The Welfare Effects of Trade with Incomplete Markets

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Motivation

Large literature on the positive welfare effects associated with trade

- Consensus that trade increases overall welfare but associated distributional impacts
- Some individuals are left worse off due to political or informational inability to compensate

Revisit this question: Is it possible that opening up to trade reduces welfare even with redistributive transfers?

Introduction: Main Result

Two key aspects of the model:

- Frictional labour market with labour immobility
- Risk aversion with incomplete financial markets

Key result:

- For some parameters, moving from autarky to free trade reduces welfare
- Differs from highlighting trade has unequal welfare effects
- Application of the theory of the second best

Mechanisms and intuition:

- Trade may hurt the vulnerable relatively more than it helps the safe
- Market insurance and endogenous response of vacancies and job creation
- The envelope theorem

Introduction: Scope of this result

This focuses upon a traditional source of gains from trade

- *Productive efficiency:* reallocating resources towards sectors that are relatively more productive
- *Allocative efficiency:* moving consumer goods to countries with relatively high marginal utility

Also, other sources of the gains from trade are possible

- Specific factor model: reallocation of resources between sectors is partially restricted
- Technology transfer
- Variety of goods consumed
- Pro-productivity (market size) effects

Literature

Trade and welfare

- A long list starting with Ricardo but more recently Arkolakis, Costinot and Rodriguez-Clare (2012), Dix-Carneiro (2014), McLaren and co-authors (2010, 2015), Behrens and Murata (2012) Guren et al (2015)

Trade and labour market frictions

- Davidson, Martin & Matusz (1987, 1988), Helpman & Itskhoki (2010), Helpman, Itskhoki & Redding (2010)

Trade and incomplete financial markets

- Newbery and Stiglitz (1984) and Ranjan (2016)

The Model: Overview

- Two sector economy: produce good $j \in \{1, 2\}$
- Workers
  - Find and lose jobs *and* consume and save
  - Size normalised to one, with π proportion of workers devoted to sector 1
- Firms
  - Post vacancies and wages to hire workers, and buy capital
  - Sell goods in perfectly competitive goods market
- Markets
  - Labour is sector specific *and* frictional (DMP)
  - Goods market is frictionless - consumption plus capital investment equals output
  - Financial market is incomplete - workers access a single traded annuity

Worker's Problem

Preferences:

$$E_0 \int_0^{\infty} -e^{-(\rho+d)t} e^{-\gamma C(t)}\, dt$$

where

$$C = \left((1-\beta)^{\frac{1}{\eta}} c_1^{\frac{\eta-1}{\eta}} + \beta^{\frac{1}{\eta}} c_2^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$\dot{a} = ra + y_i - p_1 c_1 - p_2 c_2$$

Notation:

- Income risk, y_i varies due to stochastic job gain ($y_i = w$) and loss ($y_i = 0$)
- ρ time discount rate and d rate of death
- β weight on good 2 in consumption
- η controls elasticity of substitution and γ risk aversion

Solution to Worker's Problem

- Take labour market transition rates as exogenous (for now)
- Within-period, CES utility allows for explicit solution of within-period consumption ▸ CES utility

$$E_0 \int_0^\infty e^{-(\rho+d)t} e^{-\gamma C(t)} \, dt \quad (1)$$

where

$$\dot{a} = ra + y_i - PC$$

and P is CES price index

- Across periods, CARA utility allows for explicit solution of Bellman equations ▸ Bellman Equations

Solution to Worker's Problem

Employment state is $i \in \{e, u\}$

- Value functions

$$V_e(a) = -\frac{exp\left(-\frac{\gamma}{P}\left(ra + b_e + P\left(\frac{\rho+d-r}{\gamma r}\right)\right)\right)}{r}$$
$$V_u(a) = -\frac{exp\left(-\frac{\gamma}{P}\left(ra + b_u + P\left(\frac{\rho+d-r}{\gamma r}\right)\right)\right)}{r}$$

  allows discussion of welfare

- Solution for expenditure allows derivation of asset evolution over time

$$c_i = ra + b_i + P\left(\frac{\rho + d - r}{\gamma r}\right)$$

- b_i reflects precautionary saving and is given by implicit system of equations ▸ Consumption equations

