Lecture on "Endogenous Growth and Trade"

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Introduction

This lecture is based on

- Elias Dinopoulos and Paul Segerstrom (1999), "A Schumpeterian Model of Protection and Relative Wages," *American Economic Review*.
- Paul Segerstrom (2011), "Trade and Economic Growth," chapter in *Palgrave Handbook of International Trade*.

- The demand for unskilled labor has decreased dramatically over time in the U.S., leading to a decrease in the relative wage of unskilled labor, particularly in the 1980s. (Johnson [1997], 13% increase in U.S. relative wage from 1970 to 1993).
- International trade has also increased dramatically over time. In the U.S., imports and exports rose from about 3 percent of GDP in 1970 to about 10-12 percent in 1995. (Richardson [1995], Between 1965 and 1990, share of output exported rose from 12 to 20% for high-income countries, 17 to 25% for middle-income countries, 8 to 18% for low-income countries).
- Is there a connection between the rising inequality of wages and global trade?

- Some economists interpret the evidence as a manifestation of the Stolper-Samuelson (1941) mechanism. (Wood [1995], Leamer [1994], Borjas and Ramey [1994]).
- *Stolper-Samuelson Theorem:* A decline in the relative price of the importable good must reduce the return to the factor that is used intensively in its production.
- $\Rightarrow$ lower trade barriers between a developed (skilled-labor abundant) country and a developing (unskilled-labor abundant) country puts downward pressure on the relative wage of unskilled workers in the developed country.
- Other economists think that exogenous labor-saving technological change is the more likely cause of the increase in wage inequality. (Lawrence and Slaughter [1993], Berman, Bound and Griliches [1994], Johnson [1997]).

Some reasons given for why international trade is not important:

- U.S. domestic relative prices remained roughly constant during the 1980s. (Lawrence and Slaughter [1993])
- Skill upgrading and employment shifts occurred across all industries and mostly within (as opposed to between) four-digit manufacturing industries. (Berman, Bound and Griliches [1994]).
- The decline in the demand for unskilled workers occurred in many countries, not just the U.S. (Richardson [1995])
- R&D expenditures and the rate of technological change increased. (Berman, Bound and Griliches [1994])

I will now present a 2 country model where trade liberalization

- has no effect on domestic relative prices
- leads to skill upgrading in each industry
- does not lead to employment shifts across industries
- decreases the relative wage of unskilled workers in both countries
- increases R&D expenditure and the rate of technological change

In other words, all of the above-mentioned reasons why trade is not important are implications of trade liberalization in the model!

The Model

- The model is a modified and slightly simplified version of the model in Dinopoulos and Segerstrom (1999, AER).
- There are 2 structurally identical countries (everything that happens in one country happens in the other country as well).
  [2nd trade model allows for asymmetric countries]
- Trade between the 2 countries is not free but is subject to positive trade costs τ (main exercise is $\tau \downarrow \Rightarrow ?$).
  [3rd trade model allows for a single country opening up to trade]

Household Behavior

- There is a continuum of households in each country indexed by ability $\theta \in [0, 1]$.
- All members of household θ have the same ability level equal to θ, and all households have the same number of members at each point in time.
- Each household is modelled as a dynastic family whose size grows over time at an exogenously given rate $n > 0$.
- Each individual member of a household lives forever. Letting $N_0 = 1$ denote the number of members of each household at time $t = 0$, the population size in each country at time t is $N(t) = N_0 e^{nt} = e^{nt}$.

- Family-optimization considerations determine the allocation of income across final goods, the evolution of consumption expenditure over time, and the decision whether to become skilled or enter the labour force as unskilled workers.
- In making these decisions, each family takes prices of final products, wages, and the interest rate as given.
- Each individual knows her own ability level θ, as do all the firms that might potentially hire her.

- An individual can enter the labour force as unskilled and earn the wage w_L from then on. ['L' for low-skilled]
- Alternatively, an individual with ability θ can enter the labour force after spending an exogenously given period of time T in 'training' to become skilled. A skilled worker with ability θ earns a wage θw_H from then on and does not earn any income during her period of training or apprenticeship. (Thus skilled workers with higher ability levels earn higher wages.)
- The training process does not require any real resources (other than the time of the trainee: no teacher salaries). $\Rightarrow$ make education choice to maximize discounted wage income.
- Income is evenly shared within each family (between employed and trainees) so that, at each point in time, consumption expenditure is the same for each member of a family.

The optimization problem of a family with ability θ is

$$\max_{q_\theta} U_\theta \equiv \int_0^\infty e^{-(\rho-n)t} \ln u_\theta(t)\, dt \qquad \text{maximize discounted utility}$$

subject to the 3 constraints

$$\ln u_\theta(t) \equiv \int_0^1 \ln \left[\sum_j \lambda^j q_\theta(j,\omega,t) \right] d\omega, \qquad \text{static utility function}$$

$$c_\theta(t) \equiv \int_0^1 \left[\sum_j p(j,\omega,t) q_\theta(j,\omega,t) \right] d\omega, \qquad \text{static budget constraint}$$

$$W_\theta + Z_\theta = \int_0^\infty c_\theta(t) e^{nt} e^{-R(t)}\, dt. \qquad \text{intertemporal budget constraint}$$

Discounted utility

$$\max_{q_\theta} U_\theta \equiv \int_0^\infty e^{-(\rho-n)t} \ln u_\theta(t)\, dt$$

- U_θ is the discounted utility of a household with ability θ,
- $\rho > 0$ is the constant subjective discount rate,
- $n > 0$ is the exogenous population growth rate (assume $\rho - n > 0$),
- $\ln u_\theta(t)$ is the static utility function of each household member

Static utility

$$\ln u_\theta(t) \equiv \int_0^1 \ln \left[\sum_j \lambda^j q_\theta(j, \omega, t) \right] d\omega,$$

- $q_\theta(j, \omega, t)$ denotes the quantity consumed by an individual with ability θ of a good with j improvements (innovations) in its quality in industry $\omega \in [0, 1]$ at time t
- Parameter $\lambda > 1$ captures the size of each quality improvement and λ^j denotes the total quality of a good after j innovations.
- Since λ^j is increasing in j, this equation captures in a simple way the idea that consumers prefer higher quality products [introduced in Segerstrom, Anant and Dinopoulos (1990, AER)].

Static budget constraint

$$c_\theta(t) \equiv \int_0^1 \left[\sum_j p(j, \omega, t) q_\theta(j, \omega, t) \right] d\omega,$$

- per capita consumption expenditure $c_\theta(t)$ at time t must equal the value of all final goods consumed.
- $p(j, \omega, t)$ and $q_\theta(j, \omega, t)$ denote the price and quantity of a final product with j improvements in its quality in industry ω at time t.

