1 Eaton and Kortum (2002)

1.1 Basic Assumptions

- $N$ countries, $i = 1, ..., N$
- Continuum of goods $u \in [0, 1]$
- Preferences are CES with elasticity of substitution $\sigma$:
  \[ U_i = \left( \int_0^1 q_i(u)^{(\sigma-1)/\sigma} \, du \right)^{\sigma/(\sigma-1)}, \]
- One factor of production (labor)
- There may also be intermediate goods (more on that later)
- $c_i \equiv$ unit cost of the "common input" used in production of all goods
  - Without intermediate goods, $c_i$ is equal to wage $w_i$ in country $i$
- Constant returns to scale:
  - $Z_i(u)$ denotes productivity of (any) firm producing $u$ in country $i$
  - $Z_i(u)$ is drawn independently (across goods and countries) from a Fréchet distribution:
    \[ \Pr(Z_i \leq z) = F_i(z) = e^{-z_i^{\theta}}, \]
    with $\theta > \sigma - 1$ (important restriction, see below)
  - Since goods are symmetric except for productivity, we can forget about index $u$ and keep track of goods through $Z \equiv (Z_1, ..., Z_N)$.
- Trade is subject to iceberg costs $d_{ni} \geq 1$
  - $d_{ni}$ units need to be shipped from $i$ so that 1 unit makes it to $n$
- All markets are perfectly competitive

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1. The notes are based on lecture slides with inclusion of important insights emphasized during the class.
1.2 Four Key Results

1.2.1 The Price Distribution

- Let $P_{ni}(Z) \equiv c_id_{ni}/Z_i$ be the unit cost at which country $i$ can serve a good $Z$ to country $n$ and let $G_{ni}(p) \equiv \Pr(P_{ni}(Z) \leq p)$. Then:
  \[ G_{ni}(p) = \Pr(Z_i \geq c_id_{ni}/p) = 1 - F_i(c_id_{ni}/p) \]

- Let $P_n(Z) \equiv \min\{P_{n1}(Z), ..., P_{nN}(Z)\}$ and let $G_n(p) \equiv \Pr(P_n(Z) \leq p)$ be the price distribution in country $n$. Then:
  \[ G_n(p) = 1 - \exp[-\Phi_n p^\theta] \]
  where
  \[ \Phi_n = \sum_{i=1}^{N} T_i(c_id_{ni})^{-\theta} \]

- To show this, note that (suppressing notation $Z$ from here onwards)
  \[ \Pr(P_n \leq p) = 1 - \Pi_i \Pr(P_{ni} \geq p) = 1 - \Pi_i [1 - G_{ni}(p)] \]

- Using
  \[ G_{ni}(p) = 1 - F_i(c_id_{ni}/p) \]
  then
  \[ 1 - \Pi_i [1 - G_{ni}(p)] = 1 - \Pi_i F_i(c_id_{ni}/p) = 1 - \Pi_i e^{-T_i(c_id_{ni})^{-\theta} p^\theta} = 1 - e^{-\Phi_n p^\theta} \]

1.2.2 The Allocation of Purchases

- Consider a particular good. Country $n$ buys the good from country $i$ if $i = \arg\min\{p_{n1}, ..., p_{nN}\}$. The probability of this event is simply country $i$’s contribution to country $n$’s price parameter $\Phi_n$,
  \[ \pi_{ni} = \frac{T_i(c_id_{ni})^{-\theta}}{\Phi_n} \]

- To show this, note that
  \[ \pi_{ni} = \Pr\left(P_{ni} \leq \min_{s \neq i} P_{ns}\right) \]

- If $P_{ni} = p$, then the probability that country $i$ is the least cost supplier to country $n$ is equal to the probability that $P_{ns} \geq p$ for all $s \neq i$
• The previous probability is equal to
\[ \Pi_{s \neq i} \Pr(P_{ns} \geq p) = \Pi_{s \neq i} [1 - G_{ns}(p)] = e^{-\Phi^{-1} p^\theta} \]

where
\[ \Phi_n^{-i} = \sum_{s \neq i} T_i (c_id_{ni})^{-\theta} \]

• Now we integrate over this for all possible \( p \)'s times the density \( dG_{ni} (p) \) to obtain
\[
\int_0^\infty e^{-\Phi^{-1} p^\theta} T_i (c_id_{ni})^{-\theta} \theta p^{\theta-1} e^{-T_i(c_id_{ni})^{-\theta} p^\theta} dp \\
= \left( \frac{T_i (c_id_{ni})^{-\theta}}{\Phi_n} \right) \int_0^\infty \theta \Phi_n e^{-\Phi_n q^\theta} p^{\theta-1} dp \\
= \pi_n \int_0^\infty dG_n (p) dp = \pi_n \]

### 1.2.3 The Conditional Price Distribution

• The price of a good that country \( n \) actually buys from any country \( i \) also has the distribution \( G_n(p) \).

