Taxing Entrepreneurs and Workers

A Linear Optimization Approach for Multidimensional Screening

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Introduction

Large share of high income are entrepreneurs: how should we design redistributive taxation?

- Mirrlees model ill-suited to answer this question: only considers workers with fixed wage.
- Ideally: GE model w/ two-dimensional ability (worker, entrepreneur) & occupational choice.

Major technical issue: multidimensional screening problem!

- With two-dim private info, the structure of binding incentive constraints is intractable.
- Most of the literature ends up assuming or ensuring that only local IC constraints bind.

This paper: we solve the full multidimensional mechanism design problem numerically.

- Impose *all* (global) IC constraints in a non-convex environment (fixed costs).

A Numerical Approach to Solving Multidimensional Screening Problems

Starting point: recast the problem as a linear program over lotteries.

- Well-established theory developed by Prescott-Townsend 1984, Doepke-Townsend 2006.
- Curse of dimensionality: requires introducing large number of constraints and controls.

We leverage modern large-scale linear programming (LP) solvers.

This approach is applicable more broadly than to the specific economic problem we're studying!

- Key advantage: method can handle *arbitrary* non-convexities and non-differentiabilities.

This paper

We study optimal taxation when agents privately types are two-dimensional and choose between work and entrepreneurship.

- **Environment.** Agents differ in labor skill s and entrepreneurial ability z; wage work is riskless, entrepreneurs face idiosyncratic productivity risk.
- **Policy.** The government observes labor income y and realized dividends d, so feasible taxes are $T(y, d)$.
- **Solution.** We solve a lottery-based linear formulation of the planner's problem, with *all* (global) IC constraints.

Main result

Key takeaway

Optimal policies create tax breaks, or subsidies, for types near the occupational choice frontier, where non-local IC constraints bind.

- High-skill workers have attractive labor outside options.
- Some of them are also good potential entrepreneurs.
- To induce entry into entrepreneurship, the planner grants information rents near the occupational frontier.

General equilibrium amplification

With decreasing returns, no single firm can absorb the entire labor supply. The economy needs enough entrepreneurial entry to generate sufficient labor demand.

Related Literature

- **Multidimensional Screening:** Armstrong (1996), Rochet (1998), Manelli & Vincent (2007); recent public finance applications: Kleven et al. (2009), Scheuer (2014), Rothschild & Scheuer (2013), Golosov et al. (2025), Shen et al. (2025).
- **Global Incentive Compatibility:** Lottery-based LP (Prescott Townsend 1984, Phelan Townsend 1991, Doepke Townsend 2006) + constraint generation + modern solvers (Gurobi/CPLEX).
- **Alternative LP Approaches:** Rochet (2024); Carlier et al. (2024); Boerma, Tsyvinski & Zimin (2022): we allow for non-convex, non-smooth primitives.
- **Optimal taxation of entrepreneurs:** Scheuer (2014).

Model

Model: heterogeneity and choices

A unit mass of agents, each with privately known type

$$(s, z) \in \mathcal{S} \times \mathcal{Z}$$

- s: labor skill.
- z: entrepreneurial ability.
- Joint distribution $f(s, z)$; quantitative model uses Fréchet marginals and a copula.

Before entrepreneurial shocks are realized, each agent chooses one occupation:

Worker | Entrepreneur | Inactive

Exclusive occupations:

workers supply effort ℓ, entrepreneurs choose effort e and hire labor n, inactive agents consume home production c_0.

Model: observables

The government observes realized labor income and realized entrepreneurial dividends.

$$
\begin{aligned}
\text{Worker:} \quad & y = w \cdot s \cdot \ell - \kappa_1 \cdot \mathbf{1}[\ell > 0] \\
\text{Entrepreneur:} \quad & q = z \cdot \varepsilon \cdot e^{\alpha} \cdot n^{1-\alpha} \\
& d = q - w \cdot n - \kappa_2 \cdot \mathbf{1}[n > 0]
\end{aligned}
$$

What is hidden?