Optimal Consumption Plan

Workers save (if employed) or dissave (if unemployed) a constant amount regardless of wealth level

$$
\begin{aligned}
\dot{a} &= \underbrace{ra + w_i}_{\text{income}} - \left(\underbrace{ra + b_i + P\left(\frac{\rho + d - r}{\gamma r}\right)}_{\text{consumption}} \right) \\
&= w_i - b_i - P\left(\frac{\rho + d - r}{\gamma r}\right)
\end{aligned}
$$

Key result:

- Saving is independent of assets (CARA utility)
- Allows us to represent mass of workers at wage w in employment state e or u in steady state

Steady State Distribution of Wealth

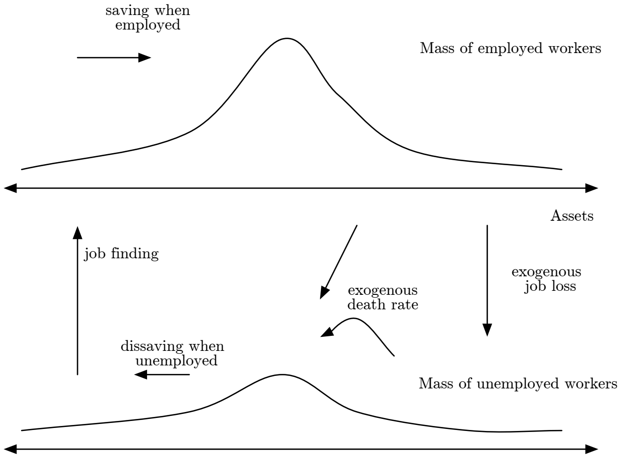

Figure: Evolution of wealth ▸ Explicit evolution of assets

Labour Market

- Labour associated with a sector
- Labour market frictions (DMP)

$$m(u, v) = \mu u^{\alpha} v^{1-\alpha}$$

- Let θ be the vacancy-unemployment rate
- Rate at which workers find jobs denoted $h(\theta)$
- Rate at which firms find workers denoted $q(\theta)$
- Steady state unemployment

$$u_i = \frac{\delta + d}{\delta + d + h(\theta)}$$

- Firm technology: one worker and capital choice, $x_j \cdot f(k_j) = x_j k_j^{\phi}$

Financial Markets

- Workers have access to an annuity that returns r
- Firms rate of interest r_f
- Following Blanchard-Yaari $r = r_f + d$
- Net value of assets held by workers equals value of firms

Firm's Problem: Description of Payoffs

- Follow Acemoglu and Shimer (1999) in using a directed search environment
- Create vacancies, post wages and purchase capital
- Define F as the value of a firm with a worker and N the value of a vacancy
- Firms purchase capital prior to hiring so $p_j k_j = N(k_j, w_j)$

$$r_f F(k_j, w_j) = p_j x_j f(k_j) - w_j + (\delta_j + d)(-F(k_j, w_j))$$
$$r_f N(k_j, w_j) = q_j(\theta_j)(F(k_j, w_j) - N(k_j, w_j))$$

Firm's Problem: Choices

Formal description of the problem

$$\max_{\{k_j, w_j, \theta_j\}} V_{u,j}(a)$$

subject to $q_j(\theta_j)(F(k_j, w_j) - p_j k_j) = r_f p_j k_j$.