Intertemporal budget constraint

$$W_\theta + Z_\theta = \int_0^\infty c_\theta(t) e^{nt} e^{-R(t)} \, dt.$$

- From the perspective of time $t = 0$, W_θ is the family's discounted wage income and Z_θ is the value of the family's financial assets.
- The right-hand side (RHS) equals the discounted value of the family's consumption and $R(t) \equiv \int_0^t r(s) \, ds$ is the market discount factor with $\dot{R}(t) = r(t)$ denoting the market interest rate at time t.

Appendix: About the intertemporal budget constraint

Here are some calculations to help you better understand the intertemporal budget constraint.

- Start with

$$W_\theta + Z_\theta = \int_0^\infty c_\theta(t) e^{nt} e^{-R(t)}\, dt.$$

- Drop subscript θ to simplify the expression:

$$W + Z = \int_0^\infty C(t) e^{-R(t)}\, dt$$

where $C(t) \equiv c(t)e^{nt}$ is the current value of family expenditure at time t.

- Then

$$W \equiv \int_0^\infty W(t)e^{-R(t)}\,dt$$

where $W(t)$ is the current value of family wage income at time t and it follow that

$$Z = \int_0^\infty [C(t) - W(t)]e^{-R(t)}\,dt$$

- Let $A_p(t)$ be the present value of family assets at time t and let $A(t)$ be the current value of family assets at time t. Then

$$A_p(t) = A(t)e^{-R(t)} \quad \text{and} \quad Z = A_p(0)$$

- It follows that

$$A_p(t) = \int_t^{\infty} [C(\tau) - W(\tau)]e^{-R(\tau)}\, d\tau$$

and

$$\dot{A}_p(t) = \dot{A}e^{-R(t)} + A(t)e^{-R(t)}[-r(t)] = -1[C(t) - W(t)]e^{-R(t)}$$

where the last equality follows from Leibniz's Rule.

- Rearranging yields

$$\dot{A}(t) - r(t)A(t) = W(t) - C(t)$$

$$\dot{A}(t) = W(t) + r(t)A(t) - C(t)$$

which is the same differential equation as in the Optimal Control lecture (slide 57).

Solving the Household/Family Optimization Problem

- This problem can be solved in 4 steps.
- First, solving for the utility-maximizing allocation of consumer expenditure across products within an industry ω at time t yields that consumers only buy the product(s) in each industry with the lowest quality-adjusted price $\frac{p(j,\omega,t)}{\lambda^j}$.
- Second, maximizing static utility subject to the static budget constraint yields a unit elastic demand function

$$q_\theta(j,\omega,t) = \frac{c_\theta(t)}{p(j,\omega,t)}$$

for the product(s) in each industry with the lowest quality-adjusted price. A unit elastic demand function is the simplest type of demand function. [In textbooks, $q = cp^{-\epsilon}$ where ϵ is the elasticity of demand.]

- Third, maximizing discounted utility subject to the intertemporal budget constraint yields the usual intertemporal optimization condition

$$\frac{\dot{c}_\theta(t)}{c_\theta(t)} = r(t) - \rho.$$

- This differential equation states that per capita consumption expenditure grows over time if and only if the market interest rate exceeds the subjective discount rate.
- When the market interest rate is relatively high, consumers want to save more now and spend more later, resulting on positive growth in per capita consumption expenditure over time.

- Fourth, training/employment decisions are made to maximize each family's discounted wage income, which is equivalent to maximizing each member's discounted wage income. The latter depends on whether the individual member earns the unskilled wage or becomes a skilled worker and then earns the skilled wage.
- It is optimal for an individual with ability θ born at time t to train and become a skilled worker if and only if

$$\int_t^{\infty} e^{-[R(s)-R(t)]} w_L(s)\, ds < \int_{t+T}^{\infty} e^{-[R(s)-R(t)]} \theta w_H(s)\, ds.$$

- $\Rightarrow$ all individuals with ability lower than θ_0 choose to remain unskilled.
- $\Rightarrow$ all individuals with ability greater than θ_0 undergo training and then enter the labour force as skilled workers.

- To better understand

$$\int_t^\infty e^{-[R(s)-R(t)]} w_L(s)\, ds < \int_{t+T}^\infty e^{-[R(s)-R(t)]} \theta w_H(s)\, ds,$$

suppose the interest rate $r(t)$ is constant over time.

- Then

$$R(t) \equiv \int_0^t r(s)\, ds = \int_0^t r\, ds = rt,$$

so

$$e^{-[R(s)-R(t)]} = e^{-[rs-rt]} = e^{-r(s-t)}.$$

Solving for the threshold ability level θ_0

- I focus on the model's steady-state equilibrium properties where w_L, w_H and c_θ are all constants over time.
- Then $\dot{c}_\theta(t)/c_\theta(t) = r(t) - \rho$ implies that $r(t) = \rho$ for all t.

$$\int_t^\infty e^{-[R(s)-R(t)]} w_L(s)\, ds = \int_{t+T}^\infty e^{-[R(s)-R(t)]} \theta_0 w_H(s)\, ds.$$

$$\int_t^\infty e^{-\rho(s-t)} w_L\, ds = \int_{t+T}^\infty e^{-\rho(s-t)} \theta_0 w_H\, ds$$

$$e^{\rho t} w_L \int_t^\infty e^{-\rho s}\, ds = e^{\rho t} w_L \left.\frac{e^{-\rho s}}{-\rho}\right|_t^\infty = e^{\rho t} w_L \left(0 - \frac{e^{-\rho t}}{-\rho}\right) = \frac{w_L}{\rho}$$

$$e^{\rho t} \int_{t+T}^\infty e^{-\rho s}\, ds = e^{\rho t} \left.\frac{e^{-\rho s}}{-\rho}\right|_{t+T}^\infty = e^{\rho t} \left(0 - \frac{e^{-\rho(t+T)}}{-\rho}\right) = \frac{e^{-\rho T}}{\rho}$$

$$\frac{w_L}{\rho} = \frac{e^{-\rho T} \theta_0 w_H}{\rho} \qquad \Longrightarrow \qquad \theta_0 = \frac{w_L}{w_H} e^{\rho T}$$

The supply of unskilled labour

$$\theta_0 = \frac{w_L}{w_H} e^{\rho T}$$

- The wage of a skilled worker θw_H must always be higher than the wage of any unskilled worker w_L.
- An increase in the duration of training T or in the relative wage of unskilled labour w_L/w_H increases the fraction of the population that chooses to remain unskilled θ_0.
- The supply of unskilled labour in each country at time t, $L(t)$, equals the number of individuals in the population that choose to remain unskilled:

$$L(t) = \theta_0 N(t).$$

The supply of skilled labour (derivation more complicated)

- A fraction $(1-\theta_0)$ of each country's population train and become skilled workers, and therefore $(1-\theta_0)N(t)$ individuals either work as skilled workers or are training to become skilled workers in each country at time t.
- In this sub-population, the skilled workers are the older individuals, namely, those individuals that were born before $t-T$:

$$[\text{using } \dot{N}(s)/N(s) = n \;\Rightarrow\; \dot{N}(s) = nN(s)]$$

$$\int_{-\infty}^{t-T} n(1-\theta_0)N(s)\, ds = n(1-\theta_0)\int_{-\infty}^{t-T} e^{ns}\, ds$$

$$= n(1-\theta_0)\left.\frac{e^{ns}}{n}\right|_{-\infty}^{t-T} = (1-\theta_0)e^{n(t-T)} = (1-\theta_0)e^{-nT}N(t)$$

