International Tax and Public Finance (2022) 29:1321–1347
https://doi.org/10.1007/s10797-022-09746-w

POLICY WATCH

How well-targeted are payroll tax cuts as a response to COVID-19? evidence from China

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Accepted: 16 June 2022 / Published online: 5 August 2022

Abstract

Numerous countries cut payroll taxes in response to COVID-19, including China, which reduced employer contributions by up to 21 percentage points. We use administrative data on more than 800,000 Chinese firms to evaluate payroll tax cuts as a business relief measure. We estimate that the tax cuts cover 31.5% of the decline in business cash flow, but labor informality causes 53% of registered firms-24% of aggregate economic activity-to receive no benefits at all. We quantify the targeting of the policy in terms of how much benefits flow to small firms less able to access external finance and to sectors worse hit by COVID-19. We find that (1) small firms and vulnerable industries are comparatively more labor intensive, which leads to desirable targeting; (2) labor informality worsens, but does not eliminate, targeting by firm size; and (3) labor informality is uncorrelated with the COVID-19 shock, and therefore does not affect targeting by sector.

Keywords Payroll taxes · Social insurance · Labor informality · COVID · China

JEL Codes H25 · H26 · H55

Governments around the world enacted large stabilization measures in 2020 to respond to economic downturns caused by the COVID-19 pandemic. The mitigation of employer obligations for payroll taxes or social insurance (SI) contributions featured prominently in these policies (IMF, 2020; International Labour Organization, 2020). Many countries permitted deferred payments of SI contributions, while a smaller but still significant number of them-including both high-income countries

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like Finland, Norway, Spain, and Sweden and emerging economies like Argentina, Poland, and Thailand-enacted temporary payroll tax cuts (Table A.1).

China adopted perhaps the most substantial payroll tax cut. It completely exempted most firms from the employer portion of three types of SI contributions-pension, unemployment, and workplace injury-for 11 months in 2020. Employer contributions to mandatory medical insurance (MI) were also reduced by half for 5 months in certain regions. The temporary exemptions and rate reductions lowered the payroll tax rate by up to 21 percentage points (p.p.). These payroll tax cuts represented the most prominent component of China's fiscal response to COVID-19: the government's cost from the suspension of pension, unemployment, and workplace injury contributions was estimated to be CNY 1.54 trillion (223 billion USD) for 2020,[1] dwarfing the cost of other COVID-19-related government support such as the reduction of small taxpayers' VAT rate, special lending programs (Chen et al., 2020), and the activation of unemployment insurance.[2]

China's 2020 payroll tax cuts are relevant for a general understanding of fiscal responses to the pandemic for two reasons. First, reductions of SI contributions are equivalent to wage subsidies: they directly reduce per worker labor costs and support worker retention during the downturn. Payroll tax cuts therefore bear direct analogies to the wage subsidies prominently enacted in the USA (e.g., forgivable loans under the Paycheck Protection Program (Autor et al., 2022; Granja et al., 2020; Humphries et al., 2020)), Canada (Canada Emergency Wage Subsidy), Australia (JobKeeper program), and elsewhere (Scarpetta et al., 2020). Indeed, payroll tax cuts could be seen as a more conventional public finance instrument than the unprecedented wage subsidies introduced in 2020, given the familiarity of payroll tax rate changes. Evaluating the pros and cons of payroll tax cuts as a response to COVID-19 therefore should be of general interest to public economists; doing so in the context of the world's second largest economy should be especially informative.

Second, informal labor is widely prevalent in China, as reflected in the much lower degree of participation in SI than is common in developed countries. By analyzing payroll tax cuts in China, one can study the impact of labor informality on the effectiveness of government responses to the pandemic. While it is widely recognized that labor informality can significantly determine the efficacy of government labor market interventions in developing and emerging economies (Alon et al., 2020; Bruhn, 2020; Loayza & Pennings, 2020; Alfaro et al., 2020), there is still little empirical work to quantify labor informality's impact on policy efficacy during the pandemic.

In this paper, we evaluate China's 2020 payroll tax reductions by estimating the distribution of the policy's benefits. We ask the questions: How did China's payroll tax cuts fare in terms of concerns that have been expressed regarding wage subsidies elsewhere, e.g., poorly targeted policies deliver windfall benefits to large, resilient

[1] http://www.gov.cn/xinwen/2021-03/01/content_5589524.htm. The total reduction of MI contributions was estimated to be CNY 164.9 billion. http://www.gov.cn/guoqing/2021-04/09/content_5598659.htm. The average exchange rate of the Chinese Yuan in 2020 was 1 USD = 6.9 CNY.

[2] The scale of unemployment insurance in China is still quite limited (Qian, 2021).

firms, while offering insufficient support to the firms and sectors most vulnerable to the downturn (Giupponi et al., May 2022; Autor et al., 2022)? And how did labor informality affect the reach and targeting of the policy?

We address these questions using unique administrative data that contain all tax-registered firms in one large province in China. As we discuss in Sect. 2, China has a remarkably low degree of *firm* informality: a surprisingly high proportion of firms are registered with tax authorities. Consequently, our data set covers essentially all firms in the province. This allows us to directly observe the prevalence of *labor* informality, manifest as non-participation in SI.[3] While non-participation is thought to be commonplace in China among registered firms (Fang & Feng, 2018; Li et al., 2020), our data allows us to quantify its extent throughout the firm size distribution.[4]

Our main findings are as follows:

Magnitude of the Tax Cut: Employer SI contributions account for 12% of total taxes remitted by firms, implying that payroll tax cuts allow the government to confer significant and immediate benefits to firms. Among firms that participate in SI, we estimate the average value of the SI tax cut to be 67% of the predicted cash flow loss caused by COVID-19, 1.7% of total annual business costs, and 1.8% of total liquid assets. Additionally, the tax cuts reduce the median average tax rate (ATR) on labor by 21.25 p.p., generating strong incentives to maintain employment.

Targeting properties: Among SI participating firms, the value of the tax cuts-expressed as a fraction of cash flow loss, total costs, or total liquidity-decreases with firm size. In this sense, payroll tax cuts target liquidity support to firms with less ability to smooth cash flow shocks. Additionally, because the SI system creates high ATRs for low-wage firms, the tax cut reduces median ATRs among the smallest firms by approximately 40 p.p., compared to 22 p.p. for large firms. The value of the tax cut also correlates with an industry's exposure to the COVID-19 shock, generating a further desirable dimension of targeting.

Source of targeting properties: Desirable targeting across industry and firm size originates from differences in labor intensity. Small firms are far more labor intensive than large firms, as are those industries hit hardest by the COVID downturn. In this sense, payroll tax cuts are uniquely suited to the COVID shock relative to past recessions that fell less heavily on in-person services.

The ffect of labor informality: 53% of active firms-representing 24% of aggregate firm revenue and 33.35% of employees-make no SI contributions, and therefore receive no support from the policy. Furthermore, only 23% of the smallest decile of firms make SI contributions compared to 79% of the top decile. As a result, the positive targeting of benefits across firm size dramatically decreases when including non-participating firms. However, even with such firms included, the tax cuts still direct weakly more support to smaller firms on average. Labor informality also notably has no effect on targeting across industries, because informality is uncorrelated

[3] The importance of distinguishing between firm and labor informality is stressed by Ulyssea (2018, 2020).

[4] Sect. 2 discusses other advantages of our data; Sect. 3.3 discusses our results' validity for the rest of China.

with the extent of revenue shocks generated by COVID. Labor informality thus does not fully erode targeting.

Windfall gains: Despite the inherent targeting features of payroll tax cuts (by firm size and affected sectors), still substantial amounts of the subsidy flow to infra-marginal firms. In a back-of-the-envelope exercise (following Bachas et al. (2020)), we infer that almost 70% of the total tax reduction could be directed toward firms that would have remained in positive profits in the absence of government intervention.

Overall, our findings suggest that for governments aiming to support businesses during the pandemic, payroll tax cuts have attractive built-in targeting properties, which may be significant even in the presence of moderate levels of labor informality. Nonetheless, substantial windfall gains may accrue to infra-marginal firms. One simple approach to further improve targeting would be to tailor the degree of the tax cut by firm size and industry. China, for instance, limited rate reductions for the very largest firms, but did not target the cuts based on industry. More aggressive targeting may have been desirable.

