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Abstract

We offer a new explanation for why taxes have become less redistributive in many countries in parallel with an increase in income concentration. When performance-based contracts are needed to incentivize effort, redistribution through progressive income taxes becomes less precisely targeted. Taxation reduces after-tax income inequality but undermines performance-based contracts, lowering effort and raising pre-tax income differentials. Product market integration can widen the spread of project returns and make contract choices more responsive to changes in the level of taxation, resulting in a lower optimal income tax rate even when individuals are not inter-jurisdictionally mobile.

KEY WORDS: Performance Contracts; Market Integration; Redistributive Taxation

JEL CLASSIFICATION: D63, F15, H21

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1 Introduction

Starting from the 1980s, the distribution of income in many developed economies has progressively become more unequal and more concentrated.[1] And yet, tax-transfer systems have not become more redistributive—on the contrary, in a number of countries they have actually become less so. Egger et al. (2019) have recently shown that, since the mid-1990s, economic globalization has resulted in a higher labor tax burden on the middle classes of OECD countries and a lower labor tax burden for the top one percent of earners. Similarly, Immervoll and Richardson (2011, Table 4) find in a comprehensive study of redistribution policy among OECD countries that the gap between the Gini coefficient of market incomes and that of disposable incomes—a broad measure of redistribution—has fallen from the mid-1990s onwards.[2] For the U.S., several studies find a reduced progressivity of the tax system (Bargain et al., 2015; Piketty et al., 2018; Wu, 2020), only partially offset by changes in the transfer system (Heathcote et al., 2020).

The observation of greater inequality going hand-in-hand with less redistribution through taxation poses a puzzle, and one that is of major policy importance. Standard theories of optimal taxation would predict an increase in tax levels when top incomes rise (Saez, 2001; Slemrod and Bakija, 2001). A combination of higher levels of inequality with less redistributive taxes can only be reconciled with those theories if the increase in inequality is accompanied by an increase in the elasticity of the tax base. Accordingly, one prominent argument in the literature is that the tax base has become more elastic at the upper end of the income distribution because high-income earners have become more inter-jurisdictionally mobile (e.g., Lehmann et al., 2014). However, for a significant fraction of individuals at the top of the income distribution, international mobility remains limited (Battisti et al., 2018; Kleven et al., 2020).[3]

In this paper we advance an alternative, and complementary, explanation for the concurrent observation of higher income concentration and lower redistribution. Our argument focuses on how optimal redistributive policies are affected by the internationalization of *product markets*—rather than labor markets— and how this feeds back on the structure of incentive contracts in the labor market.

Our starting point is the observation that labor markets are fundamentally shaped by incentive contracts. In a narrow sense, performance-based contracts can be distinguished by an explicit bonus element that is based on measured performance. In the UK, Bell and

[1] In many countries this has mainly happened at the top of the income distribution (Atkinson et al., 2011). But in some countries, like the United States, it has been shown to apply to the entire distribution (Piketty et al., 2018). Detailed international evidence on the development of various measures of income inequality on income and wealth is collected by the OECD (the IDD and WDD databases) and is summarized in the World Inequality Database (Alvaredo et al., 2017).

[2] According to both studies, this reverses the pattern from the 1980s and early 1990s, when globalization led to higher tax progressivity and increased income redistribution.

[3] One likely reason for this limited mobility is that many high-earning occupations, such as the provision of legal services, often involve jurisdiction-specific human capital investment.

Van Reenen (2014) show that bonus income represents more than 10% of the total salary for the top 10% of earners employed in financial services, and for the top 5% of earners in other sectors. More generally, Lemieux et al. (2009) find, for a panel of more than 3,000 employees in the U.S., that almost 40% of workers receive some form of performance pay. In other OECD countries, the share of incentive contracts is somewhat lower, but still above 20% (Bryson et al., 2012). In a broader interpretation, many employed individuals who do not explicitly receive bonuses still face implicit performance-related incentives. Fama (1980) and Holmstrom (1999) have emphasized the role of implicit incentive contracts in a dynamic setting where satisfactory performance of a worker today is rewarded by promotions and a higher (nominally fixed) pay tomorrow. The importance of such implicit incentives has been empirically confirmed with both field and experimental data (Frederiksen, 2013; Sliwka and Werner, 2017). Increased reliance on performance pay is also a core reason for why U.S. wages have become substantially more volatile since the mid-1980s (Champagne and Kurmann, 2013; Nucci and Riggi, 2013).

With incentive contracts, income inequality stems from two different sources: differences in individual abilities and outcome-dependent wage differentials for individuals of identical abilities.[4] Redistributive taxation can address the first source of wage inequality but not the second, as the latter arises as a second-best market solution to a moral hazard problem. Performance pay thus limits the redistributive role of tax policy for any empirically observed distribution of earnings.

The second building block in our argument is the observation that product market integration is associated with higher individual income risk and steeper pay incentives. Rodrik (1997, 1998) was among the first to show that rising trade exposure is associated with higher aggregate income volatility. More recently, Autor et al. (2017a, 2017b) have documented rising concentration indices in major industry groups of the U.S. economy and have proposed a *superstar firm* model to explain why industries seem to be increasingly characterized by 'winner-takes-most' features. This matches international evidence of 'export superstars', showing that the top percentile of firms is responsible for 80% of a country's exports (Bernard et al., 2018), and that the top firm alone is able to create sectoral comparative advantage (Freund and Pierola, 2015).

Moreover, there is ample evidence that international product market integration feeds back on labor markets. Cuñat and Guadalupe (2009) provide empirical evidence that increased foreign competition raises the share of performance pay and increases wage differentials among executives in U.S. firms. Similarly, Dasgupta et al. (2018) report that major industry-level tariff cuts induced CEO turnover in U.S. firms and increased incentive pay for the new, outside CEOs. On the exporting side, Ma and Ruzic (2020) show that China's accession to the WTO in 2001 increased within-firm earnings differentials among U.S. firms that exported to China before the trade shock. In line with

[4] Abraham et al. (2017) find that incentive contracts contribute about 10% of the observed U.S. wage inequality.

these findings, we model product market integration as a process that increases aggregate productivity but also raises income risks for firms and their workers as a result of increasingly global product market competition.

To develop our arguments, we describe a model of second-best contracting where incomplete insurance is required to elicit effort in the presence of moral hazard. Risk-averse workers with heterogeneous abilities face a continuous choice of labor supply, and a discrete choice between a performance-based contract that induces effort and a less efficient fixed-wage contract that does not. In equilibrium, higher productivity workers select into performance contracts, whereas less productive workers choose fixed-wage contracts. We then introduce a model of international competition in product markets, where market integration leads to a concentration of project returns. This increases the variance of returns within incentive contracts, which in turn raises the critical productivity level above which a worker will select into a performance-based contract.

Finally, we ask how these changes feed into the choice of an optimal linear tax rate financing a lump-sum transfer.[5] To this end, we characterize optimal tax policy in our model of incomplete contracting, before studying how the optimal tax formula is affected by a wider spread in market returns that follows from globalization. The increased prevalence of lower-productivity, fixed-wage contracts induced by this increase in income uncertainty, and the rising costs of disrupting higher-productivity performance-based contracts through taxes, both contribute to a push for lower taxes. As a result, we show that economic globalization can lead to a reduction in taxes, despite the concomitant increase in income concentration. Results obtained from a numerical version of the model calibrated to 2016 U.S. data shows that a globalization-induced increase in income concentration leads to a fall in the optimal tax rate under plausible parameter values. In contrast, we show that a similar increase in income concentration in a standard optimal tax model with complete contracting leads to an increase in the optimal tax rate.

Our study is related to several strands of literature, starting with the large literature on the optimal progressivity of income taxes (see Diamond and Saez, 2011, for an overview), and, more specifically, on redistributive taxation in the presence of earnings risk (see Boadway and Sato, 2015, for a recent synthesis). Following Varian (1980), most of this literature considers earnings volatility as exogenous, driven by luck. The implications of endogenous earnings risk are considered in a small literature strand that focuses on the 'crowding out' of private insurance by social insurance or redistributive taxation (Golosov and Tsyvinski, 2007; Chetty and Saez, 2010; Krueger and Perri, 2011; Chang and Park, 2021). Most closely related to our analysis is Doligalski et al. (2022), who analyze redistributive taxation in a model of performance pay contracts where individuals make continuous effort decisions within contracts. Besides differences in the way they model effort and contracts, their focus is on the implications of performance pay for

[5]Our analysis thus perceives government policies as being chosen in the best interest of citizens, rather than being determined in a political market. Recent empirical evidence, surveyed in Potrafke (2017), indicates that the impact of partisan politics on tax policies has significantly fallen since the 1990s.

the optimal non-linear income tax. Our focus is instead on the effects that international market integration has on the optimal linear income tax.

A number of recent studies (Lemieux et al., 2009; Abraham et al., 2017) have emphasized the contribution of performance-based pay to rising wage inequality, while a number of older studies (Schmidt, 1997; Raith, 2003) have stressed the role of market competition in the determination of incentive pay. Our analysis connects these findings to the optimal taxation literature.

The fact that globalization induces changes in income inequality differentiates our analysis from the literature focusing on the increased mobility of high-income earners under labor market integration (Simula and Trannoy, 2010; Bierbrauer et al., 2013; Lehmann et al., 2014; Tóbias, 2016), which generally finds that economic integration leads to inefficiently low redistributive income taxes.[6] In these models, changes in optimal non-linear income tax rates are exclusively driven by efficiency considerations related to the level and the slope of the semi-elasticity of migration.[7] Here we focus instead on the global competition in product markets and its effects on performance-based contracts as an alternative channel through which economic globalization influences tax policy choices. In our model, the increase in income dispersion within contracts induced by economic globalization generates an effect analogous to the 'superstar effect' examined by Scheuer and Werning (2017). However, introducing superstar effects for a given distribution of abilities in the setting they study leaves the optimal redistributive tax rate unchanged, because the higher redistributive gain from the tax is exactly offset by the larger elasticity of the tax base; whereas in our setting the increase in the dispersion of income within contracts can lead to a fall in the optimal tax rate.

Our analysis proceeds as follows. Section 2 describes our model of incomplete contracting, studies the sorting of heterogeneous workers into performance-based versus fixed-wage contracts, and analyzes how taxation affects the structure of contracts. Section 3 introduces a model of international trade and discusses the relationship between the structure of contracts and economic globalization. Section 4 turns to redistributive taxation: it analyzes the effects of economic globalization on the optimal tax rate and presents numerical simulation results from a calibrated version of the model. Section 5 discusses our findings and their robustness to extensions. Section 6 concludes. Proofs of propositions are in the Appendix.

[6] Empirical contributions to this literature have studied the migration responses of high-income earners both at the international level (Kleven et al., 2014) and at the national level (e.g., Agrawal and Foremny (2019). The literature is summarized in Kleven et al. (2020).

[7] In line with their focus on efficiency effects, Simula and Trannoy (2010) and Lehmann et al. (2014) only consider revenue maximizing governments. Bierbrauer et al. (2013) assume utilitarian governments, but relocation of all workers is costless in their model. As they show, this makes it impossible to levy positive taxes on individuals with above-average incomes.

2 A model of incomplete contracting

2.1 Preferences, technologies, and contracts

We consider an economy with risk-averse individuals who are heterogeneous in their productivity type, α, drawn from a continuous distribution with positive support characterized by a cumulative density function $F(\alpha)$. Production takes place through risky projects that are run by risk-neutral firms earning zero profits in expectations. Each project involves a single individual, hired by a firm as a worker.

In this setting, individuals face three decisions: (i) a discrete contract choice between a fixed-wage contract and an incentive contract, (ii) a discrete effort choice $e \in \{0,1\}$ that increases the likelihood of success of a project, and (iii) a continuous choice of labor supply ℓ that increases the output generated in case of success, but does not affect the likelihood of success.

A project succeeds with probability $\pi \in (0,1)$ when positive effort is exerted and with probability $\eta\pi < \pi$ otherwise. A project that employs an individual of productivity type α supplying labor ℓ yields return $\alpha\ell/\pi$ if successful, and nothing otherwise. As a result, the expected return of a project is

$$\begin{cases} \alpha\ell & \text{if } e = 1, \\ \eta\alpha\ell & \text{if } e = 0. \end{cases} \tag{1}$$

In other words, exerting effort discontinuously increases a project's expected return through a discrete change in the likelihood of success governed by the parameter $\eta \in [0,1)$, independently of productivity, α, or hours worked, ℓ.

For tractability, we assume preferences to be additively separable between the utility derived from consumption, the disutility from effort, and the disutility from labor supply. Utility from consumption is logarithmic, implying a constant coefficient of relative risk aversion equal to unity—consistent with available evidence in the context of labor supply (Chetty, 2006). Exerting effort entails a fixed cost $c > 0$, independent of productivity or hours worked. The disutility of labor supply is convex and isoelastic: it equals $\kappa\ell^{1+\varepsilon}/(1+\varepsilon)$, where $\kappa > 0$, and where $\varepsilon > 0$ governs the elasticity of labor supply (Saez, 2001).

We restrict our attention to linear systems and assume that the government levies taxes on labor income, z, at a flat rate $t \geq 0$, using the revenue to finance a lump-sum transfer $g \geq 0$. This makes the disposable income allocated to consumption equal to $(1-t)z + g$.

Incentive contracts

Productivity, α, hours worked, ℓ, and the project's ex-post outcome are fully observable, but effort, e, is not. Since effort is non-verifiable, wage payments cannot be conditioned on it and contracting between firms and workers thus runs against a moral hazard problem, which can only be (partially) addressed by incentive-compatible contracts that induce workers to exert positive effort by conditioning wage payments on a signal that is positively correlated with effort. These performance-based contracts pay a high income, z_H, if the project is successful and a low income, z_L, otherwise. Since hours worked, ℓ, can be observed, they are fully verifiable and contractible, implying that ℓ is independent of effort provision.

When exerting effort, a worker's expected utility in a performance-based contract is

$$EU^P_{e=1} \equiv \pi \ln\Big((1-t)z_H + g\Big) + (1-\pi)\ln\Big((1-t)z_L + g\Big) - c - \kappa\frac{\ell^{1+\varepsilon}}{1+\varepsilon}. \tag{2a}$$

In the absence of effort, expected utility in a performance-based contract is instead

$$EU^P_{e=0} \equiv \eta\pi \ln\Big((1-t)z_H + g\Big) + (1-\eta\pi)\ln\Big((1-t)z_L + g\Big) - \kappa\frac{\ell^{1+\varepsilon}}{1+\varepsilon}. \tag{2b}$$

To induce positive effort from workers, incentive contracts must satisfy the incentive-compatibility constraint $EU^P_{e=1} \geq EU^P_{e=0}$.[8] Profit maximizing firms will choose the contract that involves the lowest expected wage cost to them and still induces workers to exert effort. Hence, $EU^P_{e=1} = EU^P_{e=0}$ by profit maximization, which implies

$$\frac{(1-t)z_H + g}{(1-t)z_L + g} = e^{\frac{c}{\pi(1-\eta)}} > 1. \tag{3}$$

Condition (3) determines the equilibrium spread between the high payment, z_H, and the low payment, z_L, that just induces effort. This spread is expressed in terms of disposable income after taxes and transfers, which highlights that pre-tax income levels, z_H and z_L, in performance-based contracts are endogenous to the tax system.[9]

A risk-neutral firm makes zero profits in expectations when expected labor income is equal to the project's expected return:

$$\pi z_H + (1-\pi)z_L = \alpha\ell. \tag{4}$$

The incentive-compatibility constraint (3) and the zero-profit condition (4) jointly determine the equilibrium levels of pre-tax income in each of the two states:

$$z_L = \frac{\alpha\ell - \pi\big(e^{\frac{c}{(1-\eta)\pi}} - 1\big)g/(1-t)}{1+\pi\big(e^{\frac{c}{(1-\eta)\pi}} - 1\big)}, \tag{5a}$$

$$z_H = \frac{\alpha\ell e^{\frac{c}{(1-\eta)\pi}} + (1-\pi)\,\big(e^{\frac{c}{(1-\eta)\pi}} - 1\big)g/(1-t)}{1+\pi\big(e^{\frac{c}{(1-\eta)\pi}} - 1\big)}. \tag{5b}$$

[8] An incentive contract that does not induce effort is strictly dominated by a fixed-wage contract. Indeed, an incentive contract weakly preferred by a risk-averse worker must feature an expected payment that is strictly higher than a fixed-wage contract, which would not be offered by a profit-maximizing firm. Conversely, an incentive contract weakly more profitable to the firm must yield a strictly lower expected utility to a risk-averse worker, who would not accept it.

[9] Eq. (3) implies that incentive payments, $z_H - z_L$, are proportional to the value of the project (α), consistent with the stylized empirical fact that CEO pay incentives are independent of firm size (Edmans et al., 2009).

In performance-based contracts, individuals are thus paid the expected product of their labor, $\alpha\ell$. However, in order to induce effort, this needs to be delivered in the form of a lottery that leaves the worker exposed to income risk: a high income, $z_H > \alpha\ell$, in favorable realizations and a low income, $z_L < \alpha\ell$, in unfavorable realizations.

