*)}} \\ &< 0 \end{aligned}$$

because $f''(k+b^*) < 0$.
Total investment as a function of tax: $\frac{\partial(k+b^*)}{\partial t} = \frac{\partial b^*}{\partial t} < 0$.
Since $\frac{\partial b^*}{\partial k} \geq -1$ then $\frac{\partial(k+b^*)}{\partial k} = 1 + \frac{\partial b^*}{\partial k} \geq 0$.
Change in sales $p(e) Af(k+b)$ as a function of a change in tax:

$$\begin{aligned} \frac{\partial [p(e) Af(k+b)]}{\partial t} &= Af(k+b) \frac{\partial}{\partial t} p(e) + p(e) A \frac{\partial}{\partial t} f(k+b) \\ &< 0. \end{aligned}$$

A.4 Equity financing version of the base model

We consider now an alternative case where additional capital b is provided by investors that obtain some promised dividends r paid out from after-tax profits when the project is successful. The rate of return r is announced to the entrepreneur prior to her effort e and level of equity b choices so that in expectations investors obtain R_f on invested capital. This means $r = \frac{R_f}{p(e^*)}$.

The objective function of the entrepreneur is then to choose the effort level e and borrowing b to maximize the following utility

$$\max_{e,b} p(e) ((1-t) Af(k+b) - rb) - \psi(e) \tag{9}$$

The first order conditions of the maximization problem (9) are:

$$(1-t) Af'(k+b^*) = r \tag{10}$$

and

$$p'(e^*) ((1-t) Af(k+b^*) - rb^*) = \psi'(e^*) \tag{11}$$

From (10) we get, since $r = \frac{R_f}{p(e^*)}$

$$p(e^*) - \frac{R_f}{(1-t)\,Af'(k+b)} = 0 \tag{12}$$

while from (11)

$$p'(e^*)(1-t)\,A\,(f(k+b) - f'(k+b)\,b) = \psi'(e^*)$$

Normalize $R_f = 1$ and set $q(e) = \frac{\psi'(e^*)}{p'(e^*)}$ where $q'(e) > 0$ and $q''(e) > 0$.

$$(1-t)\,A\,(f(k+b) - f'(k+b)\,b) - q(e^*) = 0$$

Solving, we can arrive at a system of two equations that, as for the debt financing case, implicitly define optimal e^* and b^*

$$p(e^*) - \frac{1}{(1-t)\,Af'(k+b^*)} = 0 \tag{13}$$

$$(1-t)\,A\,(f(k+b^*) - bf'(k+b^*)) - q(e^*) = 0 \tag{14}$$

In comparison to the debt financing case presented in Section 2.3, equation (4), there is only a difference in the first equation. This is because in contrast to equity financing, debt offers a tax shield and does not lead to a distortion in the optimal choice of borrowing b given the level of effort e. The comparative static results remain qualitatively similar as in the debt financing case (available upon request).

A.5 Specialized version of the model

In this section, we present a specialized version of the model that allows for closed form solutions and deriving conditions on more quantities that can give intuition when we approach data.

Let $R_f = 1, Af(z) = z^\alpha$ with $\alpha = \frac{1}{2}, A = 2, p(e) = e$, $\psi(e) = \frac{3}{4}e^2$ and $t \to 0$. We solve the problem for $t > 0$ & $k > 0$ small enough to guarantee interior solutions.

The entrepreneur' problem is

$$\max_{e,b} e\,(1-t)\left(2\,(k+b)^{\frac{1}{2}} - rb\right) - \frac{3}{4}e^2 \tag{15}$$

A.5.1 Solution

The first-order conditions are, respectively, wrt e

$$(1-t)\left(2\left(k+b\right)^{\frac{1}{2}}-rb\right)=\frac{3}{2}e$$

and wrt b

$$\left(k+b\right)^{-\frac{1}{2}}=r$$

which, after solving, substituting for external funder break-even condition $r\left(\cdot\right)=\frac{R_f}{e^*}$ and rearranging gives

$$e^*=\left(k+b^*\right)^{\frac{1}{2}} \tag{16}$$

$$b^*=\frac{\left(2\left(1-t\right)-\frac{3}{2}\right)}{\left(1-t\right)}\left(e^*\right)^2 \tag{17}$$

