# Robots, Trade, and Luddism

## by Arnaud Costinot & Iván Werning

**Brian C. Albrecht**, **V. V. Chari**,

**Adway De**, & **Keyvan Eslami**

University of Minnesota
&
Federal Reserve Bank of Minneapolis

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# Costinot-Werning Contribution

- Claims by many non-economists:
  - Increased trade with China made some people worse off
    - *Only* remedy is to reduce trade
  - Robots will lead to widespread misery
    - *Only* remedy is to ban robots
- C-W show: If government cares about redistribution, even if tax instruments are somewhat restricted, these claims are wrong

# My Discussion

- Are C-W instruments restricted? Not really
- Argue that C-W results are very nice and helpful

# Mechanism Design Question

- Can we write down hidden trade environment in which "prices" show up in incentive constraints?
- If so, tax system is not "restricted"

# Naito/Costinot-Werning Environment

- 2 consumption goods: “happy meals” and “tractors”
- 2 types of labor: skilled and unskilled
- Equal measures of 2 types of household: skilled, $\theta_s$, and unskilled, $\theta_u$
- Utility:

$$U(\theta) = U_\theta(c(\theta), l(\theta))$$

- Resource constraint:

$$C^i = F^i\left(L^i(\theta_s), L^i(\theta_u)\right)$$

# Competitive Equilibrium with Nonlinear Taxes

- Allocation: $c(\theta) = (c^1(\theta), c^2(\theta))$, $l(\theta) = (l^1(\theta), l^2(\theta))$
- Consumer prices: $\tilde{p} = (\tilde{p}^1, \tilde{p}^2)$, $w = (w(\theta_s), w(\theta_u))$
- Producer prices: $p = (p^1, p^2)$, $w = (w_s, w_u)$
- Tax function $T(wl)$ can depend only on labor income $wl$
- Pre-tax labor income: $R(\theta) = w(\theta)[l^1(\theta) + l^2(\theta)]$
- Standard definition of competitive equilibrium
- Problem: Find the best competitive equilibrium

# Restricted Ramsey-Like Problem

- Choose allocations and prices to solve

$$\max \quad \sum \lambda(\theta) U(\theta)$$

subject to

- Incentive compatibility:

$$U^{\theta}\left(c(\theta), \frac{R(\theta)}{w(\theta)}\right) \geq U^{\theta}\left(c\left(\hat{\theta}\right), \frac{R\left(\hat{\theta}\right) w\left(\hat{\theta}\right)}{w(\theta)}\right)$$

- Firms' first order conditions
- Resource feasibility

# Production Efficiency and All That

- Recall production efficiency for convex technologies simply says allocation is on frontier of production possibility set

$$\frac{F^1_{\theta_s}}{F^1_{\theta_u}} = \frac{F^2_{\theta_s}}{F^2_{\theta_u}}$$

- Note that in this Ramsey problem, prices show up in incentive constraints
    - So, Ramsey allocations typically not production efficient

# Our Mechanism Design Challenge

- Write down a physical environment in some detail that produce same problem as Ramsey problem
- Don’t restrict outcomes to “competitive equilibria”

# Hidden Trade Environment

- Happy meals and tractors produced in area populated by many factories
- Each factory produces one type of good
- Planner at the gate to area asks if people going in are skilled or unskilled
- Private agents announce type and go in to produce
- Planner *cannot observe trade* inside factory
- After production, leave area with happy meals and tractors
- People cannot consume until after they leave
- Planner can observe vector of happy meals and tractors when agents leave gate

# Hidden Trade Formalized Somewhat

- Allocation:
  - Consumption: $c(\theta) = \left(c^1(\theta), c^2(\theta)\right)$
  - Required output delivery at gate: $y(\theta) = \left(y^1(\theta), y^2(\theta)\right)$
  - Recommended labor input: $l(\theta) = \left(l^1(\theta), l^2(\theta)\right)$
- Hidden trade: Within each factory agent chooses how much to produce and how to split up output

# Hidden Trading Interactions

- Agents within each factory choose how much surplus to produce and how to divide it up
- Take as given how other factories are making their choices
- Take as given required output delivery, $y^i(\theta)$, and consumption, $c^i(\theta)$
- Call this the *factories game*