Given that workers are risk-averse and firms are risk-neutral (and therefore able, in principle, to insure workers at no cost), this outcome is inefficient and the result of the moral hazard problem between firms and workers. Yet, there is no scope for the government to provide insurance against income risk, since pre-tax income levels endogenously respond to changes in the tax system. Indeed, an increase in the transfer g or in the tax t leads to an increase in z_H and a decrease in z_L.

To see this point more formally, plug the equilibrium pre-tax income in each state, (5a) and (5a), into the expression for expected utility in performance contract, (2b), to obtain, after simplification,[10]

$$EU^P = \ln\Big((1-t)\alpha\ell + g\Big) - \kappa\frac{\ell^{1+\varepsilon}}{1+\varepsilon} + \ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right). \tag{6}$$

This expression breaks down expected utility into two distinct components: a first component that is fully independent of income risk within contracts and corresponds to the utility of expected consumption, $(1-t)\alpha\ell + g$, net of the disutility of labor supply, ℓ; and a second component that captures the utility cost associated with income risk and only depends on the structural parameters c, η, and π that determine the equilibrium spread of income levels through (3).[11] As the tax-transfer system only features in the first component, it can only redistribute income across individuals that differ in relation to their productivity, α, but it cannot insure individuals against income risk within contracts.

Maximizing (6) with respect to ℓ, the first-order condition characterizing the optimal level of labor supply, ℓ^P, contracted with the firm in an incentive contract is

$$\frac{(1-t)\alpha}{(1-t)\alpha\ell^P + g} = \kappa\left(\ell^P\right)^{\varepsilon}; \tag{7}$$

this is independent of the dispersion of pre-tax income within the contract and coincides with the solution of a standard labor supply model with a fixed-wage contract for a productivity level α.

Fixed-wage contracts

Alternatively, firms can offer fixed-wage contracts that fully insure the worker and pay the same wage level, w_F, in all contingencies, whether or not the project is successful.[12]

[10] Since $EU^P_{e=1} = EU^P_{e=0}$, we can use either (2a) or (2b).

[11] This second component is indeed negative for any $c > 0$, $\eta \in [0;1]$, and $\pi \in [0;1]$—see Appendix A.1.

[12] The choice between performance-based and fixed-wage contracts in the model is a stylized representation of what would in reality be a choice within a continuum of possible contract structures all featuring

The firm then fully anticipates that, absent any incentive to exert effort, workers will choose to exert no effort. The expected return of the project in this case is thus $\eta\alpha\ell < \alpha\ell$.

Expected profits under this contract must also be zero, which implies a non-stochastic level of labor income equal to

$$z_F = \eta\alpha\ell. \tag{8}$$

The expected utility of a worker in a fixed-wage contract is thus

$$EU^F = \ln\left((1-t)\eta\alpha\ell + g\right) - \kappa\frac{\ell^{1+\varepsilon}}{1+\varepsilon}. \tag{9}$$

Hence, a fixed-wage contract removes the welfare cost associated with income risk but replaces it with a welfare cost that comes from inefficient production choices, translating in a lower labor income, $\eta\alpha\ell$. Maximizing (9) with respect to ℓ, the optimal level of labor supply contracted with the firm in a fixed-wage contract, ℓ^F, solves

$$\frac{(1-t)\eta\alpha}{(1-t)\eta\alpha\ell^F + g} = \kappa\left(\ell^F\right)^{\varepsilon}, \tag{10}$$

where the marginal benefit to increase hours worked (LHS) is increasing in the expected wage rate $\eta\alpha$. Hence, with $\eta < 1$,

$$\ell^P > \ell^F, \tag{11}$$

meaning that a given type α always works more hours in an incentive contract than in a fixed-wage contract, which reinforces the efficiency loss associated with selecting a fixed-wage contract over a performance-based contract.

2.2 Contract choice

Sorting by productivity type

We here analyze the conditions under which individuals select performance-based contracts and the sorting of different productivity types into different contract forms. Individuals will select a performance-based contract if it yields a higher expected utility than a fixed-wage contract does, i.e., if $EU^P > EU^F$.

We assume that in the absence of taxes and transfers all individuals would choose a performance-based contract. This implies

$$\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} - \eta\left(1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right)\right) \geq 0, \tag{12}$$

some performance-based element to a greater or lesser extent. Here we just restrict the contract choice to the two endpoints of this distribution. From this perspective, fixed-wage employment contracts that do not provide full job security would correspond to some combination between these two extremes rather than to what we call here a 'fixed-wage contract'.

which effectively places an upper bound $\bar{c}$ on the fixed cost c, for particular values of η and π. More generally, (12) defines the set of admissible parameters (c, η, π).[13]

The monotonic sorting of productivity types into contract forms then relies on the fact that the attractiveness of the performance-based contract is increasing with an individual's productivity type:

$$\frac{\partial(EU^P - EU^F)}{\partial \alpha} > 0. \tag{13}$$

Therefore, if $EU^P \geq EU^F$ for a productivity type α, this must also be true for all productivity types $\alpha' \geq \alpha$; and if $EU^P < EU^F$ for a productivity type α, this must also be true for productivity types $\alpha'' < \alpha$. This implies a cut-off rule for the choice of contracts around the productivity level, $\hat{\alpha}$, for which $EU^P = EU^F$, given by

$$\hat{\alpha} = \frac{g}{1-t}\frac{1}{K}, \tag{14}$$

where K is defined as

$$\frac{1}{K} \equiv \frac{1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) - \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right)}}{\ell^P\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} e^{-\frac{\kappa}{1+\varepsilon}\left((\ell^P)^{1+\varepsilon} - (\ell^F)^{1+\varepsilon}\right)} - \eta\ell^F\left(1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right)\right)}, \tag{15}$$

and is guaranteed to be positive under condition (12)—see Appendix A.2.

The critical value $\hat{\alpha}$ thus partitions the range of productivity types into two intervals:

Proposition 1. *For any tax-transfer system (t, g), and any set of parameters (c, η, π) satisfying condition* (12)*, there exists a productivity level $\hat{\alpha} \geq 0$ such that:*

- *individuals with productivity $\alpha \geq \hat{\alpha}$ select into incentive contracts with state-contingent labor incomes, z_H and z_L, given by* (5a)-(5b)*, and exert positive effort;*
- *individuals with productivity $\alpha < \hat{\alpha}$ select into fixed-wage contracts with a deterministic labor income, $z_F = \eta\alpha\ell$, and exert no effort.*

Proposition 1 states that, in the presence of redistributive income taxes, performance-based contracts are concentrated among high-ability individuals. This prediction is aligned with the empirical evidence. Bell and Van Reenen (2014, Figure 3) document a strong and positive relationship between the percentile of earners in the U.K. wage distribution, and their bonus share in the total pay. Similarly, Lemieux et al. (2009, Table 1) show that hourly earnings of U.S. employees were 30% higher in performance-pay jobs, as compared to non-performance-pay jobs.

[13] We are grateful to an anonymous reviewer for pointing out that, when $\eta \to 0$, the choice between a performance contract and a fixed-wage contract becomes an extensive margin choice between working and not working. Indeed, labor income in fixed-wage contracts then converges to zero ($z_F \to 0$), implying that individuals can choose to stay inactive and receive the transfer g, rather than incurring the fixed cost of effort c and work in performance-based contracts.

Effects of taxes and transfers on contract choices

The productivity cut-off, $\hat{\alpha} = g/\big((1-t)\,K\big)$, depends on taxes and transfers directly through $g/(1-t)$ and indirectly through the effect of taxes and transfers on labor supply choices, ℓ^P and ℓ^F, that enter K. Since labor supply choices are utility maximizing, these indirect effects cancel out (as stipulated by the envelope theorem). As a result, we show in Appendix A.3 that changes in the productivity cut-off are related to changes in the tax rate t or in the transfer g through

$$\frac{\partial \hat{\alpha}}{\partial t} = \frac{\hat{\alpha}}{1-t} \geq 0, \qquad \frac{\partial \hat{\alpha}}{\partial g} = \frac{\hat{\alpha}}{g} \geq 0. \tag{16}$$

An increase in the tax rate raises the critical productivity level $\hat{\alpha}$ below which workers select low-return, fixed-wage contracts. This result corresponds to the standard labor supply distortion in models with continuous effort choice (e.g., Doligalski et al., 2022), as the fixed-wage contract substitutes leisure in exchange for a lower expected wage. An increase in the transfer also raises $\hat{\alpha}$ through income effects, because it reduces the marginal utility of income and hence the benefits of receiving higher expected income in incentive contracts.

The comparative statics effects discussed above do not take into account the fact that t and g are linked, in equilibrium, through the resource constraint of the government. The total effect of a change in t must incorporate the induced change in the transfer g, which yields

$$\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}t} = \frac{\partial \hat{\alpha}}{\partial t} + \frac{\partial \hat{\alpha}}{\partial g}\frac{\mathrm{d}g}{\mathrm{d}t} \geq 0\,. \tag{17}$$

This total derivative has to be positive if the amount of transfer increases with taxes, $\mathrm{d}g/\mathrm{d}t \geq 0$. It can never be optimal, however, to select a tax rate where this is not the case—this would imply being on the wrong side of the Laffer curve. Therefore, an increase in taxes unambiguously raises $\hat{\alpha}$ and reduces the number of individuals in incentive contracts:

Proposition 2. *Consider two tax levels, t' and $t'' > t'$. The range of productivity types that select into performance contracts is narrower under t'' than under t', and the tax base is thus smaller.*

Proposition 2 highlights the novel efficiency cost associated with redistribution in this model. Levying taxes to finance redistribution will destroy some incentive contracts and replace them with less efficient fixed-wage contracts.

Figure 1 illustrates this result. An increase in the tax rate leads to an upward shift in $\hat{\alpha}$, implying that a larger range of productivity types select into fixed-wage contracts. Also, productivity types that still select into performance-based contracts now face a larger variability in their pre-tax income, because incentive contracts respond to offset the tax change by increasing the pre-tax wage differential in order to still induce effort under the higher tax rate. Last, an increase in tax rate triggers a reduction in labor supply (which is responsible for the decrease in income in fixed-wage contracts that can be seen in the figure).

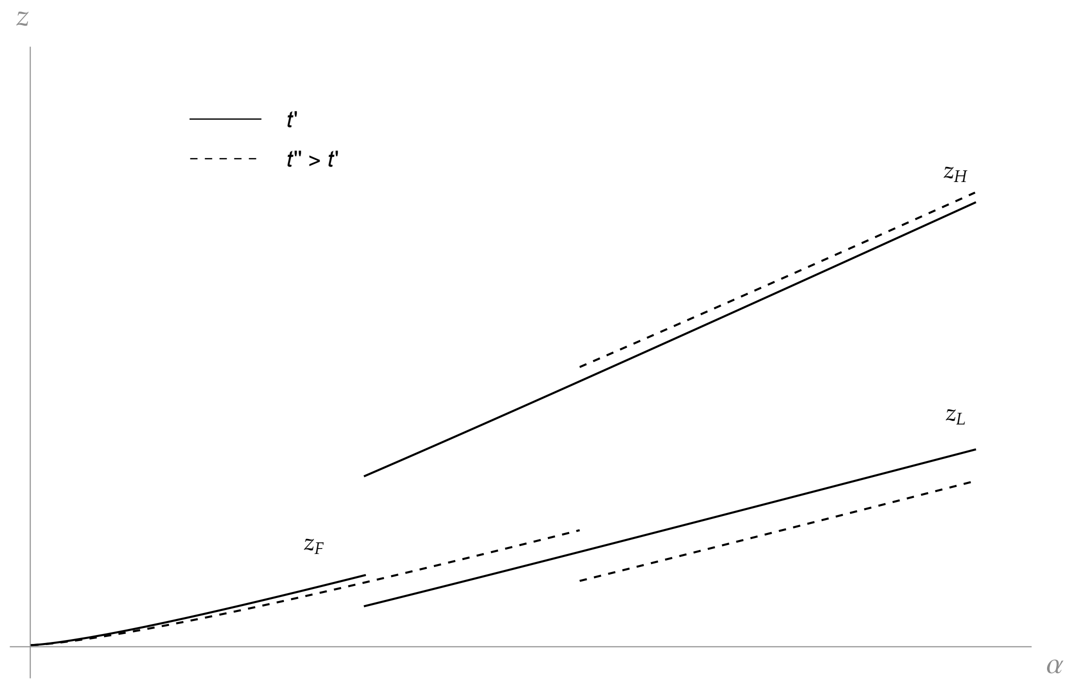

Figure 1: Equilibrium contracts for different levels of taxation

3 Economic globalization and incentive contracts

In this section, we describe a model of international competition and trade where economic globalization leads to a concentration of project returns, in turn leading to a change in the structure of contracts.

3.1 International trade and international competition

The model features symmetrically differentiated good varieties, iceberg trade costs, and a finite number of ex-post heterogeneously productive firms competing in the international market for each variety (the term 'firm' to be interpreted here as being synonymous with 'project').[14] These are the same basic ingredients found in Eaton and Kortum (2002), where comparative-advantage driven trade is the result of productivity differentials that arise from a stochastic sampling process. Our key departure from that model is in considering technologies that exhibit decreasing rather than constant average costs, which gives rise to an oligopolistic (Bertrand) rather than a perfectly competitive market structure. Combined with the stochastic process generating the distribution of firm productivity levels, this gives rise to an equilibrium where ex-ante symmetric firms obtain heterogeneous ex-post levels of revenue, with positive profits being concentrated in a subset of firms—and the more so the smaller trade costs are.

This property is akin to that of the 'superstar firm' model of Autor et al. (2017a,

[14] In this interpretation, real-world business entities consist of a collection of individual projects.

2017b), and is consistent with empirical evidence on 'export superstars' (Freund and Pierola, 2015; Bernard et al., 2018). Market integration through globalization gives each firm access to a larger combined market with more competitors. This increases the size of the revenues a firm can obtain if it manages to capture more markets, but it makes capturing any particular market comparatively less likely because of the larger number of competitors.

Technologies and preferences

Consider a world economy with L symmetric locations, each denoted by l. There is a unit mass of varieties, $i \in [0,1]$, of a traded good, as well as a non-traded composite good and two non-traded, non-produced inputs in each country, an elastically supplied input (labor) and an input in fixed supply (capital or land).

There is a finite number of producers in each location, each producing a given variety of the traded good. Production involves a fixed amount (fixed cost), ω, of labor and a constant marginal input requirement (marginal cost) of a composite good (as in Eaton and Kortum, 2002).[15] For a given producer k, marginal cost is equal to $1/\phi_k$, where $\phi_k > 1$ is k's productivity type is.[16] International trade in varieties of the traded good incurs unit iceberg trade costs: $\tau > 1$ units must be shipped from any given location for a single unit to reach a different location.

The composite good at each location is obtained by combining the varieties of the traded good into a constant-returns-to-scale (CES) composite and then combining the resulting CES composite with the inelastically supplied input according to a constant-returns-to-scale Cobb-Douglas technology:

$$Y_l = n_l^{1-\xi} \left(\int x_l(i)^{(\sigma-1)/\sigma} \, \mathrm{d}i \right)^{\xi\,\sigma/(\sigma-1)}, \quad \sigma > 1, \;\; \xi \in (0,1), \tag{18}$$

where Y_l is output of the composite good produced at location l, n_l is the inelastically supplied input, ξ is its input share, $x_l(i)$ is the profile of input quantities of all varieties, and σ is the elasticity of substitution between varieties. The above specification implies symmetric differentiation across different varieties of the traded good. Each variety is in turn produced by different firm types whose outputs are perfect substitutes.

There is a unit mass of individuals, $j \in [0,1]$, each elastically supplying $\alpha(j)\ell(j)$ effective units of labor. Individuals derive utility from consumption of the composite good—funded by their disposable income—and incur a disutility from hours worked $\ell(j)$, as assumed in Section 2. The composite good in location l is thus used both as an intermediate input in production by producers and as a final consumption good by consumers. The endowment, $\bar{n}_l$, of the inelastically supplied input is the same at all locations and is

[15] As highlighted in Section 3.3, these technological assumptions are crucial for establishing a link between economic globalization and contract structure.

[16] This restriction ensures that the economy's production set is non-empty.

uniformly distributed across all individuals.[17]

Firm heterogeneity and price competition

For each variety of the traded good, there are M producers (firms) at each location engaging in Bertrand (price) competition in all markets with all other firms producing the same variety. As we shall see later, the number of firms is determined endogenously in the model, but for time being we shall take M as being exogenous. We shall also assume the price of the composite good at each location to be the same across locations (we will later show that this is indeed the case in equilibrium), and, without loss of generality, to be equal to unity.

Firms' productivity levels, ϕ_k, are IID random draws from a probability distribution with c.d.f. $F(\phi)$, having support $(1, \infty)$, with the draws taking place once the fixed cost has been incurred and is therefore sunk.

In the absence of trade costs, Bertrand competition in a given market, l, for a given variety, i, implies that a firm k producing that variety will select a price, in equilibrium, that equals the minimum between its own marginal cost, $1/\phi_k$, and the marginal cost of its lowest-cost competitor. If the former is greater than the latter, firm k will sell zero units and make zero gross returns.[18] If instead k's marginal cost draw is the lowest (its productivity draw is the highest) amongst all firms that sell in l, it will 'take' the whole of market l.