All these relationships yield:

$$b^*=\frac{\frac{1}{2}-2t}{\frac{1}{2}+t}k \tag{18}$$

$$e^*=\left(\frac{1-t}{\frac{1}{2}+t}k\right)^{\frac{1}{2}} \tag{19}$$

Capital invested in production is $k+b^*=\frac{1-t}{\frac{1}{2}+t}k$. Note that with $t=0$ then $b^*=k$ and $e^*=\left(2k\right)^{\frac{1}{2}}$ and $k+b^*=2k$.

A.5.2 Discussion

The interior solution is valid if $\frac{1-t}{\frac{1}{2}+t}k<1$ (so that $p\left(e^*\right)=e^*<1$) or if $k<\frac{\frac{1}{2}+t}{1-t}\equiv k_{opt}$. There needs to be a condition also on t (it cannot be too high) given our parameters so that e,b are well behaved: $\left(1-t\right)>\frac{3}{4}>\frac{1}{2}\left(1-t\right)$. The one that is binding in $t\in[0,1]$ is the first inequality, and we require $t<\frac{1}{4}$.

Both the effort exerted e^* and borrowing b^* increase with the capital k on hand while r is decreasing as long as $k<\frac{\frac{1}{2}+t}{1-t}\equiv k_{opt}$. A measure of leverage $\frac{b}{k}=\frac{\frac{1}{2}-2t}{\frac{1}{2}+t}$ is constant.

For $k>k_{opt}$ the problem needs to be rewritten with a constraint that $p\left(e\right)\leq 1$ or $e^*\leq 1$ that will be binding as we have $e^*=1,r=R_f=1$ in this case. There is an optimal level of production capital $k+b^*=1$. As a result, k increases beyond k_{opt}, b^* declines until it is zero, $b=1-k$. As a result, the leverage $\frac{b}{k}$ declines with k for $k\geq k_{opt}$.

A.5.3 Modeling CICE.

CICE is an unexpected fall in the tax $\Delta t<0$. For an entrepreneur with $k<k_{opt}$: the project becomes more profitable relative to the exerted effort. As a consequence for a given

level of k the entrepreneur puts in more effort, and they also wants to invest more which leads both to more borrowing: $-\frac{\partial e^*}{\partial t}\frac{t}{e^*} = \frac{3t}{4(1-t)\left(\frac{1}{2}+t\right)} > 0$; $-\frac{\partial b^*}{\partial t}\frac{t}{b^*} = \frac{3t}{2\left(\frac{1}{2}+t\right)\left(\frac{1}{2}-2t\right)} > 0$ and $-\frac{\partial (k+b^*)}{\partial t}\frac{t}{(k+b^*)} = \frac{3t}{2\left(\frac{1}{2}+t\right)(1-t)} > 0$.

CICE could be prefinanced — so a firm can get part of the tax early. As a result, an entrepreneur can get immediately $-\Delta t p A\left(k+b\right)^{\alpha}$ and add that to their capital (liquidity) k on hand, increasing investment directly (more capital on hand) and indirectly (via more borrowing because of increased effort and lower interest rates). Such a prefinancement would not matter for CICE-eligible established firms as they can already obtain the optimal level of investment.

A.5.4 Effects of CICE on other variables

We now consider the effects of the CICE policy for constrained firms (with low levels of capital when the entrepreneur optimally exerts effort below $e^{star} < 1$)

Expected sales. Let expected sales $S = 2e\left(k+b^*\right)^{\frac{1}{2}}$. The elasticity of sales with respect to CICE is $-\frac{\partial\left[2e(k+b^*)^{\frac{1}{2}}\right]}{\partial t}\frac{t}{2e(k+b^*)^{\frac{1}{2}}} = \frac{3t}{2\left(\frac{1}{2}+t\right)^2(1-t)} > 0$.

