Numerical Methods-Lecture XII: CGE Modelling

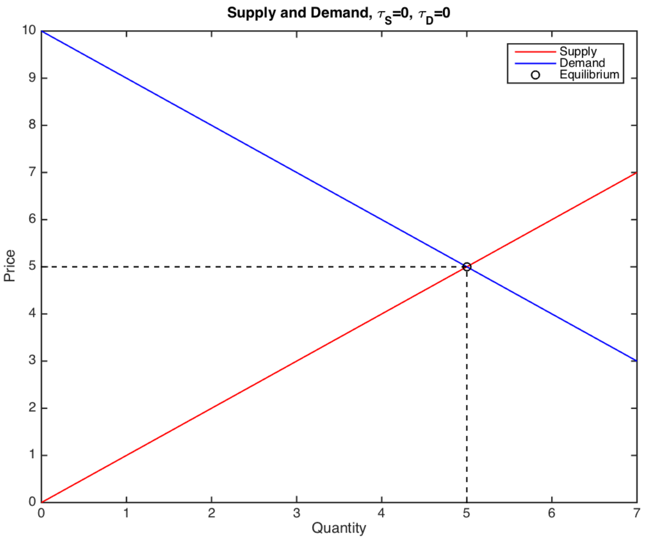
(See Harberger 1962, Shoven & Whalley 1984, Gallen & Mulligan 2016)

Trevor Gallen

Harberger 1962: Motivation

- Federal Insurance Contributions Act funds Social Security & Medicare
- In 2015, 7.65% employer, 7.65% employee
- Every so often, a temporary cut or permanent hike
- Example: in 2010 and 2011, FICA employee portion reduced to 5.65%
- Who benefits?

Harberger 1962: Motivation



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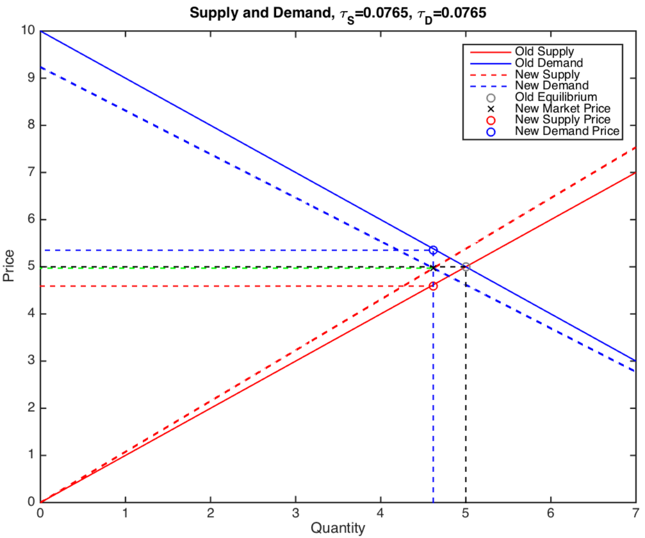

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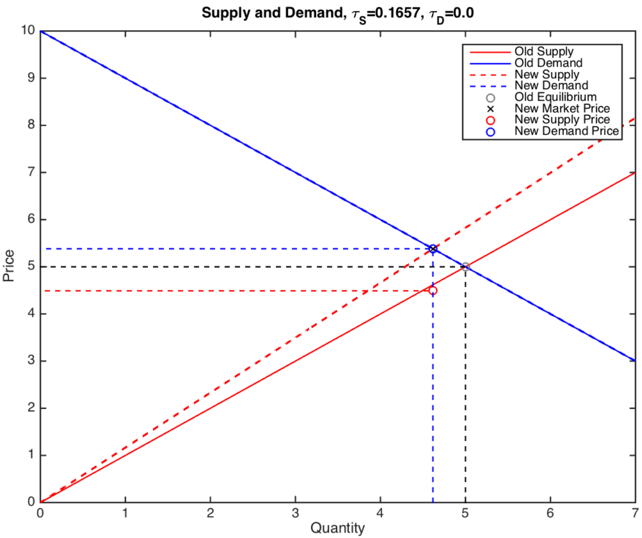