- The average skill level of workers $\theta \in [\theta_0, 1]$ that have finished training equals $\frac{\theta_0+1}{2}$.
- The total number of skilled workers is $(1-\theta_0)e^{-nT}N(t)$
- Therefore, the supply of skilled labour at time t, measured in efficiency units of human capital, is given by

$$H(t) = \frac{(\theta_0+1)(1-\theta_0)}{2}e^{-nT}N(t) = \frac{[1-(\theta_0)^2]}{2}e^{-nT}N(t).$$

- A decline in the relative wage of unskilled workers decreases θ_0 and $L(t)$, and increases $H(t)$, resulting in a rise of skilled labour abundance $\frac{H(t)}{L(t)}$ in each country.

Product Markets

- There is a continuum of industries in each country indexed by $\omega \in [0, 1]$.
- In each industry, firms produce final consumption goods using unskilled labour.
- Firms compete in prices and maximize their expected discounted profits.
- For every firm that knows how to produce a good, one unit of unskilled labour produces one unit of output and production is characterized by constant returns to scale.
- Thus, each firm has a constant marginal cost of production equal to w_L.

- There are also trade costs separating the two countries that take the 'iceberg' form: $\tau > 1$ units of a good must be produced and exported in order to have one unit arriving at its destination.
- Thus, the marginal cost of a firm serving the domestic market is w_L and the marginal cost of a firm serving the foreign market is τw_L.
- I treat the unskilled wage as the numeraire price ($w_L = 1$), that is, I measure all prices relative to the price of unskilled labour.

- In each industry, I will refer to the firms that produce the state-of-the-art quality product as ‘quality leaders’ and I will use the term ‘quality followers’ to refer to firms producing a product one quality step below the highest-quality product.
- When a firm wins a R&D race and becomes a quality leader, it receives a patent to exclusively produce the new product and sell it to all consumers in the world.
- This patent expires (or ceases to be enforced) when further innovation occurs in the industry.
- All products that are not protected by patents can be produced competitively in both countries.

- I will refer to the two countries as Home and Foreign.
- Consider a Home quality leader that exports its product to the Foreign market (the analysis of the exporting behavior of a Foreign quality leader is identical because of structural symmetry between the two countries).
- Because unit costs of all Foreign quality followers are identical ($w_L = 1$) and Home quality followers have higher unit costs when serving the Foreign market ($\tau w_L > w_L$), Home leaders compete against a competitive fringe of Foreign followers in the Foreign market (and against a competitive fringe of Home followers in the Home market).

- Let Q_ℓ^* denote the output that the Home leader sells to Foreign consumers,
- let P_ℓ^* denote the price that Foreign consumers pay for the state-of-the-art quality product,
- let Q_f^* denote the output of Foreign followers,
- let P_f^* denote the price that Foreign followers charge Foreign consumers.
- With the competitive fringe of Foreign followers charging the competitive price $P_f^* = 1$, the profit flow earned by the Home leader from selling to Foreign consumers is

$$\pi_\ell^* = \begin{cases} P_\ell^* Q_\ell^* - \tau Q_\ell^* & \text{if } P_\ell^* \leq \lambda \\ 0 & \text{if } P_\ell^* > \lambda. \end{cases}$$

- If the price charged by the Home leader is too high ($P_\ell^* > \lambda$), then all Foreign consumers buy from Foreign followers.
- The Home leader has to charge a sufficiently low price to attract Foreign consumers ($P_\ell^* \leq \lambda$) and I assume that in the borderline case ($P_\ell^* = \lambda$) where consumers are indifferent, they only buy from the firm selling the higher quality product (the Home leader).

- Taking into account that consumer demand is unit elastic, the profit flow earned by the Home leader becomes

$$\pi_\ell^* = \begin{cases} P_\ell^* \frac{c^* N^*(t)}{P_\ell^*} - \tau \frac{c^* N^*(t)}{P_\ell^*} & \text{if } P_\ell^* \leq \lambda \\ 0 & \text{if } P_\ell^* > \lambda, \end{cases}$$

- where c^* is the per capita consumption expenditure in the Foreign country and $N^*(t)$ is the number of consumers in the Foreign country.
- Assuming that $\tau \in (1, \lambda)$, this profit flow is maximized by charging the limit price $P_\ell^* = \lambda > 1$.

- In equilibrium the Home leader sells $Q_\ell^* = c^* N^*(t)/\lambda$, Foreign followers sell $Q_f^* = 0$ and the Home leader earns the profit flow

$$\pi_\ell^* = P_\ell^* \frac{c^* N^*(t)}{P_\ell^*} - \tau \frac{c^* N^*(t)}{P_\ell^*} = c^* N^*(t) \left[1 - \frac{\tau}{\lambda}\right].$$

- Note that trade liberalization ($\tau \downarrow$) contributes to increasing the profits earned from exporting.

- Because a Home quality leader faces segmented markets and does not incur the trade cost τ when selling to Home consumers, the analysis of price competition in the Home market is identical to the analysis in the Foreign market when $\tau = 1$.
- The Home quality leader charges the limit price $P_\ell = \lambda > 1$ to Home consumers, the Home leader sells $Q_\ell = cN(t)/\lambda$ to Home consumers, Home followers sell $Q_f = 0$ to Home consumers.
- The Home leader earns the profit flow

$$\pi_\ell = cN(t)\left[1 - \frac{1}{\lambda}\right],$$

where c and $N(t)$ are per capita consumption expenditure and population in the Home country.

- Structural symmetry across the two countries implies that $c = c^*$ and $N(t) = N^*(t)$.

- Therefore, each quality leader (Home or Foreign) exports the state-of-the-art quality product as well as sells to domestic consumers and earns the global profit flow

$$\pi \equiv \pi_\ell + \pi_\ell^* = cN(t)\left[1 - \frac{1}{\lambda} + 1 - \frac{\tau}{\lambda}\right] = cN(t)\left[2 - \frac{1+\tau}{\lambda}\right].$$

- First, note that only the state-of-the-art quality products are produced and traded.
- Second, all followers charge the same price $P_f = P_f^* = 1$ which is used as the numeraire, and all quality leaders charge the same price $P_\ell = P_\ell^* = \lambda > 1$ since they are price-constrained by domestic follower firms selling inferior quality goods.
- Third, trade liberalization ($\tau \downarrow$) does not have any effect on relative prices (of domestically produced goods versus imported ones) but increases the global profit flows of quality leaders [$\tau \downarrow \Longrightarrow \pi \uparrow$].