Our work contributes to several strands in the evolving literature on governmental responses to COVID-19. The first comprises studies using pre-2020 administrative data to project the distribution of fiscal relief (Alstadsæter et al., 2020; Ganong et al., 2020; Bachas et al., 2020). A second strand analyzes various forms of job retention subsidies (Bartik et al., 2020; Bennedsen et al., 2020; Birinci et al., 2021; Chetty et al., 2020; Granja et al., 2020; Kaplan et al., 2020). Even though adoptions of temporary payroll tax cuts in 2020 were not uncommon around the world (Table A.1), they have received limited attention in the economic literature. Third, our distributional findings complement early preliminary evidence suggesting that payroll tax cuts bolstered Chinese firms' ability to weather the economic downturn.[5] Finally, to our knowledge, our study may be the first to empirically analyze the role of labor informality in determining the effectiveness of policies targeted at businesses in response to COVID-19, adding important insights to the literature on the appropriate government response to the pandemic in developing countries (Alon et al., 2020; Bruhn, 2020; Loayza & Pennings, 2020; Alfaro et al., 2020).

1 Policy background

In the mid- to late-1990s, China adopted a mandatory "pay-as-you-go" pension system, Basic Old Age Insurance (BOAI), for employed persons funded mainly through employer contributions (see Fang and Feng (2018) for a history of pension programs in China). Likewise, in the early 2000s, a medical insurance (MI) program

[5] Based on a survey of 2,044 firms, Chen et al. (2020) indicate that deferrals of SI contributions provided by Chinese cities in early February 2020 improved the cash flow of small and medium enterprises (SMEs). With respect to the subsequent SI contribution cuts that are the focus of our analysis, the surveyed firms also report that they improve cash flow, re-opening, and the likelihood of having a majority of employees return to work. Likewise, Chen et al. (2020) suggest that China's payroll tax exemptions had a positive effect on firm revenue between February and April. We shed light on the magnitude and distribution of this fiscal support.

for employed persons was established, also funded by payroll taxes (Huang, 2020). These two programs are the largest components of the SI system. As of 2019, the nationally prescribed employer contribution rate for BOAI and MI was 16 and 8% of wages, respectively. BOAI and MI also require employee-side contributions-8 and 2%-which are recorded in notional individual accounts that are effectively pay-as-you-go.

Beginning in late January 2020, many Chinese cities announced economic stabilization policies in response to COVID-19. The two most frequently mentioned measures were the deferral of the employer portion of SI contributions and partial refunds of prior-year unemployment insurance (UI) contributions for firms that retain their employees.

The national policies introduced on February 20, 2020 by the Ministry of Human Resources and Social Security (MOHRSS)[6] superseded these prior policies and provided a far larger tax reduction. First, they temporarily exempted or reduced three types of SI contribution (BOAI, UI, and injury). As initially announced in February, all firms other than "large firms" and all individual proprietors received an exemption from employer contributions for 5 months (February–June); and all large firms and private non-business organizations received a 50% reduction in contributions for 3 months (February-April).[7] On June 22, 2020, MOHRSS extended the exemption for the first group of firms to the end of 2020, and the 50% reduction for the second group to June.[8] Second, delays in SI contributions for firms that have residual obligations were allowed for up to 6 months.

On February 21, 2020, China's National Healthcare Security Administration (NHSA) announced guidelines for mitigating employer contributions for MI.[9] Under these guidelines, local jurisdictions that form medical pooling units may in principle *either* reduce employer MI contributions by half for 5 months (February to June) *or* continue any prior practice of providing for deferrals of contributions for up to 6 months. The choice depended on whether the pooling unit's cumulative balance provided sufficient cushion for current expenditures. The NHSA guidelines provided greater discretion to local governments than the MOHRSS-announced policy, reflecting the fact that MI pooling in China is even more decentralized than for other types of SI. As the rates for employer MI contributions vary across pooling units (within provinces and even within some prefectures), the magnitude of any tax cut also varied. In the province we study, all prefectures adopted rate reductions instead

[6] Notice by the MOHRSS, the Ministry of Finance and the State Taxation Administration of the Temporary Reduction and Exemption of Social Insurance Premiums Payable by Enterprises, MOHRSS No. 11 (2020).

[7] The Ministry of Industry and Information Technology (MIIT) sets revenue, asset, and employee thresholds for each industry which determine whether firms are Micro, Small, Medium, or Large. The revenue threshold delineating medium from large ranges from CNY 20,000,000 for Agricultural firms to CNY 2,000,000,000 for Real Estate firms. Table C.3 shows the full set of revenue thresholds.

[8] Notice by the MOHRSS, the Ministry of Finance and the State Taxation Administration of Extending the Implementation Period of the Policies Regarding the Temporary Reduction and Exemption of Enterprises' Social Insurance Contributions and Other Issues, MOHRSS No. 49 (2020).

[9] Guiding Opinions of the NHSA, the Ministry of Finance and the State Taxation Administration on the Temporary Reduction of the Premiums of Basic Medical Insurance for Employees, NHSA No. 6 (2020).

of payment deferrals, with the rate reduction ranging from 3 p.p to 4.5 p.p. In the analyses below, we include the temporary MI rate cuts in calculating benefits to firms, while reminding readers that such cuts may not have been uniformly adopted across China.

In the province we study, the average combined employer contribution rate of BOAI, UI, and injury employer contributions was 21 and 17.25% in 2016 and 2019, respectively. MI and maternity insurance employer contributions added another 8.6–8.7%.[10] The temporary measures in place from February to June 2020 lowered rates by 21.25 p.p. for non-large firms and 10.625 p.p. for large firms. The July to December provisions lowered rates by 17.25 p.p. for non-large firms but reinstated the full rates on large firms.

SI obligations are determined on a monthly basis. The rate (τ) applies to each employee i's monthly wage w_i to determine their liability. However, w_i is bounded by $[.6\bar{w}_c, 3\bar{w}_c]$, where $\bar{w}_c$ is the average monthly wage in city c as announced by the government, to create a minimum and maximum SI contribution per employee. Panel A of Fig. 1 plots this schedule. Panel B shows the implied marginal and average tax rates (MTR and ATR) for a given w_i.

The collared structure has implications for the nature of labor adjustment and the effect of cutting SI taxes. First, for firms paying monthly wages outside of $[.6\bar{w}_c, 3\bar{w}_c]$, the MTR on each employee's additional earnings is zero. In contrast, the ATR is nonzero and substantial for all firms. As a result, SI tax cuts may have a limited effect on intensive margin adjustment (monthly hours) and more substantial effects on extensive margin decisions (job retention and hiring). Second, low-wage firms ($w_i < .6\bar{w}_c$) face the highest ATRs, and as a result, receive the largest ATR reduction from the temporary exemption. Third, because the minimum contribution must be made monthly, rather than annually, and firms must make SI payments even if employees are temporarily not working (and not receiving wage payments), firms may have a strong incentive to lay off employees in the face of temporary demand shocks.

Finally, non-participation is a major feature of China's SI system as actually implemented. Official statistics suggest that in spite of basic pension insurance being compulsory, only 70.5% of urban employees participated in 2019.[11] Previous scholarship has examined various determinants of SI non-participation in China, including tax rates (Li et al., 2020), regional and industry characteristics (Rickne, 2013; Chen & Mingqin, 2014), firm-level characteristics (Nyland et al., 2006), enforcement agencies (Tang & Feng, 2021), local government fiscal conditions (Li et al., 2021), and other factors. Here, we limit our focus to the effect of SI non-participation

[10] A recent survey (Social Security Administration, 2019) covering 183 countries lists total (employer and employee) SI contribution rate in China as 32.5%. This puts China as having the 25th highest rate among the 183 countries. See Appendix Fig. A.1 for the full distribution of rates across countries.

[11] MOHRSS 2020: Statistical Bulletin on the Development of the Human Resources and Social Security Enterprise, http://www.mohrss.gov.cn/SYrlzyhshbzb/zwgk/szrs/tjgb/202006/t20200608_375774.html. A think tank estimates that in 2015, 70% of all firms that participated in SI under-contributed relative to statutory requirements (Feng & Faqiang, 2019). Tang and Feng (2019) provides additional citations.

(which we view as a key measure of labor informality, in line with Perry et al. (2007) and Ulyssea (2018)) on the distribution of pandemic fiscal support.

2 Data and sample

2.1 Tax returns and financial statements:

We use an administrative data set from a large province in China containing financial statements, tax returns, tax remittance, and tax registry information for the universe of firms in 2016.[12] This data provides two advantages for characterizing firm participation in SI. First, it contains all tax-registered firms, including those that do not make SI contributions. China is unusual in having a very high degree of tax registration such that most labor informality manifests at tax-registered firms, as opposed to labor hired by non-registered, informal firms.[13] For example, the China Taxation Yearbook (2002) reports outcomes for tax registration of newly established businesses in 2000 for the entire country, and across 31 provincial and 5 prefectural jurisdictions (pp. 621-2, 627-8). The national average rate of registration for the State Tax Bureau (*guoshui*) system was 97% (out of 8.659 million firms and individual proprietors), while it was 95.7% for the Local Tax Bureau (*dishui*) system (out of 6.135 million firms and individual proprietors). While no similar national statistics have been published since then, internal reports within Chinese tax administration quote similarly high rates of registration for more recent years. As a result, we directly observe the varying degrees of labor formality across the entire firm-size distribution.