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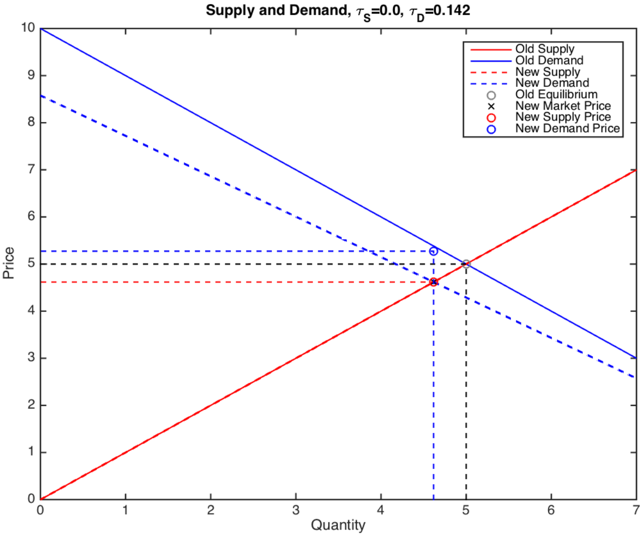

Harberger 1962

- Incidence is important
- What if we had two industries, two types of labor?
- Labor demand for one depends on labor demand for other (CES)
- Free labor supply means after-tax wages must be equal within type
- Harberger:
  - Two factors: labor and capital
  - Two industries: "corporate" and "noncorporate"

Harberger 1962

	Labor	Capital
Corporate	L_a	K_a
Non-corporate	L_b	K_b

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- What if $K_a + K_b$, $L_a + L_b$, and $P_a Y_a + P_b Y_b$ stays the same?

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- Why?

Harberger 1962

- Basic idea:
  - Say taxed sector was heavy in untaxed input L
  - With tax, sector shrinks
  - As taxed sector shrinks, other sector absorbs its K and L
  - Taxed sector releases little K and lots of L
  - If untaxed sector can't absorb much L, price falls, potentially a lot
  - Example
    - Taxed sector has production function $min(10L_b, K_b)$
    - Untaxed sector has production function $L_b^{\alpha} K_b^{1-\alpha}$
    - Elasticity of demand for taxed sector good is very high
    - For untaxed sector to absorb L, wages (all wages!) must decline precipitously

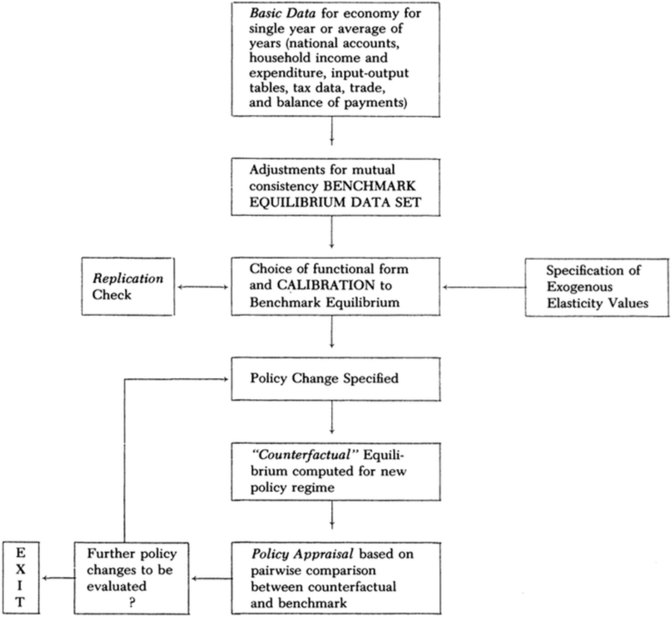
Harberger 1962

- Harberger 1968 gave analytical formulas
- Numerical examples with Cobb-Douglas and Leontief are possible
- What if we want to go further?
- Want to write down a CGE model

CGE Models

- Assume functional forms
- Interacting agents (agent FOC's)
- Markets clear
- Everything adds up

CGE Models


Basic Data for economy for single year or average of years (national accounts, household income and expenditure, input-output tables, tax data, trade, and balance of payments)
Adjustments for mutual consistency BENCHMARK EQUILIBRIUM DATA SET
Replication Check
Choice of functional form and CALIBRATION to Benchmark Equilibrium
Specification of Exogenous Elasticity Values
Policy Change Specified
"Counterfactual" Equilibrium computed for new policy regime
E X I T
Further policy changes to be evaluated ?
Policy Appraisal based on pairwise comparison between counterfactual and benchmark

CGE Example: Gallen & Mulligan 2016

- Want to understand PPACA
- Two sectors: taxed and untaxed
- Two types of labor: low-skill and high-skill
- Many types of firms, some primarily low-skill, some primarily high-skill

Gallen & Mulligan 2016

- At core, firms differ in two ways
  - Their ability to offer healthcare (administrative overhead)
  - Their (ideal) skill composition
- Firms either lose production by administrating healthcare or by not having healthcare