Adding labor. Suppose the entrepreneur provides also some fixed number of hours so that the entrepreneurs objective is

$$e\left(1-t\right)\left(2\left(k+b\right)^{\frac{1}{2}}h^{\frac{1}{2}} - rb\right) - \frac{3}{4}e^2$$

but with $\overline{h} = 1$ it is as problem (15). Then labor productivity

$$\frac{Y}{h} = 2e\left(k+b\right)^{\frac{1}{2}} = S$$

and comoves exactly as sales.

Accounts receivable. We modify the entrepreneurs' problem to introduce the notion that some capital c needs to be set aside to finance trade credit to buyers. Let the sales if the project is successful be $A\left(k+b-c\right)^{\frac{1}{4}}\left(c\right)^{\frac{1}{4}}$ while production $A\left(k+b-c\right)^{\frac{1}{4}}$. We modify the effort function to obtain closed form solutions to $\psi\left(e\right) = \frac{3}{8}e^2$. The objective becomes now

$$\max_{e,b,c} e\left(1-t\right)\left(2\left(k+b-c\right)^{\frac{1}{4}}\left(c\right)^{\frac{1}{4}} - rb\right) - \frac{3}{8}e^2 \tag{20}$$

The first order conditions yield $c^* = \frac{k+b^*}{2} = \left(\frac{1-t}{t+\frac{1}{2}}\right)\frac{k}{2}$, $b^* = 2\left(\frac{(1-t)-\frac{3}{4}}{t+\frac{1}{2}}\right)k$ and $e^* = \left(2k\left(\frac{1-t}{t+\frac{1}{2}}\right)\right)^{\frac{1}{2}}$. Given that $(k+b^*)$ is decreasing in an interior solution with t, $-\frac{\partial c^*}{\partial t} > 0$. Accounts receivable should increase with the introduction of CICE.

Figure A3: Distribution of different financial quantities among startups and non-startups in 2011