- Three first order conditions pin down wages, w, capital choice, k and vacancy-unemployment rate, θ
- Directed search implies labour market is constrained efficient when workers risk neutral

Firm's Problem: First Order Conditions

- Optimal capital choice

$$x_j f'(k_j) = \frac{q(\theta_j) + r_f}{q_j(\theta_j)}(r_f + \delta_j + d)$$

- Zero profit

$$\frac{q(\theta_j)}{q(\theta_j) + r_f} \cdot \frac{p_j x_j f(k_j) - w_j}{r + \delta_j + d} = p_j k_j$$

- Third condition: Optimal tradeoff between (w, θ) depends upon attitude of workers to risk

$$\frac{V_w(a; w, \theta)}{V_\theta(a; w, \theta)} = \frac{q(\theta) F_w}{q'(\theta)(F - N)}$$

Firm's FOC

Equilibrium

Equilibrium Concepts:

- Closed economy - demand for goods (consumption and investment) equals supply (output) Goods Market Equilibrium
- Two country model - world demand for goods equals world supply
- Small open economy - takes world prices and interest rates as exogenous

Solution:

- Normalise $p_2 = 1$
- Equilibrium conditions pin down p_1 and r_f
- Endogenous choices run off prices: consumption, assets, capital, vacancy creation, wages

Measuring Welfare Changes

We use an analog of traditional compensating variation

- Workers face autarky (initial) prices (r, p_1) and move to (trade) price (r', p_1') with $p_2 = 1$
- Value functions are known, so can calculate equivalent level of real assets to make worker indifferent
- Can calculate compensating variation for each individual and can aggregate over individuals
  1. Positive compensating variation implies need net inflow of assets to compensate all workers
  2. Negative compensating variation implies can compensate all workers and have left overs

Compensating Variation

Use value functions to solve for real change in assets needed to compensate workers for changing from (p_1, r) to (p_1', r')

$$\frac{a'}{P'} - \frac{a}{P} = \frac{1}{r'}\left((r - r')\frac{a}{P} + \frac{b_{i,0}}{P} - \frac{b_{i,1}}{P'}\right) + \frac{1}{r'}\left(\frac{\rho + d - r}{\gamma r} - \frac{\rho + d - r'}{\gamma r'} - \frac{1}{\gamma}\log\left(\frac{r'}{r}\right)\right)$$

And if interest rates are unchanged,

$$\frac{a_{i,1}}{P'} - \frac{a_{i,0}}{P} = \frac{1}{r}\left(\frac{b_{i,0}}{P} - \frac{b_{i,1}}{P'}\right)$$

Aggregate by summing across individuals

Results

Two benchmarks:

- Model without frictional labour markets
- Model without risk aversion

Proposition 1

In a model **without frictions**, moving from autarky to free trade involves a net negative compensating variation

Proposition 2

In a model **without risk aversion** and c_1 and c_2 as perfect substitutes, moving from autarky to free trade involves a net negative compensating variation

Numerical Example

Table: Parameter Values

Parameter	Interpretation	Value
γ	CARA	8
ρ	Discount rate	0.01
μ	Matching efficiency	0.7
δ	Rate of job destruction	0.1
d	Rate of death	0.03
α	Elasticity of matching with respect to u	0.5
ϕ	Capital share of output	0.4
x_1	Productivity, sector 1	1.25
x_2	Productivity, sector 2	0.75
β	Weight on good 2	0.3
η	CES parameter	1.5
p_2	Price of good 2 (normalised)	1

Numerical Example

Table: Endogenous Steady State Outcomes

Parameter	Interpretation	Value
w_1	Wage sector 1	1.05
w_2	Wage sector 2	0.463
u_1	Unemployment sector 1	5.6 %
u_2	Unemployment sector 2	7 %
r_f	Interest rate	8.9 %
a	Aggregate assets	3
p_1	Price, good 1	1.006
P	Aggregate price	1.004

Trade Experiment: Small Open Economy

Calculate compensating variation as price p_1 varies, maintaining $p_2 = 1$ normalisation

