Across many developed countries, real average hourly earnings have stagnated or fallen for less skilled workers while wages for skilled workers continue to rise since the 1970s.

Consequently, the “skill premium” has increased leading to increased wage inequality.

At the same time, trade volume (as a proportion of GDP) has increased rapidly since the early 1980s.

Trade Agreements.
“Death of distance”

Is there a connection? If so, how strong is it?
Source: DeNavas-Walt, Carmen; B. D. Proctor, R. J. Mills (08 2004)
▶ Inequality has grown by 40% based on the measures above.
▶ Inequality has increased by approximately 25% based on more common survey measures.
▶ This summarizes the discussion in Freeman (1995), Bivens (2007), and Krugman (2008).
▶ From the perspective of developed countries opening up to trade with developing countries, the Heckscher-Ohlin model makes a sharp (testable) prediction.
▶ Instead of capital and labor, suppose that the two factors of production are skilled and unskilled labor.
For simplicity....

Two countries: China and Canada.

Two factors: skilled and unskilled labor.

- China possesses a relative abundance of unskilled labor.

Two goods: Skilled and unskilled labor intensive goods.

This augments the previous HO diagram to:
Canada’s abundant factor (skilled labor) will win and its scarce factor (unskilled labor) will lose.

In the real world, complete factor price equalization is unlikely to occur:
- Transportation costs
- Productivity differences
- Among others...

However, the direction of the change is likely to hold.
Effect of Trade on Wages

- **HO Mechanism:**
  - Canada has a Comparative Advantage in skill-intensive sectors because it is skill-abundant.
  - The price of skill-intensive goods is increased through trade and skilled wage increase.
  - Both sectors use less skilled labor because of the wage change.
  - But the skill-intensive sector expands and the unskilled-labor-intensive sector contracts.

- **Key comparative static:** If wage-changes are due to trade, then $S/U$ and $w_S/w_U$ are negatively correlated at the industry level.
  - Firms substitute away from more expensive factor.
Recall our basic Lerner diagram with computers being skilled-labor intensive and textiles unskilled-labor intensive.
As $\frac{w_s}{w_u}$ ↑ due to trade, firms will substitute toward more unskilled labor intensive techniques such that as $S/U \downarrow$. 
Now let’s instead consider **Skill-Biased Technological Change** (SBTC) as a source of inequality.

Let’s first make some important distinctions:

- Technological Change is **Factor-Biased** if it makes one factor more productive
- Technological Change is **Sector-Biased** if it makes one sector more productive
- Technological Change is **Factor-Augmenting** if it raises the return to one factor

If technological change explains the increasing wage-inequality, it needs to be skill-augmenting.

When is technological change skill-augmenting?
Consider the following Cobb-Douglas production functions for textiles and computers:

\[ Q_T = A_T S_T^\alpha U_T^{1-\alpha} \quad Q_C = A_C S_C^\beta U_C^{1-\beta} \]

Firms producing \( X \) maximize \( P_X Q_X - w_S S_X - w_U U_X \)

First Order Conditions (FOC) give:

1. \( w_S = p_T A_T \alpha S_T^{\alpha-1} U_T^{1-\alpha} \)
2. \( w_U = p_T A_T (1 - \alpha) S_T^\alpha U_T^{-\alpha} \)
3. \( w_S = p_C A_C \beta S_C^{\beta-1} U_C^{1-\beta} \)
4. \( w_U = p_C A_C (1 - \beta) S_C^\beta U_C^{-\beta} \)

Dividing (1)/(2) and (3)/(4) gives us:

\[ \frac{w_S}{w_U} = \frac{\alpha U_T}{1-\alpha S_T} \quad \frac{w_S}{w_U} = \frac{\beta U_C}{1-\beta S_C} \]
Setting (1)=(3) and plugging in the two expressions for \( \frac{w_s}{w_u} \) gives us:

\[
\left( \frac{w_U}{w_S} \right)^{\beta - \alpha} = \frac{p_T}{p_C} \frac{A_T}{A_C} (1 - \alpha)^{(1 - \alpha)} \alpha^\alpha (1 - \beta)^{(1 - \beta)} \beta^\beta
\]

- Let’s consider skill-biased and sector-biased technological change:
  - skill-biased TC raises \( \alpha \) and \( \beta \) while sector-biased TC changes \( \frac{A_T}{A_C} \).
  - You can check that the effect of changes in \( \alpha \) and \( \beta \) on \( \left( \frac{w_U}{w_S} \right) \) is non-monotonic: it does not always raise the return to skill!
  - But the effect of an increase in \( \frac{A_C}{A_T} \) on \( \left( \frac{w_S}{w_U} \right) \) is always positive.
  - What’s the message? We need TC to be at least partly sector-biased to be skill-augmenting.
Purely Factor-Biased Technological Change (both isoquants tilt toward skill) can leave w/r unaffected
Sector-Biased Technological Change always changes w/r
There is a big debate on whether SBTC in the past decades has been more sector- or more factor-biased.