• To show this, note that if country \( n \) buys a good from country \( i \) it means that \( i \) is the least cost supplier. If the price at which country \( i \) sells this good in country \( n \) is \( q \), then the probability that \( i \) is the least cost supplier is
\[ \Pi_{s \neq i} \Pr(P_{ni} \geq q) = \Pi_{s \neq i} [1 - G_{ns}(q)] = e^{-\Phi^{-1} q^\theta} \]

• The joint probability that country \( i \) has a unit cost \( q \) of delivering the good to country \( n \) and is the least cost supplier of that good in country \( n \) is then
\[ e^{-\Phi_n^{-1} q^\theta} dG_{ni}(q) \]

• Integrating this probability \( e^{-\Phi_n^{-1} q^\theta} dG_{ni}(q) \) over all prices \( q \leq p \) and using \( G_{ni}(q) = 1 - e^{-T_i(c_id_{ni})^{-\theta} q^\theta} \) then
\[
\int_0^p e^{-\Phi_n^{-1} q^\theta} dG_{ni}(q) \\
= \int_0^p \frac{e^{-\Phi_n^{-1} q^\theta} \theta T_i (c_id_{ni})^{-\theta} q^{\theta-1} e^{-T_i(c_id_{ni})^{-\theta} q^\theta}}{\Phi_n} dq \\
= \left( \frac{T_i (c_id_{ni})^{-\theta}}{\Phi_n} \right) \int_0^p \theta \Phi_n q^{\theta-1} dq \\
= \pi_n G_n(p) \]
- Given that $\pi_{ni} \equiv$ probability that for any particular good country $i$ is the least cost supplier in $n$, then conditional distribution of the price charged by $i$ in $n$ for the goods that $i$ actually sells in $n$ is
\[
\frac{1}{\pi_{ni}} \int_0^p e^{-\Phi_n q} dG_n(q) = G_n(p)
\]

- In Eaton and Kortum (2002):
  1. All the adjustment is at the extensive margin: countries that are more distant, have higher costs, or lower $T_0$s, simply sell a smaller range of goods, but the average price charged is the same.
  2. The share of spending by country $n$ on goods from country $i$ is the same as the probability $\pi_{ni}$ calculated above.

- We will establish a similar property in models of monopolistic competition with Pareto distributions of firm-level productivity.

1.2.4 The Price Index

- The exact price index for a CES utility with elasticity of substitution $\sigma < 1 + \theta$, defined as
\[
p_n \equiv \left(\int_0^1 p_n(u)^{1-\sigma} du\right)^{1/(1-\sigma)},
\]
is given by
\[
p_n = \gamma \Phi_n^{-1/\theta}
\]
where
\[
\gamma = \left[\Gamma\left(\frac{1 - \sigma}{\theta} + 1\right)\right]^{1/(1-\sigma)}
\]
where $\Gamma$ is the Gamma function, i.e. $\Gamma(a) \equiv \int_0^\infty x^{a-1} e^{-x} dx$.

- To show this, note that
\[
\int_0^\infty p_n^{1-\sigma} dG_n(p) = \int_0^\infty p^{1-\sigma} \Phi_n \theta p^{\theta-1} e^{-\Phi_n p^\theta} dp.
\]
• Defining $x = \Phi_n p^\theta$, then $dx = \Phi_n \theta p^{\theta - 1}$, $p^{1 - \sigma} = (x/\Phi_n)^{(1 - \sigma)/\theta}$, and

$$
p_n^{1 - \sigma} = \int_0^\infty (x/\Phi_n)^{(1 - \sigma)/\theta} e^{-x} dx
= \Phi_n^{-(1 - \sigma)/\theta} \int_0^\infty x^{(1 - \sigma)/\theta} e^{-x} dx
= \Phi_n^{-(1 - \sigma)/\theta} T \left( \frac{1 - \sigma}{\theta} + 1 \right)
$$

• This implies $p_n = \gamma \Phi_n^{-1/\theta}$ with $\frac{1 - \sigma}{\theta} + 1 > 0$ or $\sigma < 0$ for gamma function to be well defined.