Gallen & Mulligan 2016: Firs

- Firm production for type i is:

$$y(i) = z(i)e^{-\delta(i)Ins(i)-(1-Ins(i))\chi}\left[(1-\alpha(i))K(i)^{\frac{\sigma-1}{\sigma}} + \alpha(i)A(i)L(i)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

- $z(i)$ is overall productivity
- $\delta(i)$ is insurance cos
- χ is non-insurance cost
- $Ins(i)$ is binary insurance decision
- $\alpha(i)$ is skill weight
- $K(i)$ is high-skilled labor
- $L(i)$ is low-skilled labor
- σ is elasticity of substitution
- $A(i)$ is low-skill technology
- $i \in [0,1]$, administrative cost distribution quantiles $\delta(i)$ (also $z(i)$, $\alpha(i)$, $A(i)$).

Gallen & Mulligan 2016: Taxes

- Taxes in sector i on factors L and K (firms):

$$(1+\tau_{iL})w, \quad (1+\tau_{iK})r$$

- Reward to work for low- and high-skilled labor:

$$(1-s_L)w, \quad (1-s_K)r$$

Gallen & Mulligan 2016: Household Preferences

- Representative household's utility:

$$\log \left(\int_0^1 e^{\rho(i)} y(i)^{\frac{\lambda-1}{\lambda}} di \right)^{\frac{\lambda}{\lambda-1}}$$

$$-\gamma_L \frac{\eta}{1+\eta} \left(\int_0^1 L(i) di \right)^{\frac{1+\eta}{\eta}}$$

$$-\gamma_K \frac{\eta}{1+\eta} \left(\int_0^1 K(i) di \right)^{\frac{1+\eta}{\eta}}$$

- $\rho(i)$ reflects consumer preferences over sectors
- λ is elasticity of substitution over sectoral output
- η is the Frisch elasticity of labor supply
- γ_L and γ_K are the disutility of work

Gallen & Mulligan 2016: Household B.C.

- Budget constraint:

$$\int_0^1 p(i)y(i)di = (1-s_L)w\int_0^1 L(i)di + (1-s_K)r\int_0^1 K(i)di + b$$

- Where $p(i)$ is sectoral price
- b is a lump-sum transfer

Gallen & Mulligan 2016: Equilibrium - I

- Need to know tax rates for $\{lo - skill, hi - skill\} \times \{none, NGI, ESI\}$
- Need to know taste parameters $\eta, \lambda, \gamma_L, \gamma_H$
- Need to know distributions for $\alpha(i), \delta(i), \rho(i), A(i), z(i)$.
- Our equilibrium will find r and w and firm decisions for employment, output, prices, and coverage such that:
  - industry patterns of employment and consumption maximize utility
  - subject to the HH B.C.
  - Industry employment, output, and coverage are consistent with their utility function
  - Coverage decision comes at minimum production cost
  - Each industry has zero profits

Gallen & Mulligan 2016: Simple Calibration

- Look up initial quantities of labor by sector in March 2012 CPS
- Assume elasticity of substitution high vs. low-skill labor of 1.5.
- Assume elasticity of ESI offering with respect to price
- Measure tax rates

Gallen & Mulligan 2016: Tax Rates

ACA Tax Rates

Employer Type	without ACA		with ACA	
	High skill	Low Skill	High skill	Low skill
	Tax Amounts			
ESI	-2,554	-2,421	-1,562	7,363
NGI	0	0	2,694	2,295
Uninsured	0	0	6,027	13,192
Employer Type	Tax Rates			
ESI	4.6%	0.2%	5.8%	36.8%
NGI	7.7%	7.7%	11.2%	15.6%
Uninsured	7.7%	7.7%	15.8%	65.9%

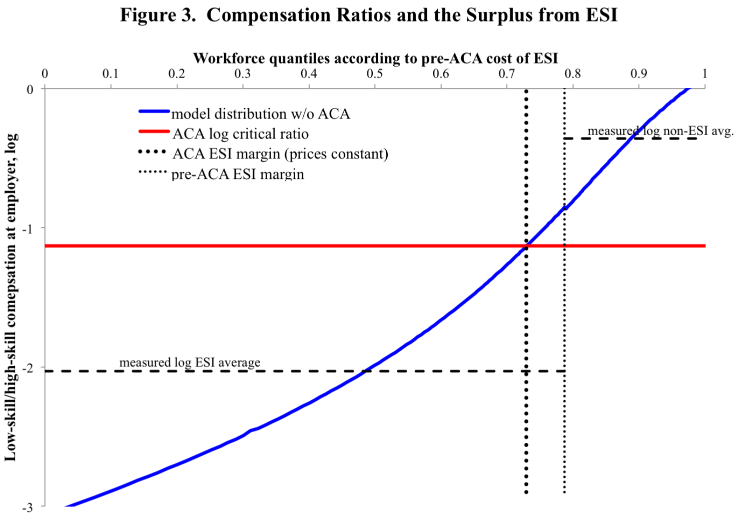
Gallen & Mulligan 2016: Functional forms

- Assume consumer preferences over sector $\rho(i)$ is linear
- Assume skill intensity $\alpha(i)$ and cost of administrating health insurance $\delta(i)$ are linear.
- Set $A(i)$ to a constant ($\alpha(i)$ will cause low skill to vary).

