Erschienen in: Review of Economic Dynamics. Elsevier. 2021, 40, pp. 198-227
https://doi.org/10.1016/j.red.2020.09.009

The aggregate consequences of tax evasion

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A B S T R A C T

This paper studies how tax evasion in the self-employment sector affects aggregate outcomes and welfare. We develop a dynamic general equilibrium model with incomplete markets in which heterogeneous agents choose between being a worker or self-employed. Self-employed agents may misreport their business income but face the risk of being detected by the tax authorities. Our model replicates important quantitative features of the U.S. economy in terms of income, wealth, self-employment, and misreporting. Tax evasion alleviates credit constraints and leads to a larger self-employment sector but reduces the average size and productivity of self-employed businesses. Tax evasion generates positive welfare effects for the self-employed at the expense of the workers.

Keywords:
Tax evasion
Self-employment
Occupational choice
Wealth inequality
Incomplete markets
Heterogeneous agents

1. Introduction

Tax evasion of individual income is substantial in the United States. The Internal Revenue Service (IRS) estimates that the lost federal tax revenue due to underreported individual income is $197 billion in 2001, which is 18 percent of the actual individual income tax liability (U.S. Department of the Treasury 2006).[1] Tax evasion is concentrated among self-employed businesses. While only 1 percent of wages and salaries is misreported, this figure rises to 57 percent for self-employed income (Johns and Slemrod 2010). Self-employed businesses constitute an important component of the U.S. economy. They account for 39 percent of the assets and 21 percent of the income in the economy.[2]

What are the aggregate consequences of tax evasion in the self-employment sector in the U.S.? Does evading taxes by self-employed businesses matter for aggregate outcomes, inequality, and welfare? What are the channels through which such effects operate? What are the implications for tax enforcement policies?

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[1] For the remainder of the paper we refer to the underreporting of individual income as tax evasion. Tax evasion is a violation of the tax code and differs from tax avoidance practices, which reduce tax liability via legal means.

[2] These numbers are derived from the Panel Study of Income Dynamics (PSID). For more details on the data work, see Appendix A.

To answer these questions we develop a dynamic general equilibrium model with incomplete markets and occupational choice and study the impact of tax evasion on aggregate outcomes, the distribution of wealth, and welfare. In our model environment, infinitely-lived households face idiosyncratic and persistent shocks to their labor productivity and their talent of running a self-employed business. They pay progressive income taxes, make consumption and saving decisions, and choose between being a worker or self-employed each period. Workers supply their labor services to the labor market and cannot evade taxes. Self-employed households invest in capital, hire labor, and use a decreasing returns to scale technology to produce the consumption good. They are credit-constrained and face a borrowing limit proportional to the amount of their net wealth. Self-employed households may hide a share of their business income, however, tax evasion is costly. When misreporting their business income, they are confronted with the probability of being detected by the tax authorities and punished by a proportional fine on the evaded taxes. Therefore, they optimally determine the size of their firms, taking into account that detection becomes more likely as their business grows. In addition to the self-employment sector, there is a corporate sector in which firms operate with a constant returns to scale technology and use labor and capital competitively to produce the consumption good.

We calibrate the model to the U.S. economy at the start of the 2000s using the Panel Survey of Income Dynamics (PSID). Importantly, the parameters related to tax evasion are set to match the average misreporting rate of income as well as the cross-sectional misreporting rates conditional on the level of income. The model replicates important quantitative features of the U.S. economy in terms of income, wealth, and self-employment. The model successfully matches the size distribution as well as the average leverage of self-employed businesses. The overall excellent fit of the model with respect to this broad set of empirical facts for the U.S. economy gives us confidence to use the model for a quantitative analysis.

We study the impact of tax evasion by comparing our benchmark economy with a counterfactual economy in which taxes are perfectly enforced. The optimal decision rules highlight three important channels through which tax evasion affects aggregate outcomes. *(i)* The *subsidy channel*: tax evasion acts like a subsidy and stimulates asset accumulation, allowing higher investment in business capital. *(ii)* The *selection channel*: the opportunity to evade taxes induces less talented agents to run self-employed businesses. *(iii)* The *detection channel*: self-employed agents have incentives to keep their businesses small in order to stay under the radar of the tax authorities and to reduce the probability of being audited.

The quantitative analysis of the stationary equilibrium suggests that tax evasion by self-employed businesses matters for aggregate and distributional outcomes. In our application to the U.S. economy, the opportunity to evade taxes increases the number of self-employed businesses but reduces the average productivity of the self-employment sector. Moreover, tax evasion increases the share of small businesses, which is crucial for replicating the empirical self-employed firm size distribution. Furthermore, the economy with tax evasion is characterized by higher aggregate savings and larger aggregate output than the counterfactual economy with perfect tax enforcement. While in the aggregate, wealth inequality increases, self-employed households and workers are affected differently by tax evasion. Within the group of the self-employed, wealth inequality is reduced, whereas it is raised within the group of workers.

Our finding that tax evasion raises output in the aggregate is not trivial since tax evasion distorts the self-employed firm size and induces less able agents to self-select into self-employment. However, at the same time, tax evasion reduces the distortionary impact of income taxation and alleviates the financial frictions imposed on self-employed households via the credit constraint. Our results highlight that in the aggregate the *subsidy channel* dominates the *selection channel* and the *detection channel*. Importantly, the *subsidy channel* is quantitatively stronger in economies in which self-employed businesses face tighter borrowing limits.

Next, we study the welfare implications of tax evasion. To this end, we calculate the welfare effects of eliminating tax evasion by adopting a perfect tax enforcement technology. Our analysis suggests that the elimination of tax evasion generates an aggregate welfare loss of about 1.7 percent, measured in consumption equivalence units. However, perfect tax enforcement raises tax revenues by around 1.9 percent of GDP, which corresponds to the empirical estimate of the U.S. underreported tax gap of 2 percent of GDP (U.S. Department of the Treasury (2009)). If these additional tax revenues are redistributed to all households via lump-sum transfers or tax cuts, perfect tax enforcement still adversely affects aggregate productivity and the welfare of the self-employed, but workers substantially benefit. In this case, the aggregate welfare effect turns positive and amounts to around 1.9 percent, measured in consumption equivalent units. Importantly, poor self-employed households in the lowest decile of the wealth distribution suffer most from perfect tax enforcement because tax evasion allows them to relax their credit constraint. If the additional tax revenues are used for tax cuts targeted to the self-employed to alleviate their financial constraints, then perfect tax enforcement generates higher aggregate productivity and an overall aggregate welfare gain of about 1 percent. Not only the self-employed benefit from the tax cut but also workers, albeit their gains are significantly lower.

Against the backdrop that taxes are imperfectly enforceable, we focus on the penalty for tax evasion as a tax enforcement policy instrument. In the U.S., the fine for tax fraud amounts to 75 percent of the missing taxes. To analyze how a rise in the penalty affects aggregate outcomes and welfare, we employ our benchmark economy and vary the fine between 25 and 400 percent. Our quantitative findings suggest that raising the penalty from 75 to 125 percent reduces misreporting and sharply increases tax revenues. If these additional tax revenues are redistributed to all households via lump-sum transfers or tax cuts, both workers and self-employed households experience welfare gains between 0.2 and 0.3 percent, measured in consumption equivalence units. Penalties beyond 125 percent of the missing taxes reduce the share of self-employed, depress aggregate output and dampen the increase in tax revenues with adverse welfare effects for the self-employed.

The rest of the paper is organized as follows. The next subsection discusses the related literature. In Section 2, we provide further details on tax evasion in the U.S. Section 3 presents the model. Section 4 explains the calibration procedure and shows the model fit. In Section 5, we present and discuss how tax evasion affects aggregate outcomes, inequality, and welfare. Moreover, we analyze the interaction between credit constraints and tax evasion. Section 6 studies the impact of tax enforcement policy on aggregate outcomes and welfare. The last section concludes.

1.1. Related literature

The economic theory of the technology and practices of tax evasion was initiated by the seminal works of Allingham and Sandmo (1972) and Yitzhaki (1974). They present a stylized model of tax evasion by a risk-averse agent who faces the probability of getting caught and penalized by the tax authorities. The theoretical analysis shows that evasion depends on income and risk aversion. Andreoni (1992) extends this framework to a two-period model with income uncertainty and borrowing constraints. Other notable extensions of the static theory are presented by Yitzhaki (1974) and Pencavel (1979) who allow for a more general penalization structure and introduce labor supply choice, respectively. For a detailed summary of the literature, see Andreoni et al. (1998), Slemrod and Yitzhaki (2002), and Slemrod (2007). We take this classic modeling approach to tax evasion and incorporate it in a modern heterogeneous agent macroeconomic model of income and wealth inequality.

The macroeconomic literature on the aggregate effects of tax evasion is scarce. Our paper is related to Maffezzoli (2011) who explores the distributional effects of tax evasion in a heterogeneous agent framework with incomplete markets. His model, similarly to ours, successfully replicates the cross-sectional pattern of tax evasion which is increasing in income. His findings point out that moving from a progressive to a proportional taxation reduces the amount of evaded taxes and raises government revenues. In contrast to his model, our framework explicitly accounts for the role of self-employed businesses. This allows us to quantitatively document the consequences of tax evasion for capital accumulation and aggregate productivity. More recently, Kotsogiannis and Mateos-Planas (2019) study tax evasion as a form of contingent debt within a quantitative life-cycle model with incomplete markets. They find that eliminating tax evasion leads to significant welfare gains but reduces capital accumulation. In a related contribution, Fernandez-Bastidas (2019) studies the role of tax evasion in a heterogeneous agent model with occupational choice. The main quantitative experiment differs from ours and evaluates a tax reform in which the existing progressive tax code is replaced by a proportional income tax. The results point out that tax evasion matters when assessing the welfare consequences of the reform.

Our work builds on existing quantitative macroeconomic models with heterogeneous agents and incomplete markets in which entrepreneurs face borrowing constraints. The seminal works of Quadrini (2000) and Cagetti and De Nardi (2006) paved the way for generating adequate distributions of wealth in macroeconomic environments due to the savings behavior of entrepreneurs. Kitao (2008) explores the productive and welfare effects of capital taxation in a similar framework and shows that these effects depend on whether entrepreneurial or non-entrepreneurial capital is taxed. Cagetti and De Nardi (2009) incorporate the role of hiring in the entrepreneurial sector and study the effects of eliminating the estate tax. Imrohoroglu et al. (2018) and Brüggemann (2019) use a similar framework as Cagetti and De Nardi (2009) to study the optimal taxation of the rich. We complement these works by introducing the possibility of tax evasion for self-employed businesses and by exploring its role for aggregate economic outcomes and welfare.

Our paper is also related to the vast literature on misallocation and productivity. Hsieh and Klenow (2009) and Restuccia and Rogerson (2008) document that firm-level distortions such as idiosyncratic taxes, subsidies, or sector-specific government regulations can distort the optimal allocation of capital and labor across firms, leading to a significant loss in aggregate productivity. More closely related to our analysis, Ordonez (2014) shows that imperfect tax enforcement leads to several distortions that reduce output and productivity in the economy. In particular, tax evasion reduces the optimal capital-labor ratios in firms that actively engage in underreporting, since they want to remain undetected by the government. A similar channel is operational also in our paper, where self-employed evading businesses have an incentive to keep their scale small in order to stay under the radar of the tax authorities (*detection channel*).

2. Tax evasion in the United States

The Internal Revenue Code contains three primary obligations on taxpayers: *(i)* to file timely returns, *(ii)* to report accurately on those returns, and *(iii)* to pay the required tax voluntarily and on time. Thus, non-compliance takes three forms: *(i)* underreporting (not reporting full liability on a timely-filed return), *(ii)* underpayment (not paying the full amount of tax reported on a timely-filed return), and, *(iii)* non-filing (not filing the required returns on time). Given the scope of this paper, we concentrate on the first component of non-compliance, namely, underreporting.

Individual income tax evasion and its distribution. The underreported tax gap is defined as the amount of tax liability which is not reported voluntarily by taxpayers who file tax returns on time. The IRS estimates that in 2001 underreporting of individual income tax led to a tax gap of $197 billion (U.S. Department of the Treasury 2009). This amounts to around 2 percent of the U.S. GDP in that year.[3] Only 1 percent of wages and salaries and 4 percent of taxable interest and dividends are misreported to the IRS. In contrast, 57 percent of self-employed business income is not reported. Using U.S. household survey data, Hurst et al. (2014) report that self-employed income is underreported by 30 percent.[4]

Johns and Slemrod (2010) assess the distribution of tax non-compliance for the fiscal year of 2001. In their analysis, tax payers are grouped according to percentiles of their true income, i.e., the gross income they should have reported if not evading. According to their calculations, 11 percent of true income is misreported to the IRS. However, the misreporting rate varies with income levels. Income in the first decile is not misreported at all. Income levels in all other deciles below the median are misreported at a steady rate of around 5 percent. Around 7-8 percent of income in the four deciles above the median is hidden. Finally, tax evasion is highest in the top decile, where more than 15 percent of income is misreported.

Detecting and punishing tax evasion. The IRS had around 13,000 revenue and tax agents in 2002 whose main responsibility was detecting tax evasion (Dubin 2018). The individual income tax examination coverage, i.e., the audit rate was 1.27 percent in 1997. In the following years, the audit rate declined and fell below 1 percent (TIGTA 2002). The aggregate numbers mask, however, a large variation by type and size of reported income, as documented in Slemrod and Gillitzer (2014), Chapter 6.5, and the U.S. Department of the Treasury (2011). The probability of auditing is generally rising in reported income. Individuals' tax returns with reported income between $25,000 and $50,000 had a 0.73 percent probability of being audited. The probability rises to 29.93 percent for tax returns with reported income over $10 million. Auditing rates depend considerably on the type of income declared. Individuals with business income face a higher audit probability than those not reporting business income (2.1 percent and 0.6 percent, respectively). Likewise, for corporations the audit rate dramatically rises with the amount of total assets.[5]

Legally, it is very demanding to prove that a taxpayer knowingly committed a fraudulent act when evading taxes. Therefore, the IRS performs very few criminal investigations and more often pursues civil charges for evasion. Accuracy-related penalties vary between 20-40 percent of the missing taxes, while the civil fraud penalty is fixed at 75 percent (U.S. Department of the Treasury 2016).

3. The model

The model builds on the seminal contributions of Quadrini (2000), Cagetti and De Nardi (2006, 2009) who introduce entrepreneurs in macroeconomic models of wealth inequality but it differs from them in two key aspects. First, we introduce income tax evasion following the classic papers by Allingham and Sandmo (1972) and Yitzhaki (1974). Second, in light of the empirical facts on tax evasion, we concentrate on self-employed businesses and not on the general category of entrepreneurs.

Our model economy includes households, firms, and the government. Households are infinitely lived. Each time period corresponds to one year. Each period, households receive a pair of idiosyncratic realizations of their working ability and their ability of running a self-employed business. Based on these realizations and their stock of savings, they decide whether to form a self-employed business or to be a worker. Following, e.g., Cagetti and De Nardi (2009), self-employed firms hire labor. Moreover, households' labor supply is endogenous. As in Aiyagari (1994), asset markets are incomplete, i.e., households cannot insure against shocks to their working or business abilities. In addition, there is another source of market imperfection: borrowing of self-employed businesses is subject to a credit constraint.

We follow Cagetti and De Nardi (2009) and assume that the ability of working in the corporate sector and the ability of running a self-employed business evolve independently. We abstract from the fact that agents with a high self-employed business ability may also be very productive as managers in the corporate sector. In recent papers, Lee (2019) and Allub and Erosa (2019) explicitly distinguish between entrepreneurs and managers to account for the distribution of income across occupations.

