Misallocation and Productivity under Income Taxation

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Introduction

- Resource allocation
- Implications for output, TFP, welfare
- Aggregate distortion
- Idiosyncratic distortion

Literature Review

- Guner, Ventura and Xu: size-dependent policies
- Restuccia and Rogerson: idiosyncratic distortions

Introduction

- Progressive taxes
  - idiosyncratic distortions
  - can be directly measured from the data
- Focus on the production side
  - corporate (sales) taxes
  - entry and exit decision
- Quantitative Implications for output, TFP, welfare

US corporate tax

Taxable Income ($)	Tax Rate
0 to 50,000	15%
50,000 to 75,000	$7,500 + 25% over 50,000
75,000 to 100,000	$13,750 + 34% over 75,000
100,000 to 335,000	$22,250 + 39% over 100,000
335,000 to 10,000,000	$113,900 + 34% over 335,000
10,000,000 to 15,000,000	$3,400,000 + 35% over 10,000,000
15,000,000 to 18,333,333	$5,150,000 + 38% over 15,000,000
22,333,000 and up	35%

Road map

- Introduction
- Investigate
  - Fixed labor supply, No entry, exit
  - Fixed labor supply, Endogenous entry, exit
  - Flexible labor supply, No entry, exit
  - Flexible labor supply, Endogenous entry and exit
- Future research

GE with heterogeneous firms

- A general equilibrium model in which production is carried out by heterogeneous firms
- Three types of agents
  - Representative household
  - Heterogeneous firms with different productivity
  - Government
- Progressive cooperate taxes where the tax rates are different for firms with different income
- Focus on the stationary equilibrium

Household maximization problem

$$\max_{\{C_t, N_t, K_{t+1}\}_{t=0}^{\infty}} \quad \sum_{t=0}^{\infty} \beta^t u(C_t)$$

subject to

$$\sum_{t=0}^{\infty} p_t(C_t + K_{t+1} - (1-\delta)K_t) = \sum_{t=0}^{\infty} p_t(r_t K_t + w_t N_t + \Pi_t - T_t)$$

$$C_t \geq 0,$$

$$K_t \geq 0,$$

$$0 \leq N_t \leq 1,$$

K_0 given

Optimality Conditions

- labor : $N_t = 1 \ \forall t$
- consumption & capital : $u'(C_t) = \beta(1 + r_{t+1} - \delta)u'(C_{t+1})$

Therefore, at stead state,

$$N = 1$$

$$r = \frac{1}{\beta} + \delta - 1$$

Progressive tax

- Tax schedule a la Guo and Lansing (1998, JET)
- $\tau_t = 1 - \eta \left(\frac{\bar{y_t}}{y_t} \right)^{\phi}$.
- When $\phi \lesseqgtr 0$, $\frac{\partial \tau_t}{\partial y_t} \lesseqgtr 0$
- When $\phi = 0$, $\tau_t = 1 - \eta$

Progressive features

- Average tax rate $= \frac{\tau y}{y} = \tau$
- Marginal tax rate $= \frac{\partial(\tau y)}{\partial y} = \tau_m$
- When $\phi > 0$, $\tau_m > \tau \rightarrow$ A progressive tax
- When $\phi = 0$, $\tau_m = \tau \rightarrow$ A flat tax
- When $\phi < 0$, $\tau_m < \tau \rightarrow$ A regressive tax

Firms' maximization problem

$$\max \pi_t(s) = (1-\tau_t)y_t - w_t n_t - r_t k_t - c_f,$$

where

$$\tau_t = 1 - \eta\Big(\frac{\bar{y_t}}{y_t}\Big)^{\phi}.$$

$$y_t = s k_t^{\alpha} n_t^{\gamma}$$

- s: productivity of a firm
- τ_t : tax rate on firm's output
- $\bar{y_t} = \int \hat{y}_t(s)\nu(s)ds$: average production level of the economy
- c_f : fixed operation cost
- Decreasing return to scale $\alpha + \gamma < 1$