Second, the universal coverage and recency of the data provides significant advantages over data used in prior literature. Past research relied on either a survey of 2,200-5,400 audited firms from Shanghai in 2001 and 2002 (Nyland et al., 2006; Maitra et al., 2007; Nielsen & Smyth, 2008) or the Annual Survey of Industrial Firms for years 2001 to 2007 (Gao & Rickne, 2017; Rickne, 2013; Li et al., 2021; Tang & Feng, 2021). The latter contains all State-Owned Enterprises (SOEs) and private industrial firms above 5 million CNY in revenue. These criteria would exclude 88% of the firms (representing 65% of employees) in our data. Furthermore, the SI landscape evolved considerably since 2007. More recently, Li et al. (2020) have used data from the National Taxpayer Survey to analyze SI compliance. However, the survey sample is still heavily weighted toward large firms and is less recent than ours.[14]

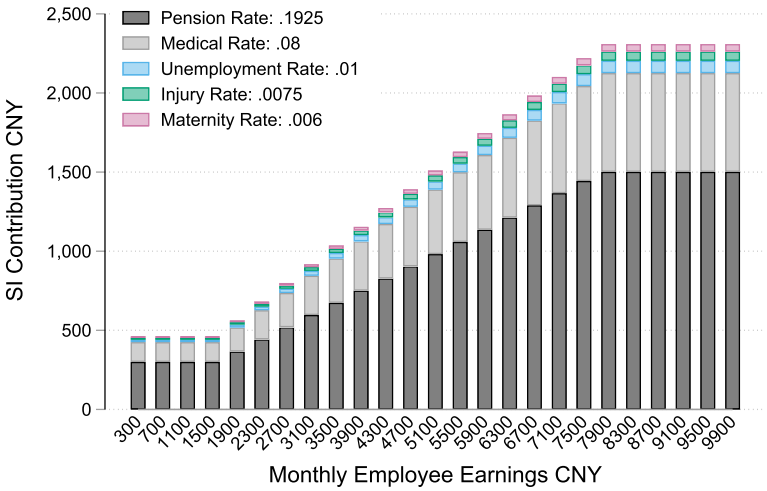
Sample selection: We observe 1.4 million firms in the tax registry (excluding non-business entities and individual proprietors). To drop firms that are inactive or barely active, we remove firms that (i) filed empty financial statements, (ii) those

[12] This data set was first used in Cui et al. (2022) to study tax preferences for investment under the CIT. The current paper presents the first analysis of SI patterns.

[13] The combination of high firm formality and high labor informality in China is discussed in Chapter 3 of Cui (2022).

[14] In Li et al. (2020)'s sample covering 2007–2011, for example, the average firm has 245 employees, whereas in ours the average firm has 11 employees.

(a) 2016 Rates



(b) Marginal and Average Tax Rates

	$w_i < .6\bar{w}_c$	$w_i \in [.6\bar{w}_c, 3\bar{w}_c]$	$w_i > 3\bar{w}_c$
MTR	0	τ	0
ATR	$\tau \times \frac{.6\bar{w}_c}{w}$	τ	$\tau \times \frac{3\bar{w}_c}{w}$

Category	$100 \times \tau_{2016}$	$100 \times \tau_{2019}$
Pension	19.25	16
Unemployment	1	.5
Injury (Inferred)	.75	.75
Medical	8	7.88
Maternity	.6	.8
Total	29.6	25.93

Fig. 1 The SI Employer Contribution Schedule. Note: Panel A illustrates the schedule for SI contributions using 2016 rules. The tax base w_i is the monthly wage for employee i. The SI contribution required of the employer is the base multiplied by the mandated rate τ. The taxable base is bounded below and above by $.6\bar{w}_c$ and $3\bar{w}_c$, where $\bar{w}_c$ approximates the average monthly wage in city c—we use the average w_c across jurisdictions to plot this panel. Panel B shows marginal and average tax rates for employer contributions. The marginal rate is the increase in employer contributions when the firm increases the employee's monthly wage by a dollar. The average rate is the ratio of total employer contributions for an employee over that employee's monthly wage. Panel B also compares the statutory rates in 2016 to those in 2019

that report less than 10,000 CNY ($1,600 USD) revenue or costs on their financial statements, and (iii) those with zero tax remittance.[15] Our final sample contains 832,124 firms. We use several variables from this data set:

Tax remittances: We observe all tax remittances made throughout the tax year, net of any refunds. We aggregate taxes into 5 categories: SI contributions, value-added tax (VAT) and sales taxes, corporate income tax (CIT), personal income tax (PIT, which are withheld by firms), and other taxes.[16] Total taxes paid are the sum across these categories.

Wages and employees: Total wages paid for the tax year are reported on the CIT return inclusive of SI contributions (which are CIT deductible). We calculate net-of-SI wages by subtracting SI remittances from the CIT wage bill. The number of employees is reported in the tax registry which we observe a snapshot of for 2017. Firms are prompted to update tax registry information annually, although we do not observe the date of the most recent update. Additionally, this point-in-time measure does not reflect turnover in the workforce within a given year. Firm employee count therefore is observed with error.

Total input costs: We use two measures of costs: variable costs (costs of goods sold); and total costs, defined as the sum of (i) variable costs and (ii) business expenses. The former is an approximation of the "direct cost" of the goods and services produced. Business expenses are overhead costs, including sales, management, and financing expenses. Labor costs are included in both and apportioned accordingly.

Cash flow, liquidity, and external financing: We construct cash flow as revenue minus variable costs ($R - VC$). We define firm liquidity as the total value of current assets reported on the balance sheet, which includes cash holdings.[17] Finally, we generate two measures of firms' access to financing. First, we create a dummy variable that indicates whether firms claim interest deductions on their CIT returns, capturing the extensive margin of access to loans. Second, we impute the interest rate firms face on liabilities as the ratio of financing costs (from the income statement) over total liabilities (from the balance sheet), conditional on financing costs being positive.[18]

[15] Restriction (i) is by far the most binding. Conditional on restriction (i) and (iii), results throughout the paper are very similar if we do not impose restriction (ii).

[16] Sales taxes include the Business Tax (*yingyeshui*), Excise Tax (*xiaofeishui*), and revenue-based surcharges; the Business Tax was replaced by the VAT in 2016. Other taxes include deed and property taxes; land value, maintenance, and use taxes; resource tax; vehicle taxes; and stamp duty.

[17] Total liquidity is the upper bound on the firm's internal resources that can be marshaled to cover cash flow losses.

[18] Total liabilities include (1) short term liabilities, (2) long term liabilities, and (3) accounts payable. We exclude from total liabilities (1) outstanding tax liabilities and (2) outstanding interests payable.

Firm size and industry: We use revenue as reported on financial statements to categorize firm sizes. Detailed industry codes are recorded in the tax registry.

Table 1 reports summary statistics for each of these variables. The median firm makes 1,460,000 CNY (≈ $230,000) in annual revenue and holds approximately the same amount in liquid assets. On average, firms employ 11 workers at an average annual wage of 70,000 CNY.[19] This is very similar to the average wages ($\bar{w}_c$) that the cities in our province announced in 2016 for determining SI contribution caps and floors (68,807 CNY). Finally, the first column of Table C.1 shows the fraction of firms in each sector. Over one third of firms are in manufacturing industries; one fifth in wholesale; 12% in retail; 8% in business services; and 6.5% in construction.

2.2 Sales shocks from VAT transactions:

Chen et al. (2020) use 1.5 billion VAT transactions in China, from January 1, 2019 to April 16, 2020, to estimate how firm sales changed in the twelve-week period following the onset of Wuhan's lockdown (January 23, 2020). They estimate the average percent change in total sales filed through the VAT reporting system, relative to the same time in 2019, for 4 firm size bins and 18 industries, resulting in 72 bins.[20] Appendix Table C.3 shows these 18 industries and size thresholds, which we use to merge their measure of revenue loss with our data. We use the estimated sales change for the 4-week period of March 26 to April 16, 2020 as a measure of the medium-term revenue decline for firms in 2020 due to COVID-19. Table 1 shows that the average revenue drop was 16% while over 95% of firms experienced some revenue loss.[21]

Predicted Cash Flow Loss: Using those revenue declines (s), we predict a firm's cash flow loss as $s(R - VC)$, which assumes that variable costs decline in proportion to revenue declines. $s(R - VC)$ is also the decline in total profit assuming fixed costs do not change. This definition of cash flow loss corresponds to a short-run perspective in which overhead costs, such as building leases and debt payments, are fixed.[22] This assumption is used in Bachas et al. (2020) and underpins the need to inject liquidity into firms, since if firms could temporarily scale back their overhead, there would be little need for firm liquidity injections.