With iceberg trade costs, $\tau > 1$ units must be shipped from any given location for a single unit to reach a different location. As a result, the relevant comparison in each market is between firms' trade-cost adjusted marginal costs. A firm k will then be able to take its own domestic market, l—and experience positive gross returns, Λ_{kl}, in that market—if its marginal cost draw is lower than that of all its domestic competitors located in l and lower than the trade cost-inclusive marginal cost draws of all foreign competitors not located in l. In contrast, a firm will be able to take a given foreign market, l'—and experience positive gross returns, $\Lambda_{kl'}$, in that market—if its own trade cost-inclusive marginal cost draw is lower than the marginal cost draw of domestic competitors located in l' and lower than the trade cost-inclusive marginal cost draw of all other foreign competitors not located in l'.

Equilibrium

With a unit mass of individuals at each location, the total amount of labor units of supplied at each location will equal $E[\alpha\ell]$ where $E[\cdot]$ is used here to denote the mean. Since the fixed input cost for operating a production unit (a firm) is ω, labor market clearing

[17] Without loss of generality, we will assume $\bar{n}_l = \bar{n} = 1$, implying $n_l^{1-\xi} = 1$ in (18), which is equivalent to specifying technologies as exhibiting decreasing returns to scale.

[18] If two or more firms are tied—a zero-measure event—each will get an equal share of the market but gross returns (profits gross of fixed costs) for all of them will be zero.

implies that in equilibrium the number of production units (firms) in each country must equal

$$\frac{E[\alpha\ell]}{\omega} \equiv M \tag{19}$$

for each good variety. As M is finite, the market structure for each good variety is oligopolistic.[19] In turn, with ex-post heterogeneous firms, Bertrand competition gives rise to positive gross profits in expectations even if the output of the competing oligopolists is undifferentiated.

Let q denote the price of the non-traded labor input. Our assumption that fixed costs are incurred before the realization of productivity draws means that a firm must employ the input and commit to a contracted price before observing its productivity draw. In a free entry-equilibrium, the fixed costs $q\,\omega$ must thus equal the expected gross returns of a representative firm $E\left[\Lambda\right]$—the same for all firms in a symmetric equilibrium—and so we must have

$$q = \frac{E\left[\Lambda\right]}{\omega}. \tag{20}$$

The level of income of an individual, j, supplying an amount $\alpha(j)\ell(j)$ of the non-traded input will then be equal to $q\,\alpha(j)\ell(j) = w\big(\alpha(j)\big)\ell(j)$, where

$$w(\alpha) = \frac{E\left[\Lambda\right]}{\omega}\,\alpha. \tag{21}$$

The characterization of an equilibrium is completed by conditions defining individually optimal labor supply choices, zero-profit conditions in the production of the location-specific composite, and market-clearing conditions for the same (all described in Appendix B.1).

3.2 Market integration and the concentration of project returns

For the purposes of our analysis, we are interested in understanding how the probability that a firm, k, makes overall positive gross returns—i.e., $\Pr\{\Lambda_k \equiv \sum_l \Lambda_{kl} > 0\}$—varies with the level of international economic integration, as measured by the trade costs, τ.

An outcome where a firm only takes one or more foreign markets without also taking its own domestic market cannot occur, because if a firm prevails over all other firms in a foreign market despite the trade costs, then it must have experienced a draw that makes it the lowest cost producer in the domestic market. This implies that the probability of k failing to take any market and experiencing overall zero gross returns is equal to the

[19]Profit maximization, convexity of preferences and symmetric differentiation across varieties ensure that the number of production units is the same across all varieties, i.e., exactly M production units per variety.

probability of k failing to take its own domestic market, and we show in Appendix B.2 that this probability can be expressed as

$$\Pr\{\Lambda_k > 0\} = \int F(\phi_k)^{M-1} F(\tau \phi_k)^{(L-1)M} \, \mathrm{d}F(\phi_k), \tag{22}$$

which is increasing in τ. Hence a decrease in τ—corresponding to a fall in institutional or technological trade costs and marking an increase in economic globalization—lowers the probability that a firm experiences ex-post success (positive gross returns), making the distribution of ex-post gross returns more concentrated:

Proposition 3. *A reduction in trade costs, τ, lowers the probability of a representative firm experiencing positive gross returns across all markets.*

Intuitively, trade costs shield firms in each market from foreign competitors that are potentially more productive. If trade costs are prohibitively high, there will be one 'national champion' in each country and for each variety that takes its entire domestic market and makes positive gross returns. As trade costs fall, it becomes more likely for any given set of productivity draws that a superior foreign competitor is able to underbid the national champion and capture the market.[20]

Globalization also affects real expected returns and real incomes. For a given price of the composite input, a reduction in τ lowers marginal costs and thus the prices of the traded goods. This leads to an increase in the level of expected returns of a representative firm, in turn leading to a uniform increase in real wages, i.e., an equi-proportional increase in $\alpha(j)$ for all j.

3.3 Market integration and incentive contracts

Link with the model of incomplete contracting

In our previous discussion, we have characterized the relationship between economic globalization and the probability that a firm succeeds, abstracting from any performance contracts. In the model of incomplete contracting presented in Section 2, this probability corresponds to π, the probability of success with effort.

A full correspondence between the model of globalization we have described and our model of incomplete contracting is achieved by assuming that the distribution of the productivity draws, ϕ_k, for a firm k also depends on the effort, $e_k \in \{0, 1\}$, exerted by the worker who supplies labor (which is used as a fixed input to the project). Specifically, we assume that the distribution of productivity realizations when exerting positive effort, $e_k = 1$, first-order stochastically dominates the corresponding distribution when

[20] This is broadly analogous to the selection effect brought about by market integration in heterogeneous firms models with firm-differentiated varieties and monopolistic competition (Melitz, 2003), where the proportion of active firms is decreasing as markets become more integrated and expected ex-post profits (gross of an ex-ante entry cost) for the remaining active firms increase.

exerting no effort, $e_k = 0$, i.e., $F(\phi_k \,|\, e_k = 1) > F(\phi_k \,|\, e_k = 0)$. This implies that there exists a value $\eta \in [0, 1)$ such that[21]

$$\pi \equiv \Pr\left\{\Lambda_k > 0 \,|\, e_k = 1\right\} > \Pr\left\{\Lambda_k > 0 \,|\, e_k = 0\right\} = \eta \Pr\left\{\Lambda_k > 0 \,|\, e_k = 1\right\} = \eta\pi. \quad (23)$$

As previously discussed, wage payments cannot be conditioned on effort and must be conditioned on an alternative signal that is correlated with effort, i.e., on failure or success as revealed by realized gross returns being positive or zero. This then leads to the same contracting problem as that described in Section 2, thereby establishing a full link with the model of economic globalization described here.[22] Formally establishing this link requires assuming, as we do here, that labor is used in a fixed amount in each given project. This means that, following a favorable ex-post realization of ϕ, ex-post output can be expanded by using inputs other than labor. Since expected profits and fixed cost (expected wages) are equalized in equilibrium under conditions of free entry and exit, the returns to effort then ultimately accrue to labor and changes in π affect incentives to exert positive effort.

Impact of globalization on incomplete contracting

In relation to our model of incomplete contracting, the analysis of Section 3.2 implies that economic globalization produces two effects. First, a reduction in the probability of success, π. Second, a uniform increase in real wages, equivalent to a positive shift that raises the productivity of each worker by a factor $\beta > 1$.

Our model of redistribution with incomplete contracting is fully invariant to this second effect: it does not affect the structure of equilibrium contracts or how they respond to taxation. To see this, consider an economy where the productivity cut-off is $\hat{\alpha}_0$, the tax rate is t_0 and the transfer is g_0. Keeping t_0 constant, a uniform shift in productivity levels by a factor β increases pre-tax incomes and thus tax revenue by the same factor β, resulting in a new transfer equal to $g_1 = \beta g_0$. The new productivity cut-off is then $\hat{\alpha}_1 = \beta\hat{\alpha}_0$ and labor supply decisions are unaffected. As a result, disposable incomes also rise by a (multiplicative) factor β, which shifts all utility levels by some (additive) constant, since utility is logarithmic in consumption. Anticipating our discussion of optimal taxes in the next section, this leaves responses to tax changes, and thus the optimal tax rate, unaffected.

Proposition 4. *An economy-wide change in productivity that increases wages under all contract types by a factor β has no effect on contract choices or on responses to taxes.*

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[21] In general, the size of η will vary with τ, i.e., a reduction in π will be accompanied by a change in η. However, η will remain constant if we assume that the distribution of ϕ is Pareto (as in Chaney, 2008) with c.d.f. $F(\phi) = 1 - (\underline{\phi}/\phi)^{\nu}$, $\underline{\phi} \geq 1$, $\alpha > 1$, and that first-order stochastic dominance across distributions is obtained by varying the value of the parameter $\underline{\phi}$.

[22] Note that a firm only employs ω units of labor. Hence, a worker supplying $\alpha\ell$ efficiency units of labor is formally involved in $\alpha\ell/\omega$ projects (or firms), see Appendix B.3 for details.

Since our problem is fully invariant to uniform changes in the productivity of all types, the rest of our analysis will abstract from this effect and model economic globalization as a process that increases the concentration of ex-post gross project returns through a reduction in π.

A reduction in the probability of success π corresponds to a mean-preserving spread in returns realizations. This raises income risk in performance-based contracts, making them less attractive to risk-averse workers by comparison with the fixed-wage alternative. As a result, the direct effect of a fall in π, holding tax policy constant, is to induce risk-averse workers to switch to fixed-wage contracts; i.e., by (14), the productivity cut-off $\hat{\alpha}$ increases. At the same time, by (3), a reduction in the probability of success π raises the income spread that is needed to induce effort in performance contracts, raising the payment in favorable realizations (z_H) and lowering the payment in unfavorable realizations (z_L). This implies that a decrease in π unambiguously raises the fraction of total income that accrues to a subset of high earners in favorable realizations:

Proposition 5. *Holding tax policy, (t, g), constant, a reduction in the probability of success of all projects from π' to $\pi'' < \pi'$ reduces the range of productivity types that select into performance contracts ($\hat{\alpha}'' > \hat{\alpha}'$) and raises the fraction of pre-tax income accruing to individuals above a given percentile point in the distribution of realized incomes.*

These results are illustrated in Figure 2, which shows that a reduction in the probability of success π raises the productivity cut-off $\hat{\alpha}$ as well as the dispersion of pre-tax incomes within incentive contracts. Both effects lead to an increase in the concentration of realized income, consistent with the empirical evidence that economic globalization increases wage inequality (Goldberg and Pavcnik, 2007; Dreher and Gaston, 2008).[23] It is also consistent with evidence showing that stronger competition in global markets increases the sensitivity of performance contracts and leads to increased pay differentials within firms (Cuñat and Guadaloupe, 2009; Ma and Ruzic, 2020).

4 Optimal redistribution and economic globalization

We now turn to our main question: how optimal redistribution is affected by an increase in income risk brought about by market integration. First, we characterize optimal redistribution in an economy with performance contracts. Second, although market integration (modeled as a reduction in the probability of success in performance contracts) increases inequality, we show that it may concomitantly decrease the optimal tax rate. We conclude with numerical simulations showing that this prediction applies to a calibrated economy with performance-based contracts, whereas a similar increase in

[23] Dorn et al. (2018) re-examine the link between globalization and income inequality for 140 countries over the period 1970-2014. They find a robust positive relationship between globalization and wage inequality for most countries, including China and Eastern Europe, though the effect is not significant for the most advanced economies.

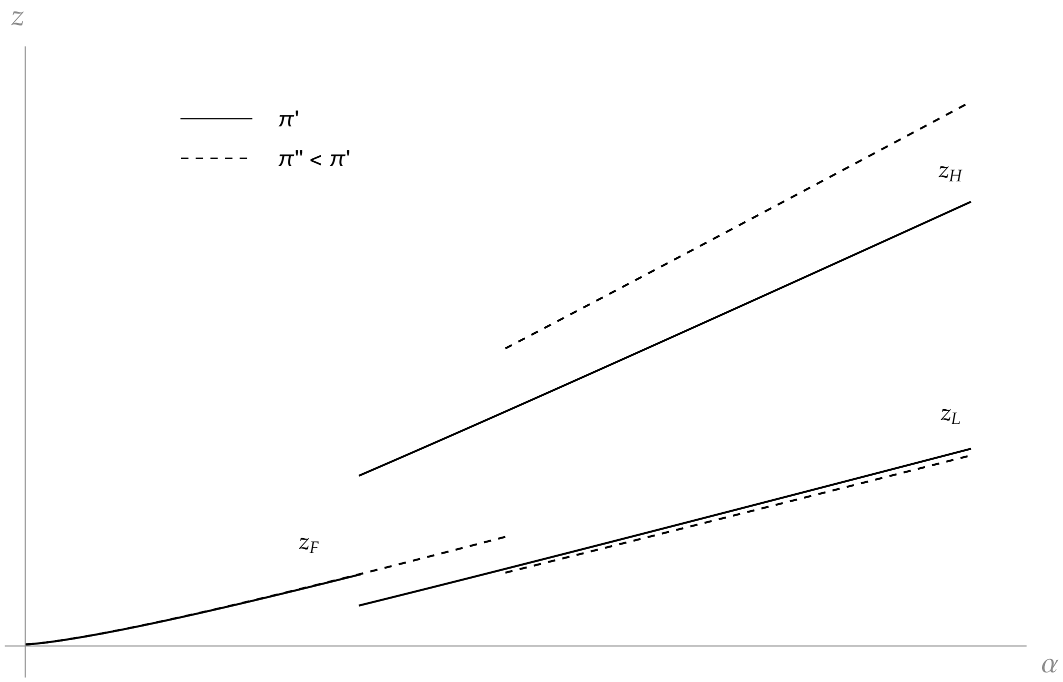

Figure 2: Equilibrium contracts and the effects of globalization

income concentration in a comparable economy with complete contracts would lead to an increase in the optimal tax rate.

4.1 Optimal redistribution with incomplete contracting

As the tax-transfer system cannot insure individuals against the income risk they face conditional on their productivity type, its role is limited to redistributing income across individuals of different productivity types.[24] However, since income taxation is conditioned on income realizations, and since performance contracts imply that the ranking of income realizations is not aligned with the ranking of productivity types, redistribution via income taxation is imperfectly targeted and can only occur at the cost of interfering with contract design and contract choice. Here we analyze how this affects the optimal tax formula.

We consider the problem of a government (welfarist planner) seeking to maximize a weighted sum of individuals' expected utilities,

$$W = \int_{\alpha \leq \hat{\alpha}} \mu(\alpha) EU^F(\alpha) \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \mu(\alpha) EU^P(\alpha) \mathrm{d}F(\alpha), \tag{24}$$

[24]The optimal income tax literature often distinguishes between an *insurance role* of the income tax, which reduces the variance of exogenous earnings risk for a given productivity type, and a *redistributive role*, which reduces the after-tax variation in the incomes of different productivity types. See Boadway and Sato (2015) for a theoretical survey and Hoynes and Luttmer (2011) for an empirical analysis distinguishing the insurance and redistributive effects of state tax-and-transfer programs in the United States.

where $\mu(\alpha)$ are the Pareto-weights attached to individuals of productivity α, which encapsulate the government's tastes for redistribution. The government's resource constraint is

$$t\Big(\underbrace{\int_{\alpha\leq\hat{\alpha}}\eta\alpha\ell^F\,\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\alpha\ell^P\,\mathrm{d}F(\alpha)}_{\equiv Q}\Big)\geq g, \tag{25}$$

where Q is the aggregate tax base. The Lagrangian associated with this problem is

$$\mathcal{L}=\int_{\alpha\leq\hat{\alpha}}\mu(\alpha)EU^F(\alpha)\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\mu(\alpha)EU^P(\alpha)\mathrm{d}F(\alpha)+\lambda\big(tQ-g\big), \tag{26}$$

where λ is the multiplier of the resource constraint, equal to the social marginal value of public funds at the optimum.

