

# Binding Up the Nation's Wounds: An Economic Analysis of the Korean Reunification

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Work in progress—Abstract and presentation slides

## Abstract

When economies of different levels of development integrate, the post-integration transition dynamics is slow and the convergence between the economies is accompanied by divergences within. We develop a task-based macro model with individual skill heterogeneity that can account for these facts. In the model, individuals sort into differentiated worker tasks (or occupations) and differentiated managerial tasks based on one-dimensional skill. Managers produce differentiated products, and each product combines worker tasks differently for production, in a way that in equilibrium there is positive assortative one-to-many matching between managers and workers. Individual skills are accumulated stochastically over the life cycle.

In our theoretical analysis, imperfect substitutability across worker tasks is key for the income divergences within along the transition, and the life-cycle considerations can explain the slow convergence between the economies.

We apply the model to a hypothetical reunification of North and South Korea. Although data on North Korea is almost non-existent, we overcome this challenge by putting together available data on North Korean refugees in the south and on South Korean firms that operated in (now-defunct) Kaesong Industrial Complex employing North Korean workers. Using the model, we project the transitional dynamics of the unified Korean economy under various integration scenarios and policy regimes.

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## Broader Question: Economic Integration

- Removal/reduction of barriers to the flow of goods, capital, labor and technology across economies
- To varying degrees:
  - Within-country integration:  
e.g. China (hukou), post-apartheid South Africa
  - (Re-)Unification:  
e.g. East/West Germany, North/South Korea
  - European Union, NAFTA
  - Trade, migration and development in general

# Transition Economies

## 1. Aggregate transitions are gradual

- Former Eastern European countries (Blanchard, 1998)
- GDP, TFP and labor productivity adjust slowly

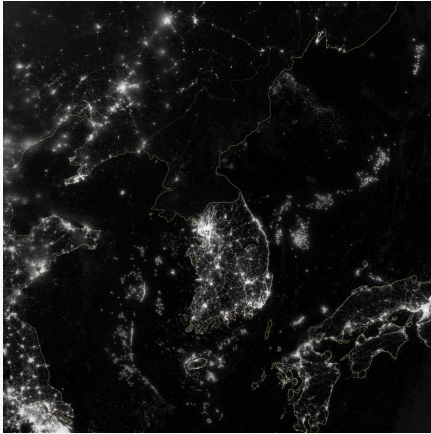
## 2. Income convergence between but divergence within

- East/West German wage convergence but increased inequality within (Fuchs-Schündeln et al., 2010)
- Trade models with heterogeneous firms and/or workers: (Helpman et al., 2010)

# What We (Want to) Do

1. Model of integration with emphasis on labor market heterogeneity:
  - Aggregate income and inequality within and between origin economies are endogenous outcomes of
    - evolution of skill distribution
    - equilibrium occupation choice
    - firm-worker sorting
2. Empirical: data on
  - North Korean refugees in the south
  - South Korean firms that operated in the north
3. Simulate post-reunification paths under different scenarios  
(in progress)

# Difference in Living Standards



S vs N Korea GDP / capita today:  
20–35 to 1 (PPP)

► Prox

W vs E Germany GDP / capita  
at reunification: 2–3 to 1



# Overview of the Talk

1. Model description and solution
2. Numerical example and simulated dynamics
3. NK refugees in SK, Kaesong Industrial Complex (empirics)

# Modeling Reunification

- Ignore advanced NK capabilities:
  - rocket science, nuclear weaponry
  - super notes, cyber-warfare...
- NK absorbed into SK technology and labor market
  - Poor managers and self-employed ▶ NK emp/occ ▶ NK type of emp
  - One-to-many matching between firms and workers (partly exogenous) ▶ NK emp/ind
- First consider 2 separate, small-open economies

## Model: Individuals

- Each country has mass of individuals with heterogeneous skills  $s \in \mathcal{S}$  with distribution  $F(s)$
- Occupation choice: **manager** or **worker**
- Managers choose industries, workers choose jobs
  - $z(s, n)$ : productivity as a manager in industry  $n \in [0, 1]$
  - $h(s, j)$ : productivity as a worker in task (job)  $j \in [0, 1]$
  - Assume both are **log-supermodular**