3.1. Preferences and endowments

Each household is endowed with one unit of time. Households derive utility from consumption c_t and leisure $1-\ell_t$, where ℓ_t denotes labor supply. Households maximize the expected sum of discounted utility given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, 1-\ell_t),$$

[3] The estimate is based on the data collected through the National Research Program (NRP) Individual Income Tax Reporting Compliance Study for the 2001 tax year. The NRP analyzes approximately 46,000 randomly selected individual income tax returns. The estimated underreporting gap excludes unpaid taxes due to purely illegal activities.

[4] Kleven et al. (2011) finds similar facts using audit data for Denmark. They document that tax evasion is around zero for income subject to third-party reporting (such as wages and salaries) but is substantial for self-reported income. Using U.K. survey data, Pissarides and Weber (1989) and Cabral et al. (2019) report that self-employed households underreport on average between 20 and 55 percent of their income. Using data across countries and occupations, Barany (2017) documents that the opportunity to evade taxes is a key driver behind the choice of becoming self-employed.

[5] We report more data on the relationship between auditing and income levels/size of business activity in Appendix A.4.

where $\beta \in (0, 1)$ is the time discount factor. The utility function u is defined as $u(c, 1-\ell) = \frac{c^{1-\sigma_1}}{1-\sigma_1} - \psi \frac{\ell^{1+\sigma_2}}{1+\sigma_2}$, where $\sigma_1 > 0$ denotes the coefficient of risk aversion and $\sigma_2 > 0$ is the inverse of the Frisch elasticity of labor supply. The parameter ψ relates to the disutility from work. Each household is endowed with a working ability $\varepsilon \in \mathcal{E}$ and a business ability $\theta \in \Theta$, where ε and θ are drawn from a finite-state Markov process with transition probability $F(\varepsilon', \theta'|\varepsilon, \theta)$.

3.2. Technology

The economy consists of two sectors of production. The single consumption good is produced either in a large corporate sector with a representative firm or by self-employed businesses run by households. Actors in both sectors are price takers.

Following Cagetti and De Nardi (2006), self-employed households decide how much capital to use in the production process. In addition, as in Imrohoroglu et al. (2018), they decide how much to work in their own businesses and how much labor to hire. They combine their business ability θ, their own labor input ℓ, capital k, and hired labor n according to a production function,

$$f(\theta, k, n, \ell) = \theta(k^{\gamma}(\ell + n)^{1-\gamma})^{\nu},$$

where $0 < \nu < 1$ and $0 < \gamma < 1$. The production function exhibits decreasing returns to scale capturing the *span of control* idea introduced by Lucas (1978): self-employed business skills gradually deteriorate as the size of the firm increases. Self-employed households can save at a risk-free rate r and use their wealth to finance capital used in their businesses. In addition to using their own assets, they can borrow from a financial intermediary at a rate r.[6] This borrowing is limited up to a constant share of their assets which self-employed households can pledge as collateral, $k \leq \lambda a$, where $\lambda \geq 1$. The two polar cases of $\lambda = 1$ and $\lambda = \infty$ capture the two extremes of financial autarky and perfect credit markets, respectively.

The corporate firm operates according to a constant returns to scale technology,

$$F(K_C, N_C) = K_C^{\alpha} N_C^{1-\alpha},$$

where $0 < \alpha < 1$. The corporate firm rents capital K_C from households at a rate r and labor services N_C from workers paying a wage w. Capital in both sectors depreciates at a rate $\delta \in (0, 1)$. Profit maximization in the corporate sector implies that in equilibrium input prices are set according to their marginal products,

$$r = \alpha K_C^{\alpha-1} N_C^{1-\alpha} - \delta \tag{1}$$

and

$$w = (1-\alpha) K_C^{\alpha} N_C^{-\alpha}. \tag{2}$$

3.3. Government and taxation

The government raises tax revenues to finance exogenously given public spending G. Both workers and self-employed households are subject to a non-linear personal income tax $T^i(\cdot)$ meant to approximate the actual tax code for the U.S. by capturing not only the statutory tax rates but also deductions, exemptions, and tax credits. We allow the tax schedules to be different for workers and self-employed. In particular, following Gouveia and Strauss (1999), we assume that each agent of type $i = \{W, E\}$, where W stands for workers and E stands for self-employed, has to pay tax liabilities given by the following tax function[7]:

$$T^i(y) = a_0^i \left[y - \left(y^{-a_1^i} + a_2^i \right)^{-1/a_1^i} \right]. \tag{3}$$

Note that for $a_1 > 0$, we have a progressive tax system since the average tax rate,

$$\frac{T^i(y)}{y} = a_0^i \left[1 - \left(1 + a_2^i y^{a_1^i} \right)^{-1/a_1^i} \right],$$

is increasing with income y.[8]

[6] The financial intermediary collects deposits from households and lends the proceeds to the corporate firm or the self-employed businesses. The ability of the self-employed household is not observed by the intermediary, and, therefore, borrowing contracts cannot be conditioned on it.

[7] Guner et al. (2014) show that this tax function is very flexible and provides a good approximation of the effective U.S. tax schedule. This functional form has been used extensively in the quantitative macroeconomic and public finance literature. Notable examples are Conesa et al. (2006), Kitao (2008), and Cagetti and De Nardi (2009).

[8] In addition, the degree of tax progressivity is increasing with a_1. If $a_1 \to 0$, then $T^i(y) \to a_0 y$, i.e. taxes are proportional.

The crucial element of our modeling exercise is the introduction of tax evasion. Whereas workers cannot evade taxes, self-employed households may hide a share $\phi \in [0, 1]$ of their business income.[9] Evading taxes, however, is costly. Following Chen (2003), hiding business income generates a fixed resource cost $\kappa > 0$. As argued by Chetty (2009), this cost may reflect a loss of business profit from concealing activities and transacting in cash.

The government can monitor through audits and verify the individual tax returns. Let $p(k)$, with $p'(k) > 0$, be the probability that a self-employed tax return is subject to monitoring. If the self-employed household is audited and underreporting is detected, a fine $s > 1$ proportional to the amount of the underreported taxes is issued.[10] In essence, the self-employed needs to pay back the hidden taxes and an additional proportional penalty. For simplicity, we assume that the auditing efforts of the tax authorities are costless.

Similar to Ordonez (2014), our key assumption is that the probability of being audited depends positively on capital, $p'(k) > 0$, capturing the idea that larger firms are more visible to the tax authorities. This modeling strategy is in line with the empirical evidence: Lewis (2005) and Ordonez (2014) report that government agencies target larger establishments when it comes to audits. Ulyssea (2018) provides empirical evidence that evading firms are smaller and use less capital per worker. Moreover, in Chapter 6.5, Slemrod and Gillitzer (2014) document that in the U.S. the probability of auditing generally rises with income levels.[11]

3.4. Household problem

Timing of events. The sequence of events in this economy unfolds as follows. At the beginning of each period, the idiosyncratic shocks ε and θ for working and business ability are realized. After observing these shocks, and conditional on the value of assets a inherited from the previous period, an individual chooses whether to be a worker or self-employed for the current period. Workers make optimal decisions regarding consumption, labor supply, and savings and pay income taxes to the government. Self-employed households decide how much to invest taking their credit constraint into account. Moreover, they choose how much labor to hire and how much to work in their own businesses. They decide how much to evade taking into account the costs related to tax evasion and the probability of getting detected by the tax authorities. After the business decisions are made, auditing by the government takes place. After observing whether they are detected, self-employed households make consumption and savings decisions.

The optimization problem of a household can be recursively formulated, with the individual states being the assets level a and the current abilities ε and θ. Let V^W and V^E denote the values of being a worker or self-employed, respectively. The beginning-of-the-period value function is given by:

$$V(a, \varepsilon, \theta) = \max \left\{ V^W(a, \varepsilon, \theta), V^E(a, \varepsilon, \theta) \right\}. \tag{4}$$

Let $o(a, \varepsilon, \theta)$ denote the occupational choice associated with problem (4):

$$o(a, \varepsilon, \theta) = \begin{cases} 1, & \text{if } V^E(a, \varepsilon, \theta) \geq V^W(a, \varepsilon, \theta) \\ 0, & \text{otherwise.} \end{cases}$$

Workers. The worker's problem can be written as:

$$V^W(a, \varepsilon, \theta) = \max_{c, \ell, a'} \left\{ u(c, 1 - \ell) + \beta \mathbb{E}\left[V\left(a', \varepsilon', \theta'\right) | \varepsilon, \theta \right] \right\} \tag{5}$$

subject to

$$y^W = w\varepsilon\ell + ra, \tag{6}$$

$$c + a' \leq y^W + a - T^W\left(y^W\right), \tag{7}$$

$$a' \geq 0, \tag{8}$$

with $c \geq 0$ and $\ell \in [0, 1]$. $T^W(\cdot)$ is the non-linear tax schedule defined in Section 3.3. The worker supplies labor services ℓ, earning a wage w for each productivity unit ε. Equation (6) represents the worker's taxable income, which consists of labor income $w\varepsilon\ell$ and income from financial assets ra. Equation (7) states that all available resources net of taxes are split between consumption and savings. The last constraint reflects the assumption that workers cannot borrow.[12] In line with the data, employed workers cannot misreport their true income to the tax authorities.

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[9] We assume that interest income generated by savings cannot be underreported, for both workers and self-employed households.

[10] In the seminal work of Allingham and Sandmo (1972), the fine paid upon detection of tax fraud is proportional to the evaded income. However, in the U.S., the administrative penalty for evading taxes is proportional to the amount of unpaid taxes.

[11] See Appendix A.4 for more evidence on this.

[12] More generally, equation (8) can be replaced by $a' \geq -\underline{a}$ where $\underline{a} \geq 0$ is an *ad hoc* borrowing limit.

Self-employed. The decisions of a self-employed household amount to choosing business capital k, hired labor n, own labor input ℓ, and the share of business income ϕ, which is not reported to the tax authorities. The self-employed household takes into account the fixed cost of tax evasion κ and the probability of an audit by the tax authorities, $p(k)$, which is conditional on capital.

The beginning-of-the-period value function is given by

$$V^E(a,\varepsilon,\theta) = \max_{k,n,\ell,\phi}\left\{p(k)\,V_d^E(a,\varepsilon,\theta,k,n,\ell,\phi) + (1-p(k))\,V_n^E(a,\varepsilon,\theta,k,n,\ell,\phi)\right\} \tag{9}$$

subject to

$$0 \le k \le \lambda a, \tag{10}$$

with $n \ge 0$, $\ell \in [0,1]$, $\phi \in [0,1]$. Equation (10) is the credit constraint of the self-employed household. The value function for the case of detection is given by

$$V_d^E(a,\varepsilon,\theta,k,n,\ell,\phi) = \max_{c,a'}\left\{u(c,1-\ell) + \beta\mathbb{E}\left[V\left(a',\varepsilon',\theta'\right)|\varepsilon,\theta\right]\right\} \tag{11}$$

subject to

$$\pi = \theta(k^{\gamma}(\ell+n)^{1-\gamma})^{\nu} - wn - (r+\delta)k, \tag{12}$$

$$y^E = \pi + ra, \tag{13}$$

$$c + a' \le y^E + a - T^E((1-\phi)\pi + ra) - s\left[T^E(\pi+ra) - T^E((1-\phi)\pi+ra)\right] - \mathbf{1}_{\phi>0}\kappa, \tag{14}$$

$$a' \ge 0, \tag{15}$$

with $c \ge 0$. Equation (12) defines the profits from business activity. Equation (13) specifies taxable income, which includes both business income π and financial income from savings ra. The indicator function $\mathbf{1}_{\phi>0}$ takes the value of one if tax evasion is present. The budget constraint is given by equation (14) and states that income, net of taxes, fines, and tax evasion costs, is allocated between consumption and savings. Since the self-employed is audited, she has to pay a fine $s > 1$ proportional to the amount of the underreported taxes. Notice that while self-employed households may hide a fraction ϕ of their business income π, they report truthfully their interest income ra.

The value function for the case of non-detection is defined as

$$V_{nd}^E(a,\varepsilon,\theta,k,n,\ell,\phi) = \max_{c,a'}\left\{u(c,1-\ell) + \beta\mathbb{E}\left[V\left(a',\varepsilon',\theta'\right)|\varepsilon,\theta\right]\right\} \tag{16}$$

subject to

$$\pi = \theta(k^{\gamma}(\ell+n)^{1-\gamma})^{\nu} - wn - (r+\delta)k,$$

$$y^E = \pi + ra,$$

$$c + a' \le y^E + a - T^E((1-\phi)\pi + ra) - \mathbf{1}_{\phi>0}\kappa, \tag{17}$$

$$a' \ge 0,$$

with $c \ge 0$. The optimization problem in (16) is very similar to (11) with the only difference coming from the flow budget constraint (17), which now does not show the penalty that applies when the self-employed household is detected by the tax authorities.

For future reference, let us summarize the policy functions associated with the above problems. After solving the worker's maximization problem (5), we get the policy function for asset holdings a' if the agent is a worker, $g^W(a,\varepsilon,\theta)$. $\ell^W(a,\varepsilon,\theta)$ denotes the policy function for the worker's labor supply. The solutions to the maximization problems of the self-employed (11) and (16) imply the policy function for asset holdings if the agent is self-employed and detected, $g_d^E(a,\varepsilon,\theta)$, and if the agent is self-employed and not detected, $g_{nd}^E(a,\varepsilon,\theta)$. The policy function for business capital is denoted by $k(a,\varepsilon,\theta)$ and the policy function for hired labor is $n(a,\varepsilon,\theta)$. $\ell^E(a,\varepsilon,\theta)$ refers to the policy function for the labor input of a self-employed agent in her own business. $\phi(a,\varepsilon,\theta) \in [0,1]$ is the policy function for tax evasion. The policy function $o(a,\varepsilon,\theta)$ refers to the occupational choice of an agent.

3.5. Equilibrium

In a competitive stationary equilibrium, workers, self-employed households, and the corporate firm solve their maximization problems, all markets clear, and the distribution over the state variables that govern the behavior of households is stationary over time. Let the vector $x=(a,\varepsilon,\theta)$ contain the state variables, which summarize all the information necessary to solve the household problems in the economy. Given government spending G, the tax evasion fine s, and income tax functions $T^W(\cdot)$ and $T^E(\cdot)$, a stationary competitive equilibrium consists of value functions $V(x)$, $V^W(x)$, and $V^E(x)$, policy functions $o(x)$, $g^W(x)$, $g_d^E(x)$, $g_{nd}^E(x)$, $k(x)$, $\ell^W(x)$, $\ell^E(x)$, $n(x)$, and $\phi(x)$, input prices r and w, and a probability distribution $\mu(x)$ such that:

1. Given prices $\{r,w\}$, tax functions $\{T^W(\cdot),T^E(\cdot)\}$, and the tax evasion fine s, the value functions $\{V(x),V^W(x),V^E(x)\}$ and the policy functions $\{o(x),\ g^W(x),\ g_d^E(x),\ g_{nd}^E(x),\ \ell^W(x),\ \ell^E(x),\ n(x),\ k(x),\ \phi(x)\}$ solve problems (4), (5), (9), (11) and (16).
2. Prices $\{r,w\}$ satisfy the optimization conditions of corporate firms, (1) and (2).
3. The government budget constraint is satisfied:

$$G=\int\Big\{(1-o(x))T^W\left(y^W(x)\right)+o(x)\,T^E\left((1-\phi(x))\pi(x)+ra\right)+ \\ o(x)\,sp(k(x))\left[T^E(\pi(x)+ra)-T^E((1-\phi(x))\pi(x)+ra)\right]\Big\}d\mu(x). \tag{18}$$

4. The capital and labor markets clear. Capital demand is equal to capital supply:

$$K_C+\int o(x)k(x)\,d\mu(x)=\int a d\mu(x).$$

Labor demand is equal to labor supply:

$$N_C+\int o(x)n(x)d\mu(x)=\int(1-o(x))\varepsilon\ell^W(x)d\mu(x).$$

By Walras' law the goods market clearing condition holds in equilibrium. Total output can be defined as the sum of aggregate production in the self-employment sector and in the corporate sector:

$$Y=\int o(x)\,\theta(k(x)^\gamma(\ell^E(x)+n(x))^{1-\gamma})^\nu d\mu(x)+K_C^\alpha N_C^{1-\alpha}.$$

5. The distribution $\mu(x)$ is stationary, i.e., it satisfies

$$\mu=\mathcal{M}(\mu),$$

where $\mathcal{M}(\cdot)$ is a one-period ahead transition operator such that $\mu'=\mathcal{M}(\mu)$.

