

NUMERICAL METHODS-LECTURE XII: CGE MODELLING

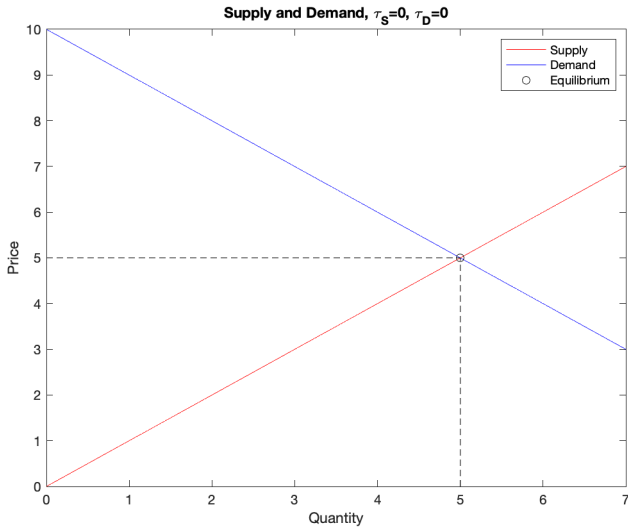
(See Harberger 1962, Shoven & Whalley 1984, Gallen & Mulligan 2016)

Trevor Gallen

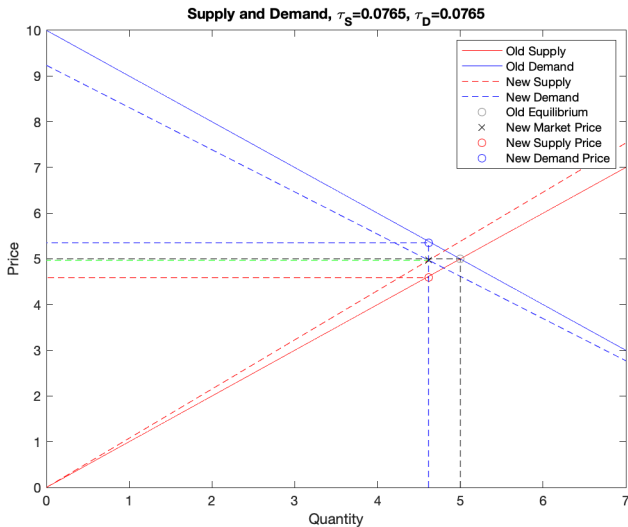
HARBERGER 1962: MOTIVATION

- ▶ 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?