1.3 Equilibrium

• Let $X_{ni}$ be total spending in country $n$ on goods from country $i$
• Let $X_n = \sum_i X_{ni}$ be country $n$’s total spending
• We know that $X_{ni}/X_n = \pi_{ni}$, so

$$X_{ni} = \frac{T_i(c_i d_{ni})^{-\theta}}{\Phi_n} X_n$$

(*)

• Suppose that there are no intermediate goods so that $c_i = w_i$.
• In equilibrium, total income in country $i$ must be equal to total spending on goods from country $i$ so

$$w_i L_i = \sum_n X_{ni}$$

• Trade balance further requires $X_n = w_n L_n$ so that

$$w_i L_i = \sum_n \frac{T_i(w_i d_{ni})^{-\theta}}{\sum_j T_j(w_j d_{nj})^{-\theta}} w_n L_n$$

• This provides system of $N - 1$ independent equations (Walras’ Law) that can be solved for wages ($w_1, ..., w_N$) up to a choice of numeraire. This is like an exchange economy, where countries trade their own labor.

• Everything is as if countries were exchanging labor
  – Fréchet distributions imply that labor demands are iso-elastic
  – Armington model leads to similar eq. conditions under assumption that each country is exogenously specialized in a differentiated good
– In the Armington model, the labor demand elasticity simply coincides with elasticity of substitution $\sigma$

- Under frictionless trade ($d_{ni} = 1$ for all $n, i$) previous system implies

$$w_i^{1+\theta} = \frac{T_i}{L_i} \sum_n w_n L_n$$

and hence

$$\frac{w_i}{w_j} = \left( \frac{T_i/L_i}{T_j/L_j} \right)^{1/(1+\theta)}$$

1.4 The Gravity Equation

- Letting $Y_i = \sum_n X_{ni}$ be country $i$’s total sales, then

$$Y_i = \sum_n T_i (c_i d_{ni})^{-\theta} X_n = T_i c_i^{-\theta} \Omega_i^{-\theta}$$

where

$$\Omega_i^{-\theta} = \sum_n d_{ni}^{-\theta} X_n / \Phi_n$$

- Solving $T_i c_i^{-\theta}$ from $Y_i = T_i c_i^{-\theta} \Omega_i^{-\theta}$ and plugging into (*) we get

$$X_{ni} = X_n Y_i d_{ni}^{-\theta} \Omega_i^\theta / \Phi_n$$

- Using $p_n = \gamma \Phi_n^{-1/\theta}$ we can then get

$$X_{ni} = \gamma^{-\theta} X_n Y_i d_{ni}^{-\theta} (p_n \Omega_i)^\theta$$

- This is the Gravity Equation, with bilateral resistance $d_{ni}$ and multi-lateral resistance terms $p_n$ (inward) and $\Omega_i$ (outward).

1.4.1 A Primer on Trade Costs

- From (*) we also get that country $i$’s share in country $n$’s expenditures normalized by its own share is

$$S_{ni} = \frac{X_{ni}/X_n}{X_{ii}/X_i} = \frac{\Phi_i d_{ni}^{-\theta}}{\Phi_n} = \left( \frac{p_i d_{ni}}{p_n} \right)^{-\theta}$$
This shows the importance of trade costs and comparative advantage in determining trade volumes. Note that if there are no trade barriers (i.e., frictionless trade), then $S_{ni} = 1$.

Letting $B_{ni} \equiv \left( \frac{X_{ni}}{X_{ii}} \cdot \frac{X_{in}}{X_{nn}} \right)^{1/2}$ then

$$B_{ni} = (S_{ni}S_{in})^{1/2} = (d_{ni}^{-\theta}d_{in}^{-\theta})^{1/2}$$

Under symmetric trade costs (i.e., $d_{ni} = d_{in}$) then $B_{ni}^{-1/\theta} = d_{ni}$ can be used as a measure of trade costs.

We can also see how $B_{ni}$ varies with physical distance between $n$ and $i$.

2 How to Estimate the Trade Elasticity?

- As we will see the trade elasticity $\theta$ is the key structural parameter for welfare and counterfactual analysis in EK model.