4. Fitting the model to the data

We choose the parameters in our model in order to replicate important quantitative features of the U.S. economy. In particular, the focus is on matching *(i)* the share of self-employed households and the distribution of their income and firm size, and, *(ii)* the overall misreporting rate and the misreporting rates across quintiles of income.

We use the PSID for the years 1990-2003 to estimate the data moments related to *(i)*, with the exception of the firm size distribution of self-employed firms, which comes from the Current Population Survey (CPS) for the years 2000-2007.[13] The data targets related to *(ii)* are taken from Johns and Slemrod (2010). For more details on our data work, we refer the reader to Appendix A.

The rest of this section is organized as follows. First, we present parameters that are fixed outside the model. Then, we discuss the internally calibrated parameters, which are set so that the model matches selected data targets. Finally, we report the model fit along several dimensions of the targeted and non-targeted data moments.

[13] Another popular choice for estimating moments of the income and wealth distribution is the Survey of Consumer Finances (SCF). While the SCF is well designed for analyzing the top of the wealth distribution (it oversamples very rich households), it lacks a panel dimension, which is needed to compute the exit rate from entrepreneurship and to estimate the labor income process. Moreover, we borrow estimates for the tax function parameters (for workers and self-employed) from Cagetti and De Nardi (2009), who use PSID data. A number of papers in the macroeconomic literature on inequality use PSID data, e.g., Quadrini (2000), de Nardi et al. (2020), or the aforementioned Cagetti and De Nardi (2009).

Table 1
Externally Calibrated Parameters.

Parameter	Description	Value	Source
σ_1	Risk aversion	2.00	Standard value
σ_2	Inverse of Frisch elasticity	1.67	Frisch elasticity = 0.59
α	Corp. capital share	0.38	Karabarbounis and Neiman (2014)
s	Tax evasion fine	1.75	U.S. Department of the Treasury (2016)
Working ability			
ρ_ε	Persistence	0.89	Micro data - PSID
σ_ε	Standard deviation	0.21	Micro data - PSID
Tax functions			
a_0^W	Workers	0.32	Cagetti and De Nardi (2009)
a_1^W	Workers	0.76	Cagetti and De Nardi (2009)
a_2^W	Workers	0.22	Cagetti and De Nardi (2009)
a_0^E	Self-employed	0.26	Cagetti and De Nardi (2009)
a_1^E	Self-employed	1.40	Cagetti and De Nardi (2009)
a_2^E	Self-employed	0.44	Cagetti and De Nardi (2009)

4.1. Externally calibrated parameters

Personal income tax. As explained in Section 3.3, we specify the income tax functions separately for workers and self-employed, using the functional form of Gouveia and Strauss (1999),

$$T^i(y) = a_0^i \left[y - \left(y^{-a_1^i} + a_2^i \right)^{-1/a_1^i} \right], \tag{19}$$

where $i = \{W, E\}$. The parameters $\{a_0^i, a_1^i, a_2^i\}$ are taken from Cagetti and De Nardi (2009) who estimate this functional form on federal taxes levied on the household pre-government income.

Working ability process. We estimate a stochastic process for working ability following two steps, as it is standard in the literature (see, e.g., Guvenen (2009) and Heathcote et al. (2017)). First, we regress labor earnings on observable household characteristics such as education and experience in order to obtain a measure of labor income residuals ε_t. Second, we model the residuals as a first-order autoregressive process:

$$\log \varepsilon_{t+1} = \rho_\varepsilon \log \varepsilon_t + \eta_{\varepsilon,t+1}, \tag{20}$$

where $\eta_{\varepsilon,t+1} \sim N(0, \sigma_\varepsilon^2)$. We estimate this process for workers and obtain the persistence parameter $\rho_\varepsilon = 0.89$ and the dispersion parameter $\sigma_\varepsilon = 0.21$. We approximate the stochastic process in (20) by a discrete Markov chain following the procedure described in Tauchen and Hussey (1991). More details can be found in Appendix A.2.

Further parameters. We fix the coefficient of relative risk aversion σ_1 to 2 which is standard in the macroeconomic literature. We set σ_2 to 1.67, implying a Frisch elasticity of 0.59 as in Imrohoroglu et al. (2018) and Brüggemann (2019). The parameter α represents the corporate capital share and is set to 0.38, which is the average corporate capital share for the period 1990-2007 (Karabarbounis and Neiman (2014)). Finally, the value of the tax evasion fine s is set to the existing penalty for civil fraud of 75 percent (U.S. Department of the Treasury (2016)). All externally calibrated parameter values are reported in Table 1.

4.2. Internally calibrated parameters

Business ability is assumed to follow a first-order autoregressive process:

$$\log \theta_{t+1} = \mu_\theta + \rho_\theta \log \theta_t + \nu_{\theta,t+1}, \tag{21}$$

where $\nu_{\theta,t} \sim N(0, \sigma_\theta^2)$. The audit probability is a logistic function of business capital. In particular, we assume that

$$p(k) = \frac{1}{1 + p_1 \exp(-p_2 k)}, \tag{22}$$

with $p_1 > 0$ and $p_2 > 0$.[14] As argued before, we assume that the probability of being audited increases with the size of a business, following Ordonez (2014) and Ulyssea (2018).

[14] We choose the logistic function for its flexibility. The parameter p_1 affects the vertical intercept of the function, $p(0) = 1/(1 + p_1)$. The parameter p_2 determines the inflection of the function.

Table 2
Internally Calibrated Parameters.

Parameter	Description	Value	Target
Preferences			
β	Discount factor	0.945	Interest rate
ψ	Disutility from working	0.830	Hours worked
Production			
δ	Capital depreciation	0.110	Capital-output ratio
ν	Span of control	0.740	Firm size distribution, self-employed
γ	Capital share, self-employed	0.730	Share of hiring, self-employed
λ	Leverage ratio	1.500	Leverage of self-employed
Self-employed ability			
ρ_θ	Persistence	0.952	Exit rate, self-employed
σ_θ	Standard deviation	0.670	Gini of income, self-employed
μ_θ	Unconditional mean	-1.120	Share of self-employed
Tax evasion detection			
κ	Cost of tax evasion	0.132	Overall misreporting rate
p_1	Parameter of $p(\cdot)$	2250	Tax evasion by total income (quintiles)
p_2	Parameter of $p(\cdot)$	0.350	Tax evasion by total income (quintiles)
Tax functions rescale			
χ	Rescaling parameter	11.000	Tax revenues as share of GDP

We need to assign values to the following parameters: the household discount factor β, the disutility of working ψ, the capital depreciation rate δ, the span of control for self-employed businesses ν, the capital share in self-employed production γ, the three parameters for the business ability process $(\mu_\theta, \rho_\theta, \sigma_\theta)$, the tax evasion cost κ, and the two parameters for the audit probability p_1 and p_2. Moreover, we have to calibrate the parameter λ in the credit constraint (10), which reflects the maximum amount of leverage in the self-employed sector. Finally, in the tax function (19), we need to re-scale a_2^W and a_2^E by a constant factor χ to balance the government budget in equilibrium.

We calibrate the 13 parameters as to minimize the difference between a set of targeted model moments and their counterparts in the U.S. data. Table 2 summarizes our calibration strategy. It is well-understood that all the model parameters affect all the targets but we can nonetheless outline which data moment is most informative about a certain parameter. The discount factor β affects the interest rate. The preference parameter ψ is related to the number of hours worked. The capital-output ratio identifies the depreciation rate δ. The parameter ν refers to the span of control in the self-employed production function and influences the firm size distribution. γ affects the self-employed's share of hired labor.

The persistence ρ_θ in the stochastic process for the business ability is identified mainly by the annual exit rate from self-employment: a higher persistence of the ability process implies that self-employed households change their occupation less frequently. The standard deviation σ_θ affects the distribution of income among the self-employed. The parameter μ_θ, which relates to the unconditional mean of the log of business ability (21), determines the share of self-employed households in the population.

The tax evasion cost κ and the parameters p_1 and p_2 of the audit probability $p(k)$ are set to match the relationship between tax evasion and income. More precisely, we target the taxable income misreporting rate over quintiles of household income, which are reported by Johns and Slemrod (2010). Thereby, the cost κ helps us to replicate the extent of tax evasion in the lower income quintiles. In addition, the overall taxable income misreporting rate in the U.S. economy is matched. Finally, we re-scale a_2^W and a_2^E by a constant factor χ to match a ratio of total income taxes to GDP of 15.2 percent as in Maffezzoli (2011).

The recovered values for the internally set parameters are presented in Table 2. Our calibration delivers a value of 0.74 for the span of control parameter ν. Note that this value is slightly lower than the usual ones used in models with an entrepreneurial sector.[15] The reason for this is that, unlike in other papers, our entrepreneurs are self-employed and their average size of business and productive efficiency are lower.[16]

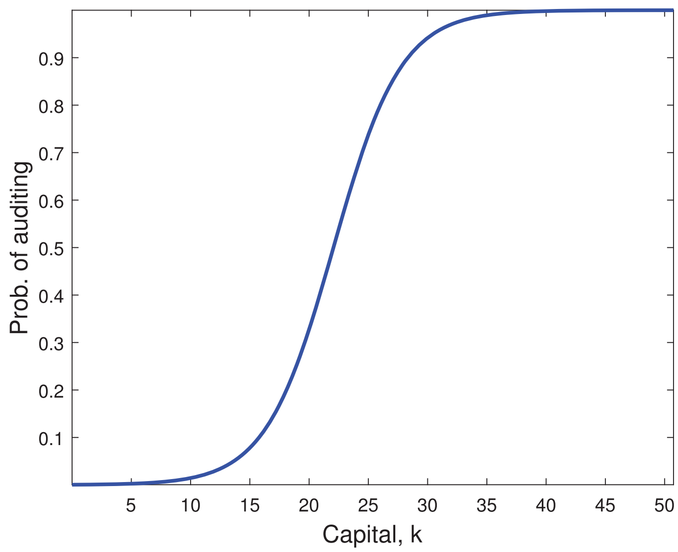
To match the empirical mean leverage in the self-employment sector, the parameter λ is set to 1.5. We estimate the mean leverage ratio of the self-employed from the SCF for the years 1998-2004 as leverage is not available in the PSID. Interestingly, the recovered $\lambda = 1.5$ corresponds to the value commonly used in the literature, see, e.g., Kitao (2008) and Brüggemann (2019). We study in detail how this parameter affects the aggregate effects of tax evasion in Section 5.5.

Fig. 1 shows the audit probability evaluated at the estimated parameters.[17]

[15] Cagetti and De Nardi (2006) calibrate this parameter to 0.88 while Buera et al. (2011) use 0.79. Guvenen et al. (2019) argue that a span of control parameter larger than 0.8 is needed to match the Pareto tail of the U.S. wealth distribution.

[16] In Table 12 in Appendix A.1, we distinguish between self-employed households and business owners and report descriptive statistics for the two groups.

[17] In a robustness analysis, we have experimented with a non-increasing functional form, namely, a constant $p(k)$. The results show that the logistic functional form achieves a better model fit in terms of tax evasion and self-employment across income quintiles. The results are available upon request.



Notes: Capital is measured in model units.

Fig. 1. Probability of Auditing.

Table 3
Basic Model Statistics.

	Data	Model
Targeted Statistics		
Interest rate (%)	4.00	4.00
Capital-output ratio	2.65	2.59
Hours worked (%)	33.00	33.77
Share of self-employed (%)	14.70	14.29
Mean leverage of self-employed (%)	28.90	27.96
Exit rate, self-employed (%)	15.73	14.31
Overall misreporting rate (%)	11.00	12.02
Tax revenues/GDP (%)	15.20	14.72
Non-Targeted Statistics		
Share of income, self-employed (%)	21.04	24.73
Median wealth ratio, self-employed/workers	4.02	3.58
Share of credit-constrained self-employed (%)	22.80	20.62

Notes: The table shows the model statistics of the benchmark economy and the empirical counterparts based on PSID data for the years 1990-2003. The misreporting rate is taken from Johns and Slemrod (2010). The mean leverage and the share of credit-constrained businesses in the self-employment sector are based on SCF data for the years 1998, 2001, and 2004.

4.3. Model fit

In this section, we compare the outcomes generated by the model with the corresponding statistics for the U.S. economy, both targeted and non-targeted. A good fit of the model along dimensions that are not explicitly targeted in the parametrization process reinforces our confidence in the validity of our approach when it comes to the counterfactual analysis.

Table 3 shows the model fit in terms of basic statistics. The targets related to aggregate capital and labor, namely, the interest rate, the average hours worked out of total non-sleeping hours, and the capital-output ratio are matched closely. In addition, the model replicates very well the targets related to self-employment, such as the share of self-employed, the mean debt-to-asset (leverage) ratio, and the annual exit rate from self-employment. Finally, the model-generated average overall misreporting rate for taxable income matches the empirical counterpart. Tax revenues from income taxation are matched as a part of the budget balancing condition for the government.

All of the above statistics are targeted. The model also provides a good fit of the non-targeted statistics related to self-employment. Specifically, the share of income of self-employed households and their median wealth ratio relative to workers are close to the empirical counterparts. Moreover, the model replicates the share of credit-constrained self-employed households.[18]

In Table 4 we report the share of self-employed businesses with employees as well as the percentage of firms hiring 1 to 4 employees, 5 to 9 employees, 10 to 19 employees, and more than 20 employees (all targeted statistics). Our model

[18] In the SCF, self-employed individuals are asked whether they have been turned down for credit or feared being denied credit in the past 5 years. This is the case for 22.8 percent of the self-employed.

Table 4
Self-Employed Firm Size Distribution.

	Data	Tax Evasion Benchmark	Perfect Tax Enforcement
Share of self-employed with employees (%)	20.30	19.90	21.73
1-4 employees (%)	75.90	75.74	70.03
5-9 employees (%)	14.70	14.15	21.35
10-19 employees (%)	5.52	6.59	5.24
More than 20 employees (%)	3.90	3.52	3.38

Notes: The first column provides the self-employed firm size distribution in the U.S. economy derived from CPS data for the years 2000-2007. Detailed yearly tabulations are presented in Hipple (2010), Table 9. The second and third columns display the firm size distribution of the benchmark economy with tax evasion and the counterfactual economy with perfect tax enforcement, respectively.

Table 5
Distribution of Self-Employed Income.

	Gini	Mean/Median	Bottom 40	Top 20	Top 10	Top 1
Model	43.72	1.53	16.49	51.10	36.11	10.48
US data	43.90	1.43	15.70	50.70	36.10	9.78

Notes: The table shows the model statistics of the benchmark economy and the empirical counterparts based on PSID data for the years 1990-2003.

Table 6
Wealth Distribution.