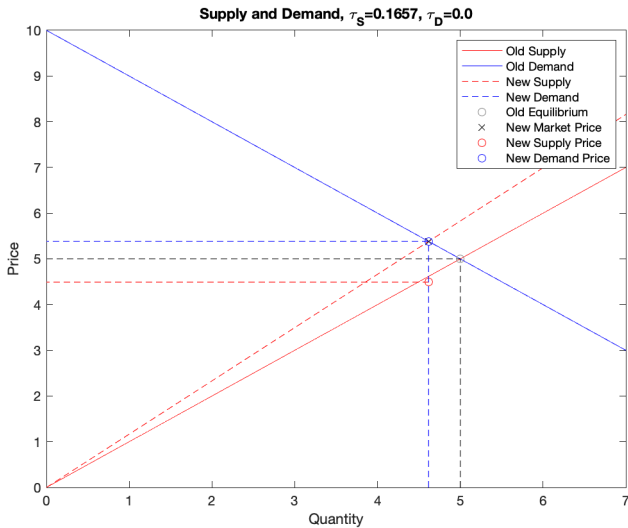
HARBERGER 1962: MOTIVATION



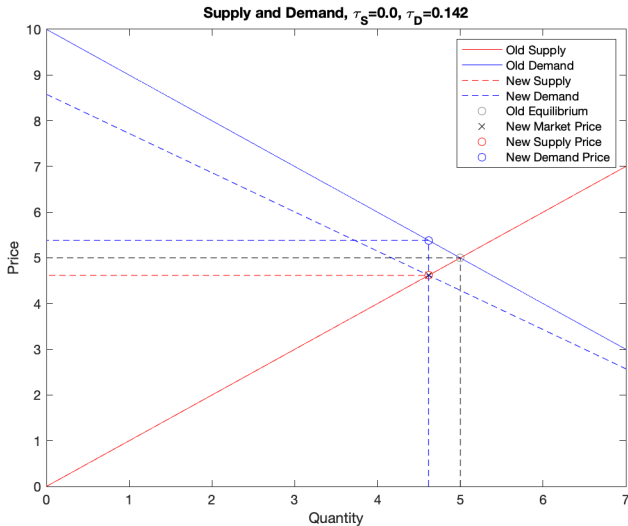
HARBERGER 1962: MOTIVATION



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HARBERGER 1962: MOTIVATION



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

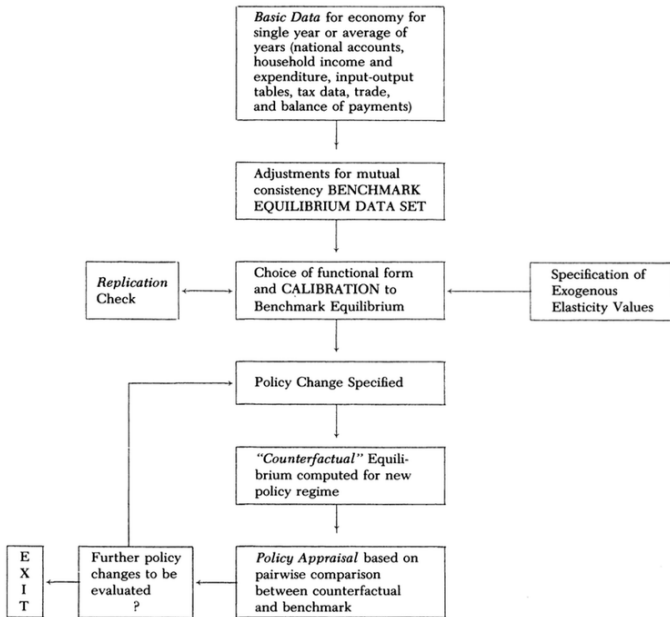
HARBERGER 1962

- ▶ 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



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

- ▶ 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:

$$\begin{aligned} & \log \left(\int_0^1 e^{\rho(i)} y(i)^{\frac{\lambda-1}{\lambda}} di \right)^{\frac{\lambda}{\lambda-1}} \\ & - \gamma_L \frac{\eta}{1+\eta} \left(\int_0^1 L(i) di \right)^{\frac{1+\eta}{\eta}} \\ & - \gamma_K \frac{\eta}{1+\eta} \left(\int_0^1 K(i) di \right)^{\frac{1+\eta}{\eta}} \end{aligned}$$

- $\rho(i)$ 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

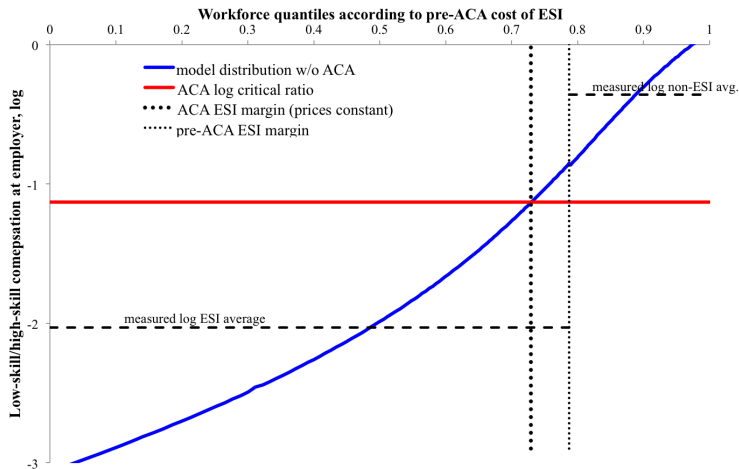
- ▶ Assume consumer preferences over sector $\rho(i)$ is linear
- ▶ Assume skill intensity $\alpha(i)$ and cost of administering health insurance $\delta(i)$ are linear.
- ▶ Set $A(i)$ to a constant ($\alpha(i)$ will cause low skill to vary).