Optimality Conditions

- the optimal amount of labor $\hat{n}(s)$ and capital $\hat{k}(s)$ input:

$$
\begin{aligned}
\hat{k}(s) &= \left[\left(\frac{\alpha}{r}\right)^{1-\gamma(1-\phi)}\left(\frac{\gamma}{w}\right)^{\gamma(1-\phi)}(1-\phi)\eta s^{1-\phi}\bar{y}^{\phi}\right]^{\frac{1}{1-(\alpha+\gamma)(1-\phi)}} \\
\hat{n}(s) &= \frac{r}{w}\frac{\gamma}{\alpha}\hat{k}(s)
\end{aligned}
$$

- Given these optimal input, denote the optimal production and profit as

$$
\begin{aligned}
\hat{y}(s) &= s\hat{k}(s)^{\alpha}\hat{n}(s)^{\gamma} \\
\hat{\pi}(s) &= (1-\tau)\hat{y}(s) - w\hat{n}(s) - r\hat{k}(s) - c_f.
\end{aligned}
$$

Market clearing

- Labor market

$$1 = \int \hat{n}(s)\mu(s)ds.$$

- Similarly, output and capital markets

$$\begin{aligned} Y &= \int \hat{y}(s)\mu(s)ds \\ K &= \int \hat{k}(s)\mu(s)ds \end{aligned}$$

- Aggregate consumption is calculated using the resource constraint of the economy.

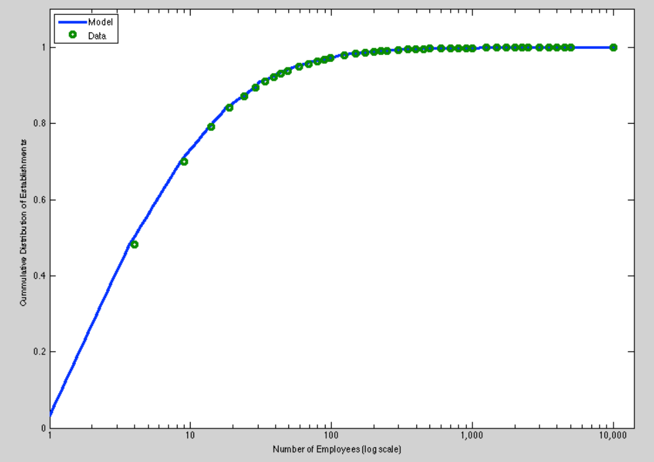
$$C = Y - c_f M - \delta K$$

Calibration of skill distribution

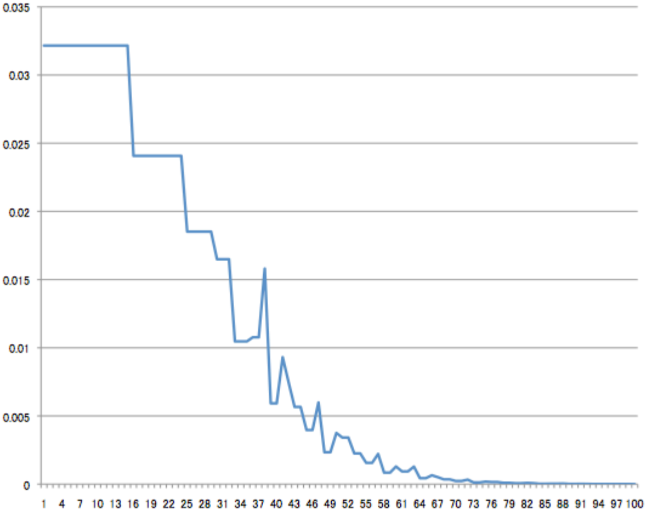
Restuccia and Rogerson (2008)

	number of employees	fraction
1	$x \leq 4$	0.482359949
2	$4 < x \leq 9$	0.21665686
3	$9 < x \leq 14$	0.092591623
⋮	⋮	⋮
44	$9999 < x \leq 10000$	0.0000145982

Calibration



Calibration of skill distribution



To simulate the economy

- A change in tax schedule
- Aggregate distortion: $\eta \neq 0$, $\phi = 0 \rightarrow \tau_i = \tau$, the average or effective tax rate, taxes as a share of income
- Idiosyncratic distortion: $\eta = 1, \phi \neq 0 \rightarrow \tau_i \neq \tau_j$, the degree of progressiveness