	Gini	Mean/Median	Bottom 40	Top 20	Top 10	Top 1
Model	71.01	2.40	3.57	72.71	59.85	22.31
US data	71.10	3.10	2.71	75.65	60.56	26.53

Notes: The table shows the model statistics of the benchmark economy and the empirical counterparts based on PSID wealth supplements for the years 1994, 1999, 2001 and 2003.

provides an excellent fit along this dimension. Note that the firm size distribution is not only influenced by the span of control parameter ν in the self-employed production function but also by the capital share γ and the audit probability $p(k)$. The increasing pattern of the audit probability induces self-employed firms to stay small in order to remain under the radar of the tax authorities. We highlight this mechanism in detail in Section 5.1.

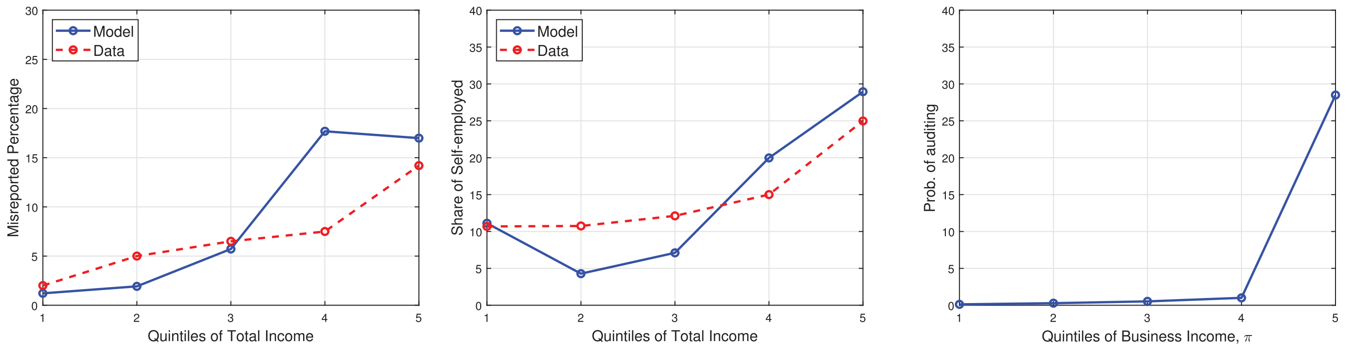
In Table 5 we report the distribution of self-employed income, which is crucially affected by the volatility σ_θ of the self-employed business ability. In our calibration procedure, we target the Gini coefficient but the model provides a very good fit of the bottom and the top of the income distribution as well.

We report selected moments of the distribution of household net wealth in Table 6. Even though we do not target the wealth distribution, the model delivers a good fit of the empirical mean-to-median ratio and the other measures of wealth concentration. The model replicates reasonably well both the bottom and the top of the wealth distribution, even though it slightly undershoots the concentration of wealth in the top 1 percent.[19]

In our calibration exercise, we use the cost of evasion κ and the parameters of the audit probability p_1 and p_2 to target the overall misreporting rate and the pattern of tax evasion by quintiles of taxable household income. Fig. 2 reports the data facts and the model outcomes related to misreporting by income level. Although we use only three parameters to match six targets, the model provides a good fit of the overall misreporting rate and the increasing pattern of tax evasion with income (Fig. 2a). In particular, the model replicates the misreporting rate at the first, third, and fifth quintile of taxable household income. The extent of tax evasion is slightly underestimated at the second quintile whereas it is overestimated at the fourth quintile. The cost of evasion κ helps to match the misreporting rate at low levels of income. p_1 and p_2 determine the level and the slope of the audit probability (Fig. 1) and crucially affect the overall misreporting rate and the extent of tax evasion at the fifth income quintile.

Fig. 2b displays the share of self-employed households by quintile of income. Although not targeted in our calibration, the model provides a decent match. In general, the share of self-employed increases with total income. In Fig. 2c, we plot the average audit probability as a function of self-employed business income. The model implies that self-employed businesses face a very low probability of being audited by the tax authorities except for those in the fifth quintile of business income. The audit probabilities generated by the model are broadly in line with the data reported in Slemrod and Gillitzer (2014), Chapter 6.5, suggesting that the audit probability is around 1 percent for low and middle incomes and increases up to 30 percent for high incomes. Note, however, that these estimates are based on income without differentiating between worker's income and self-employed business income. Further details are described in Appendix A.4.

[19] It is well known that a standard Bewley model falls short of replicating the high degree of wealth concentration observed in the U.S. data. The inclusion of entrepreneurship as in the present framework improves significantly the ability of the model to fit the data along this dimension.



(a) Tax Evasion by Total Income

(b) Share of Self-Employed by Income

(c) Expected Probability of Auditing by Self-Employed Income

Notes: U.S. data on the percentage misreporting rate by true income groups are taken from Johns and Slemrod (2010) (Table 2). Model statistics refer to the benchmark economy.

Fig. 2. Self-Employment and Tax Evasion by Income.

5. The aggregate effects of tax evasion

To highlight the aggregate effects of tax evasion, we provide a comparison between our benchmark economy and a counterfactual economy in which taxes are perfectly enforced. This is a limiting case in which the penalty for misreporting is high enough so that tax evasion does not occur. In a first step, to understand the mechanisms, we study how tax evasion affects the optimal decision rules. In a second step, we analyze the impact of tax evasion on aggregate outcomes. Finally, we discuss the welfare implications of tax evasion and the role of the credit constraint.

5.1. Understanding the mechanisms

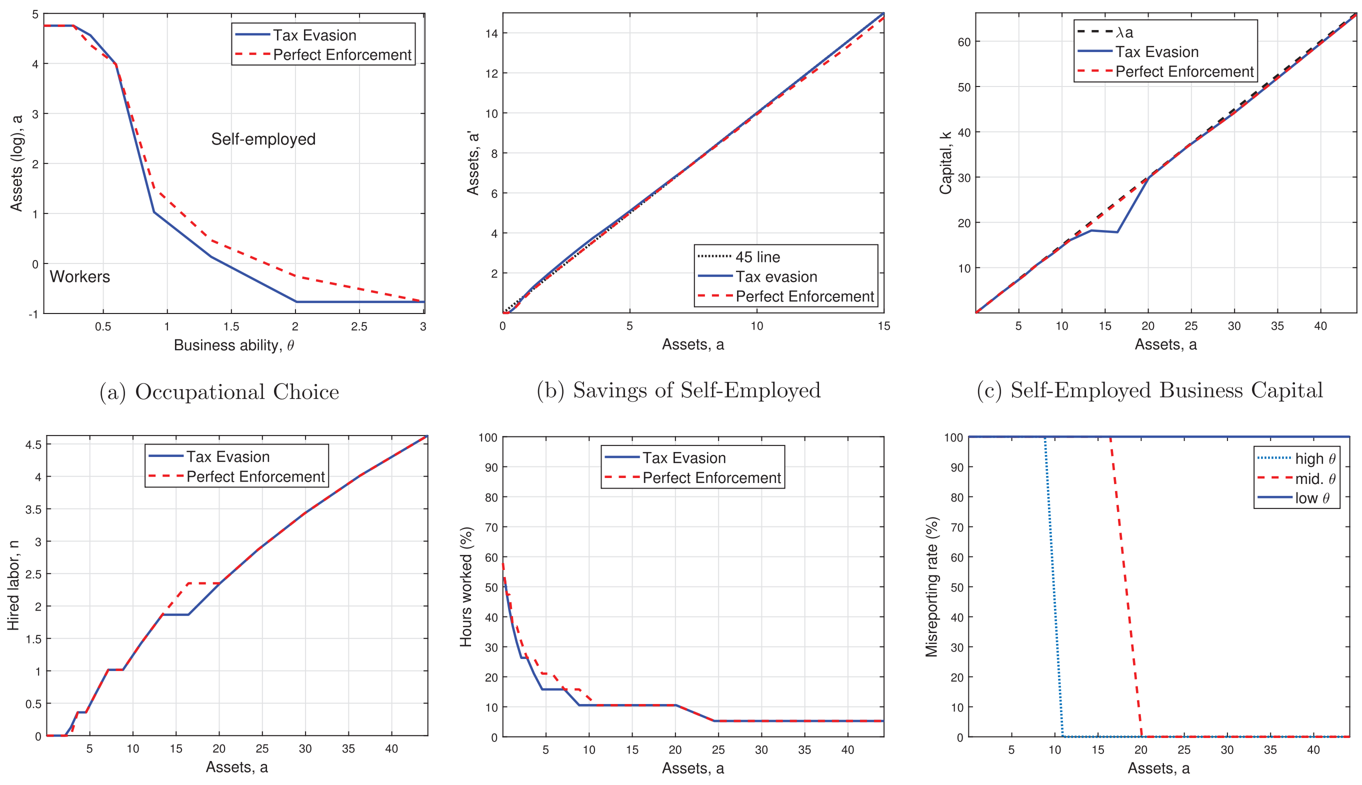
In this section, we analyze the economic mechanisms of tax evasion and discuss the policy functions displayed in Fig. 3. To understand the impact of tax evasion, we compare the policy functions of our benchmark economy with those of the counterfactual economy with perfect tax enforcement.

In our two-sector model with incomplete credit markets, the households' occupational choice, depicted in Fig. 3a, depends both on business ability θ and wealth a (given average working ability ε). For a given level of business ability, households become self-employed as long as they hold sufficient wealth. Poor talented agents who receive a high realization of business ability are credit-constrained so that they are not able to generate sufficient business income. There exists a wealth threshold $a^*(\varepsilon, \theta)$, (weakly) decreasing with business ability, such that households with $a < a^*(\varepsilon, \theta)$ become workers and those with $a \geq a^*(\varepsilon, \theta)$ become self-employed. The solid line in Fig. 3a represents the wealth threshold for running a self-employed business as a function of business ability (given average working ability) in the benchmark economy, while the dashed line refers to the same threshold in the counterfactual economy with perfect tax enforcement. Clearly, tax evasion lowers the wealth threshold and induces less wealthy households to enter self-employment. Tax evasion distorts the occupational choice at the margin because it makes self-employment more attractive. The opportunity to evade taxes raises the share of self-employed households in the economy because a group of relatively less talented agents (those between the solid and the dashed line in Fig. 3a) find it profitable to run self-employed businesses. This suggests that on average the business ability of a self-employed household in the economy with tax evasion is lower than in the counterfactual economy with perfect tax enforcement. This mechanism, through which tax evasion affects occupational choice and therefore the aggregates in the economy, is dubbed the *selection channel*.[20]

In Fig. 3b, we show the policy function for savings of the self-employed as a function of asset holdings (given average working and business ability). Tax evasion reduces the tax burden of self-employed households and acts as a subsidy that facilitates higher savings. We refer to this as the *subsidy channel*.

Fig. 3c shows the optimal capital choice of the self-employed as a function of asset holdings. The productive abilities ε and θ are fixed at their average values. The solid line shows the decision rule for business capital in the benchmark economy and the dashed red line refers to the counterfactual economy in which tax evasion is absent. Tax evasion creates a distortion in capital accumulation at low and medium values of assets, which is generated by the probability of getting detected. Recall the pattern of the audit probability $p(k)$ shown in Fig. 1: for low values of capital, the audit probability is very small and flat. Therefore, self-employed households with low wealth find it optimal to evade $\phi > 0$ and to invest in capital. As capital approaches the inflection in $p(k)$, households evade taxes but keep their business capital flat in order to avoid a sharp increase in the probability of detection. We refer to this effect of tax evasion as the *detection channel*. For

[20] Note that for very low levels of business ability, the solid line is slightly above the dashed line. This implies that in the benchmark economy self-employed households with very low business abilities have slightly more assets than in the counterfactual economy with perfect tax enforcement. This effect is driven by a decrease in interest rates in general equilibrium and disappears in a partial equilibrium setup.



(a) Occupational Choice (b) Savings of Self-Employed (c) Self-Employed Business Capital

(d) Hired Labor (e) Workers' Labor Supply (f) Misreporting Rate

Notes: In panel (a), the solid (dashed) line demarcates the occupational choice $o(a, \varepsilon, \theta)$ in the benchmark economy with tax evasion (in the counterfactual economy with perfect tax enforcement). Households with low wealth and/or low business ability become workers (southwest of the demarcation lines). Panel (b) reports the policy functions for next-period assets of self-employed households $a' = g^E(a, \varepsilon, \theta)$. Panel (c) shows the policy function for self-employed business capital $k(a, \varepsilon, \theta)$. Panel (d) shows hired labor $n(a, \varepsilon, \theta)$ in terms of number of workers of a self-employed business. Panel (e) reports the workers' labor supply. Panel (f) displays the misreporting rate $\phi(a, \varepsilon, \theta)$. In all panels, working ability ε is fixed to the average value. In panels (b), (c) and (d), business ability θ is fixed to the average values.

Fig. 3. Policy Functions. (For interpretation of the colors in the figure(s), the reader is referred to the web version of this article.)

larger asset values, however, self-employed households stop evading ($\phi = 0$) and increase their business capital until the first best is reached.[21]

The pattern of business capital is reflected in the optimal hiring decisions of self-employed businesses, shown as a function of assets in Fig. 3d. In the counterfactual economy with perfect tax enforcement, hired labor increases along with capital. In the presence of tax evasion, the distortion generated by the *detection channel* reduces the labor input of a self-employed business with low wealth.

Fig. 3e shows workers' labor supply as a function of assets (given average business and working ability). Workers' labor supply is decreasing in asset holdings because of the wealth effect. The impact of tax evasion on the labor choice is minor and mainly driven by a price effect: in the counterfactual economy with perfect tax enforcement, wages are lower such that workers with low levels of wealth have to work more than in the benchmark economy. We discuss the impact of tax evasion on prices in Section 5.3.

In Fig. 3f we display the misreporting rate of a self-employed household as a function of assets, given average business and working ability. Clearly, less talented self-employed households misreport more as they are financially constrained. Moreover, because of their small business size they face a lower probability of getting detected by the tax authorities inducing them to evade.

5.2. *Tax evasion and aggregate outcomes*

Table 7 presents the aggregate statistics for the benchmark economy and the counterfactual economy in which taxes are perfectly enforced.

[21] In both economies, the optimal choice of capital $k(a, \varepsilon, \theta)$ exhibits a second kink at high assets levels, see Fig. 7 in Appendix B.1, where we expand the x-axis to larger asset values. This kink is generated by the credit constraint. For low values of assets, self-employed households are credit-constrained and are not able to run their businesses at the optimal scale: in such a case their optimal capital choice depends on their wealth and equals the collateral requirement, $k(a, \varepsilon, \theta) = \lambda a$. For high asset levels the credit constraint is not binding, $k(a, \varepsilon, \theta) < \lambda a$ such that the optimal capital input is independent of the borrowing limit.

Table 7
Aggregate Effects of Tax Evasion.

	Tax Evasion Benchmark	Perfect Tax Enforcement
Sector of Self-Employment		
Share of self-employed (%)	14.29	13.30
$\mathbb{E}(\theta\|E)$	0.94	0.95
$\mathbb{E}(k\|E)$	9.48	9.57
$\mathbb{E}(n\|E)$	1.28	1.30
K^E	1.35	1.27
N^E	0.04	0.04
Y^E	0.49	0.46
Share of credit-constrained self-employed (%)	20.62	24.39
Corporate Sector		
K^C	3.65	3.61
N^C	0.82	0.83
Y^C	1.44	1.45
Labor		
Share of self-employed with employees (%)	19.90	21.73
Hours worked	33.77	34.01
Prices		
r(%)	4.00	4.31
w	1.10	1.08
Tax Revenues		
T/Y (%)	14.72	16.84
Wealth Inequality		
Gini, all	71.01	70.47
Gini, self-employed	65.25	67.70
Gini, workers	62.85	61.64

Notes: The table compares macroeconomic aggregates of the benchmark economy with tax evasion with those of the counterfactual economy with perfect tax enforcement. $\mathbb{E}(\theta|E)$ and $\mathbb{E}(k|E)$ denote the mean value of business ability and business capital of a self-employed household. $\mathbb{E}(n|E)$ reports the mean of hired labor by a self-employed business, conditional on hiring $n > 0$. K^E, N^E, Y^E refer to aggregate capital, hired labor, and output in the self-employment sector, respectively. K^C, N^C, and Y^C denote aggregate capital, labor, and output in the corporate sector, respectively. Tax revenues T/Y are given as a percentage share of total output. w denotes the real wage rate, while r is the real interest rate in percent.