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-skilled ESI coverage rate is correct

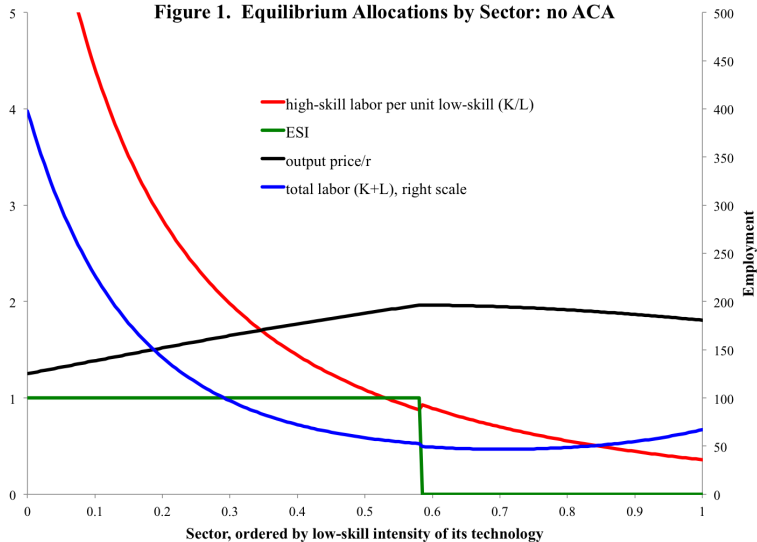
GALLEN & MULLIGAN 2016: MATCHING MOMENTS-I

Figure 3. Compensation Ratios and the Surplus from ESI



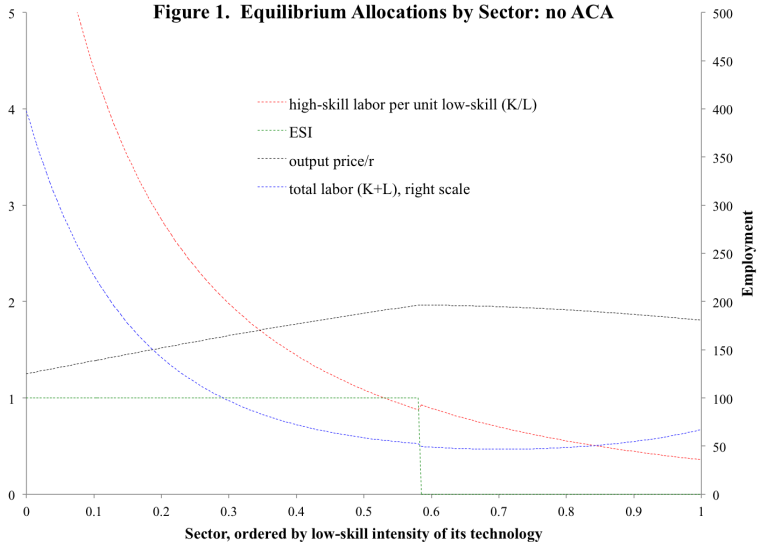
GALLEN & MULLIGAN 2016: MATCHING MOMENTS-II