The planner does not observe (s, z), effort, labor demand, or the shock ε separately.

$$
y > 0 \Rightarrow d = 0, \qquad d > 0 \Rightarrow y = 0.
$$

Model: incentive constraints

A direct mechanism assigns observable outcomes and consumption as a function of reported type.

For every true type (s, z) and every report $(\hat{s}, \hat{z})$, truthful reporting must dominate the deviation:

$$\begin{aligned}\mathbb{E}_\varepsilon[U(c(s,z,\varepsilon)) - V(e(s,z,\varepsilon)) - V(\ell(s,z))] \\ \geq \mathbb{E}_\varepsilon[U(c(\hat{s},\hat{z},\varepsilon)) - V(e(\hat{s},\hat{z},\varepsilon; z)) - V(\ell(\hat{s},\hat{z}; s))]\,.\end{aligned}$$

Why global IC matters

Not all tempting deviations are local. Non-local incentive constraint can bind near occupational switching regions.

Model: general equilibrium

The planner must also respect aggregate feasibility and labor-market clearing.

$$\int \mathbb{E}_\varepsilon[c(s,z,\varepsilon)]f(s,z)\,ds\,dz \leq \int \mathbb{E}_\varepsilon[y(s,z)+d(s,z,\varepsilon)]f(s,z)\,ds\,dz,$$

$$\int s\ell(s,z)f(s,z)\,ds\,dz = \int \mathbb{E}_\varepsilon[n(s,z,\varepsilon)]f(s,z)\,ds\,dz.$$

Key GE force

Taxes affect entry and firm scale. Entry affects labor demand. Labor demand affects wages and aggregate income.

Why the problem is hard

Four features make standard local methods fragile:

1. **Two-dimensional private information:** reports are pairs $(\hat{s}, \hat{z})$.
2. **Occupational non-convexities:** worker, entrepreneur, and inactive choices are discrete.
3. **Fixed costs:** κ_1 and κ_2 create kinks.
4. **Risk-contingent observables:** dividends are affected by shocks, which are not observed directly.

Solution strategy

Discretize types, shocks, and feasible allocations. Optimize over lotteries on this grid. Enforce all relevant IC constraints with constraint generation algorithms.

Lottery Representation

LP grid: what are the controls?

Discretize types, shocks, and allocation nodes.

$$i = 1, \dots, N, \qquad r = 1, \dots, R,$$
$$C = \{c_k\}_{k=1}^{K}, \qquad Y = \{\bar{y}_a\}_{a=1}^{A_y}, \qquad D = \{\bar{d}_b\}_{b=1}^{B_d}.$$

Admissible income-dividend pairs satisfy occupational exclusivity:

$$\mathcal{J} = \{(a, b) : \bar{y}_a > 0 \Rightarrow \bar{d}_b = 0,\ \bar{d}_b > 0 \Rightarrow \bar{y}_a = 0\}.$$

Linear representation

For each reported type and shock, the LP chooses probabilities over consumption nodes and income-dividend nodes. These probabilities are the controls. For a fixed grid, expected utility, resources, labor demand, and IC expressions are all linear in lottery weights.

A simple example of the LP expansion

Assume two labor-income nodes, two dividend nodes, and two consumption nodes:

$$Y = \{0, y\}, \qquad D = \{0, d\}, \qquad C = \{c_L, c_H\}.$$

Exclusivity removes the mixed point (y, d), so

$$\mathcal{J} = \{(0,0), (y,0), (0,d)\}.$$

For each type and shock, the LP can mix over

$$\text{2 consumption nodes} \quad + \quad \text{3 occupation/outcome nodes.}$$

Takeaway

A small economic menu induces many controls variable once we allow lotteries over consumption, occupations, dividends, and shock-contingent outcomes.