[19] This works out to $11 \times 70{,}000 = 770{,}000$ in total wages, which is more than the reported average total wages of 470,000. The discrepancy derives from our calculating the mean wage per employee among the set of firms with positive total wages, as reflected in the smaller N.

[20] Their VAT data accounts for 11% of total firm sales in China. The transactions cover 3.9 million unique corporations and 1.7 million self-employed. The authors construct size bins using annual firm revenue from 2019 following the MIIT size revenue cutoffs.

[21] One caveat is that transactions made by small firms that are exempt from the VAT are excluded, and so revenue changes are better measured for larger firms.

[22] Throughout the analysis, we exclude the approximately 0.5% of firms that had negative $(R - VC)$ in 2016 or negative s (i.e., their industry-size bin had increased average revenue during March 26 to April 16, 2020), as the ratio of subsidy to cash flow loss is not interpretable for these observations. Removing the restrictions leaves the results qualitatively unchanged.

Table 1 Descriptive statistics

	Mean	P25	P50	P75	P90	P95	N
Revenue(10000 s)	689	37	146	555	2128	5250	832124
Costs(10000 s)	665	40	147	545	2054	4989	832124
Total assets(10000s)	773	53	164	577	2241	6230	832124
Liquid assets(10000 s)	559	46	135	473	1623	4257	832124
Employees	11	3	5	10	28	60	832124
Net of SI Total Wages(10000 s)	48	0	9	38	155	374	832124
Mean wage	70039	15044	35600	80792	191440	351613	589965
Statutory mean wage	68807	67200	67200	72980	72980	72980	832124

This table shows the means and percentile values, at the firm level, for key variables used throughout the paper. Statutory Mean Wage is the statutorily defined local mean wage w_c (in CNY) used for the purposes of determining minimum and maximum SI contributions per employee, multiplied by 12, since w_c is defined as monthly earnings. This mean is weighted by the number of firms in the local area for which the local mean wage is defined. Variables are winsorized at the 5 th and 95 th percentiles before calculating averages

3 Results

3.1 SI Remittance, informality, and average tax rates

We begin by documenting the magnitude of SI remittances as a fraction of total tax payments. We contrast SI remittance against four other categories of tax remittance-CIT, VAT and sales taxes, PIT withholding, and other taxes-to illustrate the size of SI contributions relative to other tax levers at the government's disposal.

Specifically, we split firms into revenue deciles d (Table C.2 provides the decile cutoffs). Then for each decile d and tax type k, we calculate $\frac{1}{N_d}\sum_{i\in d}\frac{t_{i,k}}{\sum_k t_{i,k}}$ where $t_{i,k}$ is the amount remitted by firm i for tax k. Figure 2 plots the results. SI contributions (employer and employee-side combined) make up approximately 20% of firms' total tax remittances and this fraction increases with firm size, ranging from 19.3% for the lowest decile to 21.8% in the largest decile. For the top eight revenue deciles, SI contributions are the second highest share of taxes paid next only to VAT and sales taxes. This implies that payroll tax cuts have the potential to deliver significant cash benefits to businesses compared to other tax policy levers.

Panel B plots firm participation in SI, defined as making any SI contributions. Only 47% of firms-which collectively account for 75.91% of aggregate revenue and 66.65% of employees-make SI contributions. This leaves 53% of firms and 25% of economic activity out of the reach of the SI cut. Non-participation is only 23% among the smallest firms, and gradually rising to 79% among the largest. The largest decile of firms accounts for 77.2% of total SI contributions. This pattern means that large firms are more likely than small firms to receive benefits from SI cuts.

We next turn to the ATRs generated by SI obligations. A reduction in the ATR directly affects extensive margin employment incentives-how many workers to hire and retain. This is relevant given that one objective of the rate cut was to induce

firms to maintain employment. We construct the ATRs faced by SI contributing firms (since only they stand to benefit from the cut) as follows. For each firm, we divide its total wage bill by the number of employees, then further divide by twelve to calculate the monthly wage per employee. With the monthly wage, we calculate an ATR following the ATR formula in Panel *B* of Fig. 1.[23] For each size decile, Fig. 3 plots the median ATR using (i) 2019 rates, (ii) February to June 2020 rates, and (iii) July to December 2020 rates.

The ATR is larger than the statutory rate (τ) for the lower half of the firm distribution. This is caused by low monthly wages at smaller firms, often below the minimum SI wage base. In the upper deciles, the ATR is equal to the statutory rate, reflecting the fact that the upper bound on the taxable wage does not typically bind. Median ATRs are 25.93% for the top five firm deciles, and up to 60% for the lowest decile. The February-to-June rate reductions lower median ATRs to 4.68% for the largest 50% of firms and to less than 10% for the smallest—a substantially larger reduction for small firms. In the July–December phase, median ATRs rose to 8.7% for the largest half of firms, and just under 20% for the smallest. The less generous rate cuts for "large firms" are not visible since these firms make up only 0.3% of all firms.

3.2 Cash flow benefits and targeting properties

We now examine perhaps the primary motivation for SI cuts: providing liquidity by reducing firms' labor expenses. There are two standard rationale for providing liquidity to firms during a recession, which Hanson et al. (2020) argue are "turbo-charged" during a pandemic-induced recession. First, financing frictions imply that firms that would be perfectly viable once the COVID-19 shock subsides may fail if they cannot access credit during the shock: this market failure is particularly likely to happen to small firms. Second, keeping viable firms alive generates aggregate demand externalities that quicken the pace of recovery after the initial shock fades.

A key concern regarding policies designed to inject liquidity through reductions of business expenses (such as subsidizing labor costs) is their potential to be poorly targeted. Firms that have access to cheap credit or simply are not adversely affected by the pandemic may receive infra-marginal subsidies. Motivated by this concern, we estimate the distribution of liquidity generated by China's payroll tax cut to evaluate the liquidity targeting properties inherent in such tax cuts.

[23] Dividing total wages by the number of employees may create a downward bias of wages when employees are mismeasured, and therefore an upward bias in the ATR. As a robustness check on this division bias, Fig. C.1 instead calculates ATRs in each decile based on the decile's aggregate wage. The aggregate wage for decile d is $\sum_{i \in d} W_i$ divided by $\sum_{i \in d} E_i$, where W_i and E_i denote firm i's annual wage bill and total employees, respectively. By summing within the denominator and numerator, mean-zero measurement error collapses to zero. The trade-off is that the ATR is overly influenced by the largest firms in each decile (high W and E), and so represents a size-weighted estimate. The resulting patterns in ATRs are, however, qualitatively unchanged.

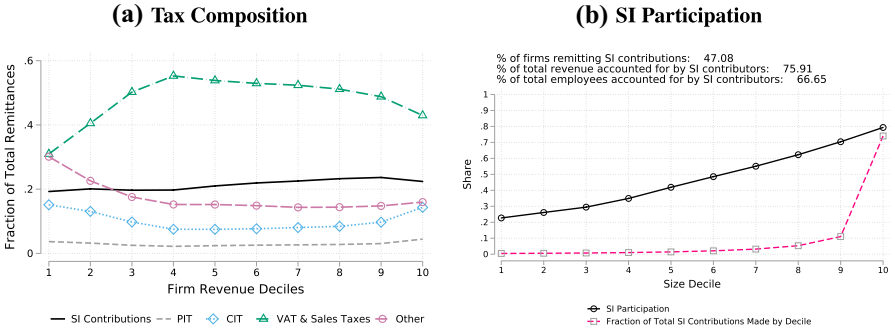


Fig. 2 Firm remittances across tax types. *Note*: For each firm revenue decile, Panel A shows the fraction of total tax remittances accounted for by each of the five main tax categories: SI contributions, PIT withholding, CIT, VAT and other sales taxes, and all other tax payments. In Panel B, the solid black series plots the fraction of firms that remitted SI contributions in 2016 in each firm size decile. The dashed magenta series plots the fraction of aggregate SI remittance that was made by each firm size decile

3.2.1 Estimating the effective subsidy

We characterize this liquidity benefit by estimating the subsidy (i.e., the tax savings) provided by the SI cut. Our approach to estimating the subsidy is to pose the counterfactual question: *If a firm's total wage bill remained constant, how much would the SI cuts generate in tax savings*? As an alternative, we will also consider the case where payroll declines in proportion to firm revenue losses. We construct the main counterfactual using tax remittance data as follows:

1. **Non-large firms**: Calculated as 11/12 ths of the employer share of pension, UI, and injury contributions-corresponding to the complete exemption for 11 months-and 5/24 ths of the employer share of MI contributions-corresponding to a 50% reduction for 5 months.
2. **Large firms**: Calculated as 5/24ths of the employer share of pension, UI, injury, and MI contributions-corresponding to a 50% reduction for five months.
3. Because statutory rates have declined slightly since 2016 (see Fig. 1), we shrink 2016 contributions for each contribution type k by multiplying firm i's remittance T_{ik} by $\frac{\tau_{2019,k}}{\tau_{2016,k}}$.