No entry exit- fixed labor supply

- Aggregate distortion, $\tau_i = \tau$
- What happen with an increase in τ. A larger average tax rate
- Y, w, K, C falls
- A higher tax, reduces the return from production, therefore lower the demand for capital
- Similarly, a higher tax lower the demand for labor input, given labor supply fixed, leads to a lower equilibrium wage
- Output falls, and therefore C falls
- The relative changes in wage and aggregate capital are the same, $\frac{\hat{n}(s)}{\hat{k}(s)} = \frac{r}{w}\frac{\gamma}{\alpha} = \frac{1}{K}$

No entry exit- fixed labor supply (Continued)

- Aggregate distortion, $\tau_i = \tau_A$
- TFP depends on
  - How resources are allocated across firms as skill levels are different across firms
  - How much resource are employed at firm level due to decreasing return to scale: a higher skill firm use lots of resources, might end up be less productive than a low skill firm use little resource
- With aggregate distortion and no entry and exit
  - aggregate distortion does not affect the relative resource allocation, i.e., $\frac{k_i}{n_i}(\tau_{A1}) = \frac{k_i}{n_i}(\tau_{A2})$
  - without entry and exit, the number of firms remain constant
  - the capital and output are proportional to their skill levels
  - TFP remains constant

Flat taxes: No entry exit- fixed labor supply

		η		
Variable	1	0.9	0.8	0.7
Relative Y	1	0.96	0.92	0.87
Relative TFP	1	1	1	1
Relative w	1	0.86	0.73	0.61
Relative K	1	0.86	0.73	0.61
Relative C	1	0.98	0.96	0.93

Progressive taxes: No entry exit-fixed labor supply

- Idiosyncratic distortion, $\tau_i \neq \tau_j$ for $y_i \neq y_j$
- A larger degree of progressiveness ($\phi_1 > \phi_2 > 0$ increases)
- Y, TFP, w, K falls
- Each firm faces a different distorted relative price, more productive firm faces a higher tax rate, and therefore demands less inputs $\rightarrow$ Resource allocated from more productive firms to less productive firms.
- More productive firm requires less capital stock, while less productive firm requires more capital stock, therefore aggregate capital demand falls
- As capital is complementary input for production, lower capital stock leads the shift of labor demand, while labor supply is fixed, therefore equilibrium wage falls

Progressive taxes: No entry exit-fixed labor supply (Continued)

- TFP depends on
  - How resources are allocated across firms
  - How much resource are employed at the firm level
- With idiosyncratic distortion and no entry and exit
  - Idiosyncratic distortion affect the resource allocation, i.e., $\frac{k_i}{n_i}(\tau_{\phi_1}) \neq \frac{k_i}{n_i}(\tau_{\phi_2})$
  - without entry and exit, the number of firms remain constant
  - More productive firm employs less inputs while less productive employs more inputs
  - TFP falls

Progressive taxes: No entry exit-fixed labor supply

		ϕ		
Variable	0	0.1	0.2	0.3
Relative Y	1	0.89	0.81	0.74
Relative TFP	1	0.96	0.93	0.90
Relative w	1	0.77	0.62	0.51
Relative K	1	0.77	0.62	0.51
Relative C	1	0.92	0.85	0.80

Endogenous entry exit - fixed labor supply

- The optimal problem of incumbent firms are defined recursively by

$$W(s) = \max\{\pi(n, k; s, \tau, r, w)\} + \beta(1 - \lambda)W(s),$$

where

$$\begin{aligned} \pi(n, k; s, \tau, r, w) &= (1 - \tau)f(s, k, n) - wn - rk - c_f \\ f(s, k, n) &= sk^{\alpha}n^{\gamma} \end{aligned}$$

- The productivity of the incumbent firm remains constant over time a la Restuccia and Rogerson (2008)
- λ is the exogenous death shock

Endogenous entry exit - fixed labor supply

The law of motion for the distribution of firms is given by

$$\mu(s)' = (1-\lambda)\mu(s) + \chi(s)h(s)E$$

where

- μ : distribution of producing firms over s in the current period
- μ': distribution of producing firms over s in the next period
- E: mass of entrant

Progressive taxes/ Endogenous entry exit - fixed labor supply

The optimal problem of entering firms are defined by

$$W_e(s) = \int \max_{\chi \in \{0,1\}} \chi(s) W(s) h(s) - c_e,$$

where

- W_e : the present discounted value of a potential entrant
- $\chi(s)$: policy function of a entering firm with productivity being s, whether to remain or exit.
- $h(s)$: productivity distribution function
- c_e: entry cost