## Model: Production

Production unit: manager with  $s_z$  hires physical and human capital to produce sectoral output ( $n$ )

$$y(s_z, n) = z(s_z, n)^\omega k(s_z, n)^\alpha x(s_z, n)^\eta$$

$$x(s_z, n) = \left[ \int_{j=0}^J \nu(j, n)^{\frac{1}{\sigma}} \tau(j; s_z, n)^{\frac{\sigma-1}{\sigma}} dj \right]^{\frac{\sigma}{\sigma-1}}$$

$$\tau(j; s_z, n) = \int_{s_h} h(s_h, j) l_h(s_h, j; s_z, n) ds_h$$

where

- $l_h(s_h, j; \cdot)$ : # workers with skill  $s_h$  assigned to task  $j$
- $\int_j \nu(j, n) dj = 1$  and  $\nu(j, n) \in (0, 1)$  for all  $j, n$ ; and
- $\omega + \alpha + \eta = 1$

## Model: Profit Maximization

- Total sector  $n$  output:  $Y(n) = \int_{Z_n} y(s_z, n) d\mu$
- Final good producer

$$\max_{Y(n)} \left\{ \left( \int \gamma(n)^{\frac{1}{\epsilon}} Y(n)^{\frac{\epsilon-1}{\epsilon}} dn \right)^{\frac{\epsilon}{\epsilon-1}} - \int p(n) Y(n) dn \right\}$$

- Managers:

$$w_z(s) = \max_{k, l_h} \left\{ p(n) y(s, n) - Rk(s, n) - \int w_h(s_h) \left[ \int_j l_h(s_h, j; s, n) dj \right] ds_h \right\}$$

# Characterization

- 3 ODE's for matching skills to jobs/industries:
  1.  $\hat{j}(s), \hat{s}_h(j)$ : monotonic sorting between  $s$  and  $j$
  2.  $\hat{n}(s), \hat{s}_z(n)$ : monotonic sorting between  $s$  and  $n$
  3.  $q(j, n)$ : worker wages equalized across industries  $n$
- $r(s)$ : market clearing share of managers
  - For all  $s$  s.t. both managers and workers exist, i.e.  $r(s) \in (0, 1)$ :

$$w(s) \equiv w_z(s) = w_h(s) \Rightarrow \tilde{n}(j)$$

- So only need to solve for  $s_z(n)$ , since  $s_h(j)$  implied from

$$\hat{s}_h(j) = \hat{s}_z(\tilde{n}(j)),$$

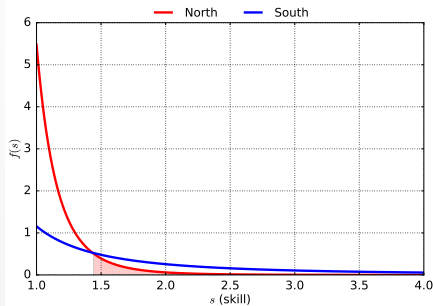
# Parametric Assumptions

Can solve more generally, but for simulations assume:

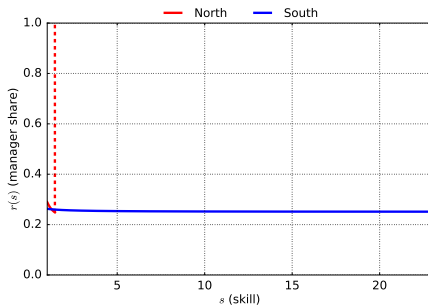
- Skills are distributed Pareto:  $F(s) = 1 - s^{-a}$
- Productivities:  $z(s, n) = s - \chi_z n$   
 $h(s, j) = s - \chi_h j$   
if  $\chi_z > \chi_h$ , only managers for all  $s > \hat{s}_z(\chi_h/\chi_z)$
- Task intensities by sector:  $\nu(j, n) = 2[1 - n - (1 - 2n)j]$   
 $\Rightarrow$  PAM between managers and workers
- Other:  $\gamma(n) = 1, \epsilon = 2, \sigma = 0.7, \chi_z = 1, \chi_h = 0.5$