An implicit assumption in this approach is that the payroll tax cuts' economic incidence falls on the employer. This seems reasonable given the cuts are temporary (between 5 and 11 months). Wage contracting changes come with transaction costs; with the expectation that the cuts will expire, it is unlikely that pre-tax wages will increase in response to the tax reduction.

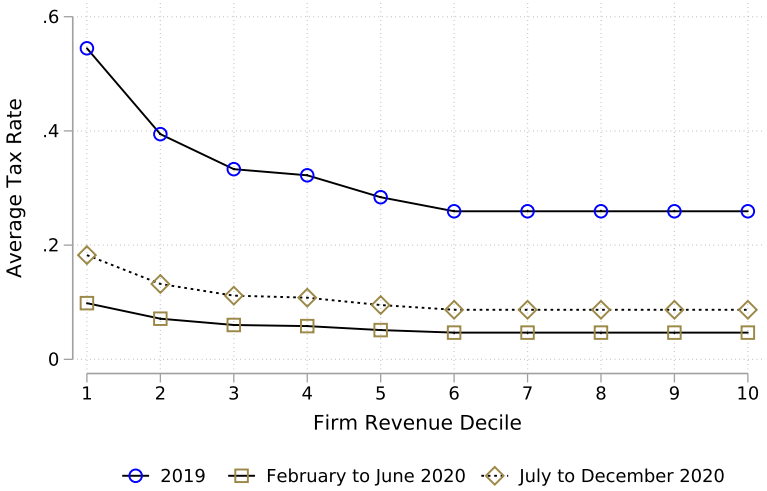


Fig. 3 Effect of 2020 Cuts on average tax rates among SI-contributing firms. *Note*: For each firm, we divide its total wage bill by the number of employees, then further divide by twelve to calculate the monthly wage per employee. With the monthly wage, we calculate an ATR following the ATR formula in Panel *B* of Fig. 1. Each series plots the median ATR in each decile under different statutory rates: 2019 rates, and the reduced rates for February to June 2020 and July to December 2020. The horizontal lines indicate the statutory rates

3.2.2 Targeting by firm size

The first dimension of targeting we consider is firm size. One motivation for directing benefits to smaller firms is that they are less able smooth cash flow shocks. This is particularly true in China and emerging economies where external financing is costlier and harder to access for small firms.

Illustrating this point, Fig. 4 shows two measures of financing constraints across the size distribution. Panel *A* shows the fraction of firms that claim interest deductions on their CIT return, a proxy for access to external lending. Most firms-especially small ones-do not claim any interest deductions. Panel B shows the estimated interest rate-interest payable over total liabilities-among firms with positive interest payable. It is clear that small firms face higher financing costs than larger firms. These results are consistent with findings from (Bai et al., 2018) and emphasize the importance of targeting government subsidies to small firms during temporary shocks.

A second motivation is that fixed costs make up a greater fraction of total costs among small firms. As a result, they are less able to reduce costs in response to temporary shocks. Panel *A* of Fig. C.2 shows this size gradient-on average, fixed costs are about 20% of total costs in the full sample, but between 40 and 60% in the lowest deciles. Bachas et al. (2020) show similar gradients of fixed costs for a collection of 16 other developing countries.

The design of China's SI tax cut reveals a preference for targeting benefits to smaller firms, since large firms had their statutory rate cut by 12.8 p.p. less than

small firms. However, the definition of large firms covers less than 0.3% of registered firms. For the remaining 99.7%, any effective targeting across firm size will stem from differences in labor intensity, wage structure, and informality rather than policy design. We investigate those patterns in this section.

Figure 5 plots the average of the implied subsidy across the firm size distribution relative to predicted cash flow loss (Panel *A*), total costs (Panel *B*), and total liquidity (Panel *C*). The average subsidy-to-cash flow loss ratio is 0.315 across the full sample and 0.67 among SI contributing firms. These numbers can be interpreted as replacement rates-the fraction of lost short-run income replaced by tax reductions. Conditional on SI participation, the benefit of the implied subsidy is much more substantial for small firms. Panel *A* shows that the subsidy was larger than predicted cash flow loss in the bottom three deciles, providing more than 100% insurance income replacement. Meanwhile, the largest two deciles had replacement rates of less than 50%.

The subsidy size gradient is similar when expressed relative to firms' total costs or total liquidity. The average subsidy-to-cost ratio is 0.008 across the full sample and 0.017 among SI contributors, and 0.009 and 0.018 for subsidy-to-liquidity. The average subsidy in the smallest decile represents 12% of liquidity among contributors compared to approximately 1% in the top decile. This is true despite the fact that small firms hold more liquid assets relative to operating costs than large firms-seen in Panel *C* of Fig. C.2-reflecting their lesser access to external financing.

Figure 5 also shows a substantial loss of targeting when including non-participating SI firms. Table 2 offers one approach to quantifying this. For each of the subsidy ratios illustrated in Fig. 5, we report the ratio for decile d relative to the ratio for the largest decile. The interpretation is straightforward. In the case of subsidy-over-cash-flow-loss, the lowest decile received 15.2 times more fiscal support than the top decile, conditional on participating. This drops to 2.4 times when including non-participating firms. Furthermore, deciles 2 to 10 receive effectively the same degree of support, illustrating how labor informality kills positive targeting over most of the size distribution. A similar pattern of substantial loss in targeting manifests in the other two subsidy ratios, and when using alternative measures of firm size (Appendix Fig. C.4).

Among participating firms, what causes the size gradient? The first source is the much higher labor intensity of small firms: Panel *B* of Fig. C.2 illustrates the firm size gradient of labor intensity.[24] The second is the regressive rate structure of China's SI contribution scheme: small firms are more likely to pay wages below $\bar{w}_c$ and therefore face a higher effective tax rate per employee than the statutory rate. Figure C.3 presents a reduced form decomposition that indicates that differential labor intensity, not rate regressivity, is the dominant driver.

Finally, Fig. 5 calculated the subsidy assuming no decline in payroll. An alternative assumption is that payroll declines in proportion to revenue declines. As a robustness check, we incorporate this assumption into the subsidy calculation in Fig. C.5 and compare the result against the baseline calculation. The average

[24] Bachas et al. (2020) show similar gradients of labor intensity in a collection of 16 other developing countries.

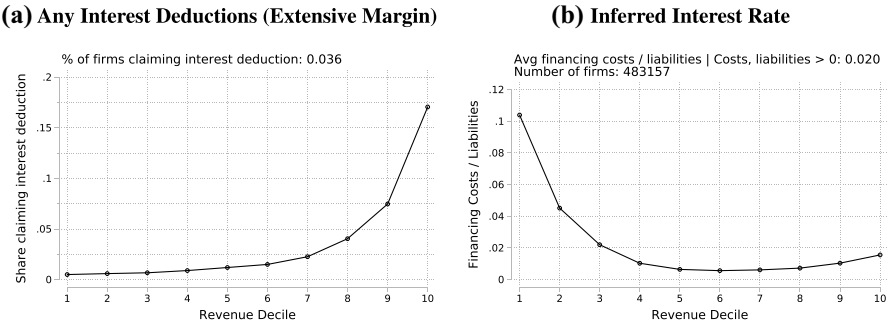


Fig. 4 Access to and cost of external financing. *Note*: Panel A plots the fraction of firms claiming interest deductions on their corporate tax returns. Panel *B* plots the inferred interest rate-financing costs on the income statement over total liabilities from the balance sheet-among firms with positive positive financing costs and liabilities

subsidy-to-cash flow ratio decreases by approximately 16% (the average size of the revenue shock), but the size gradient is qualitatively unchanged.

3.2.3 Targeting by exposure to the COVID shock

A second dimension of targeting is whether payroll tax cuts channel benefits to the hardest-hit sectors. This relates to a major potential critique of payroll tax cuts: that unaffected sectors of the economy receive windfall gains, at least when enacted broadly and without qualifying criteria.