We characterize the optimal income tax and transfer system through the first-order necessary conditions for an interior optimum.[25] To express these conditions, it is helpful to introduce the following labor supply elasticities, measuring the (absolute) magnitude of responses in ℓ^P and ℓ^F to changes in the net-of-tax-rate, $1-t$, and in the transfer, g:[26]

$$\mathcal{E}^{\ell^P}_{1-t}\equiv\frac{1-t}{\ell^P}\frac{\partial\ell^P}{\partial(1-t)}\geq 0,\qquad \mathcal{E}^{\ell^P}_{g}\equiv-\frac{g}{\ell^P}\frac{\partial\ell^P}{\partial g}\geq 0, \tag{27}$$

$$\mathcal{E}^{\ell^F}_{1-t}\equiv\frac{1-t}{\ell^F}\frac{\partial\ell^F}{\partial(1-t)}\geq 0,\qquad \mathcal{E}^{\ell^F}_{g}\equiv-\frac{g}{\ell^F}\frac{\partial\ell^P}{\partial g}\geq 0. \tag{28}$$

Equipped with this notation, we characterize the optimal income tax and transfer in this economy with fixed-wage contracts and performance contracts:

Proposition 6. *At an interior optimum, the optimal tax rate t satisfies*

$$\begin{aligned}&\frac{t}{1-t}\Big(\int_{\alpha\leq\hat{\alpha}}\eta\alpha\ell^F\mathcal{E}^{\ell^F}_{1-t}\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\alpha\ell^P\mathcal{E}^{\ell^P}_{1-t}\mathrm{d}F(\alpha)+\Big(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F\Big)\hat{\alpha}f(\hat{\alpha})\Big)\\&=\int_{\alpha\leq\hat{\alpha}}\eta\alpha\ell^F\Big(1-\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\eta\alpha\ell^F+g}\Big)\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\alpha\ell^P\Big(1-\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\alpha\ell^P+g}\Big)\mathrm{d}F(\alpha),\end{aligned} \tag{29}$$

and the optimal transfer g satisfies

$$\begin{aligned}&1+\frac{t}{g}\Big(\int_{\alpha\leq\hat{\alpha}}\eta\alpha\ell^F\mathcal{E}^{\ell^F}_{g}\,\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\alpha\ell^P\mathcal{E}^{\ell^P}_{g}\,\mathrm{d}F(\alpha)+\Big(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F\Big)\hat{\alpha}f(\hat{\alpha})\Big)\\&=\int_{\alpha\leq\hat{\alpha}}\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\eta\alpha\ell^F+g}\mathrm{d}F(\alpha)+\int_{\alpha\geq\hat{\alpha}}\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\alpha\ell^P+g}\mathrm{d}F(\alpha).\end{aligned} \tag{30}$$

Proposition 6 characterizes optimal redistribution in this economy with fixed-wage and performance-based contracts. Condition (29) is a direct extension of the optimal

[25] In our numerical application, we then check that these conditions are also sufficient implying that the optimum is indeed interior.

[26] We use elasticity concepts to ease comparison with optimal tax formulas in other papers, but in this setting closed-form expressions for these elasticities can be obtained by differentiating (7) and (10).

linear income tax formula when workers adjust labor supply along the intensive margin (Sheshinski, 1972), where the behavioral responses to taxes (LHS) are traded off against their mechanical and welfare effects (RHS).

Since individuals reduce their labor supply in response to an increase in the tax rate, the optimal linear tax rate decreases with the size of labor supply distortions as measured by the elasticities $\mathcal{E}_{1-t}^{\ell^F}$ and $\mathcal{E}_{1-t}^{\ell^P}$. Because this effect matters comparatively more for those types that generate higher incomes or that are more prevalent in the population, the optimal tax rate decreases more specifically with the expected-income-weighted average elasticity of labor supply (the first two integrals on the LHS). New to this setting, changes in the tax rate also lead individuals at the cut-off to switch contracts (Proposition 2). As a result, the optimal linear tax rate decreases with the size of the associated reduction in tax base for the marginal type, $\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F$, and with the number of individuals switching contracts, which is proportional to $\hat{\alpha}f(\hat{\alpha})$ (the third term on the LHS).

In contrast, the welfare effects capturing changes in tax revenue and in welfare upon a tax increase (the RHS) are completely standard. The latter depend on social marginal welfare weights, given by the weights $\mu(\alpha)$ scaled by the social marginal value of public funds, λ, and on the marginal utility of (expected) consumption of type α. The redistribution motive is thus both governed by the profile of weights $\mu(\alpha)$ and by the profile of marginal utilities from consumption. A stronger redistributive motive translates into a more strongly decreasing profile of social marginal welfare weights and thus a higher optimal tax rate.

Condition (30) has the standard interpretation that social marginal welfare weights (on the RHS) average to unity at the optimum, net of marginal revenue effects (on the LHS). Indeed, the value to society of providing an additional dollar of transfers to all individuals must be equal to the cost of doing so (Saez, 2001). Besides the mechanical cost of this dollar, additional revenue losses are triggered by labor supply responses that are proportional to $\mathcal{E}_g^{\ell^F}$ and $\mathcal{E}_g^{\ell^P}$, and, again new to this setting, by the switching of some individuals to less efficient fixed-wage contracts.

By comparison to a standard optimal tax model, income taxes cause additional distortions in this model through their effect on contract choice, suggesting that the optimal level of redistribution may be lower. While interesting, this is not the question that we seek to answer.[27] Instead, we are after the impact of economic globalization, represented here by a decrease in the probability of success, π, on optimal redistribution.

4.2 The impact of globalization on optimal taxes

To study the impact of globalization on optimal tax policy, it is useful to break down the optimal tax formula (29) into two components: a first component, $\text{Rev}_t \equiv \partial(tQ)/\partial t$, measuring the marginal revenue gain from increasing taxes, and a second component, $\text{Wel}_t \equiv -(\partial W/\partial t)/\lambda$, measuring the marginal welfare cost of higher taxes relative to the

[27] See Doligalski et al. (2022) for an analysis of this question in a setting with continuous effort choices within performance contracts.

social value of an extra dollar of public funds. With this notation, the equity-efficiency trade-off at the heart of optimal tax formula boils down to $\text{Rev}_t = \text{Wel}_t$.

To analyze how each of these two components is affected by a reduction in the probability of success, π, we first introduce $\mathcal{K}_{\text{Rev}} > 0$, defined as

$$\mathcal{K}_{\text{Rev}} \equiv \int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathcal{E}^{\ell^F}_{1-t} \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathcal{E}^{\ell^P}_{1-t} \, \mathrm{d}F(\alpha) + \left(\hat{\alpha}\ell^P - \eta \hat{\alpha} \ell^F\right) \hat{\alpha} f(\hat{\alpha}). \tag{31}$$

Changes in the tax base, Q, resulting from (marginal) increases in taxes can then be simply expressed as $\partial Q / \partial t = -\mathcal{K}_{\text{Rev}}/(1-t)$, and Rev_t and Wel_t can be expressed as

$$\text{Rev}_t = \int_{\alpha \leq \hat{\alpha}} \alpha \eta \ell^F \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathrm{d}F(\alpha) - \frac{t}{1-t} \mathcal{K}_{\text{Rev}}, \tag{32}$$

$$\text{Wel}_t = \int_{\alpha \leq \hat{\alpha}} \alpha \eta \ell^F \left(\frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\eta \alpha \ell^F + g} \right) \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \left(\frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\alpha \ell^P + g} \right) \mathrm{d}F(\alpha). \tag{33}$$

The only direct effect of a decrease in the probability of success, π, on this equity-efficiency trade-off is to reduce the attractiveness of performance contracts and thus to increase the productivity cut-off $\hat{\alpha}$ (Proposition 5). Yet, through the induced changes in tax policy, this triggers indirect effects on labor supply choices and further adjustments in contract choices that, in turn, affect the optimal tax.

The overall effect resulting from these adjustments is ultimately determined by the link between the tax rate t and the transfer g through the government's resource constraint. Totally differentiating (25) with respect to π, and taking endogenous labor supply changes into account, we can write

$$\frac{\mathrm{d}g}{\mathrm{d}\pi} \mathcal{C}_g = \frac{\mathrm{d}t}{\mathrm{d}\pi} \mathcal{C}_t - \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi} t \left(\hat{\alpha}\ell^P - \eta \hat{\alpha} \ell^F\right) f(\hat{\alpha}), \tag{34}$$

where $\mathcal{C}_g$ and $\mathcal{C}_t$ are strictly positive terms (defined in Appendix C.2) that summarize the effects on the resource constraint of marginal changes in t and g. This equality implies that, following a reduction in the probability of success π, changes in the tax rate t and in the transfer g must be positively related, and that we can therefore characterize changes in the equity-efficiency trade-off entirely in terms of changes in the productivity cut-off, $\hat{\alpha}$, and in the tax rate, t.

Efficiency concerns

A general characterization of how a change in π affects the revenue side, Rev_t, of the efficiency-equity trade-off in the choice of an optimal tax is

$$\begin{aligned} \frac{\mathrm{d}\text{Rev}_t}{\mathrm{d}\pi} = &- \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi} \left(\hat{\alpha}\ell^P - \eta \hat{\alpha} \ell^F\right) f(\hat{\alpha}) \left(1 + \frac{t}{1-t}\left(2 + \frac{\hat{\alpha} f'(\hat{\alpha})}{f(\hat{\alpha})}\right) + \frac{t}{g} \frac{\mathcal{K}_{\mathcal{E}}}{\mathcal{C}_g}\right) \\ &- \frac{\mathrm{d}t}{\mathrm{d}\pi} \left(\frac{\mathcal{K}_{\text{Rev}}}{(1-t)^2} - \frac{\mathcal{K}_{\mathcal{E}}}{g} \left(\frac{g}{1-t} + \frac{\mathcal{C}_t}{\mathcal{C}_g} \right) \right), \end{aligned} \tag{35}$$

where $\mathcal{K}_{\mathcal{E}}$, which can be either positive or negative, measures indirect efficiency effects associated with further adjustments in labor supply, and is defined as

$$\begin{aligned}\mathcal{K}_{\mathcal{E}} \equiv\ & \frac{t}{1-t}\left(\hat{\alpha}\ell^{P}\mathcal{E}^{\ell^{P}}_{1-t} - \eta\hat{\alpha}\ell^{F}\mathcal{E}^{\ell^{F}}_{1-t}\right)\hat{\alpha}f(\hat{\alpha}) - \int_{\alpha\le\hat{\alpha}} \eta\alpha\ell^{F}\mathcal{E}^{\ell^{F}}_{1-t}\mathrm{d}F(\alpha) - \int_{\alpha\ge\hat{\alpha}} \alpha\ell^{P}\mathcal{E}^{\ell^{P}}_{1-t}\mathrm{d}F(\alpha) \\ & - \frac{t}{1-t}\left(\int_{\alpha\le\hat{\alpha}} \eta\alpha\ell^{F}\mathcal{E}^{\ell^{F}}_{1-t}\frac{\mathcal{E}^{\ell^{F}}_{1-t}}{g}\left((1+\varepsilon)(1-t)\eta\alpha\ell^{F} - \varepsilon g\mathcal{E}^{\ell^{F}}_{1-t}\right)\mathrm{d}F(\alpha)\right) \\ & - \frac{t}{1-t}\left(\int_{\alpha\ge\hat{\alpha}} \alpha\ell^{P}\mathcal{E}^{\ell^{P}}_{1-t}\frac{\mathcal{E}^{\ell^{P}}_{1-t}}{g}\left((1+\varepsilon)(1-t)\alpha\ell^{P} - \varepsilon g\mathcal{E}^{\ell^{P}}_{1-t}\right)\mathrm{d}F(\alpha)\right). \end{aligned} \tag{36}$$

To shed light on the implications of (35), first consider the case where labor supply is exogenous and thus $\mathcal{E}^{\ell}_{1-t} = 0$ and $\mathcal{K}_{\mathcal{E}} = 0$. Then (35) simplifies to

$$\frac{\mathrm{dRev}_t}{\mathrm{d}\pi} = \left(\hat{\alpha}\ell^{P} - \eta\hat{\alpha}\ell^{F}\right) f(\hat{\alpha}) \left(-\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(1 + \frac{t}{1-t}\left(2 + \frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right) - \frac{\mathrm{d}t}{\mathrm{d}\pi}\frac{1}{(1-t)^2}\right), \tag{37}$$

highlighting that the increase in the productivity cut-off $\hat{\alpha}$ has three direct effects on the revenue gains from increasing taxes, represented by terms multiplying $\mathrm{d}\hat{\alpha}/\mathrm{d}\pi$. First, by reducing the size of the tax base, the increase in the cut-off that results from a fall in π reduces the revenue gain from increasing taxes and pushes for a lower tax rate. Second, it raises the revenue loss associated with switches to fixed-wage contracts, also pushing for a lower tax rate. A third counteracting effect is a reduction in the mass of individuals at the cut-off, $f'(\hat{\alpha}) < 0$, which reduces the revenue loss associated with switches to fixed-wage contracts, pushing for a higher tax rate.

If we consider these effects together, we conclude that the revenue-maximizing tax rate (as defined by $\mathrm{Rev}_t = 0$) is increasing in π—and thus falls if π falls as a result of economic globalization—whenever the density of types at the productivity cut-off $\hat{\alpha}$ does not decrease too steeply, i.e., iff

$$\frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})} > -\frac{1+t}{t}. \tag{38}$$

When condition (38) is satisfied, pure efficiency concerns imply that globalization tends to push optimal tax rates down while concomitantly increasing income concentration:[28]

Proposition 7. *With exogenous labor supply, efficiency concerns push for a reduction in the optimal tax rate upon a mean-preserving spread in returns realizations (a fall in π), if and only if, the distribution of productivity types does not decrease too steeply around the cut-off $\hat{\alpha}$ (i.e., when* (38) *is satisfied).*

[28]For a given distribution of types, it is easy to check whether condition (38) is satisfied. For a Pareto distribution defined by $f(\alpha) = p(\alpha_m)^p/\alpha^{p+1}$, it boils down to $p < 1/t$, which implies a direct comparison of the parameter p governing the thickness of the tail with the tax rate t. For top incomes, p often lies between 1.5 and 3 (see, e.g., Atkinson et al., 2011) implying that this condition is satisfied for tax rates up to 30 percent. In our empirical application, this condition is satisfied in all calibration scenarios that we consider.

In the general case where labor supply is endogenous, we also need to take into account the indirect efficiency effects associated with labor supply changes as captured by $\mathcal{K}_{\mathcal{E}}$ in (35). When $\mathcal{K}_{\mathcal{E}} > 0$, the increase in the productivity cut-off, $\hat{\alpha}$, additionally reduces the marginal revenue gains from increasing taxes and pushes for lower tax rates. Otherwise, these indirect effects push for higher tax rates. Since the sign of $\mathcal{K}_{\mathcal{E}}$ is theoretically ambiguous, the qualitative impact of these further adjustments in labor supply is also ambiguous.

Distributional concerns

A general characterization of how a change in π affects the distributional side, Wel_t, of the efficiency-equity trade-off is

$$\begin{aligned}\frac{\mathrm{dWel}_t}{\mathrm{d}\pi} = &-\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi} f(\hat{\alpha}) \left(\frac{\mu(\hat{\alpha})}{\lambda} \left(\frac{\hat{\alpha}\ell^P}{(1-t)\hat{\alpha}\ell^P + g} - \frac{\eta\hat{\alpha}\ell^F}{(1-t)\eta\hat{\alpha}\ell^F + g} \right) - \frac{t}{\mathcal{C}_g} \left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F \right) \mathcal{K}_{\hat{\alpha}} \right) \\ &+ \frac{\mathrm{d}t}{\mathrm{d}\pi}\mathcal{K}_t - \frac{1}{\lambda}\frac{\mathrm{d}\lambda}{\mathrm{d}\pi}\mathcal{K}_\lambda, \end{aligned} \tag{39}$$

where $\mathcal{K}_{\hat{\alpha}}$, $\mathcal{K}_t$, and $\mathcal{K}_\lambda$ are defined in Appendix C.2.

This expression highlights that the increase in the productivity cut-off $\hat{\alpha}$ arising from a fall in π has two counteracting effects on optimal tax rates in relation to their distributional effects. First, since individuals' marginal utility cost, $z/\big((1-t)z+g\big)$, from higher taxes is increasing in the level of pre-tax income, z, the fact that some individuals are induced to switch to fixed-wage contracts reduces the marginal social welfare cost of taxation and pushes for higher tax rates (the first term). Second, by reducing the size of the tax base, the increase in the cut-off level reduces the transfer g, which in turn raises the marginal utility of disposable income and thus the marginal welfare cost of taxation, thereby pushing for lower tax rates (the second term, with $\mathcal{K}_{\hat{\alpha}} > 0$).

The overall impact of globalization on both the efficiency-side and the equity-side of the trade-off is therefore generally ambiguous. In the next subsection, we turn to numerical simulations to assess whether, when accounting for equity concerns and endogenous labor supply responses, the prediction that economic globalization brings optimal tax rates down while, at the same time, increasing income concentration obtains in a realistic calibration of the economy.[29]

4.3 Model calibration and numerical simulation

To gauge whether the conditions under which economic globalization causes the optimal tax to fall are met in an empirically relevant scenario, we calibrate the model using 2016 U.S. income data and an empirically plausible combination of marginal tax rate and transfer level, and then simulate the effects of a reduction in π on the optimal tax rate.

[29]For the special case with exogenous labor supply, a utilitarian objective, and a uniform distribution of types, our working paper version (Haufler and Perroni, 2020) shows analytically that globalization decreases the welfare-maximizing tax rate.

Income distribution and the tax-transfer system

The income distribution is calibrated using data from Piketty et al. (2018) on pre-tax income percentile thresholds for adults in the U.S. for the year 2014, derived from the fiscal income reported by taxpayers to the IRS on individual income tax returns. Using this information, and assuming a smooth distribution within percentile intervals, we recover an empirical c.d.f. $H(z)$ with mean pre-tax income in the baseline economy equaling $\bar{z}_{BL} \equiv$ US\$ 69,334.

The same source also reports post-tax income percentile thresholds, measuring disposable income after all taxes and transfers, and where all public expenditures have been directly allocated to the population. Running a linear regression of the difference between pre-tax and post-tax income on pre-tax income, the calibrated tax rate in the baseline economy is $t_{BL} \equiv 0.271$ and the calibrated transfer is $g_{BL} \equiv t_{BL}\bar{z}_{BL} =$ US\$ 18,789.