- Because trade liberalization has no effect on domestic relative prices in either country, any effect that trade liberalization has on relative wages (w_H/w_L) must operate through some channel other than the traditional Stolper-Samuelson mechanism [in the Heckscher-Ohlin model].
- The previously established property that a reduction in τ directly increases the global profit flows of quality leaders will turn out to be significant.

R&D

- There are sequential and stochastic R&D races in each industry $\omega \in [0, 1]$.
- These races result in the discovery of higher-quality products.
- Only skilled workers can engage in R&D activities, unskilled workers being employed in production activities.
- All firms participating in a R&D race use the same R&D technology and there is free entry into each race.

- A firm i that hires $h_i(\omega, t)$ skilled workers to engage in R&D in industry ω at time t is successful in discovering the next higher quality product with instantaneous probability

$$I_i(\omega, t) = \frac{h_i(\omega, t)}{X(\omega, t)},$$

  where $X(\omega, t)$ is a function that captures the difficulty of conducting R&D. ['h' for human capital]
- By instantaneous probability (or Poisson arrival rate), I mean that $I_i(\omega, t)\, dt$ is the probability that the firm will innovate by time $t + dt$ conditional on not having innovated by time t, where dt is an infinitesimal increment of time.
- This R&D technology was introduced in Segerstrom (1998, AER).

- The returns to R&D investment are independently distributed across firms, across industries, and over time.
- Thus the industry-wide instantaneous probability of success in industry ω at time t is $I(\omega, t) = \sum_i I_i(\omega, t)$ in the Home country and $I^*(\omega, t) = \sum_i I_i^*(\omega, t)$ in the Foreign country.
- The global arrival of innovations in each industry is governed by a Poisson process whose intensity equals $I(\omega, t) + I^*(\omega, t)$.
- Higher levels of R&D investment increase the expected frequency of innovations and result in a higher rate of technological change.

- Concerning the function $X(\omega, t)$, I assume that R&D starts off being equally difficult in all industries $[X(\omega, 0) = X_0$ for all ω where $X_0 > 0$ is a constant].
- The level of R&D difficulty grows over time according to

$$\frac{\dot{X}(\omega, t)}{X(\omega, t)} = \mu[I(\omega, t) + I^*(\omega, t)],$$

  where $\mu > 0$ is a constant. This differential equation captures the notion that ideas that are easier to discover tend to be discovered earlier in time.
- The assumption $\mu > 0$ is the reason why the model does not have the scale effect property. In the first-generation endogenous growth model by Grossman and Helpman (1991), $\mu = 0$ is assumed and consequently the long-run economic growth rate is an increasing function of population size in their model.

- I solve the model for a symmetric steady-state equilibrium where both Home and Foreign innovation rates are constant over time and do not vary across industries: $I(\omega, t) = I = I^*(\omega, t) = I^*$ for all ω and t.
- It immediately follows that X does not vary across industries, that is, $X(\omega, t) = X(t)$ for all ω and t.
- Furthermore, I solve for a steady-state equilibrium where *relative R&D difficulty* $x(t) \equiv X(t)/N(t)$ is constant over time.
- Thus $X(t)$ grows over time at the constant population growth rate n and it follows that $\dot{X}(t)/X(t) = \mu[I + I^*] = \mu 2I = n$ fully determines the steady-state innovation rate

$$I = I^* = \frac{n}{2\mu}.$$

Growth rate of consumer utility

- Given the steady-state innovation rate, I can solve for the corresponding steady-state growth rate of consumer utility.
- By substituting for consumer demand $q_\theta = c_\theta/\lambda$ into the representative consumer's static utility function, I obtain

$$\begin{aligned} \ln u_\theta(t) &= \int_0^1 \ln\left[\lambda^{j(\omega,t)}\frac{c_\theta}{\lambda}\right] d\omega \\ &= \ln c_\theta - \ln\lambda + \int_0^1 \ln \lambda^{j(\omega,t)}\, d\omega, \end{aligned}$$

  where $j(\omega, t)$ is the number of quality improvements in industry ω from time 0 to time t.
- The last integral in this expression grows over time in the steady-state equilibrium as new higher-quality products are continuously being introduced.

- The value of $\int_0^1 \ln \lambda^{j(\omega,t)} d\omega$ equals $(I + I^*) t \ln \lambda$ or $2It \ln \lambda$.
- Thus, in the steady-state equilibrium, each consumer's utility grows at the deterministic rate

$$g_u \equiv \frac{\dot{u}_\theta(t)}{u_\theta(t)} = 2I \ln \lambda = \frac{n}{\mu} \ln \lambda.$$

- The utility growth rate g_u is completely determined by the exogenous rate of population growth n, the R&D difficulty growth parameter μ and the innovation size parameter λ. Utility growth is higher when the population of consumers grows more rapidly, when R&D difficulty increases more slowly over time and when innovations are of larger size.
- Since this utility growth rate is also the real wage growth rate, it is the proper measure of economic growth in the model.

- Equations $I = I^* = \frac{n}{2\mu}$ and $g_u \equiv \frac{\dot{u}_\theta(t)}{u_\theta(t)} = \frac{n}{\mu} \ln \lambda$ has two important implications.
- First, they imply that public policy changes like trade liberalization (a decrease in τ) have no effect on the steady-state rate of innovation I and hence the steady-state rate of economic growth g_u. In this model, growth is **semi-endogenous**.
- I view this as a virtue of the model because both total factor productivity and per capita GDP growth rates have been remarkably stable over time in spite of many public policy changes that one might think would be growth-promoting.
- For example, plotting data on per capita GDP (in logs) for the US from 1880 to 1987, Jones (1995a) shows that a simple linear trend fits the data extremely well. This data leads me to be skeptical about models where public policy changes have large long-run growth effects.

- Second, they imply that the level of per capita income in the long run is an increasing function of the size of the economy (because positive population growth is associated with positive economic growth).
- Jones (2005) has a lengthy discussion of this 'weak scale effect' property and cites Alcala and Ciccone (2004) as providing the best empirical support.
- Controlling for both trade and institutional quality, Alcala and Ciccone (2004) find that a 10 percent increase in the size of the workforce in the long run is associated with 2.5 percent higher GDP per worker.

R&D Incentives

- There is a global stock market that channels consumer savings to firms that engage in R&D.
- Because there is a continuum of industries with simultaneous R&D races, consumers can diversify completely the industry-specific risk and earn the risk-free interest rate $r = \rho$.
- Each firm engaged in R&D issues a security that pays the flow of monopoly profits if the firm wins the R&D race and zero if it does not win the race.
- Let $v(t)$ denote the expected discounted profits of a successful firm (i.e., quality leader) in each industry at time t.
- Because each quality leader is targeted by R&D firms in both countries that try to discover the next higher quality product, the shareholder suffers a loss $v(t)$ if further innovation occurs.