- Cannot estimate $\theta$ directly from $B_{ni} = d_{ni}^{-\theta}$ because distance is not an empirical counterpart of $d_{ni}$ in the model.
  - Negative relationship in Figure 1 could come from strong effect of distance on $d_{ni}$ or from mild CA (high $\theta$).

- Consider again the equation
  $$S_{ni} = \left( \frac{p_id_{ni}}{p_n} \right)^{-\theta}$$
If we had data on \( d_{ni} \), we could run a regression of \( \ln S_{ni} \) on \( \ln d_{ni} \) with importer and exporter dummies to recover \( \theta \).

- But how do we get \( d_{ni} \)?

EK use price data to measure \( p_i d_{ni}/p_n \):

- They use retail prices in 19 OECD countries for 50 manufactured products from the UNICP 1990 benchmark study.

- They interpret these data as a sample of the prices \( p_i(j) \) of individual goods in the model.

- They note that for goods that \( n \) imports from \( i \) we should have \( p_n(j)/p_i(j) = d_{ni} \), whereas goods that \( n \) doesn’t import from \( i \) can have \( p_n(j)/p_i(j) \leq d_{ni} \).

- Since every country in the sample does import manufactured goods from every other, then \( \max_j \{p_n(j)/p_i(j)\} \) should be equal to \( d_{ni} \).

- To deal with measurement error, they actually use the second highest \( p_n(j)/p_i(j) \) as a measure of \( d_{ni} \).

- Let \( r_{ni}(j) \equiv \ln p_n(j) - \ln p_i(j) \). They calculate \( \ln(p_n/p_i) \) as the mean across \( j \) of \( r_{ni}(j) \). Then they measure \( \ln(p_i d_{ni}/p_n) \) by

\[
D_{ni} = \frac{\max_j \{r_{ni}(j)\}}{\sum_j r_{ni}(j)/50}
\]

- Given \( S_{ni} = \left( \frac{p_i d_{ni}}{p_n} \right)^{-\theta} \) they estimate \( \theta \) from \( \ln(S_{ni}) = -\theta D_{ni} \). Method of moments: \( \theta = 8.28 \). OLS with zero intercept: \( \theta = 8.03 \).
2.1 Alternative Strategies

- Simonovska and Waugh (2011) argue that EK’s procedure suffers from upward bias:
  - Since EK are only considering 50 goods, maximum price gap may still be strictly lower than trade cost
  - If we underestimate trade costs, we overestimate trade elasticity
  - Simulation based method of moments leads to a $\theta$ closer to 4.

- An alternative approach is to use tariffs (Caliendo and Parro, 2011). If $d_{ni} = t_{ni} \tau_{ni}$ where $t_{ni}$ is one plus the ad-valorem tariff (they actually do this for each 2 digit industry) and $\tau_{ni}$ is assumed to be symmetric, then

$$\frac{X_{ni}X_{ij}X_{jn}}{X_{nj}X_{ji}X_{in}} = \left( \frac{d_{ni}d_{ij}d_{jn}}{d_{nj}d_{ji}d_{in}} \right)^{-\theta} = \left( \frac{t_{ni}t_{ij}t_{jn}}{t_{nj}t_{ji}t_{in}} \right)^{-\theta}$$

- They can then run an OLS regression and recover $\theta$. Their preferred specification leads to an estimate of 8.22

2.2 Gains from Trade

- Consider again the case where $c_i = w_i$

- From (*), we know that

$$\pi_{nn} = \frac{X_{nn}}{X_n} = \frac{T_n w_n^{-\theta}}{\Phi_n}$$

- We also know that $p_n = \gamma \Phi_n^{-1/\theta}$, so

$$\omega_n \equiv w_n/p_n = \gamma^{-1} T_n^{1/\theta} \pi_{nn}^{-1/\theta}.$$ 

- Under autarky we have $\omega_n^A = \gamma^{-1} T_n^{1/\theta}$, hence the gains from trade are given by

$$GT_n \equiv \omega_n/\omega_n^A = \pi_{nn}^{-1/\theta}$$

- Trade elasticity $\theta$ and share of expenditure on domestic goods $\pi_{nn}$ are sufficient statistics to compute GT

- A typical value for $\pi_{nn}$ (manufacturing) is 0.7. With $\theta = 5$ this implies $GT_n = 0.7^{-1/5} = 1.074$ or 7.4% gains. Belgium has $\pi_{nn} = 0.2$, so its gains are $GT_n = 0.2^{-1/5} = 1.38$ or 38%. 