Distribution of types and contracts

For a given income distribution, and a given tax-transfer system, the underlying distribution of productivity types is usually obtained by inverting individuals' first-order labor supply condition (Saez, 2001). Indeed, in a setting without contracts, the relationship between an individual's pre-tax income and that individual's productivity would be given by

$$\tilde{z}(\tilde{\alpha}) = \tilde{\alpha}\ell(t_{BL}, g_{BL}, \tilde{\alpha}), \tag{40}$$

where $\ell(t, g, \tilde{\alpha})$ solves the first-order condition $(1-t)\tilde{\alpha}/\big((1-t)\tilde{\alpha}\ell + g\big) = \kappa\ell^{\varepsilon}$. Assuming $\varepsilon = 2$ to match a (compensated) elasticity of labor supply, $e \approx 1/(1+\varepsilon) = 0.33$ (Chetty, 2012), and setting $\kappa = 1$ without loss of generality, the c.d.f. of $\tilde{\alpha}$ would then be recovered as $G(\tilde{\alpha}) = H\big(\tilde{z}(\tilde{\alpha})\big)$.

In a setting with contracts, however, pre-tax income not only depends on labor supply but also on the choice and structure of contracts. For instance, since individuals in fixed-wage contracts earn only $\eta\tilde{\alpha} < \tilde{\alpha}$ per unit of labor supply in our model, the distribution of abilities, $G(\tilde{\alpha})$, derived in the previous step will deliver an overall level of income (and tax base) that falls short of its corresponding empirical level. The above calibration procedure must therefore be adjusted in order to recover a distribution of types that is consistent with observed incomes.

The parameters that determine the structure of contracts are chosen as follows. First, consistent with evidence presented in Lazear (2000) and Freeman et al. (2019) on the effect of incentive contracts on worker's productivity, we set $\eta = 2/3$, meaning that switching from a performance-based contract to a fixed-wage contract reduces productivity by 33%.[30] Second, based on evidence that about one-half of all U.S. workers are in

[30] Lazear (2000) documents a 44% increase in productivity found in a U.S. manufacturing firm after the switch from hourly wages to piece-rate pay. Similarly, Freeman et al. (2021) find a 40-50% increase in productivity in a Chinese insurance company after switching to a non-linear compensation scheme with high returns above a performance threshold.

Table 1: Calibrated parameters

Exogenously specified	
ε	2
η	2/3
ρ	1/2
π	1/5
Inferred through the calibration procedure	
c	0.089
ξ	1,747
ν	1.69
θ	−0.223

performance contracts (Doligalski et al., 2022) as well as on evidence that about one-half of all U.S. jobs are in firms that trade internationally (Handley et al., 2021), we assume that a fraction $\rho = 1/2$ of the population is in performance contracts. Third, based on Doligalski et al. (2022) who suggest that the probability of individuals in performance-based contracts to receive a bonus is close to 20%, we select $\pi = 0.2$. This implies that 10% of the population ends up receiving bonus payments in incentive contracts ($\rho\pi = 0.1$).

Given this set of exogenously specified parameters, we jointly infer: (i) the fixed cost of effort in performance contracts, c, such that, for the resulting productivity threshold, $\hat{\alpha}$ (as given by (14)), a fraction ρ of the population is in performance contracts; (ii) a scaling parameter for the compensation per unit of labor supply, $\xi > 0$, such that average pre-tax income matches the empirical mean, $\bar{z}_{BL}$; (iii) a dispersion parameter for productivity levels, $\nu > 0$, such that the share of pre-tax income accruing to the top 10% earners matches its empirical value, which is about 47.5% (Piketty at al., 2018).[31] In mechanical terms, this is achieved by setting $\tilde{\alpha} = \alpha^{\nu}$ and using the re-scaling parameter ξ to replace (40) with

$$z(\alpha) = \xi \alpha^{\nu} \ell(t_{BL}, g_{BL}, \alpha^{\nu}) \tag{41}$$

and numerically deriving parameter values such that, under the resulting distribution of types $G(\alpha) = H\big(z(\alpha)\big)$, our calibrated economy with contracts matches the three aforementioned empirical targets. All parameter values are summarized in Table 1.[32] In the calibrated economy, the distribution of productivity types satisfies condition (38).

[31] Since our model generates distributional predictions that specifically relate to the top earners, we choose to calibrate the model using a tail moment, the share of income accruing to the top 10% earners.

[32] We report the values for ξ and ν for the sake of completeness; these parameters only intervene in the calibration of the model.

Planner's objective

We specify the Pareto weights of the generalized utilitarian objective (24) as $\mu(\alpha) = \alpha^{-\theta}$, where θ reflects the planner's preferences for redistribution, with a Rawlsian objective (or, equivalently, revenue maximization) corresponding to the limit case $\theta \to \infty$. We select θ such that the optimal tax and transfer in this calibrated model coincide with the baseline tax and transfer, t_{BL} and g_{BL}—in the spirit of the inverse optimum approach (Bourguignon and Spadaro, 2012; Lockwood and Weinzierl, 2016; Jacobs et al., 2017).

4.4 Simulation results

Optimal tax responses to a fall in π

Our main counterfactual experiment consists of decreasing π from its baseline level of 0.2 to 0.19. If the tax stayed at its baseline level, $t_{BL} = 0.271$, the reduction in π would cause the income share of the top 10% earners to rise from 47.5% to 49.8% and the proportion of individuals in performance contracts to fall from 50% to 41.4%.

The reduction in π, however, causes the optimal tax to fall from $t_{BL} = 0.271$ to $t = 0.255$. A one percentage point fall in the probability of success thus translates into a 1.6 percentage points fall in the optimal tax. After the optimal tax adjustment, the income share of the top 10% earners falls back partially, to 49.3%, and the proportion of individuals in performance contracts rises to 45.5%.

Hence, a fall in π triggers an increase in income concentration at the top. At the same time, despite this increase in income concentration, a fall in π triggers a decrease in the optimal tax rate and thus in redistribution. This result is robust to changes in the parameters affecting the structure of contracts: sensitivity checks for $\eta \in [0.5, 0.75]$, $\rho \in [0.4, 0.6]$, and $\pi \in [0.15, 0.25]$ yield results that are qualitatively identical and quantitatively similar.

Optimal tax responses to increased income concentration with complete contracts

It is interesting to contrast the optimal policy response in the experiment above, where the increase in income concentration is driven by a change in π, with the optimal policy response in a setting with complete contracts, where an increase in income concentration would (necessarily) be driven by changes in the distribution of types.

For this purpose, we calibrate a complete-contracting model going through the first few steps of the procedure described above so that it matches the same baseline moments as the model with incentive contracts. We then simulate the effects of a skill-biased change in the distribution of productivity types, modeled as an iso-elastic change in productivity from $\tilde{\alpha}$ to $\tilde{\alpha}^{\varphi}$ with $\varphi > 1$. We select φ such that the change in the income share of the top 10% earners matches the change—from 47.5% to 49.8%—that occurs following a fall in π in a setting with performance-based contracts, before taxes are optimally readjusted. This implies $\varphi = 1.056$.

In this case, following this increase in income concentration, the optimal tax rises from its baseline level of 0.271 to 0.289, implying an increase in redistribution.[33] The source of the increase in income concentration thus crucially matters for how optimal redistribution responds to it.

5 Discussion

The predictions we have derived in the previous sections have direct implications for the relationship between changes in tax policy and changes in the distribution of income when this relationship is mediated through a change in globalization-induced income risk. In Section 3, we have shown that economic globalization, characterized as a decrease in π, raises wage inequality and the concentration of earnings at the top of the income distribution. At the same time, we have shown in Section 4 that this can be accompanied by a fall in the optimal rate of redistributive taxation. Our results are thus consistent with the simultaneous increase in pre-tax income concentration and the reduction in redistributive income tax rates that has been documented in the empirical literature (Immervoll and Richardson, 2011; Egger et al., 2019). In our model, the decrease in taxation and the increase in earnings concentration are both consequences of structural changes associated with economic globalization.

The increase in the concentration of income is generated in our model by the wider dispersion of pre-tax wages under incentive contracts that can be attributed to increased competition under market integration. This characterization is consistent with the increase in *between-firm* wage inequality that has been documented in the empirical labor economics literature (Song et al., 2019). If performance incentives are dynamically interpreted, it is also consistent with the observation of rising *within-firm* wage inequality that has been documented in the empirical literature on life-cycle wage dynamics (Heathcote et al., 2010; Bayer and Kuhn, 2019).

Our analysis, however, captures only a subset of the relevant effects that are associated with economic globalization. While our results are invariant to an equi-proportional change in productivity levels (as discussed in Section 3), a key assumption is that *relative* productivity levels remain unchanged. To the extent that globalization raises the relative productivity of high-ability vis-à-vis low-ability types, the redistributive argument for a progressive income tax is strengthened. Yet, even in this extended setting, the increase in observed income inequality induced by globalization would be partly driven by the higher income spread in incentive contracts, and our analysis reveals that this mechanism would not provide a motive to increase redistributive taxes.

In addition, our framework predicts that globalization leads to a reduction in the share of performance contracts in the economy. As such, it may appear inconsistent with

[33] Since the economy is scale invariant, meaning that re-scaling all productivity levels by a multiplicative factor ξ has no impact on the economy, the change in productivity levels is irrelevant and only the change in the shape of the type distribution affects the optimal tax rate.

the increased reliance on performance contracts that has been documented starting in the 1980s in the U.S. and its impact on wage volatility (Champagne and Kurmann, 2013; Nucci and Riggi, 2013). However, as discussed in Appendix D, one can construct model variants where an increase in income dispersion within contracts (and overall income inequality) is accompanied by an increase in the proportion of individuals in performance-based contracts due to the productivity gains associated with globalization disproportionately accruing to projects that are comparatively more sensitive to effort.

Lastly, our discussion has so far focused on the case of an (indirectly progressive) linear tax featuring a constant marginal tax rate. Would redistribution increase if the marginal tax rate could increase with income, i.e., if taxes could be directly progressive? To examine this question, we consider local deviations from a linear tax to a tax schedule with a constant-rate-of-progressivity (CRP; see, e.g. Heathcote et al., 2017), and a lump-sum transfer, where an individual with pre-tax income z has a disposable income of $\vartheta z^{1-\varrho} + g$.[34] This specification nests the linear tax case which is obtained when the progressivity parameter is $\varrho = 0$, and the scaling factor is $\vartheta = 1 - t$.

We explore whether locally relaxing the constraint $\varrho = 0$ can lead to a tax structure that improves on the optimal linear tax. For this purpose, we raise the progressivity parameter ϱ from 0 to 0.01, derive combinations of ϑ and g that satisfy the budget constraint, and then, for each, compute the value of the planner's objective. With $\varrho = 0.01$, the optimum value of ϑ is 0.808 (compared with the implied baseline level of $\vartheta = 1 - t = 0.629$), accompanied by a transfer g equal to \$14,230 (compared with the baseline level of \$18,789). However, for this tax configuration, the planner's objective achieves a value that is below the corresponding value at the optimal linear tax. Hence, in this setting, locally relaxing the flat marginal tax rate constraint by introducing direct progressivity does not improve welfare.[35]

The intuition for this result is that for an individual of a given productivity type, direct progressivity makes taxation comparatively heavier in favorable realizations ($z = z_H$) and comparatively lighter in unfavorable realizations ($z = z_L$), thus providing direct insurance against the variability of income realizations, beyond the indirect insurance provided through the demogrant, g. However, by the same arguments we have discussed in relation to the flat tax case, this direct insurance effect of direct progressivity is poorly targeted, as it attempts to undo what performance contracts aim to do by design. Accordingly, markets will need to offset the additional insurance effect of marginal tax progression through a starker increase in the pre-tax wedge between z_H and z_L than would be needed under a flat tax. Additionally, under direct progressivity the average tax that is paid by a given individual is lower under a fixed income realization z_F than it is under a mean-preserving combination (z_H, z_L) such that $\pi z_H + (1 - \pi) z_L = z_F$.

[34]Ferrière at al. (2021) note that the combination of a CRP tax with a transfer is better able to generate realistic tax schedules than a CRP tax alone.

[35]This remains true if we consider even smaller levels of ϱ. For example, for $\varrho = 0.001$, the optimal level of ϑ is 0.747, giving a level of g equal to \$18,117; for this combination, the value of the planner's objective is still below that for the optimal linear tax.

Other things equal, this further reduces the comparative attractiveness of performance contracts, and thus lowers the tax base.[36]

6 Conclusion

Empirical studies have shown that economic globalization is associated with both an increase in income concentration and a reduction in redistribution (Egger et al., 2019). In this paper we have offered an explanation for these simultaneous developments.

In our model, increased competition in integrated product markets translates into higher idiosyncratic income risk, which performance-based contracts must impose on high productivity workers to overcome moral hazard. The higher volatility of individual earnings makes incentive contracts more sensitive to the disincentive effects caused by redistributive income tax, raising the efficiency cost of redistribution. At the same time, redistributive taxation is unable to counter the higher income inequality that arises endogenously from steeper incentive contracts. As a result, optimal redistributive income tax rates fall.

Our analysis could be extended in several directions. One example is to allow for a continuous choice of projects and contract types by each ability type in the context of a continuous distribution of possible returns realizations. At the same time, one could allow for heterogeneous effects of globalization on both the size and the volatility of returns across different ability types and occupations. Such extensions would yield a general framework that lends itself to structural estimation in future empirical work.

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[36]These results are limited to local deviations from a linear tax. An analysis of the global properties of non-linear taxation in a setting with performance contracts is beyond the scope of our study.

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Appendix

A Details and proofs for Section 2

A.1 Utility cost associated with income risk in performance contracts

We here show that the last term in the expression of expected utility in performance contracts, (6), capturing the utility cost associated with income risk is negative for any $\pi \in [0,1]$, $\eta \in [0,1]$, and $c > 0$.

We have

$$\ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right) \leq 0 \iff \frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)} \leq 1$$
$$\iff \left(e^{\frac{c}{(1-\eta)}}\right)^{\eta} - 1 \leq \pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)$$
$$\iff \left(e^{\frac{c}{(1-\eta)}}\right)^{\eta} - \pi e^{\frac{c}{(1-\eta)\pi}} \leq 1-\pi. \tag{42}$$

First, we show that for any $\pi \in [0,1]$,

$$\phi_1(\pi) \equiv \pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right) \geq \left(e^{\frac{c}{(1-\eta)}}\right)^{\eta} - 1 \tag{43}$$

Noting that $\phi_1(0) = +\infty$ and that $\phi_1(0) = e^{\frac{c}{(1-\eta)}} - 1$, (43) holds for $\pi = 0$ and $\pi = 1$. Since $\phi_1(\pi)$ is decreasing over $[0,1]$, it follows that (43) holds for any $\pi \in [0,1]$. Indeed, the derivative of $\phi_1(\pi)$, after some simplification, is equal to

$$\phi_1'(\pi) = e^{\frac{c}{(1-\eta)\pi}}\left(1-\frac{c}{(1-\eta)\,\pi}\right) - 1, \tag{44}$$

which is negative for any $\pi \in [0,1]$. [37]

Second, we show that for any $\eta \in [0,1]$,

$$\phi_2(\eta) \equiv \left(e^{\frac{c}{(1-\eta)}}\right)^{\eta} - \pi e^{\frac{c}{(1-\eta)\pi}} \leq 1-\pi. \tag{45}$$

[37] We have that $\phi_1'(0) = -\infty$ and that $\phi_1'(1) = e^{\frac{c}{1-\eta}}\left(1-\frac{c}{1-\eta}\right) - 1 < 0$, while $\phi_1'(\pi)$ is strictly increasing as $\phi_1''(\pi) = \frac{c^2}{(1-\eta)^2\pi^3}e^{\frac{c}{(1-\eta)\pi}} > 0$.

Noting that $\phi_2(0) = 1 - \pi e^{\frac{c}{\pi}}$, (45) holds for $\eta = 0$. Since $\phi_2(\eta)$ is decreasing over $[0,1]$, it follows that (45) holds for any $\eta \in [0,1]$. Indeed, the derivative of $\phi_2(\eta)$ is, after some simplification, equal to

$$\phi_2(\eta)' = \frac{c}{(1-\eta)^2}\left(\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} - e^{\frac{c}{(1-\eta)\pi}}\right), \tag{46}$$

which is negative for any $\eta\pi \in [0,1]$ as $e^{\frac{c}{(1-\eta)\pi}} > 1$.