Stationary equilibrium

- The free entry condition implies $We = 0$.
- The invariant distribution of producing firms is

$$\mu(s) = \frac{1}{\lambda}\hat{\chi}(s)h(s)E$$

- From labor market clearing condition $1 = \int \hat{n}(s)\mu(s)ds$, we can solve for E as

$$E = \frac{\lambda}{\int \hat{n}(s)\hat{\chi}(s)h(s)ds}$$

- Aggregate consumption now

$$C = Y - c_f M - \delta K - c_e E$$

Endogenous entry exit - fixed labor supply

Aggregate distortion

- Aggregate distortion reduces the benefit for production
- Output, aggregate capital, equilibrium wage falls
- mechanism are similar to the case of no entry exit
- but now with additional adjustment come from entry and exit, i.e., extensive margins
- A higher aggregate distortion (average tax rate) reduces the expected value of producing firms and therefore implies a smaller number of entrants

Flat taxes: Endogenous entry exit-fixed labor supply (Continued)

- TFP depends on
  - How resources are allocated across firms
  - How much resource are employed at the firm level
- With aggregate distortion and no entry and exit
  - Aggregate distortion does not affect the relative resource allocation, i.e., $\frac{k_i}{n_i}(\tau_{A1}) \neq \frac{k_i}{n_i}(\tau_{A2})$
  - with entry and exit, the number of firms decreases, firms produces more relative to their no entry-exit counterparts, and therefore lower TFP
  - TFP falls

Flat taxes/ Endogenous entry exit - fixed labor supply

Table: Aggregate Variables relative to no entry and exit

	η ($\phi = 0$)			
Variable	1	0.9	0.8	0.7
Relative Y	1	0.92(0.96)	0.84(0.92)	0.76(0.83)
Relative TFP	1	0.97(1)	0.94(1)	0.91(1)
Relative E	1	0.83(1)	0.67(1)	0.53(1)
Relative M	1	0.83(1)	0.67(1)	0.53(1)
Relative w	1	0.83(0.86)	0.67(0.73)	0.53(0.61)
Relative K	1	0.83 (0.86)	0.67 (0.73)	0.53 (0.61)
Relative C	1	0.96 (0.98)	0.91 (0.96)	0.86 (0.93)

Endogenous entry exit - fixed labor supply

Idiosyncratic distortion

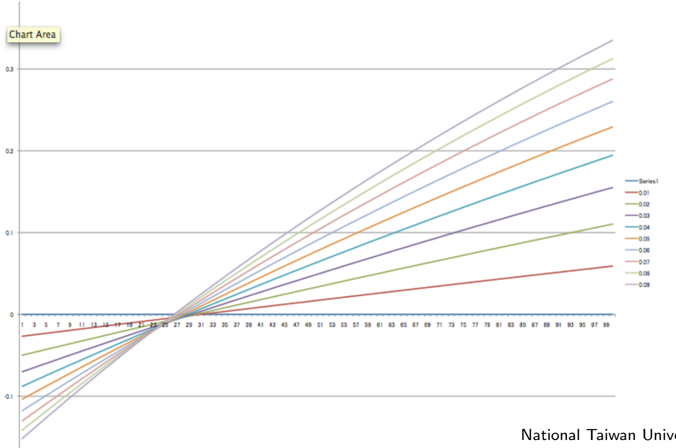
- Output, aggregate capital, equilibrium wage falls, while TFP rises
- more productive firms face a higher tax rate and the resource allocated from more productive firms to less productive firms (intensive margin)
- In addition, the adjustment come from both the extensive margin through entry and exit
- As firms are mainly concentrated in lower skill side, a higher degree of progressiveness reduces the tax rate for lower skill enterprises, which increases the expected value for producing firms and therefore more entry

Progressive taxes: Endogenous entry exit- fixed labor supply (Continued)

- TFP depends on
  - How resources are allocated across firms
  - How much resource are employed at the firm level
- With idiosyncratic distortion and endogenous entry and exit
  - Idiosyncratic distortion affect the resource allocation, i.e., $\frac{k_i}{n_i}(\tau_{\phi_1}) \neq \frac{k_i}{n_i}(\tau_{\phi_2})$
  - More productive firm employs less inputs while less productive employs more inputs, TFP decreases
  - But with entry and exit, the number of firms increases, firms produces less relative to their no entry-exit counterparts, and therefore TFP increases
  - Overall, the second effect dominates and TFP increases