- This event (further innovation) occurs with probability $[I + I^*]dt$ during the time interval dt, whereas the event of no innovation occurs with probability $1 - [I + I^*]dt$.
- Over the time interval dt, the shareholder of a stock issued by a successful R&D firm receives a dividend $\pi(t)dt$ and the value of the firm appreciates by $\dot{v}(t)dt$.
- The stock market values the firm so that its expected rate of return just equals the riskless rate of return r:

$$\frac{\dot{v}(t)}{v(t)}[1 - (I + I^*)dt]dt - \frac{v(t) - 0}{v(t)}[I + I^*]dt + \frac{\pi(t)}{v(t)}dt = r\,dt.$$

- Dividing both sides by dt and then taking the limit as $dt \to 0$ yields $\frac{\dot{v}(t)}{v(t)} - [I + I^*] + \frac{\pi(t)}{v(t)} = r$, which can be rewritten as

$$v(t) = \frac{\pi(t)}{r + I + I^* - \dot{v}(t)/v(t)}.$$

- In the equation

$$v(t) = \frac{\pi(t)}{r + I + I^* - \dot{v}(t)/v(t)}.$$

  the global profit flow π earned by a quality leader is appropriately discounted using the instantaneous market interest rate r and the instantaneous probability $I + I^*$ of being driven out of business by further innovation (the creative-destruction effect).

- Also taken into account are the capital gains $\dot{v}/v$ that accrue to the firm as the world economy grows.

- Consider a firm i that is located in the Home country and engages in R&D.
- This firm chooses its R&D intensity I_i to maximize its expected discounted profits, that is, it solves the problem

$$\max_{I_i} v(t) I_i \, dt - w_H X(t) I_i \, dt, \text{ since } I_i \equiv h_i(t)/X(t) \Longrightarrow h_i(t) = X(t) I_i$$

- Free entry into each R&D race drives these expected discounted profits down to zero and implies that $v(t) = w_H X(t)$, which can be rewritten as

$$\frac{v(t)}{X(t)} = \frac{w_H}{w_L}.$$

- In steady-state equilibrium, the reward for innovating $v(t)$ increases over time as the economy grows but $X(t)$ also increases over time as innovating becomes progressively more difficult.

- The ratio $v(t)/X(t)$ measures the reward for innovating relative to its cost and can be thought of as the 'relative price of innovation'.
- Equation

$$\frac{v(t)}{X(t)} = \frac{w_H}{w_L}$$

implies that there is a direct relationship between the relative price of innovation $v(t)/X(t)$ and the relative wage of skilled workers w_H/w_L.
- This is a Schumpeterian version of the Stolper-Samuelson mechanism.
- I will show that trade liberalization increases the relative price of innovation and consequently the relative wage of skilled workers.

- Since $X(t)$ grows at the constant rate n, the free entry condition $v(t) = w_H X(t)$ implies that $v(t)$ also grows at the constant rate n.
- It follows that the free entry condition becomes

$$v(t) = \frac{cN(t)\left[2 - \frac{1+\tau}{\lambda}\right]}{\rho + I + I^* - \dot{v}/v} = w_H X(t).$$

- Dividing both sides by $N(t)$, I obtain the steady-state R&D condition:

$$\frac{c\left[2 - \frac{1+\tau}{\lambda}\right]}{\rho + 2I - n} = w_H x.$$

- The LHS is the market size-adjusted benefit from innovating and the RHS is the market size-adjusted cost of innovating.

$$\frac{c\left[2-\frac{1+\tau}{\lambda}\right]}{\rho+2I-n}=w_H x.$$

- In steady-state calculations, I need to adjust for market size because market size changes over time.
- The market size-adjusted benefit from innovating is higher when the average consumer buys more ($c \uparrow$), there are lower trade costs associated with exporting ($\tau \downarrow$), future profits are less heavily discounted ($\rho \downarrow$), quality leaders are less threatened by further innovation ($I \downarrow$) and quality leaders experience larger capital gains over time ($n \uparrow$).
- The market size-adjusted cost of innovating is higher when skilled workers earn a higher wage ($w_H \uparrow$), and innovating is relatively more difficult ($x \uparrow$).

Labour Markets

- Labour markets are perfectly competitive, workers are perfectly mobile across industries and wages adjust instantaneously to equate labour demand and labour supply.
- Because both countries are structurally identical, I concentrate on the derivation of equilibrium for the Home country.
- The demand for unskilled labour comes from production by quality leaders since only quality leaders produce in equilibrium and only skilled labour is employed in R&D activities.
- The assumption of structurally identical countries implies that 50 percent of the world's quality leaders are Home firms and 50 percent are Foreign firms.

- In industries with a Home quality leader (exporting industries), total output produced equals $Q_\ell + \tau Q_\ell^*$.
- The Home quality leader produces output Q_ℓ for the Home market and taking into account trade costs, the Home quality leader needs to produce output τQ_ℓ^* at Home in order to sell output Q_ℓ^* in the Foreign market.
- In industries with a Foreign quality leader, total Home output is zero.
- Therefore, the total output produced in the Home country is

$$q \equiv \frac{Q_\ell + \tau Q_\ell^*}{2} = \frac{cN(t)(1+\tau)}{2\lambda},$$

where q is the average quantity of final output produced in each industry.

- The Home demand for unskilled labour is given by

$$q \equiv \frac{Q_\ell + \tau Q_\ell^*}{2} = \frac{cN(t)(1+\tau)}{2\lambda}$$

and the supply of unskilled labour is given by equation

$$L(t) = \theta_0 N(t).$$

- Full employment of unskilled labour implies that

$$L(t) = \theta_0 N(t) = \frac{cN(t)(1+\tau)}{2\lambda}.$$

- Dividing both sides by $N(t)$ yields a market size-adjusted version of the full-employment condition for unskilled labour:

$$\theta_0 = \frac{c(1+\tau)}{2\lambda}.$$

- This equation

$$\theta_0 = \frac{c(1+\tau)}{2\lambda}$$

can be rewritten in a more convenient form by substituting for the unknown c.

- Equation

$$\theta_0 = \frac{w_L}{w_H} e^{\rho T} \Rightarrow w_H = e^{\rho T}/\theta_0$$

and then

$$\frac{c\left[2 - \frac{1+\tau}{\lambda}\right]}{\rho + 2I - n} = w_H x \Rightarrow c = \frac{(\rho + 2I - n)e^{\rho T} x}{\left[2 - \frac{1+\tau}{\lambda}\right]\theta_0}.$$

- Substituting for c yields the **steady-state unskilled labour condition** in (x, θ_0) space:

$$(\theta_0)^2 = \frac{(\rho + 2I - n)e^{\rho T}(1+\tau)}{\left[2 - \frac{1+\tau}{\lambda}\right] 2\lambda} x.$$

- Equation
$$(\theta_0)^2 = \frac{(\rho + 2I - n)e^{\rho T}(1+\tau)}{\left[2 - \frac{1+\tau}{\lambda}\right] 2\lambda} x$$
is a full employment condition for unskilled labour that takes into account the implications of profit-maximizing R&D behavior by firms.
- An increase in θ_0 increases the LHS, so x must increase on the RHS to restore equality, given that I is pinned down by parameter values ($I = I^* = \frac{n}{2\mu}$). It follows that the steady-state unskilled labour condition is upward-sloping in (x, θ_0) space.
- The intuition behind the upward slope: Suppose that there is a decline in the skilled wage w_H, making it less attractive for workers to acquire skills and increasing the supply of unskilled labour ($\theta_0 \uparrow$).