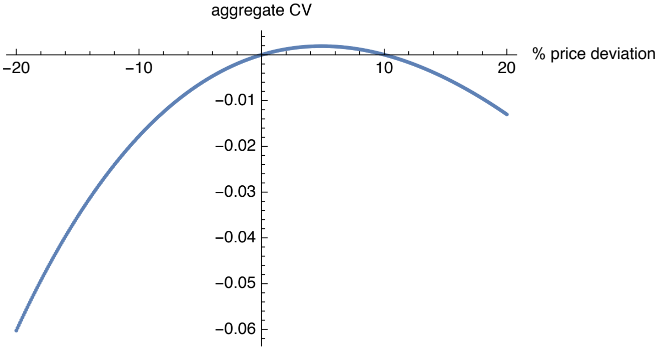

Figure: Aggregate compensating variation as price changes

Some Intuition

Two important elements are at work:

- Reallocation of resources in response to price changes - market insurance result of Acemoglu and Shimer (1999)
- Risk aversion and the envelope theorem

Examine role of market insurance

- As p_1 wages, raise w_1 proportionally and keep k_1, k_2, θ_1 and θ_2 fixed
- Feasible bundle

Some Intuition

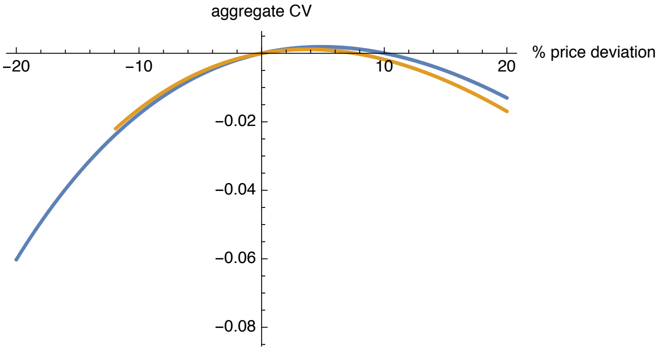

Figure: Blue: Baseline model. Orange: Maintain constant capital and θ.

Trade Experiment: Small Static Open Economy

Previous results had large asymmetry

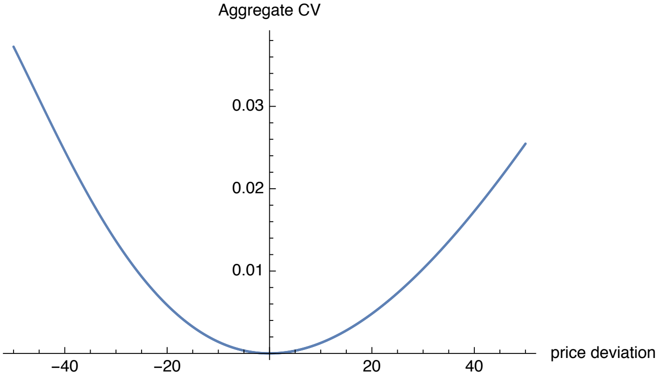

Figure: Welfare gains with low risk aversion, $\gamma = 1$

Trade Experiment: Small Static Open Economy

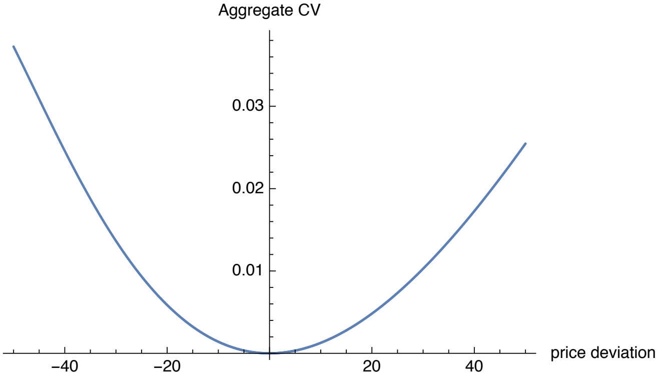

Figure: Welfare losses with low risk aversion, $\gamma = 8$

Conclusion

- Standard story, losers from international trade arise due to failure to redistribute
- Deviations from standard model
  1. Frictional labour markets and sectoral mobility
  2. Incomplete financial markets
- Even with lump sum transfers, there is an inability to compensate