# Solution: Comparative Statics

Pareto Tail, South 1.2 vs North 5.5



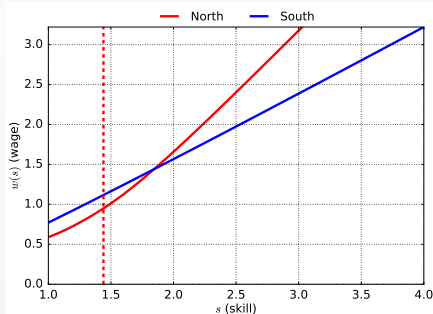
(a) Distribution



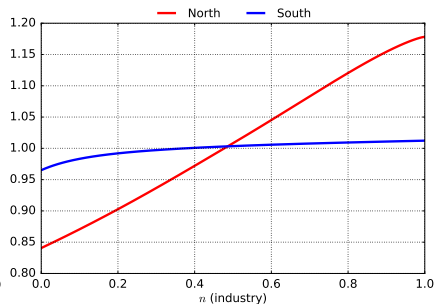
(b) Manager Share

# Solution: Comparative Statics

## Wages and Prices



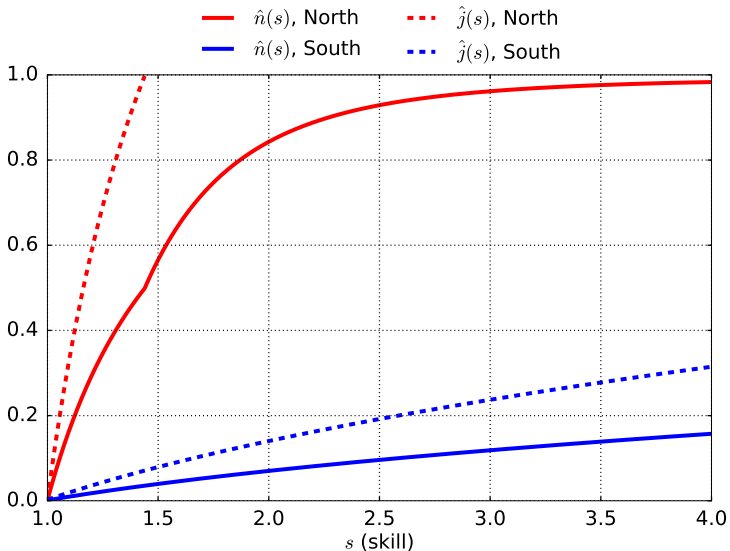
(a)  $w(s)$



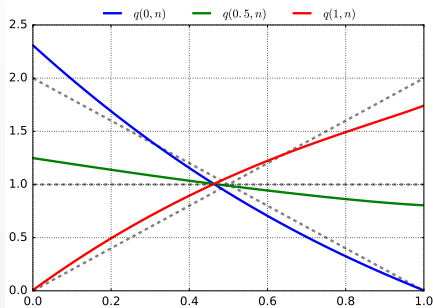
(b)  $p(n)$

# Solution: Comparative Statics

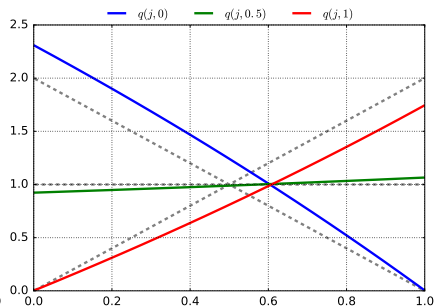
## Skill Allocations



# Worker Allocation by Task and Industry, North



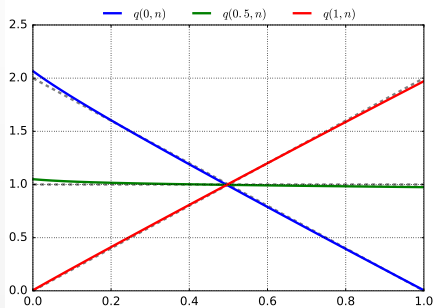
(a)  $q(\cdot, n)$ , int. to 1



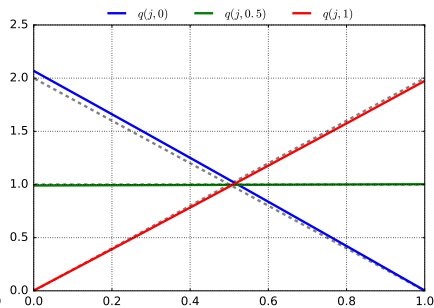
(b)  $q(j, \cdot)$



# Worker Allocation by Task and Industry, South



(a)  $q(\cdot, n)$ , int. to 1



(b)  $q(j, \cdot)$

# Integration Exercise

- \* Convergence through cohort effects (for now)