• One can also use the previous approach to measure the welfare gains associated with any foreign shock, not just moving to autarky:

\[
\omega_n^T / \omega_n = \left( \frac{\pi_n^T}{\pi_{nn}} \right)^{-1/\theta}
\]

• For more general counterfactual scenarios, however, one needs to know both \( \pi_n^T \) and \( \pi_{nn} \).

2.2.1 Adding an Input-Output Loop

• Imagine that intermediate goods are used to produce a composite good with a CES production function with elasticity \( \sigma > 1 \). This composite good can be either consumed or used to produce intermediate goods (input-output loop).

• Each intermediate good is produced from labor and the composite good with a Cobb-Douglas technology with labor share \( \beta \). We can then write \( c_i = w_i^\beta p_i^{1-\beta} \).

• The analysis above implies

\[
\pi_{nn} = \gamma^{-\theta} T_n \left( \frac{c_n}{p_n} \right)^{-\theta}
\]

and hence

\[
c_n = \gamma^{-1} T_n^{-1/\theta} \pi_{nn}^{-1/\theta} p_n
\]

• Using \( c_n = w_n^\beta p_n^{1-\beta} \) this implies

\[
w_n^\beta p_n^{1-\beta} = \gamma^{-1} T_n^{-1/\theta} \pi_{nn}^{-1/\theta} p_n
\]

so

\[
w_n/p_n = \gamma^{-1/\beta} T_n^{-1/\theta} \pi_{nn}^{-1/\theta \beta}
\]

• The gains from trade are now

\[
\omega_n/\omega_n^A = \pi_{nn}^{-1/\theta \beta}
\]

• Standard value for \( \beta \) is 1/2 (Alvarez and Lucas, 2007). For \( \pi_{nn} = 0.7 \) and \( \theta = 5 \) this implies \( GT_n = 0.7^{-2/5} = 1.15 \) or 15% gains.

2.2.2 Adding Non-Tradables

• Assume now that the composite good cannot be consumed directly.

• Instead, it can either be used to produce intermediates (as above) or to produce a consumption good (together with labor).
The production function for the consumption good is Cobb-Douglas with labor share $\alpha$.

This consumption good is assumed to be non-tradable.

The price index computed above is now $p_{gn}$, but we care about $\omega_n \equiv w_n/p_{fn}$, where

$$p_{fn} = w_n^\alpha p_{gn}^{1-\alpha}$$

This implies that

$$\omega_n = \frac{w_n}{w_n^\alpha p_{gn}^{1-\alpha}} = \left(\frac{w_n}{p_{gn}}\right)^{1-\alpha}$$

Thus, the gains from trade are now

$$\frac{\omega_n}{\omega_n^A} = \frac{\pi_{nn}^{-\eta/\theta}}{\eta}$$

where

$$\eta \equiv \frac{1-\alpha}{\beta}$$

Alvarez and Lucas argue that $\alpha = 0.75$ (share of labor in services). Thus, for $\pi_{nn} = 0.7$, $\theta = 5$ and $\beta = 0.5$, this implies $GT_n = 0.7^{-1/10} = 1.036$ or 3.6% gains

3 Comparative statics (Dekle, Eaton and Kortum, 2008)

- Go back to the simple EK model above ($\alpha = 0$, $\beta = 1$). We have

$$X_{ni} = \gamma^{-\theta} T_i(w_i d_{ni})^{-\theta} p_n^{\theta} X_n$$

$$p_n^{-\theta} = \gamma^{-\theta} \sum_{i=1}^N T_i(w_i d_{ni})^{-\theta}$$

$$\sum_n X_{ni} = w_i L_i$$

- As we have already established, this leads to a system of non-linear equations to solve for wages,

$$w_i L_i = \sum_n \frac{T_i(w_i d_{ni})^{-\theta}}{\sum_k T_k (w_k d_{nk})^{-\theta}} w_n L_n.$$

- Consider a shock to labor endowments, trade costs, or productivity. One could compute the original equilibrium, the new equilibrium and compute the changes in endogenous variables.
But there is a simpler way that uses only information for observables in the initial equilibrium, trade shares and GDP; the trade elasticity, $\theta$; and the exogenous shocks. First solve for changes in wages by solving

$$\dot{w}_i \dot{L}_i Y_i = \sum_n \pi_{ni} \dot{T}_i \left( \dot{w}_i \dot{d}_{ni} \right)^{-\theta} \dot{\pi}_n \dot{L}_n Y_n$$

and then get changes in trade shares from

$$\dot{\pi}_{ni} = \frac{\dot{T}_i \left( \dot{w}_i \dot{d}_{ni} \right)^{-\theta}}{\sum_k \pi_{nk} \dot{T}_k \left( \dot{w}_k \dot{d}_{nk} \right)^{-\theta}}.$$

From here, one can compute welfare changes by using the formula above, namely $\dot{\omega}_n = (\ddot{\pi}_{nn})^{-1/\theta}$.