In our benchmark economy, the share of self-employed households is about 1 percentage point larger than in the economy with perfect tax enforcement. At the same time, the average business ability $\mathbb{E}(\theta|E)$ is lower highlighting the *selection channel*: the opportunity to evade taxes induces less talented households to run self-employed businesses.

There are several opposing forces affecting capital in the self-employment sector. On the one hand, the *subsidy channel* stimulates asset accumulation and allows higher investment in business capital. On the other hand, the *detection channel* provides incentives to keep self-employed businesses small in order to stay under the radar of the tax authorities and to reduce the chances of being audited. In addition, the *selection channel* lowers the average productive capacity of the self-employed businesses, and thus, their average size. Our quantitative findings suggest that the capital decision of a self-employed household is critically affected by the *detection* and the *selection channels*: in the economy with tax evasion the mean value of business capital of a self-employed household, $\mathbb{E}(k|E)$, is lower than in the counterfactual economy with perfect tax enforcement. Note that in the benchmark economy with tax evasion, fewer self-employed businesses face a binding borrowing limit because the *subsidy channel* relaxes the credit constraint. We explore the important interaction between tax evasion and financial constraints in detail in Section 5.5.

The *detection* and the *selection channels* can also be seen in the hiring decision of a self-employed business: $\mathbb{E}(n|E)$ decreases if tax evasion is present. The impact of tax evasion on the firm size distribution is highlighted in the second and third columns of Table 4. Due to the *detection channel* there are more small self-employed businesses with a number of employees between 1 and 4. Note that our benchmark economy with tax evasion provides a better description of the empirical firm size distribution than our counterfactual economy in which taxes are perfectly enforced.

While the average capital input of a self-employed business decreases in the presence of tax evasion, in the aggregate, business capital K^E increases in the self-employment sector due to the higher share of self-employed in the economy. As a consequence, tax evasion raises the aggregate output of the self-employed sector.

Due to the *subsidy channel*, tax evasion fosters aggregate savings in the economy. In equilibrium, the larger supply of capital increases capital in the corporate sector and reduces the interest rate (optimality condition (1)). Since the opportunity to evade taxes raises the share of self-employed, fewer households become workers and aggregate labor N^C falls in the corporate sector. As a result, the wage goes up (optimality condition (2)), average hours worked decline, and corporate production decreases in spite of higher corporate capital.

In our quantitative application of the theoretical model to the U.S. economy, tax evasion reduces tax revenues by 1.9 percentage points of GDP. This figure is very close to the empirical estimate of the U.S. tax gap of 2 percent of GDP (U.S. Department of the Treasury 2009).

Our quantitative findings suggest that tax evasion increases overall wealth inequality due to the larger share of self-employed households who invest more in assets. Within the group of the self-employed, wealth inequality decreases because tax evasion alleviates the credit constraint of poor self-employed businesses. Moreover, the fall in the interest rate has a mitigating effect on wealth inequality among the self-employed. In contrast, wealth inequality increases among the workers, which is driven by the rise in the wealth shares of the top 20 and top 10 percent.

5.3. Quantifying the channels of tax evasion

In our discussion so far, we highlighted the three major channels through which tax evasion affects the aggregate outcomes in the economy. In the following, we seek to evaluate the quantitative importance of the three channels. Table 8 summarizes the main findings of our decomposition exercise. We consider the following aggregate outcomes: the share of self-employed households, the average capital of self-employed businesses $\mathbb{E}(k|E)$, the aggregate capital K^E and output Y^E in the self-employed sector, the aggregate capital K^C and output Y^C in the corporate sector, and the percentage of small self-employed businesses with 1 to 4 employees.

As a starting point, in column (1) of Table 8, we report the outcomes of the counterfactual economy in which taxes are perfectly enforced. Then, we move to a tax evasion economy in a partial equilibrium fashion, i.e., we keep the wage and the interest rate at the values of the perfect tax enforcement economy. In this way, we document the changes in the aggregate economic outcomes solely due to the presence of tax evasion abstracting from general equilibrium effects. We present our findings in column (5). To facilitate a comparison, in column (6), we list the outcomes of the benchmark economy with tax evasion in general equilibrium.

Let us first analyze the importance of general equilibrium price effects. Comparing columns (1), (5), and (6) reveals that when the wage and the interest rate are fixed, tax evasion has a larger positive effect on the self-employment rate. Consequently, in partial equilibrium, the average business ability $\mathbb{E}(\theta|E)$ and the mean value of business capital $\mathbb{E}(\theta|E)$ of a self-employed household decrease more than in general equilibrium. In the aggregate, self-employed business capital K^E increases less in partial than in general equilibrium. In contrast, aggregate corporate capital K^C exhibits a larger increase because savings rise due to the *subsidy channel* of tax evasion.[22] In general equilibrium, prices are updated according to their marginal products. Specifically, the interest rate decreases while the wage increases, such that the impact of tax evasion on aggregate outcomes is mitigated.

In the next step, we decompose the partial equilibrium effects to deduce the strength of the *subsidy*, *selection* and *detection channels*. To this end, we run a series of counterfactual experiments. Let $\tilde{o}(x)$, $\tilde{k}(x)$, and $\tilde{n}(x)$ denote the policy functions for the occupational choice, for business capital, and for labor hired by self-employed businesses in the economy with perfect tax enforcement, respectively. To isolate the effect of the *subsidy channel* of tax evasion, in column (2), we impose exogenously the policy functions $o(x) = \tilde{o}(x)$, $k(x) = \tilde{k}(x)$ and $n(x) = \tilde{n}(x)$ in the partial equilibrium economy with tax evasion. Thus, we allow for tax evasion but the decisions on the occupation, business capital and hiring are fixed such that the *selection* and *detection channels* are shut down. Now tax evasion affects the outcomes of the economy only through the savings behavior of households. Next, in column (3), we fix only the occupational choice $o(x) = \tilde{o}(x)$ in the partial equilibrium economy with tax evasion and shut down the *selection channel*. Finally, in column (4), we fix the choice of business capital $k(x) = \tilde{k}(x)$ and hiring $n(x) = \tilde{n}(x)$ to eliminate the *detection channel*. Note that in these decompositions we abstract from the impact of tax evasion on labor supply to focus on the three main channels which are quantitatively decisive for aggregate outcomes. However, the workers' labor supply is important for evaluating the welfare consequences of tax evasion, which we discuss in detail in Section 5.4.

Let us first focus on the quantitative importance of the *subsidy channel*. Our findings in column (2) show that in the absence of the *detection* and *selection channels* the opportunity to evade taxes increases the average business capital of a self-employed business from 9.57 to 10.69. Misreporting income allows the self-employed to pay less taxes and to accumulate more savings and, in turn, to invest more in their business capital. Moreover, they grow in terms of the number of hired employees such that the share of small self-employed businesses (with 1 to 4 employees) shrinks by 1.43 percentage points. The *subsidy channel* also raises the share of self-employed in the economy and reduces their average business ability, however, quantitatively these effects are small.

Inspecting columns (2) and (3) reveals that the *detection channel* is the main quantitative force driving the decrease in average business capital and the increase in the share of small self-employed businesses. In the economy in which both the *subsidy* and *detection channels* are in place, average capital of self-employed businesses decreases from 10.69 to 9.55 compared to the economy in which only the *subsidy channel* is present. The share of small self-employed businesses increases by 11.94 percentage points.

A comparison of columns (5), (4) and (2) suggests that the *selection channel* is quantitatively important for the increase in the share of self-employed, the decrease in the average business ability, and the decrease in the average capital of self-employed businesses due to tax evasion. In economy (4) in which both the *subsidy* and *selection channels* are at work, the share of self-employed businesses rises by 1.15 percentage points relative to economy (2) in which only the *subsidy*

[22] Due to the *selection channel* fewer households become workers such that N^C decreases. In partial equilibrium, the increase in K^C and the decrease in N^C imply that the marginal product of capital is below $r + \delta$ whereas the marginal product of labor exceeds w.

Table 8
Decomposition of Aggregate Effects.

		Tax Evasion Economies				
	Perfect Tax Enforcement	Counterfactual Experiments Partial Equilibrium				Benchmark General Equilibrium
	(1)	(2)	(3)	(4)	(5)	(6)
Setup						
Fixed prices from (1)	-	r, w	r, w	r, w	r, w	-
Fixed decisions from (1)	-	$o(x), k(x), n(x)$,	$o(x)$	$k(x), n(x)$	-	-
Operational channels	-	*Subsidy*	*Subsidy +Detection*	*Subsidy +Selection*	*Subsidy+Detection +Selection*	*Subsidy+Detection +Selection+Prices*
Outcomes						
Share of self-employed (%)	13.30	13.50	13.57	14.65	14.70	14.29
$\mathbb{E}(\theta\|E)$	0.95	0.94	0.94	0.93	0.93	0.94
$\mathbb{E}(k\|E)$	9.57	10.69	9.55	10.11	9.08	9.48
Share of small businesses (%)	70.03	68.60	80.53	68.57	80.48	75.74
K^E	1.27	1.44	1.30	1.48	1.33	1.35
K^C	3.61	4.07	4.34	3.99	4.25	3.65
Y^E	0.46	0.51	0.47	0.52	0.49	0.49
Y^C	1.45	1.50	1.54	1.48	1.52	1.44

Notes: The table provides selected outcomes of the decomposition. $\mathbb{E}(\theta|E)$ and $\mathbb{E}(k|E)$ denote the mean value of business ability and business capital of a self-employed household. K^E and Y^E refer to aggregate capital and output in the self-employment sector, respectively. K^C and Y^C denote aggregate capital and output in the corporate sector. The share of small businesses refers to self-employed businesses with 1 to 4 employees.

Table 9
Tax Evasion and Aggregate Welfare.

	Tax Evasion Benchmark	Perfect Tax Enforcement			
		No Redistribution	Redistribution		
			Lump-Sum All	Tax Cut All	Tax Cut Self-Employed
	(1)	(2)	(3)	(4)	(5)
Share of self-employed (%)	14.286	13.301	13.497	13.194	18.569
Y	1.932	1.915	1.885	1.897	1.943
r (%)	4.000	4.307	4.312	4.237	3.863
w	1.096	1.082	1.082	1.086	1.102
$\overline{\Delta}$ (%)	–	−1.746	1.917	1.809	1.038
$\overline{\Delta}^E$ (%)	–	−3.786	−1.010	−1.378	2.402
$\overline{\Delta}^W$ (%)	–	−1.406	2.405	2.340	0.810

Notes: The table summarizes selected statistics for the benchmark economy with tax evasion and counterfactual economies in which taxes are perfectly enforced. The welfare effects are measured in consumption equivalent units and show the percentage change in consumption needed to make a household indifferent between being born in the benchmark economy (column (1)) and being born in any of the counterfactual economies with perfect tax enforcement (columns (2) to (5)). Column (2) is the counterfactual economy without fiscal neutrality in which additional tax revenues are not redistributed. In column (3) the government balances the budget with lump-sum transfers to all households. In column (4) the government balances the budget by implementing tax cuts for all households while in column (5) the tax cut is for self-employed households only. Y refers to total aggregate output. r is the interest rate in percent while w refers to the wage rate. $\overline{\Delta}$ denotes the aggregate welfare effect whereas $\overline{\Delta}^E$ and $\overline{\Delta}^W$ refer to the welfare effects of self-employed households and workers.

channel is operational. The average business ability ($\mathbb{E}(\theta|E) = 0.93$) and the average capital of self-employed businesses ($\mathbb{E}(k|E) = 10.11$) are reduced relative to the economy in which only the *subsidy channel* is present ($\mathbb{E}(\theta|E) = 0.94$ and $\mathbb{E}(k|E) = 10.69$).

With respect to aggregate production, our findings suggest that the *subsidy channel* raises output in both sectors. The *detection channel* reduces production by self-employed businesses but increases production by corporate firms. In contrast, the *selection channel* fosters production in the self-employment sector at the expense of production in the corporate sector.

5.4. Tax evasion and welfare

In this section, we evaluate how tax evasion affects welfare in comparison with a counterfactual economy with perfect tax enforcement. The welfare effects of eliminating tax evasion are in terms of consumption equivalent variations, i.e., we calculate the consumption gain or loss of moving from the benchmark economy with tax evasion to an economy in which taxes are perfectly enforced. Hereby, we compare the stationary equilibria and abstract from transitional dynamics.

We follow Guvenen et al. (2019) and construct the welfare measure at the individual level. We define $\Delta(x)$ as the percentage change in consumption at future dates and states required to make an agent characterized by $x = (a, \varepsilon, \theta)$ indifferent between the benchmark economy with tax evasion and the counterfactual economy with perfect tax enforcement:

$$U\Big((1 + \Delta(x))\, c^B(x), \ell^B(x)\Big) = U\Big(c^C(x), \ell^C(x)\Big),$$

where U denotes lifetime utility and $c(x)$ and $\ell(x)$ are the consumption and leisure allocations starting from state x. The superscripts B and C refer to the benchmark economy with tax evasion and to the counterfactual economy with perfect tax enforcement, respectively. Aggregating over the population yields the aggregate welfare measure $\overline{\Delta}$:

$$\overline{\Delta} = \int \Delta(x)\, d\mu^B(x),$$

where $\mu^B(x)$ is the stationary distribution in the benchmark economy.

The individual-based measure $\Delta(x)$ is well-suited for a group-by-group analysis. Taking into account the occupation in the benchmark economy, we derive the welfare measures for the self-employed households $\overline{\Delta}^E$ and for the workers $\overline{\Delta}^W$ as:

$$\overline{\Delta}^E = \frac{\int o(x)\Delta(x) d\mu^B(x)}{\int o(x) d\mu^B(x)}, \qquad \overline{\Delta}^W = \frac{\int (1 - o(x))\Delta(x) d\mu^B(x)}{\int (1 - o(x)) d\mu^B(x)}.$$

Table 9 summarizes the results of our welfare analysis. To deepen our understanding of the welfare gains and losses, in Fig. 4 we decompose them to study how workers and self-employed in different deciles of wealth are affected by tax evasion.[23]

Since the elimination of tax evasion increases tax revenues, we distinguish several fiscal policy scenarios. In a first step, in column (2) of Table 9 and in Fig. 4a, we assume that the additional tax revenues are not redistributed to the households in the economy. In a second step, we consider fiscal scenarios under fiscal neutrality, i.e., we assume that tax policies are

[23] Appendix B.2 provides further technical details of the welfare calculations.

adjusted such that the same level of tax revenues is achieved as in the benchmark economy. Specifically, we report the welfare results if the additional tax revenues are redistributed via *lump-sum transfers* to all households (Table 9, column (3), and Fig. 4b). As an alternative policy, we assume that the additional tax revenues are redistributed by *tax cuts* for all households (Table 9, column (4), and Fig. 4c). To this end, the tax level is decreased by re-scaling proportionately down the terms (a_2^W, a_2^E) in the non-linear tax functions (3). Finally, fiscal neutrality is imposed by a *tax cut for the self-employed only* (Table 9, column (5), and Fig. 4d). To provide a better understanding of the welfare results, we also report the share of self-employed households, aggregate output, the interest rate, and the wage for the different policy scenarios.