Key for us: As long as it was partly sector-biased, $w_s/w_u$ and $S/U$ will go up together.

We have therefore arrived at two alternative explanations of the rise $w_s/w_u$ but the two explanations give us different predictions on the corresponding changes in $S/U$ at the industry level.
Trade theory predicts, counter-factually, that $S/U$ must be declining at the industry level when $w_s/w_u$ goes up.

This gives us an ability to identify one story from another

Maybe now the “Two Cheers for Formalism” in the introductory slide are more compelling?

Data show that $S/U$ has been rising dramatically within industries since the 1970s.

Skill-Upgrading has happened across the board in all sectors.

Whatever the exact form of SBTC, the pattern of wages looks a lot more like the SBTC story than the trade story.
Now we know that SBTC was a much stronger force in changing wage-inequality relative to trade.

But we also want to know how strong of a force trade was in absolute terms.

Two types of empirical studies have been used to assess the magnitude of the effect of trade on wages: Factor Content and Price Change studies.

- **Factor Content** studies look at trade and calculate how much labor is being exported/imported and how much this shifts the relative supply curve of skilled to unskilled labor for a country.

- **Price Change** studies exploit the fact that both factor prices and goods prices should be changing (Stolper-Samuelson Effects).

Intuition for Factor-Content Studies: Everyone consumes on the diagonal of the Edgeworth-box. The larger the factor-content of trade, the more different a country is from the world average endowment mix and the larger are the changes in relative wages implied by trade.
Ask how much trade in factors is implied by trade in goods.
Start with the volume of exports and imports.
Use unit labor requirements to calculate how much labor (net) imports embody.
Designed to see how much the relative supply of skilled workers has shifted.
Assumes an aggregate relative factor demand curve for the economy and asks how much a change in the RS curve for factors affects relative wages.
Assume that the North specializes in computers and the South specializes in textiles. Let $X_C^N$ and $X_T^S$ be Northern exports of computers to the South and Southern exports of textiles to the North, respectively.

- $a_{S,C}^N$ is the unit skilled labor requirement computers in the North and $a_{U,C}^N$ is the unit unskilled labor requirement computers in the North.
- $a_{S,T}^S$ is the unit skilled labor requirement textiles in the South and $a_{U,T}^S$ is the unit unskilled labor requirement computers in the South.
- Define $S_{trade}^N$ and $U_{trade}^N$ as the skilled and unskilled labor that is embodied in the exports of the North. Similar terms apply to the South.
- Define $S^N$ and $U^N$ as the absolute skilled and unskilled labor endowments in the North.
\[ S^{N}_{\text{trade}} = a_{S,C}^{N} X_{C}^{N} + a_{S,T}^{N} X_{T}^{N} \]

\[ S^{S}_{\text{trade}} = a_{S,C}^{S} X_{C}^{S} + a_{S,T}^{S} X_{T}^{S} \]

\[ U^{N}_{\text{trade}} = a_{U,C}^{N} X_{C}^{N} + a_{U,T}^{N} X_{T}^{N} \]

\[ U^{S}_{\text{trade}} = a_{U,C}^{S} X_{C}^{S} + a_{U,T}^{S} X_{T}^{S} \]

The new amounts of skilled and unskilled labor in the North will be

\[ \tilde{S}^{N} = S^{N} - S^{N}_{\text{trade}} + S^{S}_{\text{trade}} \]

\[ \tilde{U}^{N} = U^{N} - U^{N}_{\text{trade}} + U^{S}_{\text{trade}} \]

\[ \tilde{S}^{S} = S^{S} - S^{S}_{\text{trade}} + S^{N}_{\text{trade}} \]

\[ \tilde{U}^{S} = U^{S} - U^{S}_{\text{trade}} + U^{N}_{\text{trade}} \]

\[ \tilde{S}^{N}, \tilde{U}^{N} \] denote the factor content of the North’s Consumption bundle.
Factor Content Studies: Example

- Suppose that the $S^N = 200$ and $U^N = 100$. For the South, $S^S = 100$ and $U^S = 200$.