Sketch of the LP representation

For each type i, expected utility at truth-telling is

$$EU_i = \sum_r p_r \left[\sum_k \lambda_{i,k,r} U(c_k) - \sum_{(a,b)\in\mathcal{J}} \mu_{i,a,b,r} \mathcal{V}_{i,a,b,r} \right]$$

The planner solves

$$\max_{\lambda,\mu} \sum_i \omega_i \cdot W_i \cdot EU_i$$

subject to simplex constraints, resource feasibility, labor-market clearing, participation, no shock-contingent occupation switching, and

$$EU_i \geq EU_{i\to j} \qquad \forall i, j.$$

Why this is powerful

The objective and all constraints are linear in (λ, μ). All nonlinearities are precomputed on the grid.

Constraint counts

Let $N = N_s \cdot N_z$ be the number of types, R the number of shock states, K consumption nodes, and $|\mathcal{J}| = \underbrace{1}_{(0,0)} + \underbrace{(A_y - 1)}_{\text{worker nodes}} + \underbrace{(B_d - 1)}_{\text{entrepreneur nodes}}$ admissible income-dividend nodes.

Object	Lottery LP	Discretized nonlinear problem
Controls	$\underbrace{NRK}_{\lambda_{i,k,r}} + \underbrace{NR\lvert\mathcal{J}\rvert}_{\mu_{i,a,b,r}} = NR\big(K + \lvert\mathcal{J}\rvert\big)$	$\underbrace{N}_{y_i} + \underbrace{NR}_{d_{ir}} + \underbrace{NR}_{c_{ir}} = N(1+2R)$
Global IC constraints	$N(N-1)$	$N(N-1)$
Participation constraints	N	N
Resource feasibility	1	1
Labor-market clearing	1	1
Simplex / consistency constraints	$2NR + NR[K + \lvert\mathcal{J}\rvert]$	0

Computational tradeoff

The lottery representation makes the problem larger, but linear.

Constraint counts and constraint generation

Baseline grid

$$N = 60^2 = 3{,}600, \qquad R = 2, \qquad K = 50, \qquad A_y = B_d = 30, \qquad |\mathcal{J}| = A_y + B_d - 1 = 59.$$

	Lottery LP	Discretized nonlinear problem
Primitive controls	$\underbrace{NRK}_{\lambda} + \underbrace{NR\lvert\mathcal{J}\rvert}_{\mu} = 3{,}600 \cdot 2 \cdot (50 + 59) = 784{,}800$	$\underbrace{N}_{y_i} + \underbrace{NR}_{d_{ir}} + \underbrace{NR}_{c_{ir}} = 3{,}600(1 + 2R) = 18{,}000$
Global IC constraints	12,956,400 linear inequalities	12,956,400 nonlinear inequalities
Simplex constraints	14,400 equalities + 784,800 bounds	0

Constraint generation

Rather than load all $N(N-1)$ global IC constraints, we solve a relaxed LP, search for violated deviations, add the most violated constraints, and iterate.