Eliminating tax evasion without imposing fiscal neutrality has a negative effect on welfare (Table 9, column (2), and Fig. 4a). This is not surprising since in this case aggregate capital and output fall generating an overall productive loss of 0.88 percent. Eliminating tax evasion generates substantial welfare losses of 3.79 and 1.41 percent for the self-employed and workers, respectively. The self-employed exhibit larger losses since perfect tax enforcement has a direct negative impact on them. In particular, poor self-employed households lose most because they evade more. Workers suffer from a lower wage and are hurt indirectly by a worse future option value of becoming self-employed. Only workers in the last decile of wealth have small welfare gains because they benefit from the higher interest rate.

If the additional taxes are rebated via lump-sum transfers to all households, the overall welfare improves by 1.92 percent. While self-employed households lose, workers gain from the elimination of tax evasion if accompanied by lump-sum transfers. Consequently, the overall welfare effect is driven by the workers' welfare gain of 2.41 percent. Still, the self-employed benefit from the lump-sum transfers because their welfare loss is reduced by 2.78 percentage points compared to the scenario in which the additional tax revenues are not redistributed. Fig. 4b reveals that workers and self-employed households are affected differently depending on their wealth. Workers in the lowest and highest deciles of wealth enjoy the largest welfare gains from perfect tax enforcement if the additional tax revenues are redistributed via lump-sum transfers. Poor workers benefit more from lump-sum transfers whereas wealthy workers gain from the higher interest rate on their savings. Self-employed households in the first decile of the wealth distribution suffer large welfare losses from perfect tax enforcement as they are constrained by the borrowing limit and benefit most from the *subsidy channel*.

Redistribution via tax cuts to all households delivers very similar welfare effects as can be seen in column (4) of Table 9 and in Fig. 4c. Note that eliminating tax evasion generates larger welfare losses for self-employed households in the lowest decile of wealth if tax cuts are implemented rather than lump-sum transfers. At the same time, the elimination of tax evasion accompanied by tax cuts has a less negative impact on aggregate production compared to providing lump-sum transfers instead. However, higher production requires more labor input affecting welfare adversely.

In our last policy experiment (Table 9, column(5), and Fig. 4d) we assume that the tax cut is implemented for self-employed households only. In contrast to the previous policies, cutting taxes only for the self-employed raises the share of self-employed households and aggregate production. The drop in the share of workers reduces labor in the corporate sector and raises the wage. While such a policy generates a lower aggregate welfare gain than the previous two redistribution policies, now both self-employed households and workers gain. Since the self-employed benefit directly from the tax cut, they enjoy a substantial gain of 2.40 percent. Crucially, the poor self-employed who are constrained by the borrowing limit, benefit most. Although the workers do not receive a tax cut, they still gain because they earn a higher wage than in the benchmark economy. However, with 0.81 percent, the workers' welfare gain is much lower compared to the other two redistribution policies.

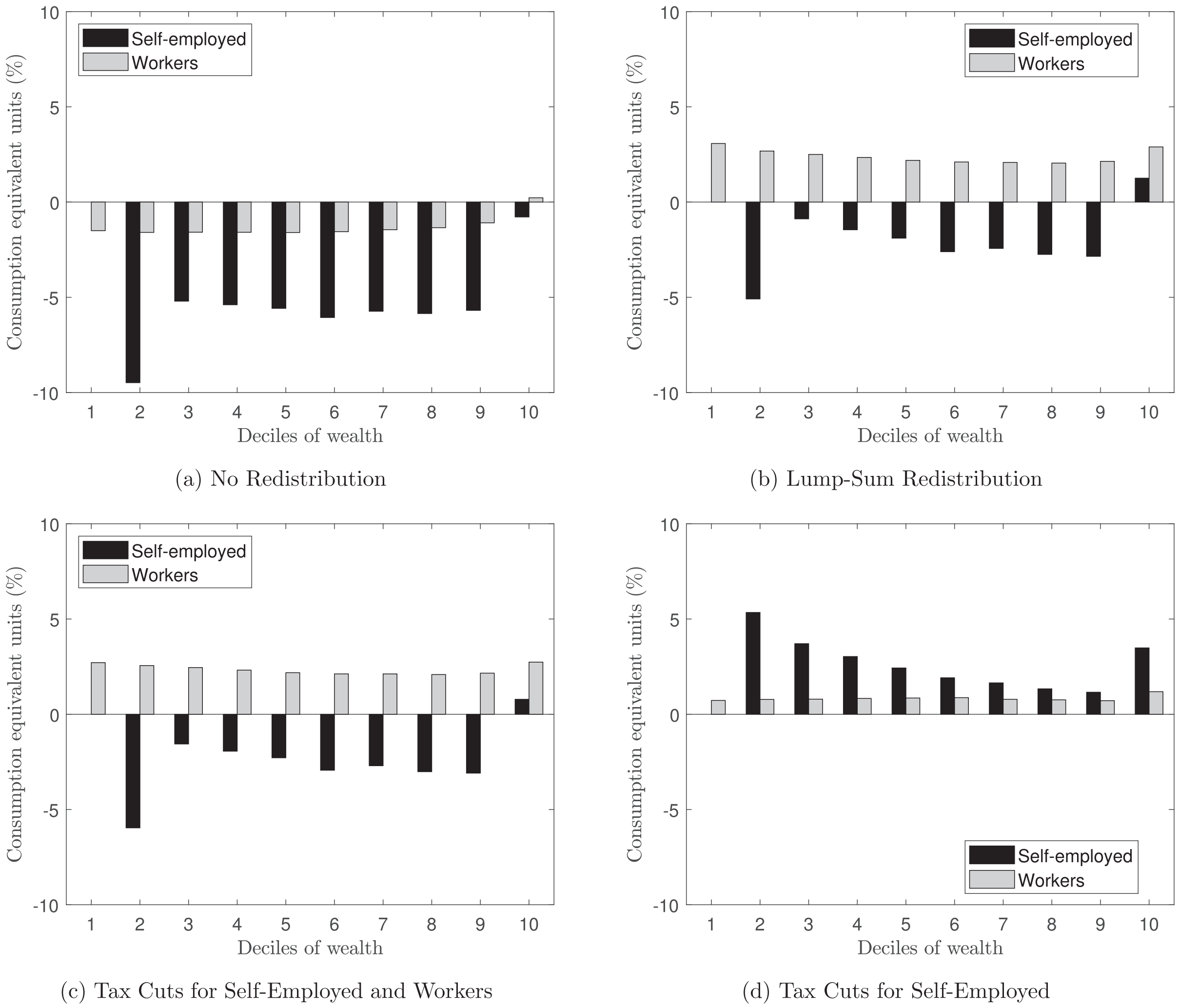
To sum up, our welfare results point out that under fiscal neutrality moving to an economy where taxes are perfectly enforced makes workers better off. Self-employed households, and in particular the poor ones, lose unless the tax cut is implemented for self-employed businesses only.

5.5. Tax evasion and credit constraints

In the benchmark economy, tax evasion increases output in the aggregate because it reduces the distortionary impact of income taxation and relaxes the credit constraint of self-employed businesses. In this section, we provide a deeper analysis of the interaction between tax evasion and financial constraints and proceed in two steps. First, we study the aggregate effects of tax evasion by looking at two re-calibrated model economies which differ in their borrowing limits. Second, we consider our benchmark economy and measure by how much tax evasion alleviates credit constraints by deriving the borrowing limit which would generate the same level of aggregate output in the absence of tax evasion.

In the first part of this section, we study the impact of tax evasion on aggregate outcomes in two economies in which the self-employed households face a tight ($\lambda = 1.2$) and a loose ($\lambda = 1.8$) borrowing limit. We re-calibrate both economies such that the main targets summarized in Table 2 are matched.[24] Since λ is now assumed to be an exogenous parameter, the mean leverage of the self-employment sector is not a target in the re-calibration procedure. Clearly, the borrowing limit affects the share of financially constrained self-employed households. Whereas in the benchmark economy ($\lambda = 1.5$), 20.62 percent of the self-employed are borrowing-constrained, the share of businesses at the borrowing limit increases to 25.33 percent for $\lambda = 1.2$ and decreases to 10.96 percent for $\lambda = 1.8$ (Table 16, Appendix B.3). As before, we compare the

[24] In Appendix B.3, Table 15 reports the parameter values of the internal calibration procedure for $\lambda = 1.2$ and $\lambda = 1.8$. Table 16 provides basic statistics for the two re-calibrated model economies.



Notes: This figure shows the percentage change in consumption needed to make a household (worker or self-employed) indifferent between being born in the benchmark economy and being born in any of the four counterfactual economies in which taxes are perfectly enforced. A formal definition of the certainty equivalents among different groups is given in Appendix B.2. Panel (a) is the counterfactual economy without fiscal neutrality in which additional tax revenues are not redistributed. In panel (b), the government balances the budget with lump-sum transfers to all households. In panel (c), the government balances the budget by implementing tax cuts for all households while in panel (d) the tax cut is implemented for self-employed households only. Note that there are no self-employed in the first decile of the wealth distribution. All figures refer to the outcomes in general equilibrium.

Fig. 4. Tax Evasion and Welfare Across Wealth and Occupation.

tax evasion economies with their counterfactuals in which taxes are perfectly enforced. Table 10 reports the changes in selected outcomes (in percent or percentage points) when moving from the benchmark economy with tax evasion to the counterfactual economy with perfect tax enforcement.

The quantitative findings provide insights on the effects of eliminating tax evasion in economies in which self-employed households face stricter or weaker credit constraints. To provide a transparent discussion of the effects, we first consider a partial equilibrium setup in which prices are kept at the level of the tax evasion economy. Clearly, via the *selection channel*, tax evasion has a larger impact on the share of self-employed and their average business ability if the credit constraint is tighter. Interestingly, for $\lambda = 1.2$, eliminating tax evasion decreases the average capital of a self-employed business $\mathbb{E}(k|E)$, whereas the opposite is true for $\lambda = 1.5$ and $\lambda = 1.8$. The same pattern can be observed for the share of small self-employed businesses with 1 to 4 employees: for $\lambda = 1.2$ the share rises with perfect tax enforcement while it falls in the other two economies. These findings suggest that on the individual level, the *subsidy channel* of tax evasion dominates the *detection channel* if the self-employed face a tight borrowing limit. In contrast, the *detection channel* is stronger than the *subsidy channel* for $\lambda = 1.5$ and $\lambda = 1.8$ such that the opportunity to evade taxes induces the self-employed businesses to keep their capital and labor input small in order to reduce their audit probability. Note, however, that in the aggregate, the *subsidy channel* of tax evasion is always dominant and affects aggregate output more strongly for stricter credit constraints.

In general equilibrium, the elimination of tax evasion raises the interest rate and reduces the wage. Importantly, the prices adjust more strongly in the presence of tight credit constraints. Inspecting the share of self-employed households, their capital choices, and aggregate capital and output suggests that the price adjustments weaken the *selection channel* and the *detection channel* but strengthen the *subsidy channel* of tax evasion.

Table 10
Tax Evasion and the Borrowing Limit.

	Partial Equilibrium			General Equilibrium		
	$\lambda = 1.2$	$\lambda = 1.5$	$\lambda = 1.8$	$\lambda = 1.2$	$\lambda = 1.5$	$\lambda = 1.8$
Aggregate outcomes						
K^E (%)	−13.48	−7.36	−2.38	−10.72	−6.02	−2.27
Y^E (%)	−12.12	−7.63	−4.43	−9.41	−5.88	−3.71
K^C (%)	−13.52	−13.35	−12.51	−1.04	−1.21	−1.02
Y^C (%)	−3.18	−3.51	−3.39	1.24	0.84	0.78
T/Y (pp.)	2.62	2.54	2.43	2.16	2.12	2.05
Sector of self-employment						
Share of self-employed (pp.)	−1.53	−1.37	−1.29	−0.98	−0.99	−0.97
$\mathbb{E}(\theta\|E)$ (%)	2.08	1.88	1.68	0.67	0.76	0.69
$\mathbb{E}(k\|E)$ (%)	−3.03	2.42	7.22	−4.09	0.94	4.80
Share of small businesses (pp.)	0.81	−5.84	−13.02	1.16	−5.71	−12.60
Prices						
r (pp.)	0.00	0.00	0.00	0.34	0.31	0.27
w (%)	0.00	0.00	0.00	−1.39	−1.24	−1.10
Welfare - no redistribution						
$\overline{\Delta}$ (%)	−1.32	−1.33	−1.33	−1.77	−1.75	−1.70
$\overline{\Delta}^E$ (%)	−4.43	−4.28	−4.09	−3.82	−3.79	−3.69
$\overline{\Delta}^W$ (%)	−0.81	−0.84	−0.86	−1.44	−1.41	−1.37
Welfare - redistribution, lump-sum						
$\overline{\Delta}$ (%)	1.80	1.89	2.02	1.77	1.92	1.96
$\overline{\Delta}^E$ (%)	−2.09	−1.86	−1.56	−1.17	−1.01	−0.86
$\overline{\Delta}^W$ (%)	2.44	2.52	2.62	2.25	2.41	2.44

Notes: The table reports the differences between the counterfactual economy with perfect tax enforcement and the benchmark economy with tax evasion for selected outcomes in % or pp. $\mathbb{E}(\theta|E)$ and $\mathbb{E}(k|E)$ denote the mean value of business ability and business capital of a self-employed business. The share of small businesses refers to self-employed businesses with 1 to 4 employees. K^E and Y^E refer to aggregate capital and output in the self-employment sector, respectively. K^C and Y^C denote aggregate capital and output in the corporate sector, respectively. T/Y refers to tax revenues as a share of total output, while w and r denote the real wage rate and the real interest rate. The welfare effects of moving from the benchmark economy with tax evasion to the counterfactual economy with perfect tax enforcement are measured in consumption equivalent units. $\overline{\Delta}$ denotes the aggregate welfare effect whereas $\overline{\Delta}^E$ and $\overline{\Delta}^W$ refer to the welfare effects of self-employed households and workers.

Table 11
Tax Evasion and the Alleviation of Credit Constraints.

	Perfect Tax Enforcement	
	$\lambda = 1.65$	$\lambda = 1.64$
Aggregate outcomes		
Y (%)	0.00	−0.05
Y^E (%)	0.31	0.00
Y^C (%)	−0.10	−0.04
K^E (%)	2.26	1.67
K^C (%)	−1.98	−1.88
Sector of self-employment		
Share of self-employed (pp.)	−0.74	−0.76
$\mathbb{E}(\theta\|E)$ (%)	0.39	0.40
$\mathbb{E}(k\|E)$ (%)	7.83	7.36
Share of small businesses (pp.)	−2.82	−2.78
Prices		
r(%)	0.28	0.28
w	−1.13	−1.14

Notes: The table considers the benchmark economy with tax evasion and measures by how much tax evasion alleviates credit constraints by deriving the borrowing limit which would generate the same level of aggregate total output (first column) or the same level of aggregate output in the self-employment sector (second column) in the absence of tax evasion. The table reports the differences between the benchmark economy with tax evasion and $\lambda = 1.5$ and the counterfactual economy with perfect tax enforcement and adjusted λ for selected outcomes in % or pp. $\mathbb{E}(\theta|E)$ and $\mathbb{E}(k|E)$ denote the mean value of business ability and business capital of a self-employed household. The share of small businesses refers to self-employed businesses with 1 to 4 employees. K^E, N^E, and Y^E refer to aggregate capital, labor, and output in the self-employment sector, respectively. K^C, N^C, and Y^C denote aggregate capital, labor, and output in the corporate sector, respectively. w and r denote the real wage rate and the real interest rate.