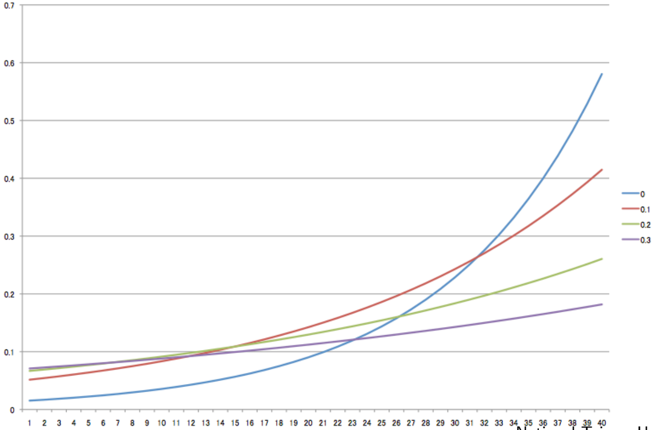
Intensive margin: Progressive taxes/ Endogenous entry exit - fixed labor supply

Figure: Tax rate.



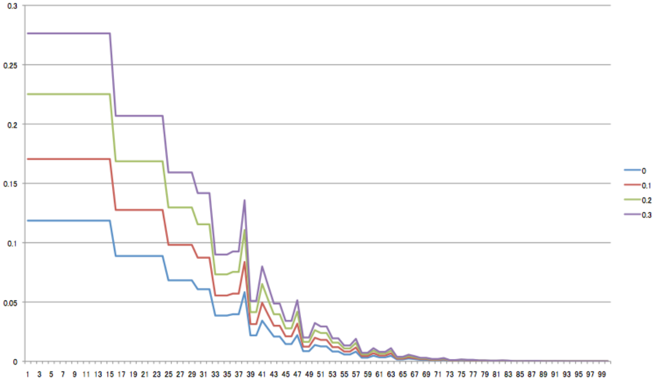
Intensive margin: Progressive taxes/ Endogenous entry exit - fixed labor supply

Figure: labor demand.



Extensive margin: Progressive taxes/ Endogenous entry exit - fixed labor supply

Figure: number of firms.



Progressive taxes/ Endogenous entry exit - fixed labor supply

Table: Aggregate Variables relative to no entry and exit

		ϕ, $\eta = 1$		
Variable	0	0.1	0.2	0.3
Relative Y	1	$0.96(0.89)$	$0.93(0.81)$	$0.89(0.74)$
Relative TFP	1	$1.01(0.96)$	$1.02(0.93)$	$1.03(0.90)$
Relative E	1	$1.44(1)$	$1.90(1)$	$2.33(1)$
Relative M	1	$1.44(1)$	$1.90(1)$	$2.33(1)$
Relative w	1	$0.83(0.77)$	$0.71(0.62)$	$0.60(0.51)$
Relative K	1	0.83 (0.77)	0.71 (0.62)	0.60 (0.51)
Relative C	1	0.92 (0.92)	0.83 (0.85)	0.74 (0.80)

Progressive taxes/ Endogenous entry exit - flexible labor supply

- Household maximization problem

$$\max_{\{C_t, N_t, K_{t+1}\}_{t=0}^{\infty}} \quad \sum_{t=0}^{\infty} \beta^t u(C_t, 1 - N_t)$$

subject to

$$\sum_{t=0}^{\infty} p_t(C_t + K_{t+1} - (1-\delta)K_t) = \sum_{t=0}^{\infty} p_t(r_t K_t + w_t N_t + \Pi_t - T_t)$$

$$C_t \geq 0,$$

$$K_t \geq 0,$$

$$0 \leq N_t \leq 1,$$

$$K_0 \text{ given}$$

Optimal condition

- labor $D_1u(C_t, 1 - N_t)w_t = D_2u(C_t, 1 - N_t)$
- Consumption and saving
  $D_1u(C_t, 1 - N_t) = \beta D_1u(C_{t+1}, 1 - N_{t+1})(1 + r_{t+1} - \delta)$
- In steady state,
  - $D_1u(C, 1 - N)w = D_2u(C, 1 - N)$
  - $1 = \beta(1 + r - \delta)$
- With endogenous labor choice, the relative changes in wage and aggregate capital are no longer the same, $\frac{\hat{n}(s)}{\hat{k}(s)} = \frac{r}{w}\frac{\gamma}{\alpha} = \frac{N}{K}$