We consider payroll tax cuts to have positive targeting properties if the size of fiscal support is positively correlated with the estimated revenue decline. We use subsidy-to-costs as the main measure of fiscal support and correlate this with the estimated percent change in sales at the industry-by-size level estimated by Chen et al. (2020) (See Sect. 2). Within each industry-size bin, we sum the subsidy and the total costs across firms, then plot the ratio on the y-axis, and the predicted percent change in sales on the *x*-axis of Fig. 6. Since a more negative revenue change represents greater exposure, a negative slope implies well-targeted benefits.

Panel *A* shows that the subsidy is higher among industries with greater sales declines in all size groups. This indicates positive targeting regardless of size. Panel *B* aggregates the subsidy-cost ratio and the predicted revenue change up to the industry level. Most of the heavily affected industries-lodging and food services, education, health and social work, rental and business services, and residential services-receive a greater subsidy as a proportion of baseline costs than unaffected industries. Among the most affected industries, only real estate receives a notably small subsidy. Table C.1 reports the subsidy ratios for each sector.

Table 3 shows the correlation between fiscal support and industry exposure for each size group, and the effect of labor informality on that correlation. Consider column (1): among small participating firms, a 1 p.p decline in revenue relative to 2019 correlates with an increase in the subsidy equal to .073% of total

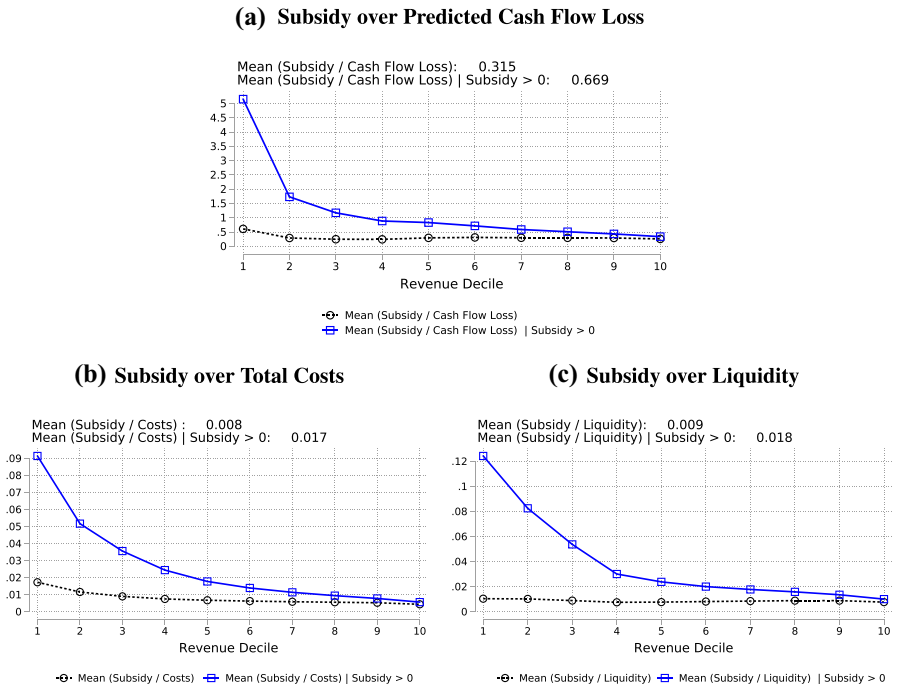


Fig. 5 Simulated SI cut relative to cash flow loss, costs, and liquidity.*Note*: For each decile, we plot the mean of the subsidy-to-cash-flow-loss, subsidy-to-costs, and subsidy-to-liquidity ratios, for all firms and the sample of SI-participants. Section 3.2.1 details the calculation of the subsidy. Section 2 outlines costs, liquidity, and predicted cash flow loss. Ratios are winsorized at the 5 th and 95 th percentiles within each decile

costs-which is indicative of positive targeting. Positive targeting across industries holds true in each size bin separately, and in the full sample.

Comparing column (1) to (2), and (3) to (4), highlights the effect on targeting of informal labor. Labor informality has relatively little impact on targeting across industries since industry-level informality is not significantly correlated with exposure to the economic shock, as illustrated in Panel *A* of Fig. 7. This sharply contrasts with informality's effect on targeting by firm size.

Panel *B* of Fig. 7 demonstrates that industry exposure is highly correlated with labor intensity, which drives the positive targeting. Health and social work, education, residential services, lodging and food services, where labor costs comprise between 20 and 35% of total costs, are all hard-hit. In contrast to the 2009 Great Recession, which hit construction and manufacturing industries hardest, the pandemic-induced demand shock fell on the industries in which labor costs loom largest. Consequently, payroll tax reductions enjoy inherent desirable targeting properties, even in the absence of deliberate program design, such as differential rate cuts across sectors.

Table 2 Extent of targeting: Subsidy by decile relative to top decile

	Ratio for decile d / Ratio for top decile									
$d =$	1	2	3	4	5	6	7	8	9	10
Subsidy / Cash Flow Loss										
Participants	15.2	5.1	3.5	2.6	2.5	2.1	1.7	1.5	1.3	1.0
All firms	2.4	1.1	1.0	0.9	1.1	1.2	1.2	1.1	1.1	1.0
Subsidy / Total Costs										
Participants	16.1	9.1	6.3	4.3	3.1	2.5	2.0	1.7	1.4	1.0
All firms	3.9	2.6	2.1	1.7	1.5	1.4	1.3	1.3	1.2	1.0
Subsidy / Liquidity										
Participants	12.3	8.2	5.3	3.0	2.4	2.0	1.8	1.6	1.3	1.0
All firms	1.4	1.3	1.2	1.0	1.0	1.1	1.1	1.2	1.2	1.0

For each denominator D (predicted cash flow loss, total costs, and liquidity) and each decile d, we calculate the mean subsidy-to-D ratio among firms in that decile: $(S/D)_d$. We then divide this by the analogous ratio in the top decile: $(S/D)_{10}$. $(S/D)_d/(S/D)_{10} > 1$ implies that smaller firms receive more fiscal support than top-decile firms, as a proportion of D. We report these comparisons for both SI participant firms and for the full sample of firms. The ratios *S/D* are winsorized within each decile at the 5 th and 95 th percentiles (before constructing the participants-only sample). The calculation of the simulated subsidy is described in Sect.3.2.1. Predicted cash flow loss, costs, and liquidity are defined in Sect. 2

3.2.4 Distribution of aggregate fiscal relief

Finally, we consider targeting in the sense of what fraction of total fiscal support goes to three groups of firms: (1) those that remain profitable during the COVID shock (always-profitable); (2) those that are pushed into negative profits because of COVID; and (3) those that would have been in negative profits even in the absence of COVID (always loss-making).

When payroll tax cuts are viewed as an instrument for business liquidity support, the fraction of the subsidy delivered to firms in the always-profitable group might be viewed as infra-marginal. Likewise, if firms reduce payroll only if they are pushed into negative profits (an assumption adopted by Bachas et al. (2020)), subsidies to the always-profitable group are arguably infra-marginal for maintaining employment. By contrast, the group of firms pushed into negative profits due to COVID may plausibly be regarded as the set of firms the government most wants to target support toward, whether for liquidity or for maintaining employment. The third group-those that would have been in negative profits even without the COVID shock-are more likely to unprofitable in the long-run (as evidenced by higher long-run exit rates (Bachas et al., 2020)) and therefore not a group that governments should prioritize in designing subsidies.

The first two columns of Table 4 calculate the fractions of firms in the sample that fall into each of the three groups, unconditional and conditional on participating in SI. Approximately 42% of all firms fall into the always-positive-profit group,

38% into the always-negative-profit group, and 19% in the marginal group. Column (3) calculates that 11.2% of total fiscal support is directed to marginal firms, 70% to always-positive-profit firms, and 19% to always-negative-profit firms. So while Sects. 3.2.2 and 3.2.3 illustrated positive targeting by firm size and industry, in the aggregate the largest fraction of fiscal subsidy is directed to infra-marginal firms. This finding is not surprising, and constitutes a chief critique of payroll tax cuts that come with weak qualifying criteria-that firms minimally affected by the COVID shock received windfall gains.

3.3 Representativeness

We use 2016 data from one province to simulate the impact of payroll tax cuts on Chinese firms in 2020. How well does our data from 2016 reflect the level of firm SI participation before the onset of COVID in early 2020? And how representative is the province we study of China as a whole?