Figure 1. Equilibrium Allocations by Sector: no ACA

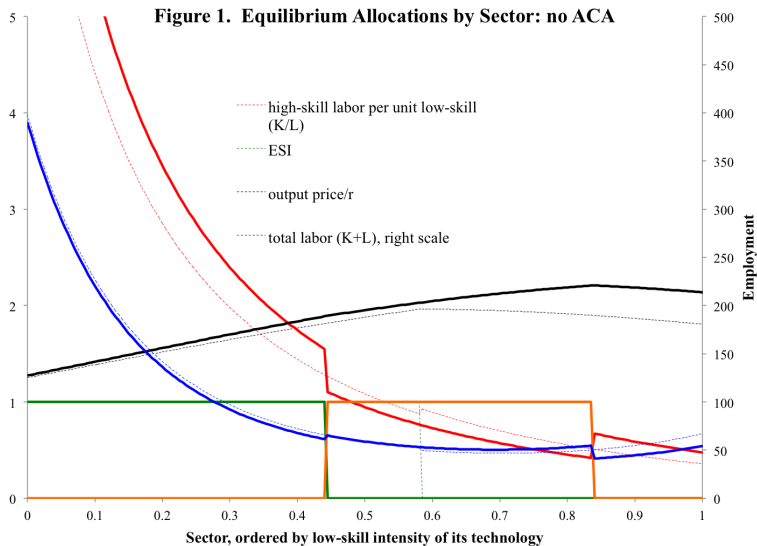


GALLEN & MULLIGAN 2016: MATCHING MOMENTS-II

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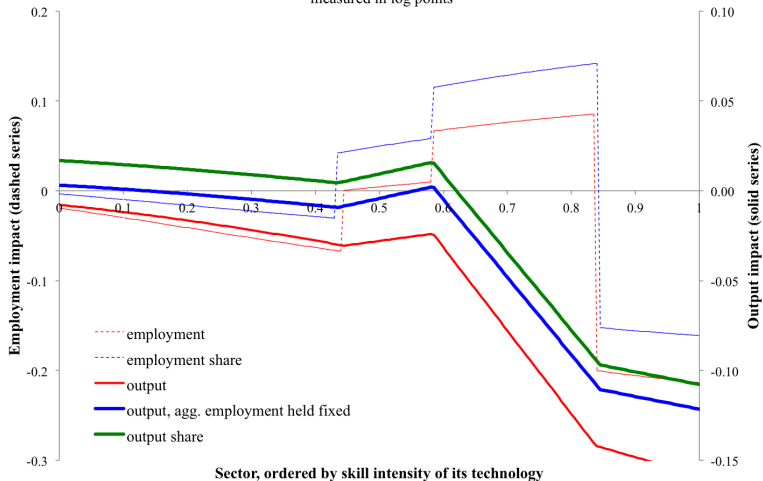
GALLEN & MULLIGAN 2016: RESULTS-I



GALLEN & MULLIGAN 2016: RESULTS-II

Figure 12. Sector-specific Impacts on Employment and Output

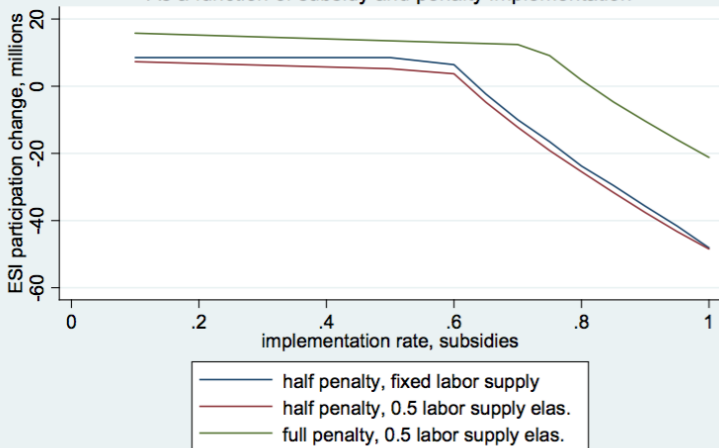
measured in log points



GALLEN & MULLIGAN 2016: RESULTS-II

Figure 4. The ACA's ESI Impact

As a function of subsidy and penalty implementation



GALLEN & MULLIGAN 2016: RESULTS

- ▶ Less ESI, as $\sim 8\%$ 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
- ▶ $\sim 3\%$ less working hours, as low-skill step out of labor force
- ▶ $\sim 2\%$ 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