- In steady-state equilibrium, any increase in the supply of unskilled labour must be matched by an increase in the demand for unskilled labour.
- But firms only want to hire more unskilled workers in production (the only activity where they are employed by assumption) if there is stronger consumer demand for their products.
- Stronger consumer demand increases the benefit from innovating and the initial fall in the skilled wage w_H decreases the cost of innovating.
- Profit-maximizing firms respond to these incentives by devoting more resources to R&D, resulting in a long-run increase in relative R&D difficulty x.
- Thus, to satisfy both labour-market clearing and R&D optimization conditions, any increase in the supply of unskilled labour ($\theta_0 \uparrow$) must be matched by an increase in consumer expenditure, which stimulates R&D investment and serves to raise the long-run level of relative R&D difficulty x.

- The demand for skilled labour comes from R&D since only unskilled labour is employed in production activities.
- The Home demand for skilled labour in industry ω at time t is $X(t)I$.
- Since there is a measure one of industries where Home firms do R&D, the country-wide demand for skilled labour is also $X(t)I$.
- The Home supply of skilled labour is given by $H(t)$.
- Full employment of skilled labour then implies that $H(t) = \frac{[1-(\theta_0)^2]}{2} e^{-nT} N(t) = X(t)I$.
- Dividing both sides by $N(t)$, I obtain a market size-adjusted version of the full-employment condition for skilled labour:

$$\frac{[1-(\theta_0)^2]}{2} e^{-nT} = xI,$$

where I have used the steady-state property that relative R&D difficulty $x \equiv X(t)/N(t)$ is constant over time.

- Rearranging terms yields the *steady-state skilled labour condition* in (x, θ_0) space:

$$1 - (\theta_0)^2 = [2Ie^{nT}]x.$$

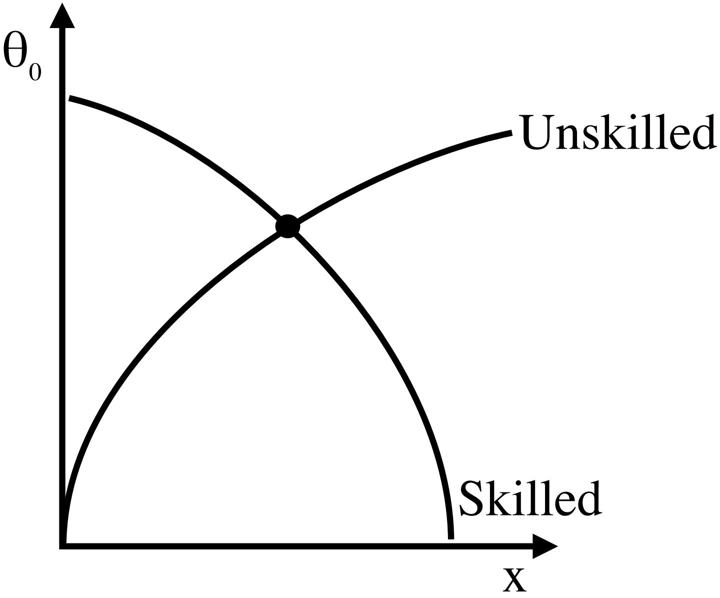
- This equation is a full employment condition for skilled labour that takes into account the skill acquisition process.
- An increase in θ_0 decreases the LHS, so x must decrease on the RHS to restore equality, given that I is pinned down by parameter values.
- It follows that the steady-state skilled labour condition is downward-sloping in (x, θ_0) space.

- The intuition behind the downward slope is straightforward: Suppose that there is a decline in the skilled wage w_H, making it less attractive for workers to acquire skills and decreasing the supply of skilled labour ($\theta_0 \uparrow$).
- In steady-state equilibrium, any decrease in the supply of skilled labour must be matched by a decrease in the demand for skilled labour.
- Since the steady-state innovation rate $I = \frac{n}{2\mu}$ is constant and given by parameter values, firms only hire less skilled workers in R&D (the only activity where they are employed by assumption) if R&D becomes relatively less difficult ($x \downarrow$).
- Thus, to satisfy market clearing for skilled labour, any decrease in the supply of skilled labour ($\theta_0 \uparrow$) must be matched by a decrease in the demand for skilled labour in R&D and this only occurs if R&D becomes relatively less difficult ($x \downarrow$).

Steady-State Equilibrium Properties

- Taking into account that $I = \frac{n}{2\mu}$ determines the steady-state innovation rate in each country, solving the model for a symmetric steady-state equilibrium reduces to solving the system of 2 equations [unskilled labour condition, skilled labour condition] in 2 unknowns [x, θ_0].
- These equations are illustrated in Figure 1 and are labeled 'Unskilled' and 'Skilled', respectively.
- Given that the steady-state unskilled labour condition is globally upward-sloping and goes through the origin, and the steady-state skilled labour condition is globally downward-sloping with strictly positive intercepts, these two curves must have a unique intersection.

Figure 1



- Thus, the steady-state equilibrium values of x and θ_0 are uniquely determined and are given by point A in Figure 1.
- Since

$$\theta_0 = \frac{w_L}{w_H} e^{\rho T}$$

then uniquely determines w_H, I have fully solved the model and have established

Theorem 1

The model has a unique symmetric steady-state equilibrium.

Trade Liberalization

- It is now straightforward to determine the steady-state equilibrium effects of trade liberalization that takes the form of a permanent reduction in trade costs τ.
- A decrease in τ has no effect on the skilled labour condition

$$1 - (\theta_0)^2 = [2le^{nT}]x.$$

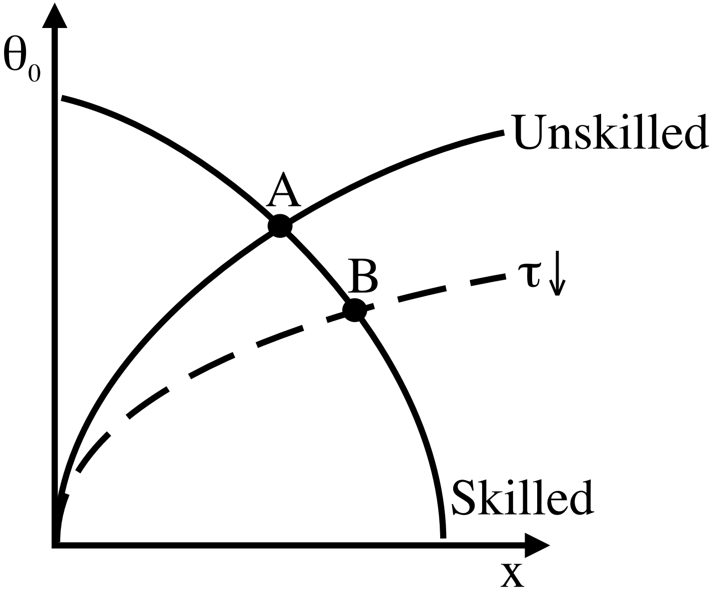
but causes the RHS of the unskilled labour condition

$$(\theta_0)^2 = \frac{(\rho + 2l - n)e^{\rho T}(1 + \tau)}{\left[2 - \frac{1+\tau}{\lambda}\right] 2\lambda} x.$$

to decrease for any given value of x.