To address the first question, we collected official budgetary figures for each of the local BOAI pooling units in our province. Fig. B.1 plots those figures, which shows that the median growth in inflation-adjusted aggregate revenues was 20% from 2016 to 2019. This growth could stem from (a) a growing workforce, (b) wage growth, or (c) increasing SI compliance. Population growth in China was limited during this period, but wage growth nationwide between 2016 and 2019 was 15.24% in real terms (CEIC, 2021) (and similar in the province we study). This suggests wage growth at formal-labor firms may be the main cause of SI revenue growth.

To examine factor (c), Fig. B.2 plots the trends in firm SI participation from 2012 to 2016 in our provincial data. Across all firm sizes, participation was stable up to 2016, suggesting no significant trend of growth in participation prior to 2017.[25] However, in official aggregate statistics, the proportion of urban employees participating in BOAI nationally increased from 67.16% in 2016 to 70.46% in 2019.[26] A similar-sized increase occurred in our province. Nonetheless, according to official aggregate statistics, the province we study has had consistently higher BOAI participation than the national average such that its level of participation in 2016, even if lower than its level in 2019, is close to the national average in 2019. Therefore, 2016 data from our province should reasonably capture the average extent of SI compliance in China on the eve of the pandemic.

[25] Additionally, 2016 pooling-unit revenues are extremely predictive of 2019 revenues. Since firm composition varies widely across pooling units, the high correlations across time within pooling unit indicates relative stability of SI burdens across the distribution of firms.

[26] For MOHRSS annual reports, see, e.g., http://www.mohrss.gov.cn/SYrlzyhshbzb/zwgk/szrs/tjgb/201805/W020180521567132619037.pdf. The government's aggregate statistics may overstate the growth in participation because they count all individuals who have ever contributed to BOAI as participants, regardless of whether the individuals currently contribute.

Fig. 6 Subsidy versus predicted change in revenue. *Note*: This *x*-axis is the mean percent change in revenue caused by the COVID-19 shock estimated by Chen et al. (2020) as outlined in Sect. 2. They report revenue changes for 4 firm size bins and 18 industries, which we show in Panel *A*. The *y*-axis is the ratio of the bin's total simulated subsidy over its total costs. The calculation of the subsidy is described in Sect. 3.2.1. Panel *B* aggregates to industry bins. To do so, the predicted percent change for an industry is calculated as total-cost-weighted average among firms of all sizes in that industry ▶

In any case, if in 2019 SI participation was higher than is observed in our 2016 sample, our estimates of the liquidity effect of payroll tax reductions can be read as reflecting a lower bound.

To address the more general question of how representative our province is of the rest of China, Appendix B discusses in detail how the provincial data matches against China as a whole by reference to national aggregate statistics from the China Statistical Yearbook (CSY). In addition, we note three considerations. First, our province is characterized by above-national-average SI participation (though it is not a far outlier), has an aggregate BOAI surplus, and had sufficient basic medical insurance (MI) surplus to adopt the discretionary MI contribution reduction in 2020.[27] This means that in Chinese provinces where SI participation is substantially lower, payroll tax cuts may have been less effective in delivering assistance to businesses. Second, in terms of the share of employment that is in a tertiary industry-which is relevant to the sectoral targeting of payroll tax cuts-our province is close to the national average. Third and finally, because a large country like China is inherently diverse, our province will invariably be more like some provinces than others. The most we can say is that it is fairly representative of national averages.

4 Discussion and conclusion

Many advanced economies responded to the COVID economic shock with fiscal policies unprecedented in both scale and form. In comparison, China's response to COVID by way of additional spending and foregone revenue is moderate as a proportion of its GDP and more typical for developing countries.[28] Its payroll tax cuts amounted to about 1.68% of 2020 GDP, whereas in the USA the Paycheck Protection Program alone delivered government support equal to 4.55% of 2020 GDP.[29] China's choice of policy instrument was also conservative: instead of launching novel spending programs, it temporarily reduced rates under an existing tax.

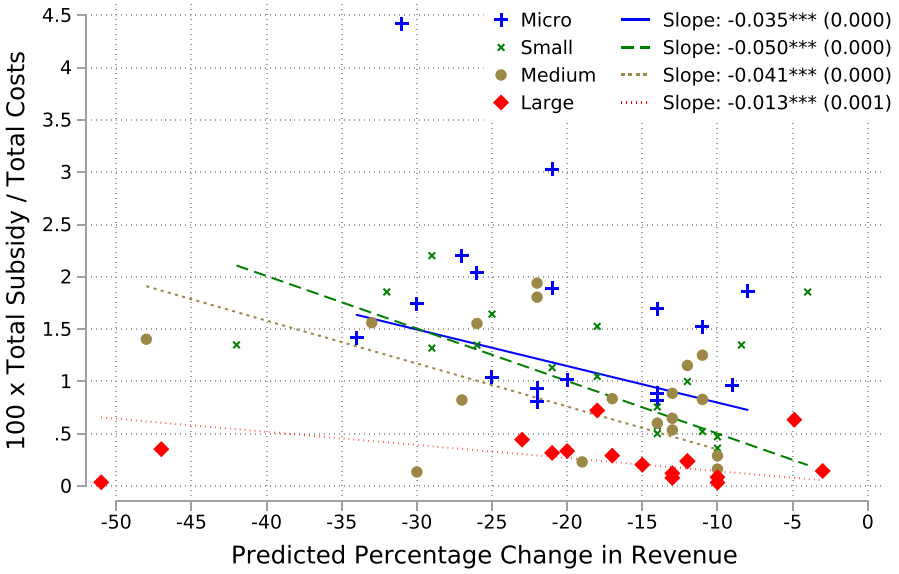
Such conservatism likely reflected China's limited fiscal capacity-a feature it shares with most other middle- or lower-income countries. Especially given such

[27] The national government regards local tax agencies as more reliable enforcers of SI obligations than local social insurance administrations. The province we study has relied on tax agencies to collect SI contributions since well before 2016, and did not undergo changes in this regard between 2016 and 2020.

[28] See the IMF's Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic, https://www.imf.org/en/Topics/imf-and-covid19/Fiscal-Policies-Database-in-Response-to-COVID-19.

[29] Similarly, the Canada Emergency Wage Subsidy cost 5.1% of 2020 GDP. The USA and Canada, like many other developed countries, also provided unprecedented fiscal support directly to individuals and families.

(a) Firm Size × Industry Bins



(b) Industry Bins

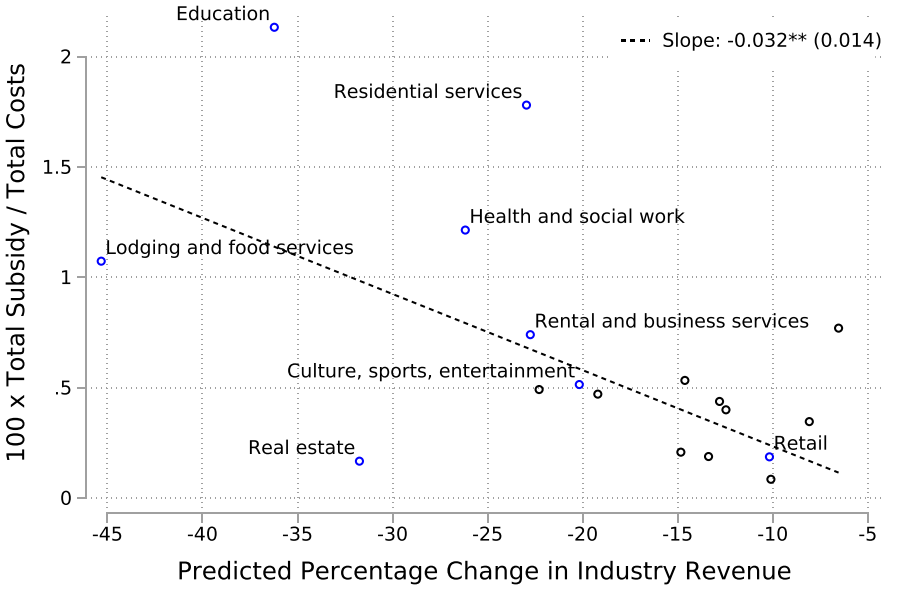


Table 3 Correlation of fiscal support and predicted revenue change across industries

	100 × Subsidy/Costs		100 × Subsidy /Liquidity	
	Participants (1)	Full sample (2)	Participants (3)	Full sample (4)
Micro	−0.146***	−0.035***	−0.018***	−0.002***
	(0.001)	(0.000)	(0.000)	(0.000)
	[132422]	[409168]	[132422]	[409168]
Small	−0.073***	−0.050***	−0.008***	−0.009***
	(0.000)	(0.000)	(0.000)	(0.000)
	[154792]	[272966]	[154792]	[272966]
Medium	−0.051***	−0.041***	−0.004***	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
	[96047]	[135599]	[96047]	[135599]
Large	−0.015***	−0.013***	−0.005***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
	[7474]	[9557]	[7474]	[9557]
_cons	−0.019**	−0.449***	−0.361***	−0.293***
	(0.008)	(0.002)	(0.006)	(0.001)
All firms	−0.040**	−0.032**	−0.048*	−0.038*
	(0.019)	(0.014)	(0.026)	(0.019)
	[390735]	[827290]	[390735]	[827290]