Third, we show that, for any $c > 0$,

$$\phi_3(c) \equiv e^{\frac{c\eta}{(1-\eta)}} - \pi e^{\frac{c}{(1-\eta)\pi}} \leq 1 - \pi. \tag{47}$$

Noting that $\phi_3(0) = 1 - \pi$, (47) holds for $c = 0$. Since $\phi_3(c)$ is a decreasing function, it follows that (47) holds for any $c > 0$. Indeed, the derivative of $\phi_3(c)$, after some simplification, is equal to

$$\phi_3'(c) = \frac{\eta}{1-\eta}\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} - \frac{1}{1-\eta}e^{\frac{c}{(1-\eta)\pi}}, \tag{48}$$

which is negative, since

$$\begin{cases} 1 < \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} < e^{\frac{c}{(1-\eta)\pi}}, \\ \frac{\eta}{1-\eta} < 1 < \frac{1}{1-\eta}, \end{cases} \implies \frac{\eta}{1-\eta}\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} < \frac{1}{1-\eta}e^{\frac{c}{(1-\eta)\pi}}. \tag{49}$$

A.2 Proof of Proposition 1

Monotonicity condition. The sorting of productivity types into different contracts relies on the monotonicity condition (13). We here establish this monotonicity condition starting from the expressions of expected utilities, given by (6) and (9), which imply

$$\frac{\partial EU^P}{\partial\alpha} = \frac{(1-t)\ell^P + (1-t)\alpha\,\partial\ell^P/\partial\alpha}{(1-t)\alpha\ell^P + g} - \kappa(\ell^P)^\varepsilon\frac{\partial\ell^P}{\partial\alpha} = \frac{(1-t)\ell^P}{(1-t)\alpha\ell^P + g}, \tag{50}$$

$$\frac{\partial EU^F}{\partial\alpha} = \frac{(1-t)\eta\ell^F + (1-t)\eta\alpha\,\partial\ell^F/\partial\alpha}{(1-t)\eta\alpha\ell^F + g} - \kappa(\ell^F)^\varepsilon\frac{\partial\ell^F}{\partial\alpha} = \frac{(1-t)\eta\ell^F}{(1-t)\eta\alpha\ell^F + g}, \tag{51}$$

where the second equality follows each time from the first-order condition for ℓ, and amounts to an application of the envelope theorem. As a result, we obtain

$$\begin{aligned}\frac{\partial(EU^P - EU^F)}{\partial\alpha} &= \frac{(1-t)\ell^P}{(1-t)\alpha\ell^P + g} - \frac{(1-t)\eta\ell^F}{(1-t)\eta\alpha\ell^F + g} \\ &= \frac{g(1-t)\left(\ell^P - \eta\ell^F\right)}{\left((1-t)\alpha\ell^P + g\right)\left((1-t)\eta\alpha\ell^F + g\right)}.\end{aligned} \tag{52}$$

For $g > 0$ and $t < 1$, this expression is strictly positive for all productivity types, since $\eta < 1$ guarantees that $\ell^P > \ell^F$ and thus that $\ell^P - \eta\ell^F > 0$.[38]

[38] In the special case where there is no transfer ($g = 0$), this expression shows that all types find it equally attractive to work in a performance contract or in a fixed-wage contract. This is consistent with the assumption that, in the absence of taxes and transfers, all individuals would choose a performance contract.

Assumption on contract choice. We assume that, in the absence of taxes and transfers, all individuals would choose performance contracts, which means that $EU^P \geq EU^F$. Setting, $t = 0$ and $g = 0$ in (6) and (9), this means that

$$\ln\left(\alpha\ell^P\right) - \kappa\frac{(\ell^P)^{1+\varepsilon}}{1+\varepsilon} + \ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right) \geq \ln\left(\eta\alpha\ell^F\right) - \kappa\frac{\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon}. \tag{53}$$

Now, the first-order conditions for labor supply, (7) and (10), imply that in the absence of taxes and transfers, $\ell^P = \ell^F = \ell$. We can thus rewrite the previous inequality as

$$\ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right) \geq \ln(\eta\alpha\ell) - \ln(\alpha\ell) = \ln\eta. \tag{54}$$

Taking exponential and rearranging yields

$$\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} \geq \eta\left(1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)\right),$$

which is condition (12) in the paper.

Productivity cut-off. The productivity cut-off $\hat{\alpha}$ is defined by $EU^P(\hat{\alpha}) = EU^F(\hat{\alpha})$, that is,

$$\begin{aligned}
&\ln\left((1-t)\hat{\alpha}\ell^P + g\right) - \kappa\frac{(\ell^P)^{1+\varepsilon}}{1+\varepsilon} + \ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right) \\
&= \ln\left((1-t)\eta\hat{\alpha}\ell^F + g\right) - \kappa\frac{\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon} \\
&\iff \ln\left(\frac{(1-t)\hat{\alpha}\ell^P + g}{(1-t)\eta\hat{\alpha}\ell^F + g}\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)}\right) = \kappa\frac{(\ell^P)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon} \\
&\iff \left((1-t)\hat{\alpha}\ell^P + g\right)\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} = \left((1-t)\eta\hat{\alpha}\ell^F + g\right)\left(1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)\right)e^{\kappa\frac{(\ell^P)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon}} \\
&\iff \hat{\alpha} = \frac{g}{(1-t)}\frac{\left(1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)\right)e^{\kappa\frac{(\ell^P)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon}} - \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{\ell^P\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} - \eta\ell^F\left(1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)\right)e^{\kappa\frac{(\ell^P)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon}}},
\end{aligned} \tag{55}$$

which is equation (14) where we rewrite the second fraction on the RHS as $\frac{1}{K}$ defined in equation (15). We now show that condition (12) guarantees that $\frac{1}{K} > 0$, provided that $\eta < 1$.

First, consider the denominator. Condition (12) together with $\eta < 1$ directly imply that the denominator is strictly positive, i.e.,

$$\ell^P\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}\right)} > \eta\ell^F\left(1+\pi\left(e^{\frac{c}{(1-\eta)\pi}}-1\right)\right), \tag{56}$$

if we can show that $\ell^P e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}\right)} \geq \ell^F$. To show this, note that

$$\begin{aligned}
&\ell^P e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon}-\left(\ell^F\right)^{1+\varepsilon}\right)} \geq \ell^F \\
&\iff \frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right) - \left(\ln\ell^P - \ln\ell^F\right) \leq 0,
\end{aligned} \tag{57}$$

and consider the function $\eta \mapsto \frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right) - \left(\ln \ell^P - \ln \ell^F\right)$, where ℓ^F is an implicit function of η and ℓ^P is independent of η. When $\eta = 1$, we have $\ell^P = \ell^F$ meaning that this function is nil. Moreover, this function's first derivative is, after simplification, equal to

$$\frac{\partial \ell^F}{\partial \eta}\left(\frac{1}{\ell^F} - \kappa\left(\ell^F\right)^{\varepsilon}\right) = \frac{g}{\varepsilon\left((1-t)\eta\alpha\ell^F + g\right) + (1-t)\eta\alpha\ell^F}\frac{1}{\eta}\frac{g}{(1-t)\eta\alpha\ell^F + g} \geq 0, \tag{58}$$

implying that this function is increasing, and thus negative for any $\eta < 1$. This shows that the denominator is strictly positive.

Second, consider the numerator. If we can show that

$$1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) \geq \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}, \tag{59}$$

then $\eta < 1$ implies that $\ell^P > \ell^F$, which in turn means that $0 < e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right)} < 1$, and thus that the numerator is strictly positive:

$$1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) > \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right)}. \tag{60}$$

To complete the proof, consider the function $\eta \mapsto 1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) - \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}$. When $\eta = 0$, this function is strictly positive since it is equal to $\pi\left(e^{\frac{c}{\pi}} - 1\right)$. Moreover, this function is increasing with η since its derivative is, after simplification, equal to

$$\frac{c}{(1-\eta)^2}\left(e^{\frac{c}{(1-\eta)\pi}} - \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}\right), \tag{61}$$

which is strictly positive given that $e^{\frac{c}{(1-\eta)\pi}} > 1$ and $0 \leq \eta\pi < 1$. Hence, this function is positive, which shows that the numerator is strictly positive. □

A.3 Proof of Proposition 2

By definition, $\hat{\alpha}$ is such that $EU^P(\hat{\alpha}) = EU^F(\hat{\alpha})$:

$$\ln\left((1-t)\hat{\alpha}\ell^P + g\right) - \kappa\frac{\left(\ell^P\right)^{1+\varepsilon}}{1+\varepsilon} + \ln\left(\frac{\left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi}}{1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right)}\right)$$
$$= \ln\left((1-t)\eta\hat{\alpha}\ell^F + g\right) - \kappa\frac{\left(\ell^F\right)^{1+\varepsilon}}{1+\varepsilon}.$$

Partially differentiating this equation with respect to t, changes in labor supply cancel out, and we obtain

$$\frac{-\hat{\alpha} + (1-t)\frac{\partial\hat{\alpha}}{\partial t}}{(1-t)\hat{\alpha}\ell^P + g}\ell^P = \frac{-\hat{\alpha} + (1-t)\frac{\partial\hat{\alpha}}{\partial t}}{(1-t)\eta\ell^F\hat{\alpha} + g}\eta\ell^F \tag{62}$$
$$\iff \left(-\hat{\alpha} + (1-t)\frac{\partial\hat{\alpha}}{\partial t}\right)\ell^P\left((1-t)\eta\ell^F\hat{\alpha} + g\right) = \left(-\hat{\alpha} + (1-t)\frac{\partial\hat{\alpha}}{\partial t}\right)\eta\ell^F\left((1-t)\hat{\alpha}\ell^P + g\right)$$
$$\iff (1-t)\frac{\partial\hat{\alpha}}{\partial t}\ell^P g - (1-t)\frac{\partial\hat{\alpha}}{\partial t}\eta\ell^F g = g\hat{\alpha}\ell^P - g\hat{\alpha}\eta\ell^F$$
$$\iff \frac{\partial\hat{\alpha}}{\partial t} = \frac{\hat{\alpha}}{1-t}.$$

Similarly, partially differentiating this equation with respect to g, changes in labor supply again cancel out, and we obtain

$$\begin{aligned}
&\frac{(1-t)\ell^P \frac{\partial \hat{\alpha}}{\partial g} + 1}{(1-t)\hat{\alpha}\ell^P + g} = \frac{(1-t)\eta\ell^F \frac{\partial \hat{\alpha}}{\partial g} + 1}{(1-t)\eta\ell^F\hat{\alpha} + g} \qquad (63)\\
\iff &\left((1-t)\ell^P \frac{\partial \hat{\alpha}}{\partial g} + 1\right)\left((1-t)\eta\ell^F\hat{\alpha} + g\right) = \left((1-t)\eta\ell^F \frac{\partial \hat{\alpha}}{\partial g} + 1\right)\left((1-t)\hat{\alpha}\ell^P + g\right)\\
\iff &(1-t)\ell^P \frac{\partial \hat{\alpha}}{\partial g} g - (1-t)\eta\ell^F \frac{\partial \hat{\alpha}}{\partial g} g = (1-t)\hat{\alpha}\ell^P - (1-t)\eta\ell^F\hat{\alpha}\\
\iff &\frac{\partial \hat{\alpha}}{\partial g} = \frac{\hat{\alpha}}{g}.
\end{aligned}$$

□

B Details and proofs for Section 3

B.1 Equilibrium closure of the open-economy model of Section 3.1

The level of input supply by an individual of type α will be the level that makes the marginal disutility of supply equal to its marginal effect on consumption utility:

$$\kappa\,\ell(\alpha)^\varepsilon = \frac{w(\alpha)}{y(\alpha)}, \qquad (64)$$

where $y(\alpha)$ is disposable income, which absent taxes and transfers, is equal to

$$y(\alpha) = w(\alpha)\ell(\alpha) + r, \qquad (65)$$

where r is the equilibrium price of the inelastically supplied input, the same at all locations in a symmetric equilibrium. Given that individuals only consume the composite good and we normalize its price to be unity, $y(\alpha)$ coincides with real income.[39]

In equilibrium, the prices of individual varieties will vary across locations, but, with a continuum of varieties, the *distribution* of prices will be the same across locations and so will the distribution of minimum marginal costs and gross returns. So, in equilibrium, P, the price of the composite good is the same at all locations (and is normalized to be unity):

$$P_l = P = r^{1-\xi}\left(\int p^{1-\sigma}\,\mathrm{d}G(p)\right)^{\xi/(1-\sigma)} = 1, \quad \forall l, \qquad (66)$$

where $G(\cdot)$ is the c.d.f. of the equilibrium distribution of prices.

Finally, the total demand for the composite good at each location must equal final demand (total disposable income) plus intermediate demand, I:

$$Y_l = Y = E\big[w(\alpha)\ell(\alpha)\big] + r + I, \quad \forall l, \qquad (67)$$

$$I_l = I \equiv \iint m\,x(p)\,Y\,\mathrm{d}G(p)\,\mathrm{d}H(m), \quad \forall l, \qquad (68)$$

where $H(\cdot)$ is the c.d.f. of the equilibrium distribution of the minimum marginal costs, m, of the firm, k_l, that in each case takes the local market for a given variety—which equals $1/\phi_{k_l}$ if k_l is a domestic firm and equals τ/ϕ_{k_l} if k_l is a foreign firm.

[39]In our discussion of optimal contracts, we abstract from this component of disposable income. If present this would act as an additional, exogenous component that adds to the demogrant, g, either representing a component of exogenous income, or additional tax revenue coming from (optimally) taxing capital and land at a 100% rate, or a combination of net-of-tax capital income and revenue transfer for any level of capital/land taxation.

B.2 Proof of Proposition 3

Let $l(k)$ denote the location where k is based (its domestic market) and let $\widetilde{\phi}_{l(k)}$ and $\widetilde{\phi}_l,\ l \neq l(k)$, be respectively the highest draw by domestic firms other than k and the highest draw by foreign firms in each foreign market producing the same variety. A firm drawing ϕ_k will be able to fully take its home market iff $1/\phi_k$ is lower than or equal to the minimum of $1/\widetilde{\phi}_{l(k)}$ and the lowest of the values $\tau/\widetilde{\phi}_l,\ l \neq l(k)$. If so, then by pricing just below the trade-cost inclusive marginal cost of its closest competitor, k will be able to obtain, for each unit unit sold, a positive gross return equal to the gap between that price and its own marginal cost; otherwise k's gross returns in its own domestic market will be zero. The same draw will allow k to fully take a particular foreign market $l \neq l(k)$ iff τ/ϕ_k is lower than or equal to the minimum of the lowest of the values $\tau/\widetilde{\phi}_{l'},\ l' \neq l$, and $1/\widetilde{\phi}_l$. If so, by charging a trade-cost inclusive price equal to the trade-cost inclusive marginal cost of its closest competitor, producer k will be able to obtain, for each unit sold, a positive gross return equal to the gap between that price and its own trade-cost inclusive marginal cost; otherwise k's gross returns in l will be zero.

Then, for given realizations of ϕ_k, $\widetilde{\phi}_{l(k)}$, and $\widetilde{\phi}_l,\ l \neq l(k)$, the prices of variety i in k's domestic market and in each of k's foreign markets, $l \neq l(k)$, will respectively equal $1/\widehat{\phi}_{l(k)}(\tau)$ and $1/\widehat{\phi}_l(\tau),\ l \neq l(k)$, where

$$\begin{aligned}&\widehat{\phi}_{l(k)}(\tau) \equiv \max\{\widetilde{\phi}_{l(k)}, \widetilde{\phi}_l/\tau, l \neq l(k)\},\\ &\widehat{\phi}_l(\tau) \equiv \max\{\widetilde{\phi}_{l'}/\tau, \widetilde{\phi}_l, l' \neq l\}, \quad l \neq l(k);\end{aligned} \tag{69}$$

and k's gross returns in its domestic and foreign markets will respectively equal

$$\begin{aligned}&\max\left\{1/\widehat{\phi}_{l(k)}(\tau) - 1/\phi_k, 0\right\} \hat{x}_i(p_{l(k)})\, Y_{l(k)} \equiv \Lambda_{l(k)},\\ &\max\left\{1/\widehat{\phi}_l(\tau) - \tau/\phi_k, 0\right\} \hat{x}_i(p_l)\, Y_l \equiv \Lambda_l, \quad l \neq l(k),\end{aligned} \tag{70}$$

where $p_l\colon [0,1] \mapsto R$ denotes is the price profile in l for all varieties, and $\hat{x}_i(p_l)$ is compensated demand for variety i in l, which equals $\hat{x}_i(p_l) = \partial P_l(p_l)/\partial p_l(i)$, with

$$P_l(p_l) \equiv \left(\int p_l(i)^{1-\sigma}\, \mathrm{d}i\right)^{1/(1-\sigma)} \tag{71}$$

denoting a CES aggregation of domestic prices (a price index) corresponding to the primal representation (18).[40]

Depending on the productivity draw realizations, k may take any number of markets between zero and L. However, an outcome where k only takes one or more foreign markets without also taking its own domestic market cannot occur, because for $\tau \geq 1$, if $\phi_k > \widehat{\phi}_l(\tau)$ in a foreign market l, then it must also be the case that $\phi_k > \widehat{\phi}_{l(k)}(\tau)$. This also means that the probability of k failing to take any market and experiencing overall zero gross returns is equal to the probability of k failing to take its own domestic market, and that the probability of k experiencing a positive level of combined gross returns is just the complementary probability of k failing to take its own domestic market, i.e., the probability of k taking its own domestic market, $l(k)$:

$$\Pr\{\Lambda_k > 0\} = 1 - \Pr\{\Lambda_{l(k)} = 0\} = \Pr\{\Lambda_{l(k)} > 0\}. \tag{72}$$

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[40] As already noted, the value of P_l will be the same across all locations in equilibrium, and we take this value to be unity.