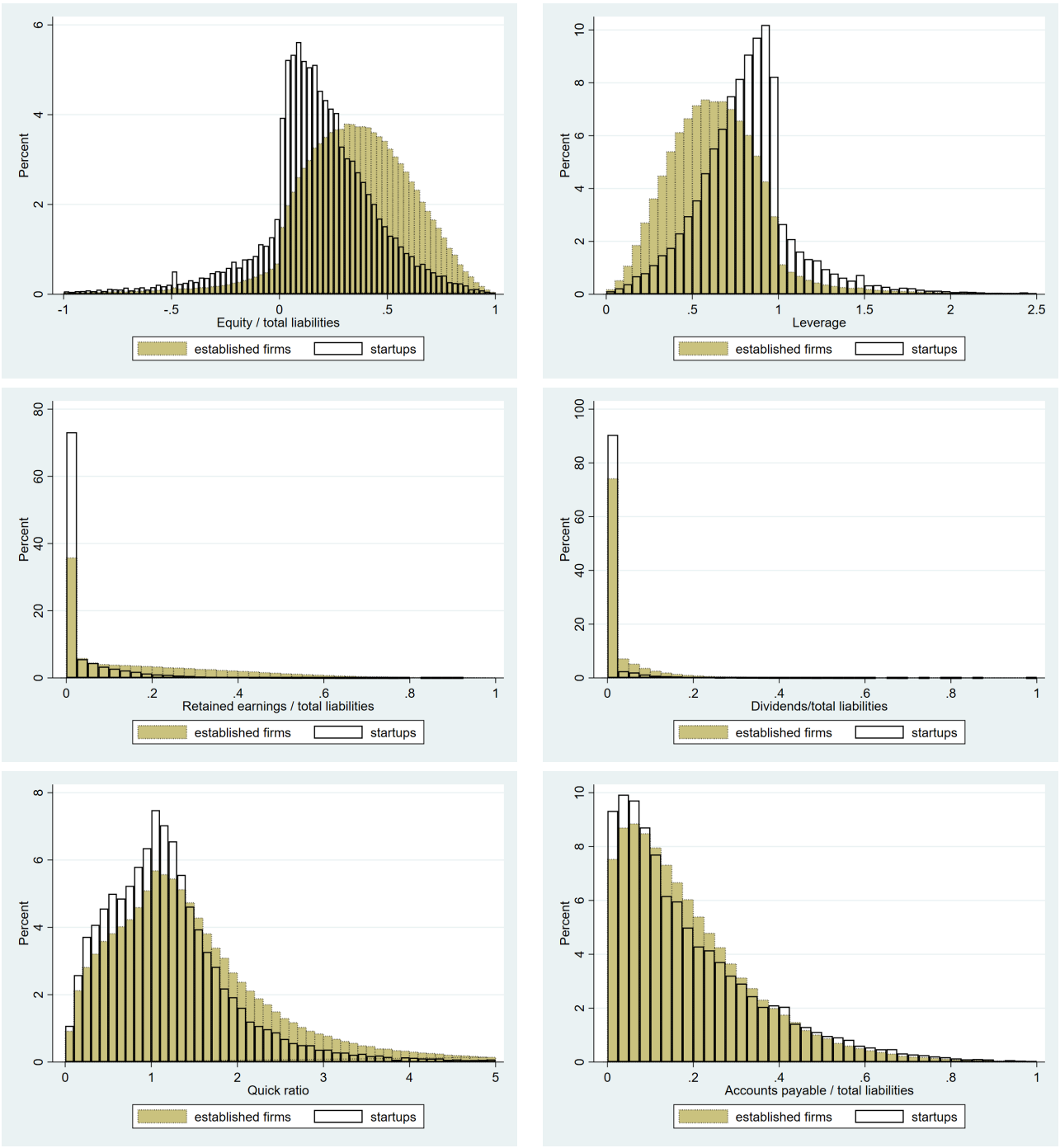
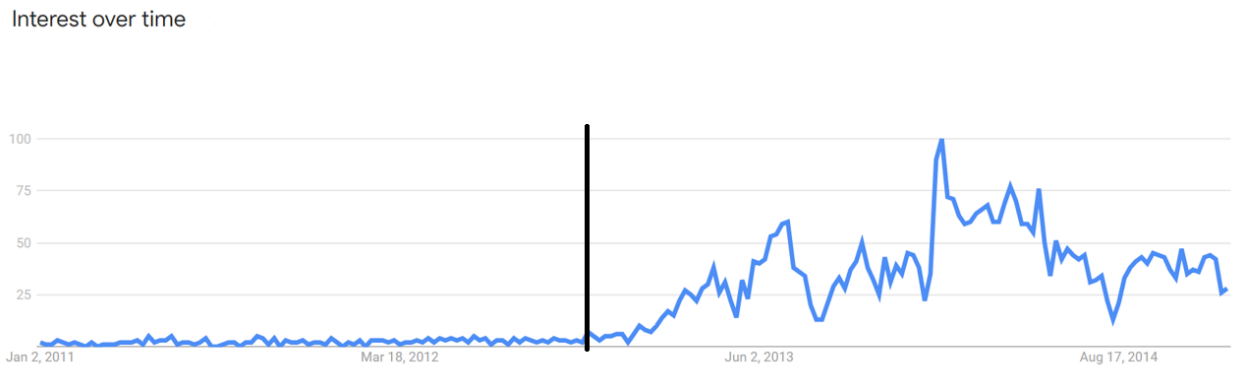


Figure A4: Intensity of searches of "CICE" on Google Trends



Notes: Index scaled to 100 equal to the maximum search intensity within the exhibited period. Black line signifies Nov 6, 2012 when the CICE reform was announced. Worldwide, the acronym "CICE" has several other different references than the tax credit policy, particularly to the Los Alamos Sea Ice Model that is being developed since middle of 1990s. The increase in search intensity for the term after November 6, 2012 is predominantly driven by French resident IPs.