The top panel reports coefficients from regressing the industry subsidy ratio on the predicted revenue change from Chen et al. (2020), separately for each of four size groups, weighted by the number of firms (reported in square brackets) in each industry-size bin. There are 18 industries. A bin's subsidy ratio is calculated by dividing the total subsidy across firms in the bin by total costs or liquidity across firms in the bin. The bottom panel further aggregates up to the industry level and reports the correlation of revenue change and subsidy ratio from the analogous regression. Robust standard errors are reported in parentheses. Firm counts are reported in square brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

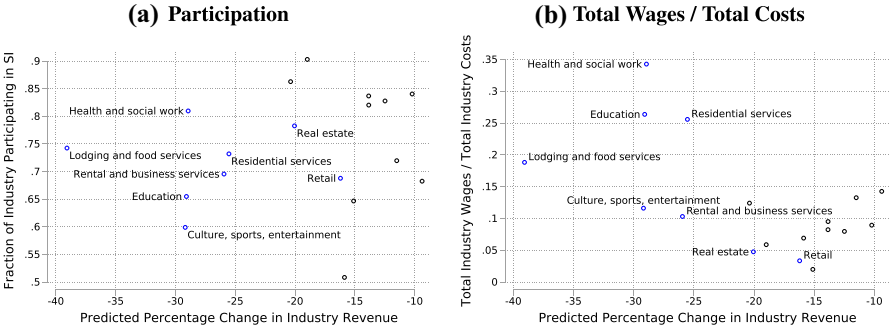


Fig. 7 SI participation and labor Intensity versus predicted change in revenue. *Note*: The *x*-axis is the mean percent change in revenue estimated by Chen et al. (2020) as described in Sect. 2. The predicted percent change we plot is the total-cost-weighted average among all firms (in our data) in the industry. In Panel *A*, the *y*-axis is the fraction of total costs in a given industry that is accounted for by SI participating firms. In Panel *B*, the *y*-axis is the ratio of total industry wages over total industry costs

Table 4 Distribution of aggregate fiscal support

	% of Firms	% of Participating firms	% Total subsidy
Marginal firms	18.84	17.86	11.20
Always negative	38.32	34.57	19.26
Always positive	42.77	47.55	69.54

This table shows the estimated fraction of total fiscal support going toward each of three groups of firms: "Marginal" firms are pushed from positive to negative profits due to the COVID shock; "Always Negative" firms are unprofitable even in the absence of the shock; and "Always Positive" firms remain profitable even during the COVID shock. Firms are assumed to reduce variable costs proportionally to their revenue loss, while fixed costs remain constant. Section 3.2.1 details the calculation of fiscal support for each firm

limited capacity, payroll tax cuts enjoy certain advantages. For example, our analysis showed that among participating firms, SI contribution obligations represent one of the largest tax bases-dominating the CIT base, for example-which allows payroll tax cuts to confer substantial and immediate benefits to many firms with minimal administrative burden. Moreover, payroll tax cuts turn out to be uniquely suited to target benefits to small firms and COVID-affected industries because these segments of the economy are disproportionately labor intensive. A crucial drawback, however, is that labor informality clearly reduces the reach of benefits among small firms.

It is useful to reflect on the conditions that render our analysis of payroll tax cuts applicable beyond China. First, the condition that greater labor intensity characterizes small firms and pandemic-exposed industries holds true widely.[30] Second, the level of labor informality at formally registered firms in China is comparable to that reported in other developing countries. For instance, Perry et al. (2007) find that, among 14 Latin American countries in the early 2000s, the percent of salaried workers that enjoy legal protections in formal firms with five or more employees ranges from only 40.9% in Bolivia, to 59.4% in Mexico and 86.7% in Uruguay.[31] China's official statistic that in 2019, 70.5% of the urban employed population participate in basic pension insurance, falls within this range. Third, while payroll tax rates vary widely even across countries at similar levels of economic development, there are many high-payroll-tax countries in both developing and rich countries (Social Security Administration, 2019). In such countries, payroll taxes are a high share of tax burdens just as in China.

Given these weak conditions, it is worth noting that country-specific institutional reasons may explain the choice of payroll tax cuts versus other forms of wage subsidy. Countries like Finland, Norway, Spain, and Sweden enacted payroll tax cuts in response to COVID, while the USA, Canada, and Australia enacted special wage

[30] Evidence that smaller firms are more labor intensive is documented in Bachas et al. (2020); Kumar et al. (1999).

[31] Shown in Table 1.1. at https://openknowledge.worldbank.org/handle/10986/6730 Since informal labor is more prevalent among small firms, these estimates understate the degree of informality by restricting to firms with 5 or more employees.

subsidy programs. Notably, in the latter countries, payroll tax rates are low. Governments, therefore, may have felt that payroll tax cuts in themselves would not deliver a sufficiently robust response to COVID-19. On the other hand, in many countries where payroll tax rates are high (e.g., France, Germany, and Italy), short-time work schemes, rather than wage subsidies, represented the most important labor market interventions (Giupponi et al., May 2022). Scarpetta et al. (2020) attribute this divergence to varying labor regulations: those countries with more rigid employment relations have more developed short-term work schemes.

Overall, we believe their targeting properties, their similarity to wage subsidies,[32] and their administrability and fiscal feasibility despite limited state capacity,[33] all render payroll tax cuts an important candidate for governments choosing policy responses to the pandemic.

However, while we have made empirical statements about the liquidity-targeting properties of payroll tax cuts, the broader welfare effect of wage subsidies is more complicated. Birinci et al. (2021) and Abbott and Van Phan (2021) use calibrated labor market search models to demonstrate that wage subsidies are an optimal fiscal response to a pandemic shock in labor markets with frictions, especially, though not exclusively, when unemployment insurance is limited (as in China). In these models, a welfare benefit arises because wage subsidies preserve employee-firm matches which provides direct income smoothing and speeds up the recovery once the initial shock subsides. This latter point resembles the argument that with frictions in credit markets, providing liquidity to firms speeds up the recovery by keeping viable businesses afloat (Hanson et al., 2020).

Yet labor market informality raises additional considerations that neither Birinci et al. (2021) nor Abbott and Van Phan (2021) incorporate. For instance, formal employment may reflect better-quality matches, increasing the social value of retention of formal matches relative to informal ones. On the other hand, the destruction of low-productivity matches may have long-lasting economic effects if these workers find it especially difficult to re-establish employment (Gregory et al., 2020). The welfare analysis of the exclusion of firms that rely on informal labor from government assistance thus requires further investigation.

In conclusion, our study offers what may be the first calculation of the extent of COVID-19-related government assistance to employers through payroll tax cuts. Our use of Chinese administrative data offers a perspective not only on policy developments in one of the world's most important economies, but also-and equally importantly-on a critical question that faces all of the world's developing economies: how much does government intervention matter when the informal economy is very large?

[32] Note that like wage subsidies, SI rate cuts incentivize new hiring, and may therefore improve labor reallocation whereas employee-retention schemes do not.

[33] Imperfect coverage of small firms is not unique to SI. For instance, in both developing (Bonomo et al., 2015; Ornelas et al., 2019) and developed countries (including the USA (Granja et al., 2020; Humphries et al., 2020)), government-sponsored credit programs typically struggle to reach small firms. This is consistent with preliminary evidence indicating that China's COVID lending program did not affect SME firm liquidity or survival (Chen et al., 2020). In contrast to such lending programs, payroll tax cuts have the benefit of administrative simplicity and non-reliance on private intermediaries.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10797-022-09746-w.

Acknowledgements We are grateful for helpful comments from Joshua Gottlieb, Kevin Milligan, Nathan Seegert, Munir Squires, Trevor Tombe, Jing Xing, and Laura Zimmermann. We also thank Tingyu Chen, Joanne Xu, and Yi Zhao for excellent research assistance. This work was supported by funding from the Social Sciences and Humanities Research Council of Canada [Insight Grant 435-2018-0538 to Cui; Postdoctoral Award 756-2021-0204 to Hicks]. All errors and omissions are our own. The authors have no competing interests to declare.

Data Availability The data used in this study are proprietary and not publicly available. Replication codes and all analysis details will be made publicly available online.

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