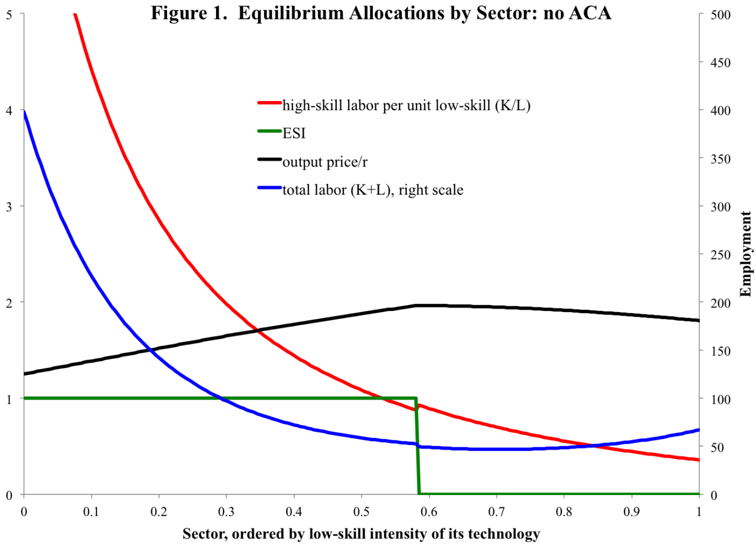
Gallen & Mulligan 2016: Matching Moments

- Need to set constant and slope of ρ, α, and δ.
- Don't need to set levels of $\delta(i) - \xi$ and the level parameter for taste $\rho(i)$ bc irrelevant.
- Set slope of $\delta(i)$ such that elasticity of ESI offering wrt price is -1/3
- Set level of α, slope of α, and slope of ρ so that:
    1. Proportion of high-skilled and low-skilled labor demanded is correct
    2. Average ESI coverage rate is correct
    3. Low-wkilled ESI coverage rate is correct

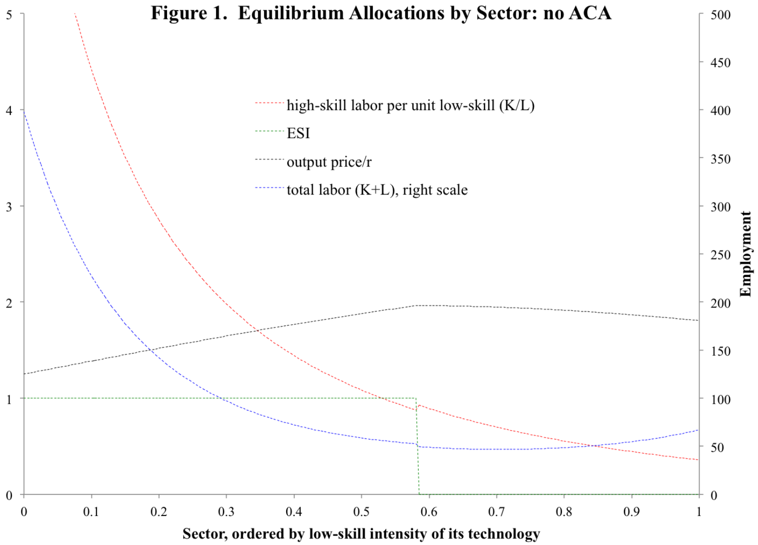
Gallen & Mulligan 2016: Matching Moments-I