To show this, note that trade shares are

$$\pi_{ni} = \frac{T_i \left( w_i d_{ni} \right)^{-\theta}}{\sum_k T_k \left( w_k d_{nk} \right)^{-\theta}} \quad \text{and} \quad \pi'_{ni} = \frac{T_i' \left( w_i' d_{ni} \right)^{-\theta}}{\sum_k T_k' \left( w_k' d_{nk} \right)^{-\theta}}.$$

Letting $\dot{x} = x' / x$, then we have

$$\ddot{\pi}_{ni} = \frac{\ddot{T}_i \left( \dot{w}_i \dot{d}_{ni} \right)^{-\theta}}{\sum_k \dot{T}_k \left( \dot{w}_k \dot{d}_{nk} \right)^{-\theta} / \sum_j T_j \left( w_j d_{nj} \right)^{-\theta}} = \frac{\ddot{T}_i \left( \dot{w}_i \dot{d}_{ni} \right)^{-\theta}}{\sum_k \dot{T}_k \left( \dot{w}_k \dot{d}_{nk} \right)^{-\theta} / \sum_j T_j \left( w_j d_{nj} \right)^{-\theta}}.$$

On the other hand, for equilibrium we have

$$w_i' L_i = \sum_n \pi_{ni} w_i' L_n = \sum_n \ddot{\pi}_{ni} \dddot{\pi}_{ni} w_n' L_n'$$

Letting $Y_n = w_n L_n$ and using the result above for $\ddot{\pi}_{ni}$ we get

$$\dot{w}_i \dot{L}_i Y_i = \sum_n \pi_{ni} \dot{T}_i \left( \dot{w}_i \dot{d}_{ni} \right)^{-\theta} \dot{\pi}_n \dot{L}_n Y_n$$
• This forms a system of $N$ equations in $N$ unknowns, $\hat{w}_i$, from which we can get $\hat{w}_i$ as a function of shocks and initial observables (establishing some numeraire). Here $\pi_{ni}$ and $Y_i$ are data and we know $\hat{d}_{ni}$, $\hat{T}_i$, $\hat{L}_i$, as well as $\theta$.

• To compute the implications for welfare of a foreign shock, simply impose that $L_n = T_n = 1$, solve the system above to get $\hat{w}_i$ and get the implied $\hat{\pi}_{nn}$ through

$$\hat{\pi}_{ni} = \frac{\hat{T}_i \left( \hat{w}_i \hat{d}_{ni} \right)^{-\theta}}{\sum_k \pi_{nk} \hat{T}_k \left( \hat{w}_k \hat{d}_{nk} \right)^{-\theta}},$$

and use the formula to get

$$\hat{\omega}_n = \hat{\pi}_{nn}^{-1/\theta}$$

• Of course, if it is not the case that $L_n = T_n = 1$, then one can still use this approach, since it is easy to show that in autarky one has $w_n/p_n = T_n^{1/\theta}$, hence in general

$$\hat{\omega}_n = \left( \hat{T}_n \right)^{1/\theta} \hat{\pi}_{nn}^{-1/\theta}$$

4 Extensions of EK

• **Bertrand Competition:** Bernard, Eaton, Jensen, and Kortum (2003)
  - Bertrand competition $\Rightarrow$ variable markups at the firm-level
  - Measured productivity varies across firms $\Rightarrow$ one can use firm-level data to calibrate model

• **Multiple Sectors:** Costinot, Donaldson, and Komunjer (2012)
  - $T_{ik}^k$ fundamental productivity in country $i$ and sector $k$
  - One can use EK’s machinery to study pattern of trade, not just volumes

• **Non-homothetic preferences:** Fieler (2011)
  - Rich and poor countries have different expenditure shares
  - Combined with differences in $\theta^k$ across sectors $k$, one can explain pattern of North-North, North-South, and South-South trade