Quantitative Analysis

Calibration: parameters

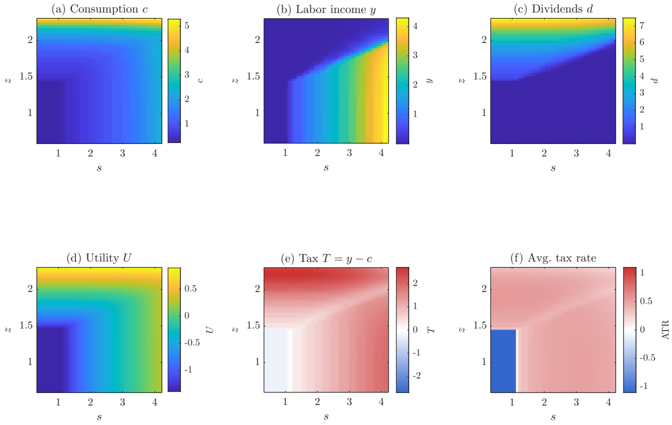
Parameter	Symbol	Value	Target moment	Source
Set externally				
Risk aversion	γ	1.00	Log utility	Standard
Inverse Frisch	ψ	2.00	Frisch $= 0.5$	Standard
Ability correlation	ρ	0.00	Independence	Standard
Calibrated jointly				
Worker fixed cost	κ_1	0.675	Labor participation	BLS (2022)
Entrep. fixed cost	κ_2	0.109	Entrepreneurship rate	BLS CPS (2022)
Span of control	α	0.251	Avg. employees/firm	U.S. Census (2021)
Shock volatility	σ_ε	0.500	CV of business income	DeBacker et al. (2021)
Skill tail (Fréchet)	ξ_s	2.54	$\log(p_{90}/p_{50})$ wage	PSZ/DINA (2022)
Ability tail (Fréchet)	ξ_z	4.00	Gini business income	PSZ/DINA (2022)
Tax progressivity	τ_L	0.079	ETR bottom 50%	DINA (2018)
Tax level	λ_L	0.778	ETR middle 40%	DINA (2018)
Home production	c_0	0.070	Participation elast.	Chetty (2012)
Statutory business tax				
Bracket 1	T_B	0%	$d \leq$ \$50k	IRC §1(h)
Bracket 2	T_B	15%	\$50k–\$550k	IRC §1(h)
Bracket 3	T_B	20%	$d >$ \$550k	IRC §1(h)

Calibration: moments

Moment	Model	Data	Identifies	Source
Panel A: Targeted moments				
Labor participation	0.672	0.620	κ_1	BLS (2022)
Entrepreneurship rate	0.093	0.100	κ_2	BLS CPS (2022)
Avg. employees per firm	9.29	10.00	α	U.S. Census (2021)
CV of business income	1.33	1.20	σ_ε	DeBacker et al. (2021)
$\log(p_{90}/p_{50})$ wage	0.987	0.997	ξ_s	PSZ/DINA (2022)
Gini of business income	0.632	0.650	ξ_z	PSZ/DINA (2022)
ETR bottom 50%	0.148	0.148	τ_L	DINA (2018)
ETR middle 40%	0.213	0.214	λ_L	DINA (2018)
Participation elasticity	0.250	0.250	c_0	Chetty (2012)
Panel B: Untargeted moments				
Inactivity rate	0.328	0.380	—	BLS (2022)
Wage Gini	0.342	0.520	—	PSZ/DINA (2019)
ETR top 10%	0.158	0.249	—	DINA (2018)
Avg. ETR labor	0.208	0.234	—	DINA (2018)
Top 10% wage share	0.279	0.375	—	PSZ/DINA (2019)
Top 10% business share	0.426	0.675	—	PSZ/DINA (2019)
Business income share	0.394	0.280	—	PSZ/DINA (2019)

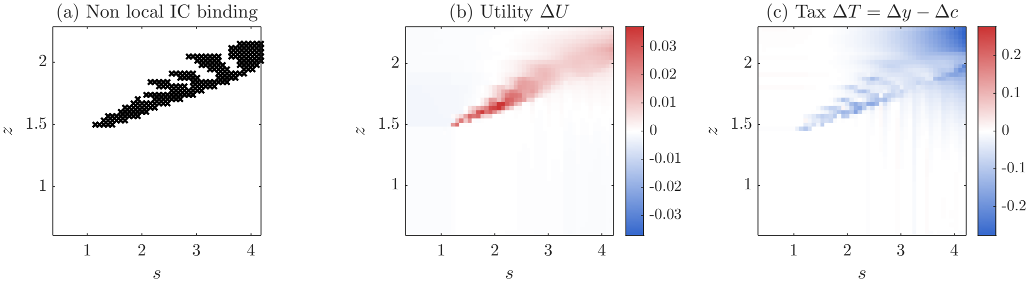
Main quantitative result: localized tax breaks

Message. Tax breaks are concentrated near the occupational frontier.