Without imposing fiscal neutrality, perfect tax enforcement generates larger welfare losses for self-employed households if their borrowing limit is tighter. If the additional tax revenues are redistributed via lump-sum transfers, workers exhibit lower welfare gains from the elimination of tax evasion if credit constraints are stricter. These findings are in line with our discussion so far and highlight the strong impact of tax evasion on aggregate output in the presence of severe financial constraints. Qualitatively, the welfare effects are similar in partial and in general equilibrium. However, the general equilibrium price effects mitigate the welfare losses of the self-employed. In contrast, because of a lower wage, workers are adversely affected and their welfare gains are smaller in general than in partial equilibrium.

In the second part of this section, we consider the benchmark economy with tax evasion and measure by how much tax evasion alleviates credit constraints. To this end, we derive the borrowing limit λ which generates the same level of aggregate output as in the benchmark economy if tax evasion is eliminated. It turns out that with perfect tax enforcement, the borrowing limit $\lambda = 1.65$ matches the aggregate total output of the benchmark economy. A very similar borrowing limit $\lambda = 1.64$ generates the same level of aggregate self-employed output Y^E as in the benchmark economy. Table 11 presents the changes in selected outcomes (in percent or percentage points) when moving from the benchmark economy with tax evasion and $\lambda = 1.5$ to the counterfactual economy with perfect tax enforcement and $\lambda = 1.65$ ($\lambda = 1.64$). In the counterfactual economies with perfect tax enforcement and a looser credit constraint the share of self-employed decreases. However, on average, the self-employed businesses are characterized by a higher business ability and a larger capital input than in the benchmark economy. Moreover, the counterfactual economies with perfect tax enforcement and a relaxed credit constraint exhibit lower shares of small firms with 1 to 4 employees. These findings highlight that perfect tax enforcement eliminates the *selection channel* and the *detection channel*. Moreover, the higher borrowing limit induces a better allocation of resources and generates an increase in aggregate capital and output in the self-employment sector.

Our analysis suggests a close link between financial constraints and tax evasion, which is in line with the literature on the interaction between financial development and informality, e.g., Antunes et al. (2007), Blackburn et al. (2012), and Franjo et al. (2019).

6. Tax enforcement policy and welfare

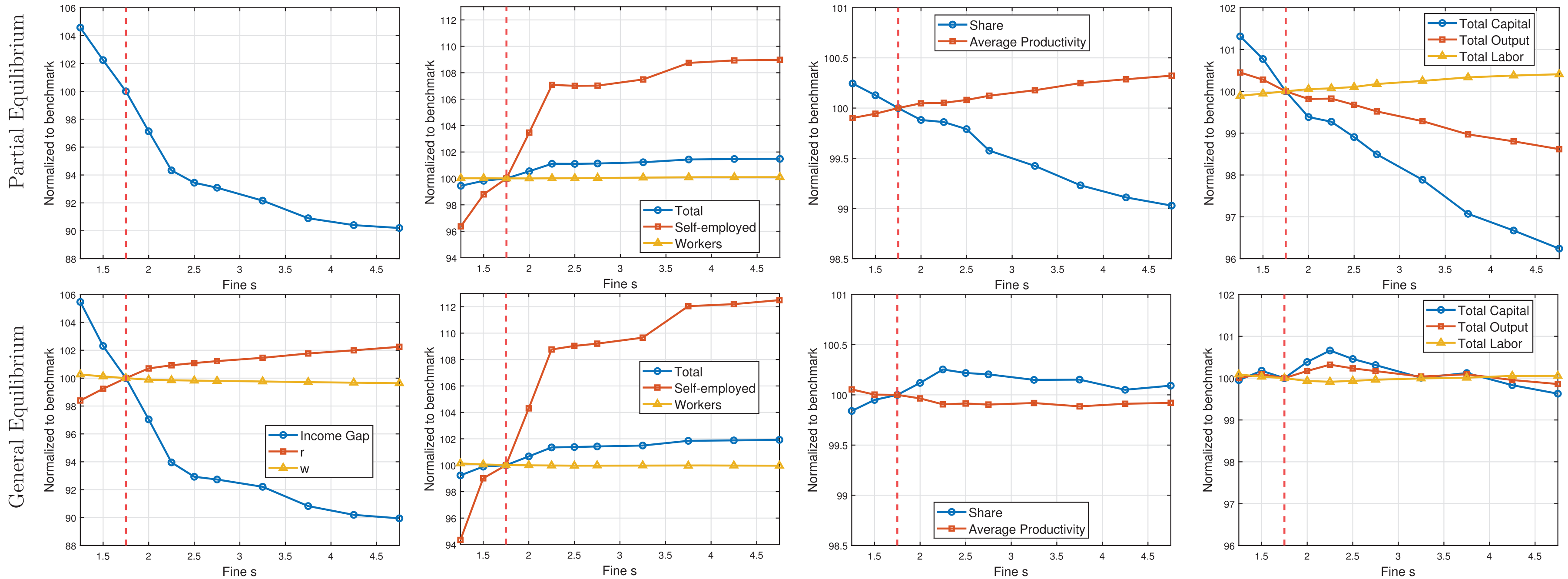
Against the backdrop that taxes are imperfectly enforceable, in this section, we focus on the tax evasion fine as tax enforcement policy instrument. According to the OECD (2011), in developed countries the penalties for tax evasion vary between 30 percent for minor offenses and 100 percent for frauds. To evaluate the effects of tax enforcement policy on aggregate outcomes and welfare, we employ our benchmark economy and vary the fine s within a range between 25 ($s = 1.25$) and 400 ($s = 5$) percent. We view these penalties as politically implementable. To provide a transparent discussion of the impact of the penalty for tax evasion on aggregate outcomes, we first consider a partial equilibrium setup in which prices are kept at the level of the benchmark economy. In a second step, we account for general equilibrium price adjustments.

In the first row of Fig. 5 we consider the partial equilibrium and display how the misreporting rate, tax revenues, the share of self-employed households, the average productivity in the self-employment sector as well as aggregate capital, labor, and output are affected by the penalty. All variables are normalized to the benchmark economy. Clearly, an increase in the penalty for tax evasion encourages self-employed households to report their business income more truthfully: the income gap shrinks such that the government can collect higher tax revenues. The rise in revenues is particularly pronounced for low values of the fine: an increase in s from 1.75 to 2 leads to a 4 percent increase in the tax revenues collected from the self-employed. At the same time, the share of self-employed households decreases as the level of the fine rises. This goes hand in hand with an increase in the average productivity of the self-employment sector. The reason is intuitive: if tax evasion is punished with a higher fine, agents with a lower business ability leave the sector of self-employment because misreporting becomes too risky for them. Since fewer households become self-employed, workers' labor supply rises. The smaller size of the self-employment sector, however, decreases aggregate capital and output in the economy. In turn, the adverse impact on aggregate production dampens the increase in tax revenues if the fine is raised beyond $s = 2.25$.

Next, we consider the general equilibrium in which the wage and the interest rate adjust (second row of Fig. 5). As seen in the partial equilibrium analysis, a larger penalty for tax evasion raises labor supply and depresses capital demand. Consequently, in general equilibrium, the wage falls while the interest rate increases in response to a higher fine. The larger interest rate increases the wealth of the self-employed and fosters tax revenues collected from the self-employed. Interestingly, the general equilibrium price adjustments generate a hump-shaped pattern of the share of self-employed. For weak penalties, an increase in the fine reduces the wage and induces more households to become self-employed. For fines larger than $s = 2.25$, however, misreporting becomes too risky and more households leave the self-employment sector. The hump-shaped pattern of the share of self-employed is reflected in aggregate capital and output. Importantly, the general equilibrium price adjustments substantially mitigate the impact of the penalty on aggregate outcomes.

To analyze the welfare effects of an increase in the penalty for tax evasion, we consider the general equilibrium scenario and assume that the additional tax revenues are redistributed either via lump-sum transfers or tax cuts. Fig. 6 displays the welfare effects measured as percentage changes in consumption required to make an agent indifferent between the benchmark economy with $s = 1.75$ and the counterfactual economy with a fine between 1.25 and 5. The first column displays the aggregate welfare effects across all households while the second column distinguishes the welfare effects by occupation.

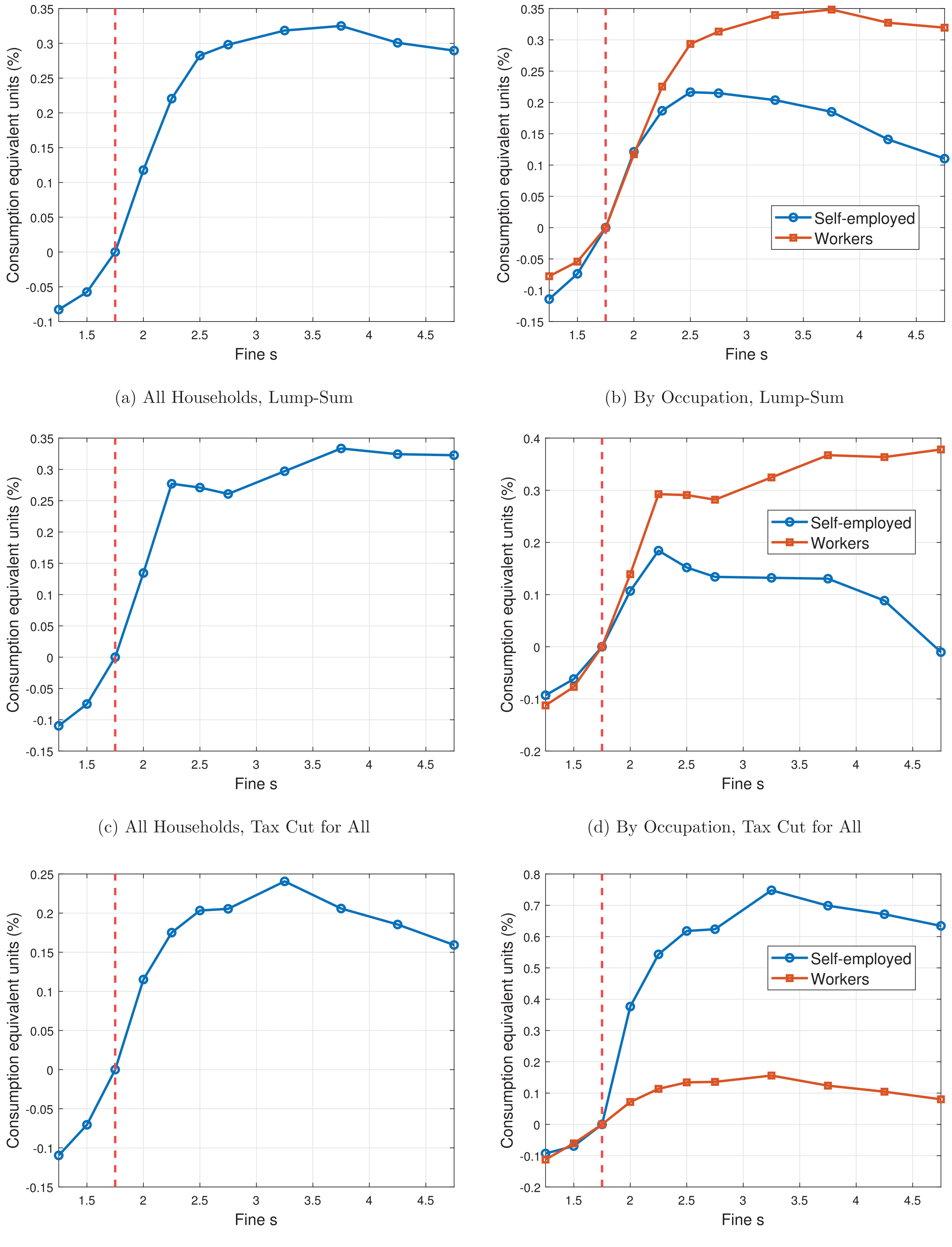
If the additional tax revenues are redistributed to all households via lump-sum transfers (Figs. 6a and 6b), workers experience a welfare gain from an increase in the fine relative to the benchmark, which is not surprising as they directly benefit from higher wages and the redistribution of the additional tax revenues. Interestingly, the group of self-employed households benefit from an increase in the penalty, too. Their welfare gain is hump-shaped and driven by two opposing forces. On the one hand, self-employed households benefit from the increase in lump-sum transfers. On the other hand, those self-employed households who evade taxes are hurt by the larger penalty. For low fines, the first effect dominates



(a) Misreporting and Prices (b) Tax Revenues (c) Share of Self-Employed (d) Production

Notes: The figure varies the fine on tax evasion s within a range between 1.25 and 5.00 and reports selected aggregate variables. The vertical dashed line indicates the benchmark economy with $s = 1.75$ in all panels. The first row of panels (a)-(d) depicts the partial equilibrium scenario in which prices are kept at benchmark levels. The second row of panels (a)-(d) depicts the general equilibrium scenario in which prices adjust. All variables are normalized to the benchmark economy with $s = 1.75$.

Fig. 5. The Impact of the Fine on Aggregate Outcomes.



(a) All Households, Lump-Sum

(b) By Occupation, Lump-Sum

(c) All Households, Tax Cut for All

(d) By Occupation, Tax Cut for All

(e) All Households, Tax Cut Self-Employed

(f) By Occupation, Tax Cut Self-Employed

Notes: The figure varies the fine on tax evasion s within a range between 1.25 and 5.00 and reports welfare effects measured as the percentage change in consumption needed to make a household indifferent between being born in the benchmark economy ($s = 1.75$) and being born in any of the counterfactual economies with a different s. The vertical dashed line indicates the benchmark economy with $s = 1.75$. The results refer to the general equilibrium under fiscal neutrality. Panels (a)-(b) assume that the additional tax revenues are distributed via lump-sum transfers to all households. In panels (c)-(d) fiscal neutrality is achieved via tax cuts for all households, while in panels (e)-(f) tax cuts are implemented only for the self-employed. Panels (a), (c) and (e) present the welfare effects for all households, while panels (b), (d) and (f) show the welfare effects by occupation.

Fig. 6. The Impact of the Fine on Welfare.

and the self-employed's welfare gain is increasing in s. If the fine is raised above $s = 2.5$, the second effect dominates and the self-employed's welfare gain decreases. For very large penalties, eventually, the self-employed's welfare effect becomes negative, and the economy approaches the perfect tax enforcement scenario, in which the group of the self-employed experiences welfare losses of 1 percent while the workers benefit from a welfare gain of 2.4 percent (Table 9). Against the backdrop that perfect tax enforcement may not be implementable, the government can still improve upon the benchmark by raising the fine from 75 percent to 150 percent: workers and self-employed households would benefit from welfare gains of 0.3 and 0.2 percent, respectively. Similar conclusions can be drawn, if the additional tax revenues are redistributed via tax cuts for all (Figs. 6c and 6d).

If the additional tax revenues are redistributed only to the self-employed via tax cuts (Figs. 6e and 6f), workers still benefit from a positive welfare effect because of higher wages. Increasing the fine from 75 to 225 percent raises the workers' welfare by 0.18 percent, whereas the group of self-employed households experiences a welfare gain of 0.75 percent. For comparison, if perfect tax enforcement was implementable, the welfare gains amount to 0.8 and 2.4 percent for workers and self-employed households, respectively (Table 9).

7. Conclusions

In the U.S., tax evasion of individual income is substantial and prevails among the self-employed businesses. To study the aggregate consequences of tax evasion, we develop a dynamic general equilibrium model with incomplete markets and occupational choice in which self-employed households may hide a share of their business income but face the risk of being detected by the tax authorities. The model replicates important quantitative features of the U.S. economy in terms of the distribution of income and wealth, self-employment, and tax evasion.

We show that tax evasion in the self-employment sector has a significant quantitative impact on aggregate outcomes and welfare. We quantify three important channels through which tax evasion affects the overall economy. The *subsidy channel* emphasizes that tax evasion acts like a subsidy and stimulates asset accumulation. The *selection channel* highlights that the opportunity to evade taxes induces less talented households to run self-employed businesses and depresses the average productivity in the self-employment sector. The *detection channel* causes self-employed households to keep their businesses small in order to reduce the probability of being audited.