- Suppose that the North exports 10 computers and the South exports 10 units of textiles. Assume that all other trade values are zero.

- Assume that unit labor requirements are as follows:
  
  $a^N_{S,C} = \frac{1}{5}$ \quad $a^S_{S,T} = \frac{1}{10}$
  
  $a^N_{U,C} = \frac{1}{10}$ \quad $a^S_{U,T} = \frac{1}{5}$

- Verify that trade leads to the North “importing” 1 unit of unskilled labor and “exporting” one unit of skilled labor.

- This leads to: $\tilde{S}^N = 199$, $\tilde{S}^S = 101$, $\tilde{U}^N = 101$, $\tilde{S}^U = 199$. 

A country that imports unskilled-labor-intensive goods is importing unskilled labor through the factor content.

The larger the factor content of trade, the stronger the forces of factor price equalization.

The factor-content of trade turns out to be much smaller than predicted by theory.
Price Change Studies

- We should also see convergence in goods prices.
- Use goods prices and assumptions about the shape of the SS curve to see how much trade might have changed wages.
- We should also see the price of unskilled-labor-intensive goods falling in developed (skill abundant) countries.
Price Change Studies

- Let’s go back and look at the HO graph:
Both types of studies find that increased trade has led to increased inequality in the OECD.

However, both find that the magnitudes only explain approximately 4%-6% of the 24% change in inequality since the mid 1970s.

Recall that imports from China and India have surged over the past 10 years and the study by Freeman (1995) is 13 years old. Do these calculations still hold up?

Bivens (2007) shows that trade has contributed little to inequality even up to today.

Krugman (2008) shows that this is somewhat of a paradox. Imports are coming from more unskilled labor abundant countries than ten years ago. Why is there no noticeable change?
Wage inequality has been increasing in the OECD in the 80s and 90s.
At the same time, the trade volume has expanded enormously.
HO Theory tells us that trade with developing countries has contributed to the deterioration of the relative wage of unskilled workers. However:
1. Trends at the industry level are inconsistent with trade models.
2. Factor Content and Stolper Samuelson studies suggest that trade only explains approximately 20 – 25% of the total deterioration (6% of about 25%) based on data from the Current Population Survey.
But SBTC is (by far) the most important determinant of the increased inequality.
What about developing countries?
Factor-Proportions Theory predicts that the skill premium in developing countries should fall. The skill premium has increased leading to increased wage inequality in many developing countries. HO gets it exactly wrong in these developing countries. Data for East Asia is still coming out. Runjuan Liu (2008) finds that Chinese provinces more subject to trade have seen inequality grow more.

In Latin America, we see the opposite of the HO predictions.
The Consensus in the late 90’s was that SBTC was the most important driving force in changing inequality across the globe.

Two recent theoretical and empirical research agendas have revitalized this debate:

1. Directed Technological Change (DTC)
2. Trade in intermediate products
Directed Technological Change

- Increasing evidence that TC is the result of firms’ R&D efforts
  - TC is “directed”!
- It can be shown that the TC will in equilibrium always be directed towards the sectors that use the abundant factor intensively.
- This means that firms in the North innovate to increase $\frac{A_C}{A_T}$ and firms in the South innovate to reduce $\frac{A_C}{A_T}$.
- This has interesting implications:
DTC in the North

- It can be shown that firms’ incentives to innovate “toward” the abundant factor are stronger with trade (as the return to the abundant factor increase)

- This implies in the North that:
  1. DTC is consistent with the SBTC explanation of rising wage-inequality
  2. but that trade might cause part of this SBTC so that trade might be to blame after all
In the South, DTC poses a puzzle:

If HO gets it exactly wrong and SBTC is the only alternative explanations, then DTC gets it exactly wrong because firms should innovate “towards” unskilled labor.

An important piece of the puzzle probably lies in the fact that developing countries are not on the technology innovation frontier, instead they are on a technology adoption frontier that lies inside the innovation frontier.

However, Southern firms would still have an incentive to adopt the most unskilled-labor-biased innovations.

The real explanation probably lies with the importance of trade in intermediate products and outsourcing/offshoring.

we will explore this issue at the end of this course.