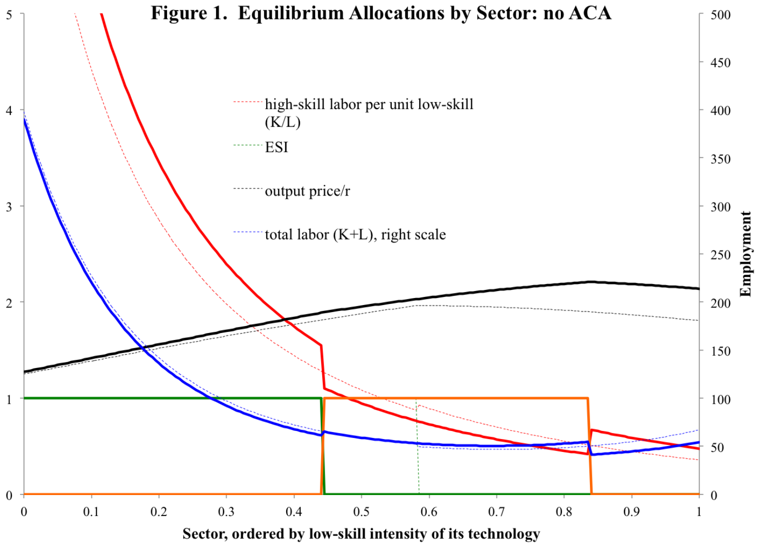
Gallen & Mulligan 2016: Matching Moments-II



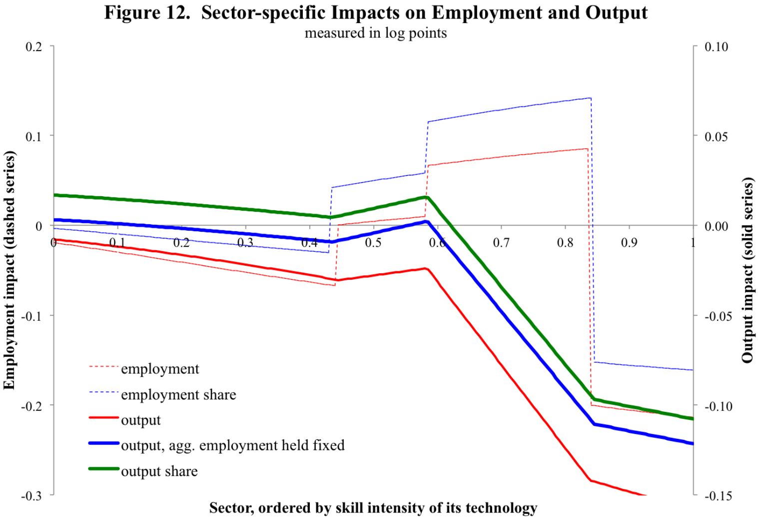
Gallen & Mulligan 2016: Matching Moments-II



Gallen & Mulligan 2016: Results-I



Gallen & Mulligan 2016: Results-II



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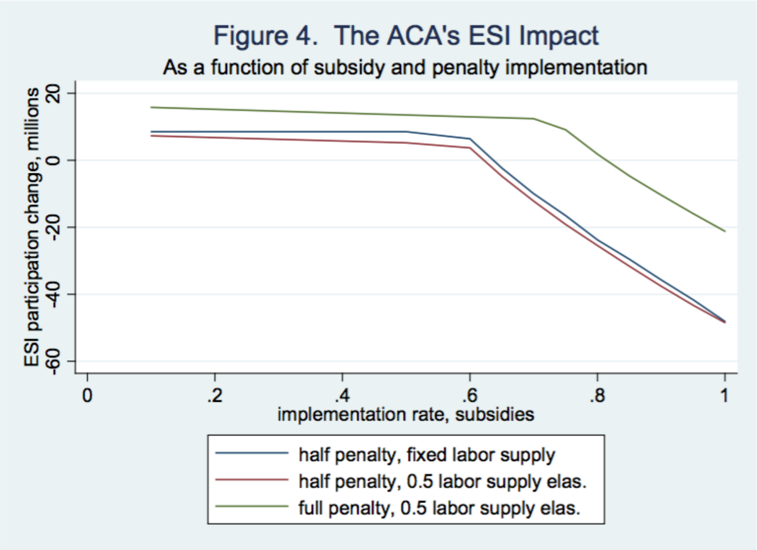

Gallen & Mulligan 2016: Results

- Less ESI, as ~8% of firms drop out of ESI
- A lot less low-skill ESI, as low-skill (non-ESI) firms become more intensive in low-skill workers
- More high-skill ESI, as high-skill (ESI) firms become more intensive in high-skill workers
- ~ 3% less working hours, as low-skill step out of labor force
- ~2% less output, as firms skill mix becomes distorted and low-skill step out of work
- 20 million people (10 million workers) leave ESI
- Effects are *extremely* nonlinear, depend on implementation rate

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- Normally, we might not care about this, but differential rewards are dramatic!
- Any elasticity of substitution (and difference) and you're cooking with gas
- Some industries "win," some industries "lose"
- Calibration is important! Massachusetts is high skill state with primarily high skill industries