Tax evasion generates positive welfare effects for the self-employed at the expense of the workers. Tax evasion is particularly beneficial for poor self-employed households because it acts as a subsidy and relaxes their credit constraints. However, implementing a perfect tax enforcement and using the additional revenues to decrease taxes for self-employed businesses leads to an increase in aggregate welfare and to a more productive economy.

Against the backdrop that taxes are imperfectly enforceable, we focus on the penalty for tax evasion as a tax enforcement policy instrument. Our quantitative findings suggest that raising the penalty from 75 to 125 percent of missing taxes reduces misreporting and sharply increases tax revenues. If these additional tax revenues are redistributed to all households via lump-sum transfers or tax cuts, both workers and self-employed households experience welfare gains. Penalties beyond 125 percent of the missing taxes reduce the share of self-employed, depress aggregate output and dampen the increase in tax revenues with adverse welfare effects for the self-employed.

Our findings are particularly important in light of the common view that entrepreneurship is a key driver of innovation and economic growth. Our paper highlights that tax evasion encourages self-employment by alleviating financial frictions. However, at the same time, tax evasion increases the share of small and less productive firms in the economy. Given that small firms are less likely to engage in R&D intensive activities, this may affect productivity growth negatively.

In this paper, we have focused on tax evasion, which is an illegal violation of the tax code. We have abstracted from tax avoidance as a way to reduce tax liability by legal means. Whereas tax evasion is relevant for small self-employed businesses, tax avoidance is particularly attractive for large firms and wealthy individuals and may substantially affect aggregate and distributional outcomes. We leave all these interesting questions for future research.

Acknowledgments

We would like to thank the editor, Mariacristina De Nardi, and three anonymous referees for excellent comments and suggestions. We are grateful to Michael Burda, Philip Jung, Leo Kaas, Dirk Krueger, Moritz Kuhn, Marco Maffezzoli, Dominik Sachs, Nawid Siassi, and seminar participants at the Bank of Italy, Humboldt University Berlin, University of Augsburg, University of Bonn, UC3M, University of Dortmund, Goethe University Frankfurt, University of Konstanz, LMU Munich, Monash University, and conference audiences at the CEF 2018, EEA 2018, the annual meeting of the German Economic Association 2018, the Konstanz - St. Gallen Workshop on Dynamic Macroeconomics 2018, and the Frankfurt-Mannheim Macro Workshop 2019 for insightful comments. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Deutsche Bundesbank. This work was supported by the German Research Foundation (grant number SCHO 1442/2-1).

Table 12
Summary Statistics: Self-Employed versus Business Owners.

Variable	Self-employed	Business Owners
Share of entrepreneurs (%)	14.70	20.11
Share of income, entrepreneurs (%)	21.04	27.98
Share of assets, entrepreneurs (%)	39.11	46.15
Ratio of median assets (E/W)	4.02	3.65
Exit rate, entrepreneurs (%)	15.73	24.43
Capital used by SE	35.00	30.93
Number of observations	22, 647	22, 704

Notes: Summary statistics are derived from the PSID for the years 1990-2003.

Appendix A. Data

A.1. Data description

We employ the Panel Study of Income Dynamics (PSID) and use the sample from 1990-2003 to estimate the moments related to income and self-employment. For the wealth targets, we link the main data set to the *Wealth Supplement File* for the years 1994, 1999, 2001 and 2003.[25] The questions in the survey refer to the previous calendar year.

Sample selection. We create our sample including variables related to the characteristics of the households and occupation and merge it with Sample A of Heathcote et al. (2010), which contains information on household tax liabilities. Heathcote et al. (2010) apply basic data cleaning by dropping records if: *(a)* there is no information on age for either the head or spouse, *(b)* either the head or spouse has positive labor income but zero annual hours, or *(c)* either the head or spouse has an hourly wage less than half of the corresponding federal minimum wage in that year. In addition, we select all households where the head of the household is male, is of age 25-65 and has worked at least 260 hours during the year.

Definition of self-employed. Traditionally, the entrepreneurial literature distinguishes between two definitions of entrepreneurs, see, e.g., Quadrini (2000). According to the first definition, entrepreneurs are families that own a business or have a financial interest in a business enterprise. This definition is based on the PSID variable “Whether Business” which is based on the following interview question: “Did you (Head) or anyone else in the family own a business at any time during the previous year or have a financial interest in any business enterprise?”. If the answer is positive (negative), this household is recorded as an entrepreneur (worker). According to the second definition, entrepreneurs are families in which the head is self-employed in his or her main job and the interview question is: “In your main job, are you (head) self-employed or do you work for someone else”. Unlike the previous survey question, which allows only a binary answer (yes/no), this one specifies the occupation of the head and allows to identify a household directly as: a self-employed, an employee, both a self-employed and an employee, or an unemployed.

In our study, we opt for the second definition. First, this definition is more consistent with the data on tax evasion since underreported self-employed business income refers to those who are self-employed (see Johns and Slemrod (2010)). Second, the answer to the first question can be positive if the household has “a financial interest in any business enterprise” and it would not reflect the occupation of the household, which we have in mind in the model. Moreover, the second survey question gives more information on the occupation of the head of the household and allows to clearly distinguish between self-employed and workers.

Based on the second survey question, we define a self-employed household as a household where the head is self-employed, a ‘worker’ household where the head is an employee or ‘both a self-employed and an employee’.[26] We drop those who answered they are ‘unemployed’ from the sample. As a result, there are 14.70 percent of self-employed households in our sample. We present selected statistics for both definitions in Table 12.

A.2. Estimating the labor income process

To estimate the labor income process, we follow the procedure described by Heathcote et al. (2010). Since our model unit is a household, we focus on household labor income. We concentrate on the residual dispersion obtained from a standard Mincerian regression:

$$\texttt{lninc}_{i,t} = \alpha_0 + \beta_0 \texttt{educ}_{i,t} + \beta_1 \texttt{potexp}_{i,t} + \beta_2 \texttt{potexp}^2_{i,t} + \varepsilon_{it}, \tag{23}$$

where i is a household index and t is time. The variable `lninc` is the logarithm of household labor income, `educ` refers to years of education and `potexp` represents years of potential experience.

[25] Although wealth data are also available for 2005 and 2007, we do not extend the analysis to these years since other variables needed are missing.

[26] There are 0.7 percent of such households, hence, either dropping those households or including them to either of the group does not change the main moments.

Table 13
Exit Rates.

Year	% Stayed Workers	Number of Workers	Exit Rate Workers (%)	% Stayed Self-employed	Number of Self-employed	Exit Rate Self-employed (%)
1990	96.82	1,572	3.18	88.85	278	11.15
1991	96.32	1,522	3.68	89.93	278	10.07
1992	96.07	1,424	3.93	79.57	235	20.43
1994	96.84	1,709	3.16	85.00	260	15.00
1995	97.96	1,715	2.04	82.14	252	17.86
1996	97.45	1,728	2.55	84.65	241	15.35
1997	96.33	1,609	3.67	83.11	219	16.89
1999	96.07	1,704	3.93	82.45	245	17.55
2001	95.93	1,844	4.07	80.80	224	19.20
Exit Rate						15.73

Notes: Summary statistics are derived from the PSID for the years 1990-2003. The year 1993 is excluded because of missing information on the occupation.

Potential experience is calculated as the difference between the age and years of education less 6, i.e., $\texttt{potexp} = \texttt{age} - \texttt{educ} - 6$, where 6 is the typical age for entering the elementary school.

We assume that the error term follows a first order Markov process of the form:

$$\log \varepsilon_{t+1} = \rho_\varepsilon \log \varepsilon_t + \eta_{\varepsilon,t+1}, \tag{24}$$

where $\eta_{\varepsilon,t+1} \sim N(0, \sigma_\varepsilon^2)$. We estimate this process for workers and obtain a persistence parameter $\rho_\varepsilon = 0.89$ whereas the dispersion parameter is $\sigma_\varepsilon = 0.21$.

A.3. Estimating entry and exit rates

The exit rates are calculated as follows. First, we sort individuals by their identification number and consider two consecutive years. Then, we calculate how many individuals remained workers from one year to another and divide by the initial number of workers. This gives us the share of people who stayed workers. In the same way, we calculate the share of those who stayed self-employed. Exit rates are calculated as one minus the share of those who stayed a worker/self-employed. Finally, we calculate a weighted sum of year-by-year exit rates to get an average number we use for calibration. We get that on average, per year, around 15.73 percent of those who were self-employed exited self-employment. This number is comparable with the exit rate of 13.6 percent reported by Quadrini (2000). Table 13 shows the year-by-year exit rates for workers and self-employed.

A.4. Data on auditing

Table 14 is based on Slemrod and Gillitzer (2014), Chapter 6.5, and U.S. Department of the Treasury (2011) and reports auditing rates by type and size of reported income, relative to the fiscal year 2011. On average only 1.11 percent of individual tax returns are audited but this percentage changes across income levels. Generally, the probability of being audited by the Internal Revenue Service is rising with income, increasing from less than 1 percent to almost 30 percent for tax returns above $10 million. Individuals who include business income in their returns are significantly more likely to be audited. Small corporations, with less than $10 million in total assets, are audited with only 1 percent probability, whereas larger corporations, with more $10 million in total assets, face an audit rate of 17.6 percent.

Appendix B. Model

B.1. Policy function: self-employed business capital

Fig. 7 shows the policy function for self-employed business capital expanding the x-axis in order to highlight the part of the state-space where the borrowing constraint is not binding, $k < \lambda a$.

B.2. Welfare analysis: details

In this section, we provide details on the derivation of the welfare measure $\Delta(x)$ defined by:

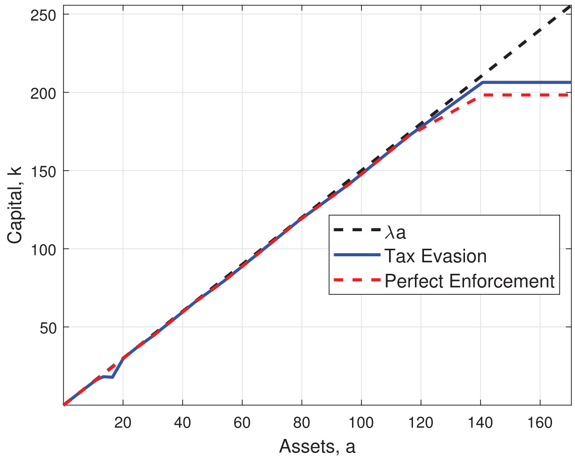
$$U\Big((1+\Delta(x))\, c^B(x), \ell^B(x)\Big) = U\Big(c^C(x), \ell^C(x)\Big),$$

with $U(c(x), \ell(x)) = E_0\left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c(x_t)^{1-\sigma_1}}{1-\sigma_1} - \psi \frac{\ell(x_t)^{1+\sigma_2}}{1+\sigma_2}\right) | x_0 = x\right]$. $\Delta(x)$ provides the percentage change in consumption at all future dates and states required to make an individual in state x to be indifferent between the benchmark economy and the counterfactual economy.

Table 14
U.S. Auditing Rates by Type and Size of Tax Return.

Type of return	Percent covered
Individual Income Tax	1.11
No adjusted gross income	3.42
[1, 25000]	1.22
[25000, 50000]	0.73
[50000, 75000]	0.83
[75000, 100000]	0.82
[100000, 200000]	1.00
[200000, 500000]	2.66
[500000, 1m]	5.38
[1m, 5m]	11.80
[5m, 10m]	20.75
> 10m	29.93
Corporate income tax	1.5
Small firms (<$10m in assets)	1.0
Large firms (>$10m in assets)	17.6

Notes: The numbers are based on the fiscal year 2011 and are taken from Slemrod and Gillitzer (2014), Chapter 6.5, and U.S. Department of the Treasury (2011).



Notes: This figure shows the policy function for self-employed business capital $k(a, \varepsilon, \theta)$. Working ability ε and business ability θ are fixed to their average values. The solid (dashed) lines refer to the benchmark economy with tax evasion (to the counterfactual economy with perfect tax enforcement).

Fig. 7. Self-Employed Business Capital: Tax Evasion vs Perfect Enforcement.

Following Heer and Trede (2003) and Brüggemann (2019), $\Delta(x)$ can be derived as:

$$\Delta(x) = \left[\frac{V^C(x) - V^B(x)}{E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{(c^B(x_t))^{1-\sigma_1}}{1-\sigma_1} \right) | x_0 = x \right]} + 1 \right]^{\frac{1}{1-\sigma_1}} - 1,$$

where $V^B(x)$ and $V^C(x)$ denote the household's value function in the benchmark economy and in the counterfactual economy, respectively.

To further decompose the welfare effects, we compute the compensating equivalence variation for each decile i of household wealth in the benchmark economy,

$$\overline{\Delta}_i^E = \frac{\int \mathbf{1}_i(x) o(x) \Delta(x) d\mu^B(x)}{\int \mathbf{1}_i(x) o(x) d\mu^B(x)}, \qquad \overline{\Delta}_i^W = \frac{\int \mathbf{1}_i(x)(1 - o(x)) \Delta(x) d\mu^B(x)}{\int \mathbf{1}_i(x)(1 - o(x)) d\mu^B(x)},$$

where $\mathbf{1}_i(x)$ is an indicator function that takes the value of one if x lies in the i-th decile of wealth.

B.3. Varying λ

In this section, we provide details on two re-calibrated counterfactual economies characterized by $\lambda = 1.2$ and $\lambda = 1.8$. Table 15 provides the values of the internally calibrated parameters. Table 16 summarizes the basic model statistics.

Table 15
Internally Calibrated Parameters: Varying λ.

Parameter	Description	λ= 1.2	λ= 1.8
Preferences			
β	Discount factor	0.945	0.946
ψ	Disutility from working	0.830	0.830
Production			
δ	Capital depreciation	0.110	0.110
ν	Span of control	0.740	0.740
γ	Capital share, self-employed	0.730	0.730
Self-employed ability			
ρ_θ	Persistence	0.952	0.952
σ_θ	Standard deviation	0.670	0.670
μ_θ	Unconditional mean	-1.100	-1.133
Tax evasion detection			
κ	Cost of tax evasion	0.137	0.127
p_1	Parameter of $p(\cdot)$	2250	1750
p_2	Parameter of $p(\cdot)$	0.350	0.350
Tax functions rescale			
χ	Rescaling parameter	11.000	11.000

Table 16
Basic Model Statistics: Varying λ.

	Data	λ = 1.2	λ = 1.5	λ = 1.8
Targeted Statistics				
Interest rate (%)	4.00	4.00	4.00	4.00
Capital-output ratio	2.65	2.57	2.59	2.61
Hours worked (%)	33.00	33.81	33.77	33.75
Share of self-employed (%)	14.70	14.16	14.29	14.39
Exit rate, self-employed (%)	15.73	14.31	14.31	14.30
Overall misreporting rate (%)	11.00	12.04	12.02	12.07
Tax revenues/GDP (%)	15.20	14.77	14.72	14.71
Non-Targeted Statistics				
Mean leverage of self-employed (%)	28.90	11.56	27.96	43.29
Share of income, self-employed (%)	21.04	24.29	24.73	25.04
Median wealth ratio, self-employed/workers	4.02	3.82	3.58	3.51
Share of credit-constrained self-employed (%)	22.80	25.33	20.62	10.96

Notes: The table shows the model statistics for different values of λ and the empirical counterparts based on PSID data for the years 1990-2003. The misreporting rate is taken from Johns and Slemrod (2010). The mean leverage and the share of credit-constrained businesses in the self-employment sector are based on SCF data for the years 1998, 2001 and 2004.

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