And more things to do:

- More theoretical results
- A more realistic calibration

CES Utility

Solution to within-period problem

$$c_1 = (1-\beta)\left(\frac{p_1}{P}\right)^{-\eta}\frac{X}{P}$$
$$c_2 = \beta\left(\frac{p_2}{P}\right)^{-\eta}\frac{X}{P}$$

where

$$P = \left((1-\beta)p_1^{1-\eta} + \beta p_2^{1-\eta}\right)^{\frac{1}{1-\eta}}$$

and X is within-period expenditure

▸ Back to worker's problem

Worker's Bellman Equation

Unemployed worker:

$$(\rho + d)V_u(a) = \max_{c_u(a)} u(c_u(a)) + \underbrace{(ra + y_u - pc_u(a))V_u'(a)}_{\text{asset accumulation}} + \underbrace{\lambda(V_e(a) - V_u(a))}_{\text{job gain}}$$

Employed workers:

$$(\rho + d)V_e(a) = \max_{c_e(a)} u(c_e(a)) + \underbrace{(ra + w - pc_e(a))V_e'(a)}_{\text{asset accumulation}} + \underbrace{\delta(V_u(a) - V_e(a))}_{\text{job loss}}$$

Back to worker's problem

Consumption-Saving Problem

System of equations that determine component of consumption related to labour income

$$\lambda e^{-\gamma b_e/p} = \left(\lambda + \frac{\gamma r}{p}(y_u - b_u)\right) e^{-\gamma b_u/p}$$
$$\delta e^{-\gamma b_u/p} = \left(\delta + \frac{\gamma r}{p}(w - b_e)\right) e^{-\gamma b_e/p}$$

Back to worker's problem

Equations of motion with exogenous matching rates:

With asset level below zero

$$\dot{F}(a,t) = \lambda \cdot G(a,t) - \delta \cdot F(a,t) - d \cdot F(a,t) - (w - b_e) \cdot F_a(a,t)$$
$$\dot{G}(a,t) = \delta \cdot F(a,t) - \lambda \cdot G(a,t) - (y_u - b_u) \cdot G_a(a,t) - d \cdot G(a,t)$$

With asset level above zero

$$\dot{F}(a,t) = \lambda \cdot G(a,t) - \delta \cdot F(a,t) - d \cdot F(a,t) - (w - b_e) \cdot F_a(a,t)$$
$$\dot{G}(a,t) = \delta \cdot F(a,t) - \lambda \cdot G(a,t) - (w - b_e) \cdot G_a(a,t) - d \cdot G(a,t) + d$$

Back to evolution of assets

First Order Conditions: Firm's problem

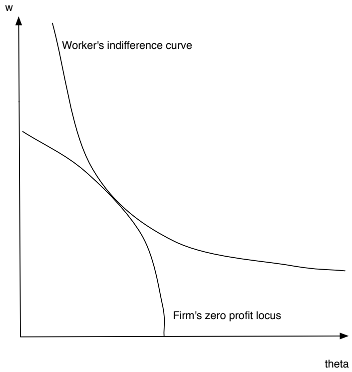

Figure: Wage-θ Equilibrium

Back to firm's problem

Goods Market Equilibrium

In autarky, supply equals demand for each sector j:

$$\pi_j(1-u_j)x_j f(k_j) = c_j + i_j$$

where

$$c_j = \beta_j \left(\frac{p_j}{P}\right)^{-\eta} \frac{C}{P}$$
$$i_j = k_j u_j h(\theta_j)$$

- In two-country trade equilibrium, world supply equals world demand for each sector j
- In small open economy, world relative prices and interest rates are exogenous

Equilibrium Conditions