# Hidden Trade Lemmas

- **Lemma:** There is an equilibrium of the factories game in which

$$y^i(\theta) = F^i_\theta(l(\theta_s), l(\theta_u))\, l(\theta)$$

- Proof:
  - At each factory, agents first maximize surplus, then decide how to split it.
  - For surplus maximization, choose measure and labor input of each type, $n(\theta)$ and $\hat{l}(\theta)$, to solve

$$\max \quad F^i\left(n(\theta_s)\hat{l}(\theta_s), n(\theta_u)\hat{l}(\theta_u)\right) - \sum_\theta y^i(\theta)\, n(\theta)$$
$$s.t. \quad \hat{l}(\theta) \leq l(\theta)$$

  - Clearly the solution satisfies the above condition

# Mirrlees Problem with Hidden Trade

- Mirrlees problem is now to choose $c^i(\theta)$, $y^i(\theta)$, and $l^i(\theta)$ to solve

$$\max \quad \sum \lambda(\theta)\, U(\theta)$$

$$s.t. \quad U^\theta\left(c(\theta), \frac{y^1(\theta)}{F^1_\theta} + \frac{y^2(\theta)}{F^2_\theta}\right) \geq U^\theta\left(c\left(\hat{\theta}\right), \frac{y^1\left(\hat{\theta}\right)}{F^1_\theta} + \frac{y^2\left(\hat{\theta}\right)}{F^2_\theta}\right)$$

$$y^i(\theta) = F^i_\theta\left(l(\theta_s), l(\theta_u)\right) l(\theta)$$

*Resource Constraint*

# Results for Mirrlees Problem

- **Theorem:** Mirrlees allocations typically not production efficient

$$\frac{F^1_{\theta_s}}{F^1_{\theta_u}} \neq \frac{F^2_{\theta_s}}{F^2_{\theta_u}}$$

- Exception: $F^i = \theta_s l^i(\theta_s) + \theta_u l^i(\theta_u)$

- **Proposition:** If preferences weakly separable in consumption and labor, *uniform commodity taxation* holds:

$$\frac{U_1(\theta_s)}{U_2(\theta_s)} = \frac{U_1(\theta_u)}{U_2(\theta_u)} \left( \neq \frac{F^2_\theta}{F^1_\theta} \right)$$

# Why We Like Our Physical Environment

- With a single good, this is how we think of Mirrlees
- In Mirrlees, planner observes $c(\theta)$ and $y(\theta)$, and recommends $l(\theta)$
- $y(\theta) = \theta l(\theta)$
- Incentive compatibility:

$$u^{\theta}\left(c(\theta), \frac{y(\theta)}{\theta}\right) \geq u^{\theta}\left(c\left(\hat{\theta}\right), \frac{y\left(\hat{\theta}\right)}{\theta}\right)$$

# Costinot-Werning Environment

- Vector of outputs and labor inputs:

$$\left\{y^i\right\}_{i=1}^N \;\; and \;\; \left\{n\left(\theta\right)\right\}_{\theta\in[\underline{\theta},\bar{\theta}]}$$

- Old technology:

$$G\left(\left\{y^i\right\},\left\{n\left(\theta\right)\right\}\right)\leq 0$$

- New technology:

$$G^*\left(\left\{y^{*i}\right\},\phi\right)\leq 0$$

# Costinot-Werning Problem, Rewritten

- Ramsey problem is to choose

$$c(\theta), n(\theta), y^i, y^{i*}, p^i, p^{i*}, q^i, \text{ and } w(\theta)$$

  to solve

$$\begin{aligned} W := \max \quad & \int U(\theta)\, d\Omega(\theta) \\ s.t. \quad & U(\theta) = \max_{\theta'} U\left(c(\theta'), n(\theta') \frac{w(\theta')}{w(\theta)}\right) \\ & G^*\left(\left\{y^{i*}\right\}, \phi\right) \leq 0 \end{aligned}$$

- Since $G^*$ does not have $n$, never want to distort it
- Minor comment 1: All the information on $G$ buried in $\mathcal{P}$. Put it in explicitly?
- Minor comment 2: Set up as a Pareto problem rather than fixed $\Omega$ weights

# Costinot-Werning Main Result (In My View)

- Envelope theorem:

$$\frac{dW}{d\phi} = \gamma \frac{dG^*}{d\phi}$$

- Technologies change raises welfare iff production possibility of new firms expand

# Summary

- Very cool paper
- **Lots** of interesting results
- Maybe “restricted” tax system is not important after all