- Thus, the unskilled labour condition shifts down as illustrated in Figure 2 and there is a new intersection of the two curves given by point B.

Figure 2



- A decrease in τ leads to a permanent decrease in θ_0 and a permanent increase in x.
- From

$$\theta_0 = \frac{w_L}{w_H} e^{\rho T},$$

the permanent decrease in θ_0 is associated with a permanent increase in w_H.

- To see the implications of the permanent increase in x, I take logs and differentiate the definition $x(t) \equiv \frac{X(t)}{N(t)}$ to obtain

$$\frac{\dot{x}(t)}{x(t)} = \frac{\dot{X}(t)}{X(t)} - \frac{\dot{N}(t)}{N(t)} = 2I\mu - n.$$

- In any steady-state equilibrium, $I = \frac{n}{2\mu}$ implies that x is constant over time ($\dot{x}(t) = 0$).
- Thus, for x to permanently increase, the global innovation rate in each industry $2I$ must temporarily increase above its steady-state level $2I = \frac{n}{\mu}$. [Given that convergence to a steady-state equilibrium is very slow for plausible parameter values, "temporarily increase" can mean "increase for more than 100 years."]

Theorem 2

Trade liberalization that takes the form of a permanent reduction in trade costs ($\tau \downarrow$) leads to

- *a permanent increase in the relative wage of skilled labour ($w_H/w_L \uparrow$),*
- *a permanent increase in the fraction of the population that chooses to acquire skills ($\theta_0 \downarrow$), and*
- *a temporary increase in the global innovation rate in each industry ($2I \uparrow$).*

Intuition

- When trade costs fall, firms earn higher profits from exporting their products and consequently their overall profits increase [$\tau \downarrow \Longrightarrow \pi \uparrow$].
- Because these profits are a reward for developing better products, it follow that when trade costs fall, firms have a stronger incentive to develop better products [$\tau \downarrow \Longrightarrow v(t) \uparrow$].
- The demand by firms for skilled workers capable of doing R&D increases, bidding up the relative wage of skilled labour [$w_H/w_L \uparrow$].
- When workers see that the reward for becoming skilled has gone up, more workers choose to undergo the training needed to acquire skills [$w_H/w_L \uparrow \Longrightarrow \theta_0 \downarrow$], R&D employment increases [$\theta_0 \downarrow \Longrightarrow (1-\theta_0)e^{-nT}N(t) \uparrow$] and the global economy experiences a faster rate of technological change [$x \uparrow \Longrightarrow 2I \uparrow$].

Reflection on Theorem 2

- In the widely used textbook *International Economics: Theory and Policy* by Paul Krugman, Maurice Obstfeld and Marc Melitz (2014), a case is made for why free trade is better than protectionism.
- It is argued that the conventionally measured costs of deviating from free trade are large, that there are additional benefits from free trade that add to the costs of protectionist policies when there are economies of scale in production, and any attempt to pursue sophisticated deviations from free trade is likely to be subverted by the political process.
- While all of these arguments are important, one of the potentially most important reasons for favoring free trade is not presented in standard textbooks like Krugman, Obstfeld and Melitz: namely, that trade liberalization promotes technological change.

- The argument is fairly easy to state.
- When trade barriers between countries are lowered, firms earn higher profits from exporting their products and consequently higher overall profits.
- Because these profits represent a reward for innovating and developing new products or lower cost ways of producing existing products, firms have a stronger incentive to innovate when there are lower trade barriers between countries.
- They devote more resources to research and development (R&D) and innovate more often.
- People living in these liberalizing countries benefit from faster technological change.

- More than any other development, what has led economists to take this argument seriously is the experience of the East Asian ‘tigers’: Hong Kong, Taiwan, South Korea and Singapore.
- While other developing economies pursued the strategy of import-substituting industrialization and experienced relatively low rates of economic growth, the East Asian ‘tigers’ adopted much more open trade policies and experienced ‘miracle’ rates of economic growth.
- Real Gross Domestic Product (GDP) in the ‘tiger’ economies grew at an average annual rate of 8-9 percent from the mid-1960s until the 1997 Asian financial crisis.
- This compares with 2-3 percent growth rates in the United States and Western Europe during the same time period.

- Since the East Asian 'tigers' were much more export-oriented than other developing economies and they experienced much higher rates of economic growth, the connection between trade policy and technological change could be very important, indeed, it could be more important for welfare than the static welfare gains from trade liberalization that are emphasized in standard economics textbooks.
- Thinking about the East Asian growth miracle lead Robert Lucas (1988) to write:
  "I do not see how one can look at figures like these without seeing them as representing possibilities. *Is there some action a government of India could take that would lead the Indian economy to grow like [South Korea's]? If so, what, exactly?...The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them, it is hard to think about anything else."*

Empirical Literature on Trade and Growth

- Sachs and Warner (1995) study 79 countries during the time period 1970-1989 and categorize each country as 'open' or 'closed'.
- A country is categorized as being 'open' if: for the duration of the 1970s and 1980s, the country's average tariff rate was less than 40 percent; non-tariff barriers covered less than 40 percent of trade; its black market exchange rate premium was less than 20 percent; there was no state monopoly on major exports; and there was no socialist economic system. If any of these five conditions is not satisfied, a country is categorized as 'closed'.
- Using this categorization, Sachs and Warner examine whether the real annual per capita growth in GDP over the time period 1970-1989 was higher for open countries than for closed countries.
- They find a surprisingly large and statistically significant effect: the average rate of economic growth for the open countries was 2.2 percent higher than for the closed countries.

- Sachs and Warners' conclusions have been called into question in a paper by Rodriguez and Rodrik (2000).
- They argue that the Sachs-Warner findings are less robust than claimed, because of difficulties in measuring openness, the statistical sensitivity of the specifications, the collinearity of protectionist policies with other bad policies, and other econometric difficulties.
- For example, Rodriguez and Rodrik point out that the Sachs-Warner dummy variable for openness derives its strength mainly from the combination of the black market premium (BMP) and the state monopoly of exports (XMB) variables. Very little of the dummy's statistical power would be lost if it were constructed using only these two indicators. In particular, there is little action in the two variables that are the most direct measures of trade policy: tariff and non-tariff barriers.
- The Rodriguez-Rodrik paper has led many economists to be skeptical (unfortunately) that open trade policies are significantly associated with economic growth.