Flat taxes/ No entry exit - flexible labor supply

Table: Aggregate Variables relative to fixed labor

		η, $(\phi = 0)$		
Variable	1	0.9	0.8	0.7
Relative Y	1	$0.87(0.96)$	$0.74(0.92)$	$0.62(0.83)$
Relative TFP	1	$0.93(1)$	$0.86(1)$	$0.79(1)$
Relative w	1	$0.89(0.86)$	$0.77(0.73)$	$0.66(0.61)$
Relative K	1	0.78 (0.86)	0.59 (0.73)	0.44 (0.61)
Relative N	1	0.88 (1)	076 (1)	0.65 (1)
Relative C	1	0.89(0.98)	0.77 (0.96)	0.66 (0.93)

Progressive taxes/ No entry exit - flexible labor supply

Table: Aggregate Variables relative to fixed labor

		$\phi, (\eta = 1)$		
Variable	0	0.1	0.2	0.3
Relative Y	1	0.77(0.87)	0.63(0.81)	0.52(0.74)
Relative TFP	1	0.87(0.96)	0.77(0.93)	0.70(0.90)
Relative w	1	0.80(0.77)	0.66(0.62)	0.56(0.51)
Relative K	1	0.66 (0.77)	0.49 (0.62)	0.35 (0.51)
Relative N	1	0.83 (1)	0.73 (1)	0.63 (1)
Relative C	1	0.80 (0.92)	0.66 (0.85)	0.56 (0.80)

Flat taxes/ Endogenous entry exit - flexible labor supply

Table: Aggregate Variables relative to fixed labor

	$\eta, (\phi = 0)$			
Variable	1	0.9	0.8	0.7
Relative Y	1	$0.80(0.92)$	$0.62(0.84)$	$0.47(0.76)$
Relative TFP	1	$0.95(0.97)$	$0.90(0.94)$	$0.85(0.91)$
Relative E	1	$0.72(0.83)$	$0.50(0.67)$	$0.33(0.53)$
Relative M	1	$0.72(0.83)$	$0.50(0.67)$	$0.33(0.53)$
Relative w	1	$0.83(0.83)$	$0.67(0.67)$	$0.53(0.53)$
Relative K	1	0.72 (0.83)	0.50 (0.67)	0.33(0.53)
Relative N	1	0.86 (1)	0.74 (1)	0.62 (1)
Relative C	1	0.83 (0.96)	0.67(0.91)	0.53 (0.86)

Progressive taxes/ Endogenous entry exit - endog labor supply

Table: Aggregate Variables relative to fixed labor

			$\phi, (\eta = 1)$	
Variable	0	0.1	0.2	0.3
Relative Y	1	0.86(0.96)	0.79(0.93)	0.73(0.89)
Relative TFP	1	1(1.01)	1(1.02)	0.99(1.03)
Relative E	1	1.29(1.44)	1.63(1.90)	1.91(2.33)
Relative M	1	1.29(1.44)	1.63(1.90)	1.91(2.33)
Relative w	1	0.83(0.83)	0.71(0.71)	0.60(0.60)
Relative K	1	0.74 (0.83)	0.61(0.71)	0.49 (0.60)
Relative N	1	0.89(1)	0.86(1)	0.82(1)
Relative C	1	0.83 (0.92)	0.71(0.83)	0.60(0.74)

Conclusion

- We have computed the general equilibrium effects of progressive taxes on heterogeneous firm with different productivity.
- We found the idiosyncratic distortion can create a much larger negative impact than aggregate distortion as suggested from the previous study.
- The quantitative impacts of idiosyncratic distortions nevertheless depends on entry and exit decisions of firms, as well as endogenous labor decision.

Future research

- Complete market vs Incomplete market
- Unproductive public expenditure vs productive public expenditure/ Utility-generating public expenditure
- Deterministic vs stochastic