Global IC constraints matter locally

Message. Global IC matters most where cross-occupation deviations are tempting.



Role of entrepreneurial risk

Entrepreneurial risk affects optimal taxes through two channels.

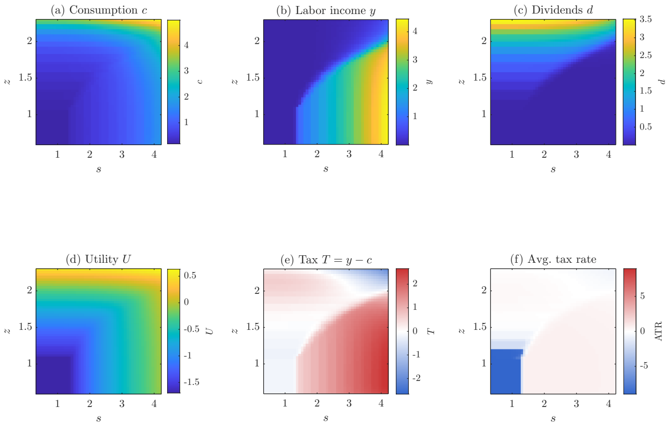
1. **Insurance.** Risk-averse agents value smoother consumption across profit realizations.
2. **Screening.** Taxes that depend on realized dividends can relax ex-ante incentive constraints.

Benchmark contrast

Without risk, there is no shock-contingent insurance or screening. The planner relies more directly on occupational-entry incentives.

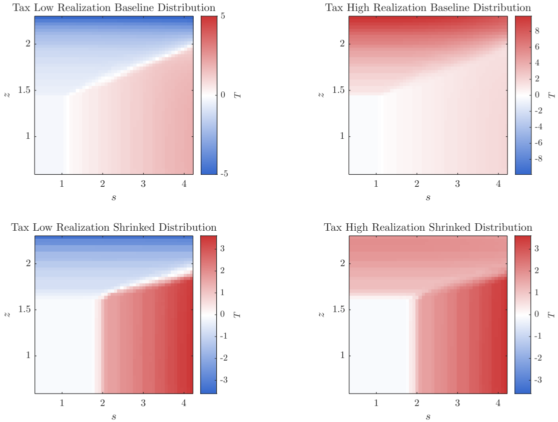
No entrepreneurial risk

Message. Removing risk makes the entry-margin force more visible because taxes cannot use shock-contingent screening.



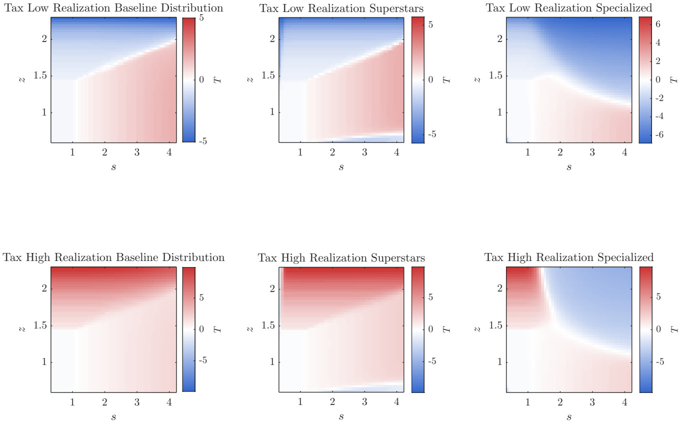
Scarcity of high-z entrepreneurs

Message. When high-ability entrepreneurs are scarce, sustaining entry becomes more valuable.



Affiliation: superstars versus specialized talent

Message. Subsidies depend on the correlation between labor skill and entrepreneurial ability.