- Wacziarg and Welch (2008) study a larger sample of 136 countries during the longer time period from 1950 to 2000.
- Wacziarg and Welch use the same five-part criterion for openness as in Sachs and Warner (1995) but instead of categorizing a country as being 'open' if it satisfies the openness criterion during the entire time period, they use the data to identify dates of trade liberalization.
- During the time period from 1950 to 2000, there are unique dates of trade liberalization for many countries, years when specific countries switched from being closed to being open.
- For example, the United Kingdom and the United States were already open in 1950, Sweden became open in 1960, Japan became open in 1964, Chile became open in 1976, Mexico became open in 1986, and both China and India were still closed in 2000.
- Responding to the Rodriguez-Rodrik critique, Wacziarg and Welch check that the dates of trade liberalization do not just capture changes in the black market premium or state monopoly of exports variables, but also reflect broader liberalization.

- Since dates of trade liberalization can be identified for many countries in the world, it is conceptually straightforward to ask the question, do countries tend to experience faster or slower economic growth rates after trade liberalization?
- Using standard statistical techniques for analyzing panel data, Wacziarg and Welch (2008) provide an answer to this question.
- They find that trade-centered reform has, on average, robust positive effects on economic growth rates within countries.
- For the typical country that switches from being closed to being open, the growth rate of real per capita GDP (income per person) increases by 1.4 percent.
- This estimate of 1.4 percent is both highly statistically significant and economically significant. It means that for a typical country growing at an average annual rate of 1.1 percent before trade liberalization, its average annual growth rate jumps up to 1.1 percent + 1.4 percent = 2.5 percent after trade liberalization.

Conclusion

- In the most careful study of the evidence to date, Wacziarg and Welch (2008) find that the typical country grows at an average annual rate of 1.1 percent before trade liberalization and its average annual growth rate jumps up to 2.5 percent after trade liberalization.
- Countries experience significantly higher growth rates after opening up to international trade.

Table: The Welfare Gains from Trade Liberalization, from Segerstrom and Stepanok (2017, "Learning How to Export", Scandinavian Journal of Economics)

Model of Trade	Change in Trade	Change in Welfare
Krugman (1980)	+10%	+0.5%
Eaton and Kortum (2002)	+10%	+0.5%
Melitz (2003)	+10%	+0.5%
A model of growth and trade with quality ladders	+10%	+ 5.0%

Evidence about Sweden

- In the essay "How Laissez-Faire Made Sweden Rich", Johan Norberg discusses the history of how Sweden became a rich country.
- Norberg writes: "Between 1850 and 1950 the average Swede's income multiplied eightfold, despite a doubling of population. Infant mortality fell from 15 to 2 per cent, and average life expectancy rose by an incredible 28 years. A poor peasant nation had become one of the world's richest countries."
- As the following table shows, Sweden had a higher GNP per capita (income per person) in 1950 than Denmark, France, West Germany, Italy, Japan, Netherlands, Portugal, Russia, Spain, Switzerland or the United Kingdom.

Table: Estimates of Real GNP per Capita for Selected Countries (in 1960 U.S. dollars). From David Landes (1999, *The Wealth and Poverty of Nations*, p. 232).

	1830	1913	1929	1950
Canada	280	1110	1220	1785
Denmark	225	885	955	1320
France	275	670	890	1055
West Germany	240	775	900	995
Italy	240	455	525	600
Japan	180	310	425	405
Netherlands	270	740	980	1115
Portugal	250	335	380	440
Russia/Soviet Union	180	345	350	600
Spain	—	400	520	430
Sweden	235	705	875	1640
Switzerland	240	895	1150	1590
United Kingdom	370	1070	1160	1400
United States	240	1350	1775	2415

- During the time period 1850-1950, there was a high rate of technological change in Sweden. Many innovations were introduced by swedish firms. For example, Alfred Nobel (1833-1896) invented dynamite and build up the firm Nitroglycerin AB, Lars Magnus Ericsson (1846-1926) invented an automatic telephone exchange and founded Ericsson, Sven Wingqvist (1876-1953) invented the self-regulating ball bearing and created SKF, and Jonas Wenström (1855-1893) invented the three-phase electric power system, the basis for ASEA (later ABB).
- Norberg attributes Sweden's success to the high level of economic freedom that the country had during this time period. In 1950, the total tax burden in Sweden was just 21%, lower than in the United States and other European countries. It was an open economy with a small government.

- Furthermore Norberg traces the high level of economic freedom in Sweden back to the ideas of a swedish priest Anders Chydenius (1729-1803).
- In 1763, Anders Chydenius submitted his entry for an essay competition. The question was the most important in Sweden at the time: "Why do so many people leave Sweden?" Emigration had increased and was seen as a big problem. The common view was that people were lazy and greedy and, rather than assume responsibility and work hard, they were lured by promises of an easier life abroad.
- Chydenius took the opposite view. There is nothing wrong with emigration, he thought. The problem was the oppressive and corrupt system that made it impossible for people to stay in Sweden and build a good life there. When detailing all the abuses, regulations and taxes that destroyed opportunities, Chydenius outlined a radical laissez-faire critique of the Swedish govenment.

- He argued that all the privileges, license requirements and trade prohibitions protected a small, lazy and indolent aristocracy, and stopped hardworking people from making their own fortune. High taxes confiscated whatever the people managed to create, a corrupt justice system made it impossible for them to win against the powerful and restrictions of the press made it illegal for them to complain about it. "Fatherland without freedom and merit is a big word with little meaning," he pointed out.
- Anders Chydenius was elected to the Swedish Parliament in Stockholm and served from 1765 to 1766. His ideas were so radical that his own political party kicked him out.
- However, during this short time period, he wrote a pamphlet *The National Gain* advocating free trade (11 years before Adam Smith's *The Wealth of Nations*) and succeeded in getting a law passed that resulted in drastic trade liberalization for towns along the Gulf of Bothnia. These towns gained the freedom to sell and ship goods directly to foreign customers.

- He was also successful in getting a 1766 freedom of the press law that abolished censorship in Sweden. This law was unique in the world at the time.
- Being kicked out of the Swedish Parliament did not hurt Chydenius's reputation. It showed that he had integrity and firmness to go against his own party. In 1779, Chydenius was back in Stockholm and he drafted a freedom of religion bill that gave Jews the right to settle in Sweden. It was Chydenius's bill that was signed into law by King Gustav III in 1781.
- Every other priest in Parliament voted against this bill. They found it scandalous that an elected priest would promote a bill that damages the church. But Chydenius pointed out that it is only gentleness and argumentation that can show people the Christian way, not coercion.
- Here are two famous Anders Chydenius quotes:

  "The exercise of one coercion always makes another inevitable."

  "I speak exclusively for the small, but blessed word, *freedom*."

Anders Chydenius (1729-1803)