To derive an expression for $\Pr\{\Lambda_{l(k)} > 0\}$, we can proceed as follows. The probability of k taking its own domestic market conditional on a draw ϕ_k is

$$\Pr\left\{\phi_k > \widehat{\phi}_{l(k)}(\tau) \mid \phi_k\right\} = F\big(\phi_k\big)^{M-1} F\big(\tau\,\phi_k\big)^{(L-1)\,M}, \tag{73}$$

where the expression on the right-hand side represents the probability that all of k's domestic competitors get a draw that is less than ϕ_k (and thus a marginal cost greater than $1/\phi_k$) and that all of k's foreign competitors get a draw that, net of trade costs, is less than $\tau\phi_k$ (and thus a gross of trade costs marginal cost greater than of $1/\phi_k$).[41] The ex-ante unconditional probability of a given firm, k, being beaten by some other firm and experiencing zero gross returns in its own domestic market can then be obtained as[42]

$$\Pr\{\Lambda_{l(k)} = 0\} = \Pr\left\{\phi_k > \widehat{\phi}_{l(k)}(\tau)\right\} = \int \Pr\left\{\phi_k > \widehat{\phi}_{l(k)}(\tau) \mid \phi_k\right\} \mathrm{d}F(\phi_k). \tag{74}$$

This gives (22), which is increasing in τ. In the limit case where τ is very large, $F\big(\tau\,\phi_k\big)$ approaches unity and $\Pr\{\Lambda_k > 0\}$ approaches $\int F\big(\phi_k\big)^{M-1}\mathrm{d}F(\phi_k)$. In the opposite limit case where $\tau = 1$, it becomes $\int F\big(\phi_k\big)^{L\,M-1}\mathrm{d}F(\phi_k) < \int F\big(\phi_k\big)^{M-1}\mathrm{d}F(\phi_k)$. □

B.3 Interpretation of the case $\alpha\,\ell \neq \omega$ in Section 3.3

To understand how the case $\alpha\ell \neq \omega$ should be interpreted in relation to performance-based contracts, consider a scenario with $\omega = 1$ and an individual with $\alpha = 2$ choosing $\ell = 1$. In this case the individual labor supply spans exactly two production units. The choice of effort by that individual will be common across the two units, but there will be two separate productivity draws, one for each unit—implying that the number of productivity draws in each location remains equal to $E[\alpha\ell]/\omega$ independently of how the total supply of labor is distributed. The individual will enter into two formally separate contracts that are linked by a common signal. Specifically, the signal structure will be such that with probability 1/2, the signal reveals whether positive gross returns have been realized in the first unit and with probability 1/2 it reveals whether positive gross returns have been realized in the second unit. If there are multiple individuals each being fractionally involved in the same unit, then, for all individuals involved in that unit, the choice of effort level will be made by a single individual selected at random among them, with the costs and the consequences of that choice being incurred by all those individuals (i.e., externalities in team production are fully internalized). Under these assumptions, our formalization of performance-based contracts generalizes to any positive value of $\alpha\ell$.[43]

B.4 Proof of Proposition 4

Denote $(\ell_0^P, \ell_0^F, \hat{\alpha}_0, g_0, t_0)$ the attributes of a baseline economy, and consider the attributes $(\ell_1^P, \ell_1^F, \hat{\alpha}_1, g_1, t_1)$ of a new economy where all productivity levels rise by a factor $\beta > 1$.

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[41] We use here the result that the probability that all r independent random draws of a random variable, X, with c.d.f. $F_1(\cdot)$ lie below a particular value $\tilde{X}$, i.e., the probability of beating r other independent draws having drawn X, is $\Pr\left\{\max_k\{X_k\} \leq \tilde{X}\right\} = F_1(\tilde{X})^r$—with the complementary probability being the probability of X lying below the maximum value of r other independent draws.

[42] Here we are using the result that, if X_1 and X_2 are two random variables respectively distributed with c.d.f.s $F_1(\cdot)$ and $F_2(\cdot)$, the probability $\Pr(X_2 > X_1)$ can be expressed as $\int F_1(X)\,\mathrm{d}F_2(X)$.

[43] This is equivalent to allowing individuals to be employed in projects where the level of fixed input equals $\alpha\ell$ and where the distribution of productivity draws, ϕ, is independently sampled $\alpha\ell$ times, with payment within contracts being conditioned on one of those realizations chosen at random among all $\alpha\ell$ realizations.

First, assume that $t_1 = t_0$ and $g_1 = \beta g_0$. Then, any productivity type $\alpha_1 = \beta\alpha_0$ in the new economy makes the same labor supply decisions as productivity type α_0 in the baseline economy. Indeed, by (7) and (10), the first-order conditions identifying the labor supply choice of type $\beta\alpha_0$ in the new economy are

$$\frac{(1-t_0)\beta\alpha_0}{(1-t_0)\beta\alpha_0\ell_1^F + \beta g_0} = \kappa\left(\ell_1^F\right)^{\varepsilon} \iff \frac{(1-t_0)\alpha_0}{(1-t_0)\alpha_0\ell_1^F + g_0} = \kappa\left(\ell_1^F\right), \tag{75}$$

$$\frac{(1-t_0)\beta\eta\alpha_0}{(1-t_0)\beta\eta\alpha_0\ell_1^P + \beta g_0} = \kappa\left(\ell_1^P\right)^{\varepsilon} \iff \frac{(1-t_0)\eta\alpha_0}{(1-t_0)\eta\alpha_0\ell_1^P + g_0} = \kappa\left(\ell_1^P\right), \tag{76}$$

which coincide with first-order conditions for type α_0. This in turn implies that the new productivity cut-off is

$$\hat{\alpha}_1 = \frac{g_1}{1-t_1}\frac{1}{K_1} = \beta\frac{g_0}{1-t_0}\frac{1}{K_0} = \beta\hat{\alpha}_0, \tag{77}$$

since, by (15), $K_1 = K_0$ (given that the labor supply decisions of $\beta\hat{\alpha}_0$ coincide with the labor supply decisions of $\hat{\alpha}_0$).

Second, assuming $t_1 = t_0$, we show that the above invariance implies that $g_1 = \beta g_0$. Indeed, since labor supply decisions are unaffected under $t_1 = t_0$ and $g_1 = \beta g_0$, we have that expected incomes are scaled by the factor β, i.e. $\alpha_1\ell = \beta\alpha_0\ell$, implying that the new tax base is $Q_1 = \beta Q_0$ which confirms that $g_1 = \beta g_0$ by the resource constraint (25).

Third, since pre-tax incomes increase by a factor β, i.e., $z_1 = \beta z_0$, this implies that, for $t_1 = t_0$, the disposable income of a type $\beta\alpha_0$ in the new economy increases by the same factor:

$$(1-t_1)z_1 + g_1 = (1-t_0)\beta z_0 + \beta g_0 = \beta\left((1-t_0)z_0 + g_0\right). \tag{78}$$

Thus, given the previous results on labor supply choices, the expected utility of an individual of productivity type $\beta\alpha_0$ is equal to

$$EU_1(\beta\alpha_0) = \ln(\beta) + EU_0(\alpha_0), \tag{79}$$

implying that the marginal utility from consumption, which enters the optimal tax formula (29) is the same for a type $\beta\alpha_0$ in the new economy as for a type α_0 in the old economy. As a result, if t_0 satisfies the optimal tax formula (29) in the old economy, then t_0 still satisfies it in the new economy. □

B.5 Proof of Proposition 5

The productivity cut-off is equal to $\hat{\alpha} = g/\left((1-t)K\right)$. Differentiating this expression with respect to π, while holding t and g constant, gives

$$\frac{\partial\hat{\alpha}}{\partial\pi} = -\frac{g}{1-t}\frac{1}{K^2}\frac{\partial K}{\partial\pi} = -\frac{\hat{\alpha}}{K}\frac{\partial K}{\partial\pi}. \tag{80}$$

Moreover, noting that labor supply choices are unaffected by changes in π when holding tax policy constant, (partially) differentiating K, as given by (15), yields, after simplification,

$$\frac{\partial K}{\partial\pi} = -\frac{\left(\eta\ell^F + K\right)\left(\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) - \frac{c}{(1-\eta)\pi}e^{\frac{c}{(1-\eta)\pi}}\right)}{1 + \pi\left(e^{\frac{c}{(1-\eta)\pi}} - 1\right) - \left(e^{\frac{c}{(1-\eta)\pi}}\right)^{\eta\pi} e^{-\frac{\kappa}{1+\varepsilon}\left(\left(\ell^P\right)^{1+\varepsilon} - \left(\ell^F\right)^{1+\varepsilon}\right)}} > 0. \tag{81}$$

We can then conclude that the direct effect of an increase in π on $\hat{\alpha}$, through its effect on K, is negative. However, $\hat{\alpha}$ is also increasing in g, which, for a given t, is decreasing in $\hat{\alpha}$. Consider then an increase in K accompanied by a reduction in $\hat{\alpha}$. If the increase in g caused by the fall in $\hat{\alpha}$ were large enough to offset the negative effect on $\hat{\alpha}$ of a higher K, then $\hat{\alpha}$ would rise, and so g would have to fall rather than rise: a contradiction. This establishes that a fall in π leads to a rise in $\hat{\alpha}$.

Turning to the second part of the proposition, the fact that fewer types select into performance contracts implies that an increasing share of types derive lower incomes in fixed-wage contracts. By reducing total income in the economy, this increases the income share going to people above a given percentile p of the distribution. In addition, people in performance contracts now face a larger spread between pre-tax incomes z_H and z_L, with z_H increasing and z_L decreasing by equations (5a)-(5b). This implies that a lower share of individuals receive higher high-income payments, z_H, and that a larger share of individuals receive lower low-income payments, z_L, which also contributes to increasing the income share going to people above a given percentile p of the distribution. □

C Details and proofs for Section 4

C.1 Proof of Proposition 6

Optimal tax rate. Partial differentiation of the Lagrangian (26) with respect to t yields

$$\frac{\partial \mathcal{L}}{\partial t} = \int_{\alpha \leq \hat{\alpha}} \mu(\alpha) \frac{\partial EU^F(\alpha)}{\partial t} \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \mu(\alpha) \frac{\partial EU^P(\alpha)}{\partial t} \mathrm{d}F(\alpha) + \lambda \left(Q + t \frac{\partial Q}{\partial t} \right), \tag{82}$$

where we use the fact that $EU^F(\hat{\alpha}) = EU^P(\hat{\alpha})$ to cancel out the term that is proportional to $\partial \hat{\alpha} / \partial t$, related to changes in the domains of integration. Applying the envelope theorem to labor supply choices, we have

$$\frac{\partial EU^F(\alpha)}{\partial t} = -\frac{\eta \alpha \ell^F}{(1-t)\eta \alpha \ell^F + g}, \qquad \frac{\partial EU^P(\alpha)}{\partial t} = -\frac{\alpha \ell^P}{(1-t)\alpha \ell^P + g}, \tag{83}$$

and, since $Q = \int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \, \mathrm{d}F(\alpha)$, we also have that

$$\frac{\partial Q}{\partial t} = \int_{\alpha \leq \hat{\alpha}} \eta \alpha \frac{\partial \ell^F}{\partial t} \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \frac{\partial \ell^P}{\partial t} \, \mathrm{d}F(\alpha) + \left(\eta \hat{\alpha} \ell^F - \hat{\alpha} \ell^P \right) \frac{\partial \hat{\alpha}}{\partial t} f(\hat{\alpha}). \tag{84}$$

Introducing labor supply elasticities and using $\partial \hat{\alpha} / \partial t = \hat{\alpha} / (1-t)$, we can rewrite the change in the Lagrangian upon a change in t as

$$\begin{aligned} \frac{1}{\lambda} \frac{\partial \mathcal{L}}{\partial t} = &-\frac{t}{1-t} \left(\int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathcal{E}^{\ell^F}_{1-t} \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathcal{E}^{\ell^P}_{1-t} \, \mathrm{d}F(\alpha) + \left(\hat{\alpha} \ell^P - \eta \hat{\alpha} \ell^F \right) \hat{\alpha} f(\hat{\alpha}) \right) \\ &+ \int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \left(1 - \frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\eta \alpha \ell^F + g} \right) \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \left(1 - \frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\alpha \ell^P + g} \right) \mathrm{d}F(\alpha). \end{aligned}$$

Characterizing the optimal tax rate through the first-order condition $\partial \mathcal{L} / \partial t = 0$ yields (29).

Optimal transfer. Partial differentiation of the Lagrangian (26) with respect to g yields

$$\frac{\partial \mathcal{L}}{\partial g} = \int_{\alpha \leq \hat{\alpha}} \mu(\alpha) \frac{\partial EU^F(\alpha)}{\partial g} \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \mu(\alpha) \frac{\partial EU^P(\alpha)}{\partial g} \mathrm{d}F(\alpha) + \lambda \left(t \frac{\partial Q}{\partial g} - 1 \right), \tag{85}$$

where we use the fact that $EU^F(\hat{\alpha}) = EU^P(\hat{\alpha})$ to cancel out the term that is proportional to $\partial \hat{\alpha} / \partial t$, related to changes in the domain of integration. Applying the envelope theorem to labor supply choices, we have

$$\frac{\partial EU^F(\alpha)}{\partial g} = \frac{1}{(1-t)\eta \alpha \ell^F + g}, \qquad \frac{\partial EU^P(\alpha)}{\partial g} = \frac{1}{(1-t)\alpha \ell^P + g}, \tag{86}$$

and, since $Q = \int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \, \mathrm{d}F(\alpha)$, we also have that

$$\frac{\partial Q}{\partial g} = \int_{\alpha \leq \hat{\alpha}} \eta \alpha \frac{\partial \ell^F}{\partial g} \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \frac{\partial \ell^P}{\partial g} \, \mathrm{d}F(\alpha) + \left(\eta \hat{\alpha} \ell^F - \hat{\alpha} \ell^P\right) \frac{\partial \hat{\alpha}}{\partial g} f(\hat{\alpha}). \tag{87}$$

Introducing labor supply elasticities and using $\partial \hat{\alpha}/\partial g = \hat{\alpha}/g$, we can rewrite the change in the Lagrangian upon a change in t as

$$\begin{aligned} \frac{1}{\lambda}\frac{\partial \mathcal{L}}{\partial g} &= -1 - \frac{t}{g}\left(\int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathcal{E}_g^{\ell^F} \, \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathcal{E}_g^{\ell^P} \, \mathrm{d}F(\alpha) + \left(\hat{\alpha}\ell^P - \eta \hat{\alpha} \ell^F\right) \hat{\alpha} f(\hat{\alpha})\right) \\ &+ \int_{\alpha \leq \hat{\alpha}} \frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\eta\alpha\ell^F + g} \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \frac{\mu(\alpha)}{\lambda} \frac{1}{(1-t)\alpha\ell^P + g} \mathrm{d}F(\alpha). \end{aligned}$$

Characterizing the optimal transfer through the first-order condition $\partial \mathcal{L}/\partial g = 0$ yields (30). □

C.2 Impact of globalization on optimal taxes and proof of Proposition 7

Expressions (33) and (32) for Wel_t and Rev_t immediately follow from the proof of the optimal tax formula (see section C.1).

Changes in transfer. From the resource constraint, $g = tQ$ where the tax base is $Q = \int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathrm{d}F(\alpha)$, such that

$$\begin{aligned} \frac{\mathrm{d}g}{\mathrm{d}\pi} =& \frac{\mathrm{d}t}{\mathrm{d}\pi}\left(\int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathrm{d}F(\alpha)\right) \\ &+ t\left(\left(\eta \hat{\alpha} \ell^F - \hat{\alpha}\ell^P\right) f(\hat{\alpha}) \frac{d\hat{\alpha}}{d\pi} + \int_{\alpha \leq \hat{\alpha}} \eta \alpha \frac{d\ell^F}{d\pi} \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \frac{d\ell^P}{d\pi} \mathrm{d}F(\alpha)\right). \end{aligned} \tag{88}$$

Differentiating the first-order conditions for labor supply (7) and (10), we get that for both ℓ^F and ℓ^P,

$$\frac{1}{\ell}\frac{\mathrm{d}\ell}{\mathrm{d}\pi} = -\mathcal{E}_{1-t}^{\ell}\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right). \tag{89}$$

Plugging this in and rearranging yields equation (34) characterizing the change in the transfer g upon a change in π,

$$\begin{aligned} &\frac{\mathrm{d}g}{\mathrm{d}\pi} \underbrace{\left(1 + \frac{t}{g}\left(\int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \mathcal{E}_{1-t}^{\ell^F} \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \mathcal{E}_{1-t}^{\ell^P} \mathrm{d}F(\alpha)\right)\right)}_{\equiv \mathcal{C}_g} \\ &= \frac{\mathrm{d}t}{\mathrm{d}\pi} \underbrace{\left(\int_{\alpha \leq \hat{\alpha}} \eta \alpha \ell^F \left(1 - \frac{t}{1-t}\mathcal{E}_{1-t}^{\ell^F}\right) \mathrm{d}F(\alpha) + \int_{\alpha \geq \hat{\alpha}} \alpha \ell^P \left(1 - \frac{t}{1-t}\mathcal{E}_{1-t}^{\ell^P}\right) \mathrm{d}F(\alpha)\right)}_{\equiv \mathcal{C}_t} \\ &\quad - \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(t\left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F\right) f(\hat{\alpha})\right), \end{aligned}$$

where $\mathcal{C}_g$ is always strictly positive, and $\mathcal{C}_t$ is strictly positive provided that $\mathcal{E}_{1-t}^{\ell} < \frac{1-t}{t}$.[44]

[44]This holds for any realistic tax rate since $\mathcal{E}_{1-t}^{\ell} = \frac{g}{(1+\varepsilon)(1-t)\alpha\ell + \varepsilon g} < 1$ and $\frac{1-t}{t} > 1$ for any $t < 0.5$.