Conclusion

- Multidimensional private information creates an entry-margin motive for entrepreneurial tax breaks.
- General equilibrium amplifies this motive because entry supports labor demand.
- The lottery LP makes the full global-IC problem computationally tractable despite non-convexities.
- Quantitatively, the relevant distortions are highly localized near the entrepreneurship frontier.

Backup slides

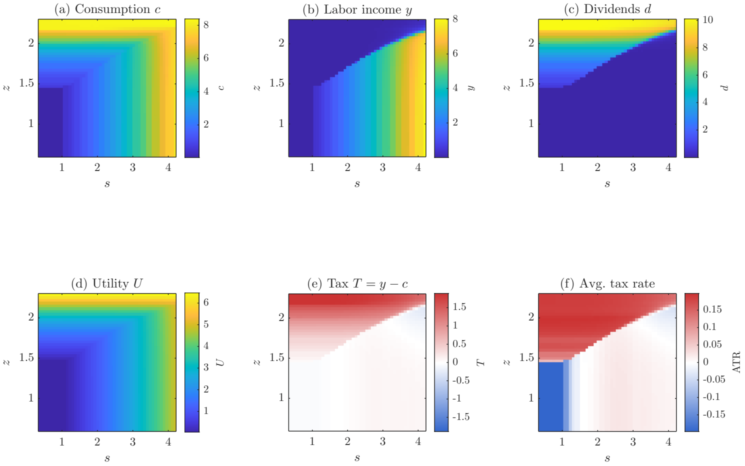
Backup: full LP in compact form

$$\max_{\lambda,\mu} \sum_i \omega_i W_i \sum_r p_r \left[\sum_k \lambda_{i,k,r} U_k - \sum_{(a,b)\in\mathcal{J}} \mu_{i,a,b,r} \mathcal{V}_{i,a,b,r} \right]$$

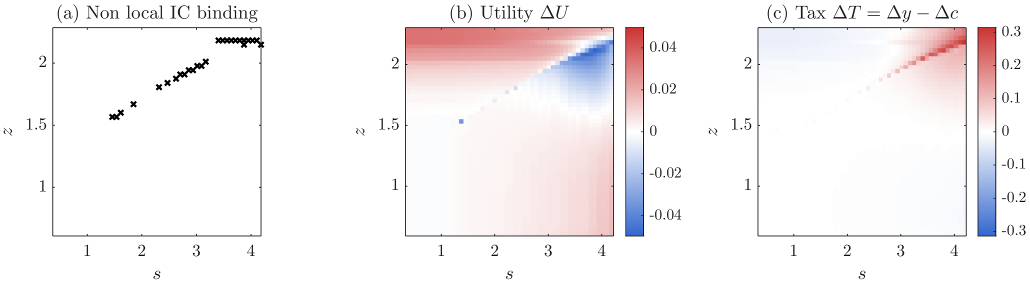
subject to simplex constraints, resource feasibility, labor-market clearing, IR, no shock-contingent occupational switching, and

$$\sum_r p_r \left[\sum_k \lambda_{i,k,r} U_k - \sum_{(a,b)\in\mathcal{J}} \mu_{i,a,b,r} \mathcal{V}_{i,a,b,r} \right] \geq \sum_r p_r \left[\sum_k \lambda_{j,k,r} U_k - \sum_{(a,b)\in\mathcal{J}} \mu_{j,a,b,r} \mathcal{V}_{i,a,b,r} \right].$$

Backup: quasi-linear utility



Backup: global IC with quasi-linear utility



References

Chetty, R. (2012). Bounds on elasticities with optimization frictions: A synthesis of micro and macro evidence on labor supply. *Econometrica*, 80(3):969–1018.

DeBacker, J., Heim, B. T., Panousi, V., Ramnath, S., and Vidangos, I. (2021). The distribution of business income: Evidence from pass-through entities. *National Tax Journal*, 74(4):911–938.