Efficiency concerns. Differentiating expression (32) for Rev_t with respect to π yields

$$\frac{\mathrm{dRev}_t}{\mathrm{d}\pi} = \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(\eta\hat{\alpha}\ell^F - \hat{\alpha}\ell^P\right) f(\hat{\alpha}) + \int_{\alpha\leq\hat{\alpha}} \eta\alpha\frac{\mathrm{d}\ell^F}{\mathrm{d}\pi}\mathrm{d}F(\alpha) + \int_{\alpha\geq\hat{\alpha}} \alpha\frac{\mathrm{d}\ell^P}{\mathrm{d}\pi}\mathrm{d}F(\alpha)$$
$$- \frac{1}{(1-t)^2}\frac{\mathrm{d}t}{\mathrm{d}\pi}\left(\int_{\alpha\leq\hat{\alpha}} \eta\alpha\ell^F\mathcal{E}^{\ell^F}_{1-t}\,\mathrm{d}F(\alpha) + \int_{\alpha\geq\hat{\alpha}} \alpha\ell^P\mathcal{E}^{\ell^P}_{1-t}\,\mathrm{d}F(\alpha) + \left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F\right)\hat{\alpha}f(\hat{\alpha})\right)$$
$$- \frac{t}{1-t}\left(\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(\eta\hat{\alpha}\ell^F\mathcal{E}^{\ell^F}_{1-t} - \hat{\alpha}\ell^P\mathcal{E}^{\ell^P}_{1-t}\right) f(\hat{\alpha}) + \int_{\alpha\leq\hat{\alpha}} \eta\alpha\frac{\mathrm{d}(\ell^F\mathcal{E}^{\ell^F}_{1-t})}{\mathrm{d}\pi}\mathrm{d}F(\alpha) + \int_{\alpha\geq\hat{\alpha}} \alpha\frac{d(\ell^P\mathcal{E}^{\ell^P}_{1-t})}{d\pi}\mathrm{d}F(\alpha)\right)$$
$$- \frac{t}{1-t}\left(\left(\frac{\mathrm{d}\ell^P}{\mathrm{d}\pi} - \eta\frac{\mathrm{d}\ell^F}{\mathrm{d}\pi}\right)\hat{\alpha}^2 f(\hat{\alpha}) + \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F\right) f(\hat{\alpha})\left(2 + \frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right). \tag{90}$$

Noting that for individuals of type $\hat{\alpha}$ changes in labor supply, ℓ^F or ℓ^P, are given by

$$\frac{1}{\ell}\frac{\mathrm{d}\ell}{\mathrm{d}\pi} = -\mathcal{E}^{\ell}_{1-t}\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi} - \frac{1}{\hat{\alpha}}\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\right); \tag{91}$$

and that, for types $\alpha \neq \hat{\alpha}$,

$$\frac{1}{\ell}\frac{\mathrm{d}\ell}{\mathrm{d}\pi} = -\mathcal{E}^{\ell}_{1-t}\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right), \tag{92}$$

$$\frac{1}{\ell^P\mathcal{E}^{\ell^P}_{1-t}}\frac{\mathrm{d}(\ell^P\mathcal{E}^{\ell^P}_{1-t})}{\mathrm{d}\pi} = \frac{\mathcal{E}^{\ell^P}_{1-t}}{g}\left((1+\varepsilon)(1-t)\alpha\ell^P - \varepsilon g\mathcal{E}^{\ell^P}_{1-t}\right)\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right), \tag{93}$$

$$\frac{1}{\ell^F\mathcal{E}^{\ell^F}_{1-t}}\frac{\mathrm{d}(\ell^F\mathcal{E}^{\ell^F}_{1-t})}{\mathrm{d}\pi} = \frac{\mathcal{E}^{\ell^F}_{1-t}}{g}\left((1+\varepsilon)(1-t)\eta\alpha\ell^F - \varepsilon g\mathcal{E}^{\ell^F}_{1-t}\right)\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right), \tag{94}$$

we obtain after simplification,

$$\frac{\mathrm{dRev}_t}{\mathrm{d}\pi} = -\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F\right) f(\hat{\alpha})\left(1 + \frac{t}{1-t}\left(2 + \frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right)$$
$$- \frac{1}{(1-t)^2}\frac{\mathrm{d}t}{\mathrm{d}\pi}\mathcal{K}_{\text{Rev}} + \left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} + \frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right)\mathcal{K}_{\mathcal{E}}, \tag{95}$$

where $\mathcal{K}_{\text{Rev}}$ is defined by (31), and $\mathcal{K}_{\mathcal{E}}$ is defined by (36). Using equation (34) to replace $\mathrm{d}g/\mathrm{d}\pi$ by its expression in terms of $\mathrm{d}\hat{\alpha}/\mathrm{d}\pi$ and $\mathrm{d}t/\mathrm{d}\pi$ yields equation (35) after rearranging.

Proof of Proposition 7. Note that, since the revenue-maximizing rate satisfies $\text{Rev}_t = 0$, we then have $\mathrm{dRev}_t/\mathrm{d}\pi = 0$. With exogenous labor supply, this implies

$$\frac{\mathrm{d}t}{\mathrm{d}\pi}\frac{1}{(1-t)^2} = -\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\left(1 + \frac{t}{1-t}\left(2 + \frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right). \tag{96}$$

Now, totally differentiating the definition of $\hat{\alpha}$, (14), yields

$$\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi} = \hat{\alpha}\left(\frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi} + \frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi} - \frac{1}{K}\frac{\mathrm{d}K}{\mathrm{d}\pi}\right), \tag{97}$$

where $\mathrm{d}K/\mathrm{d}\pi = \partial K/\partial\pi > 0$ (by the envelope theorem). Using (34), we can rewrite this as

$$\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi} = \frac{\hat{\alpha}}{1 + \frac{1}{\mathcal{C}_g}\frac{t}{g}\left(\hat{\alpha}\ell^P - \eta\hat{\alpha}\ell^F\right)\hat{\alpha}f(\hat{\alpha})}\left(\frac{\mathrm{d}t}{\mathrm{d}\pi}\left(\frac{1}{1-t} + \frac{1}{g}\frac{\mathcal{C}_t}{\mathcal{C}_g}\right) - \frac{1}{K}\frac{\mathrm{d}K}{\mathrm{d}\pi}\right). \tag{98}$$

Substituting this into the initial equation finally yields

$$\frac{\mathrm{d}t}{\mathrm{d}\pi} = \frac{\frac{\hat{\alpha}}{1+\frac{1}{\mathcal{C}_g}\frac{t}{g}(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F)\hat{\alpha}f(\hat{\alpha})}\frac{1}{K}}{\frac{1}{(1-t)^2}+\hat{\alpha}\frac{\frac{1}{1-t}+\frac{1}{g}\frac{\mathcal{C}_t}{\mathcal{C}_g}}{1+\frac{1}{\mathcal{C}_g}\frac{t}{g}(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F)\hat{\alpha}f(\hat{\alpha})}\left(1+\frac{t}{1-t}\left(2+\frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right)}\frac{\mathrm{d}K}{\mathrm{d}\pi}\left(1+\frac{t}{1-t}\left(2+\frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right)\right). \tag{99}$$

To conclude, note that the right-hand side is positive whenever condition (38) is verified:

$$1+\frac{t}{1-t}\left(2+\frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})}\right) > 0 \iff \frac{\hat{\alpha}f'(\hat{\alpha})}{f(\hat{\alpha})} > -\frac{1+t}{t}. \tag{100}$$

□

Equity concerns. Differentiating expression (33) for Wel_t with respect to π yields

$$\begin{aligned}
\frac{\mathrm{dWel}_t}{\mathrm{d}\pi} &= \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}\frac{\mu(\hat{\alpha})}{\lambda}\left(\hat{\alpha}\eta\ell^F\left(\frac{1}{(1-t)\eta\hat{\alpha}\ell^F+g}\right)-\hat{\alpha}\ell^P\left(\frac{1}{(1-t)\hat{\alpha}\ell^P+g}\right)\right)f(\hat{\alpha}) \\
&+ \int_{\alpha\le\hat{\alpha}}\alpha\eta\frac{\mathrm{d}\ell^F}{\mathrm{d}\pi}\left(\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\eta\alpha\ell^F+g}\right)\mathrm{d}F(\alpha)+\int_{\alpha\ge\hat{\alpha}}\alpha\frac{\mathrm{d}\ell^P}{\mathrm{d}\pi}\left(\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\alpha\ell^P+g}\right)\mathrm{d}F(\alpha) \\
&- \frac{1}{\lambda}\frac{\mathrm{d}\lambda}{\mathrm{d}\pi}\left(\int_{\alpha\le\hat{\alpha}}\alpha\eta\ell^F\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\eta\alpha\ell^F+g}\mathrm{d}F(\alpha)+\int_{\alpha\ge\hat{\alpha}}\alpha\ell^P\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\alpha\ell^P+g}\mathrm{d}F(\alpha)\right) \\
&- \int_{\alpha\le\hat{\alpha}}\alpha\eta\ell^F\frac{\mu(\alpha)}{\lambda}\frac{-\frac{\mathrm{d}t}{\mathrm{d}\pi}\eta\alpha\ell^F+(1-t)\eta\alpha\frac{\mathrm{d}\ell^F}{\mathrm{d}\pi}+\frac{\mathrm{d}g}{\mathrm{d}\pi}}{\left((1-t)\eta\alpha\ell^F+g\right)^2}\mathrm{d}F(\alpha) \\
&- \int_{\alpha\ge\hat{\alpha}}\alpha\ell^P\frac{\mu(\alpha)}{\lambda}\frac{-\frac{\mathrm{d}t}{\mathrm{d}\pi}\alpha\ell^P+(1-t)\alpha\frac{\mathrm{d}\ell^P}{\mathrm{d}\pi}+\frac{\mathrm{d}g}{\mathrm{d}\pi}}{\left((1-t)\alpha\ell^P+g\right)^2}\mathrm{d}F(\alpha).
\end{aligned} \tag{101}$$

Using again

$$\frac{1}{\ell}\frac{\mathrm{d}\ell}{\mathrm{d}\pi} = -\mathcal{E}^{\ell}_{1-t}\left(\frac{1}{1-t}\frac{\mathrm{d}t}{\mathrm{d}\pi}+\frac{1}{g}\frac{\mathrm{d}g}{\mathrm{d}\pi}\right), \tag{102}$$

$$\frac{\mathrm{d}g}{\mathrm{d}\pi}\mathcal{C}_g = \frac{\mathrm{d}t}{\mathrm{d}\pi}\mathcal{C}_t - \frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}t\left(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F\right)f(\hat{\alpha}), \tag{103}$$

and rearranging, yields, after simplification,

$$\begin{aligned}
\frac{\mathrm{dWel}_t}{\mathrm{d}\pi} &= -\frac{\mathrm{d}\hat{\alpha}}{\mathrm{d}\pi}f(\hat{\alpha})\left(\frac{\mu(\hat{\alpha})}{\lambda}\left(\frac{\hat{\alpha}\ell^P}{(1-t)\hat{\alpha}\ell^P+g}-\frac{\eta\hat{\alpha}\ell^F}{(1-t)\eta\hat{\alpha}\ell^F+g}\right)-\frac{t}{\mathcal{C}_g}\left(\hat{\alpha}\ell^P-\eta\hat{\alpha}\ell^F\right)\mathcal{K}_{\hat{\alpha}}\right) \\
&\quad + \frac{\mathrm{d}t}{\mathrm{d}\pi}\mathcal{K}_t - \frac{1}{\lambda}\frac{\mathrm{d}\lambda}{\mathrm{d}\pi}\mathcal{K}_\lambda,
\end{aligned} \tag{104}$$

which is equation (39), where

$$\mathcal{K}_{\hat{\alpha}} \equiv \int_{\alpha\le\hat{\alpha}}\alpha\eta\ell^F\frac{\mu(\alpha)}{\lambda}\frac{1+\mathcal{E}^{\ell^F}_{1-t}}{\left((1-t)\eta\alpha\ell^F+g\right)^2}\mathrm{d}F(\alpha)+\int_{\alpha\ge\hat{\alpha}}\alpha\ell^P\frac{\mu(\alpha)}{\lambda}\frac{1+\mathcal{E}^{\ell^P}_{1-t}}{\left((1-t)\alpha\ell^P+g\right)^2}\mathrm{d}F(\alpha), \tag{105}$$

$$\begin{aligned}
\mathcal{K}_t \equiv &\int_{\alpha\le\hat{\alpha}}\alpha\eta\ell^F\frac{\mu(\alpha)}{\lambda}\frac{\alpha\eta\ell^F-\mathcal{E}^{\ell^F}_{1-t}\frac{g}{1-t}-\frac{\mathcal{C}_t}{\mathcal{C}_g}\left(1+\mathcal{E}^{\ell^F}_{1-t}\right)}{\left((1-t)\eta\alpha\ell^F+g\right)^2}\mathrm{d}F(\alpha) \\
&+\int_{\alpha\ge\hat{\alpha}}\alpha\ell^P\frac{\mu(\alpha)}{\lambda}\frac{\alpha\ell^P-\mathcal{E}^{\ell^P}_{1-t}\frac{g}{1-t}-\frac{\mathcal{C}_t}{\mathcal{C}_g}\left(1+\mathcal{E}^{\ell^P}_{1-t}\right)}{\left((1-t)\alpha\ell^P+g\right)^2}\mathrm{d}F(\alpha),
\end{aligned} \tag{106}$$

$$\mathcal{K}_\lambda \equiv \int_{\alpha\le\hat{\alpha}}\alpha\eta\ell^F\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\eta\alpha\ell^F+g}\mathrm{d}F(\alpha)+\int_{\alpha\ge\hat{\alpha}}\alpha\ell^P\frac{\mu(\alpha)}{\lambda}\frac{1}{(1-t)\alpha\ell^P+g}\mathrm{d}F(\alpha). \tag{107}$$

D Globalization and the prevalence of incentive contracts

In our model, a fall in π associated with globalization causes t^* to fall as well as $\hat{\alpha}$ to rise, and so the model predicts that a fall in the level of taxation should be associated with a reduction in the prevalence of incentive contracts. However, this feature is not essential to the central mechanism underlying our argument; which is that a fall in π can make the tax base more tax elastic.

One can easily construct model variants in which globalization leads to a fall in t^* and broadens the range of productivity types that choose performance-based contracts. To illustrate, we return to the productivity shift β introduced in Section 3, but now assume that the productivity increase associated with globalization affects only workers in incentive contracts. Suppose that, in addition to the project yielding, for an individual with productivity type α, a level of expected returns equal to $\beta\alpha$ with effort and equal to $\eta\beta\alpha$ with no effort, there is also a fallback, no-effort project option giving expected productivity $\zeta\alpha$, with $\eta\beta < \zeta < \beta$, where ζ is invariant to globalization.[45] Then, if individuals opt for a fixed-wage contract, they will choose this alternative project; i.e., productivity types below $\hat{\alpha}$ will select into a fixed-wage contract and carry out projects yielding a level of expected returns that is independent of β, and those above $\hat{\alpha}$ will select into performance-based contracts and carry out projects that vary with β.

In this set-up, the relevant expression for K that determines the cut-off point through the relationship $\hat{\alpha} = g/\big((1-t)K\big)$ is increasing in β, implying that $\hat{\alpha}$ is decreasing in β. Then, if we model economic globalization as a simultaneous reduction in π and an increase in β, the effect of the productivity shift, β, on $\hat{\alpha}$ can dominate the effect of a reduced success probability, π, leading to a fall in $\hat{\alpha}$ and an increase in the proportion of workers who are in incentive contracts.[46]

[45]This is equivalent to saying that the value of η that determines expected productivity in fixed-wage contracts is greater than the level of η that determines expected productivity with no effort in a performance-based contract.

[46]To give an example, in a scenario with exogenous labor supply, a uniform distribution of productivity types with support $[0,1]$, $\eta = 1/2$, $c = 4/100$, and $\zeta = 6/5$, for $\pi = 2/5$ and $\beta = 1$ the revenue maximizing tax is $t^* \approx 0.88$ and the cut-off productivity type is $\hat{\alpha} \approx 0.41$. Lowering the probability of success to $\pi = 0.2$ while raising β to $\beta = 1.1$ results in $t^* \approx 0.87$, and $\hat{\alpha} \approx 0.39$. Hence, even though the total tax base increases, the elasticity of the tax base rises sufficiently so that the optimal redistributive tax rate falls.