► Germany over time

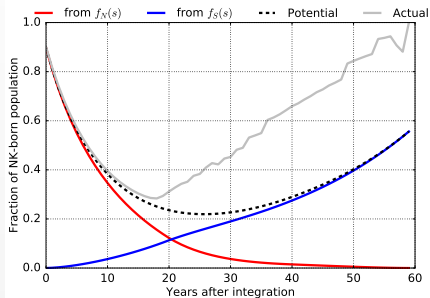
► German cohorts

- All individuals work for  $L = 40$  years
- Uniform demographic in both countries with population 2:1
- $t$  years after reunification,
  1. fraction  $\beta(t)$  of new NK entrants draw from  $F_s$ :  
 $\beta(0) = 0, \beta'(t) > 0, \beta(t) = 1$  for all  $t \geq M = 20$
  2. fraction  $\mu(c, t)$  of NK cohort  $c$  randomly given opportunity to migrate to SK
- For now assume
  1.  $\beta(t) = t/M$  for  $t \geq 0$
  2.  $\mu(c, t) = \frac{c-t+L}{L} \cdot \frac{M+L-t}{M+L} \cdot \bar{\mu}$  for  $t \geq 0, c \in (t-L, t]$

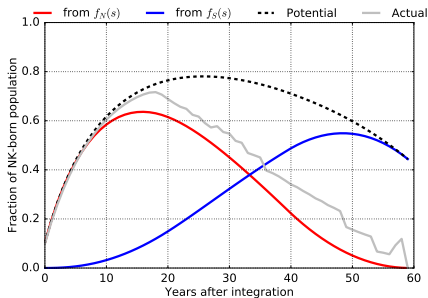
# Transitional Dynamics

1. **Stage 1**,  $t \in [0, M)$ : all entering cohorts draw from both technologies
2. **Stage 2**,  $t \in [M, L)$ : all entering cohorts identical to SK; all retiring cohorts had no access to SK technology
3. **Stage 3**,  $t \in [L, M + L)$ : all retiring cohorts drew from both technologies

# Population Dynamics

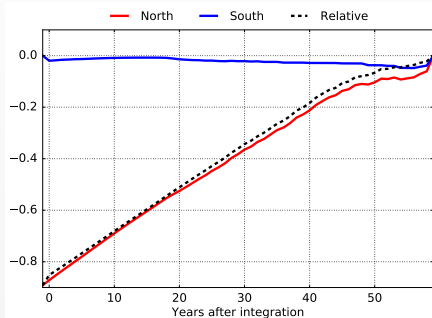


(a) North

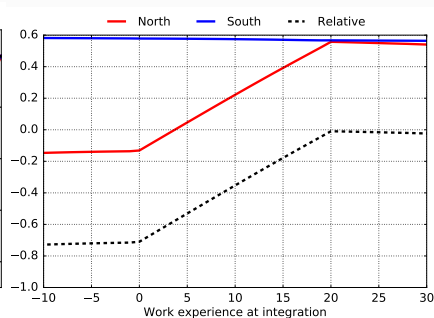


(b) South

# Evolution of Wages

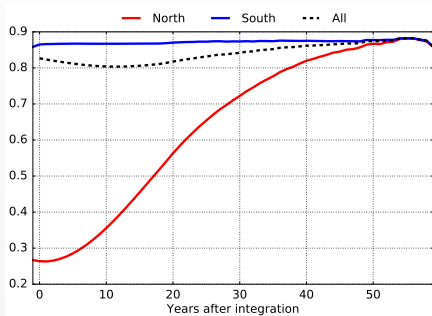


(a) over time

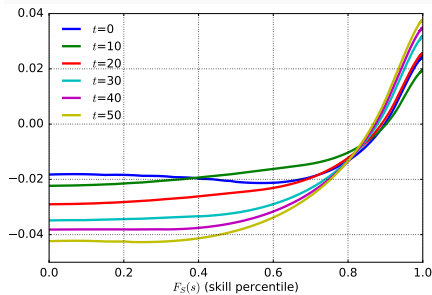


(b) by cohort

# Inequality



(a) St.Dev of Wages over Time



(b)  $\Delta$ Wage by S. Skill Perc.

## Taking Stock

- New task-based macro model of industry-occupation choice based on one-dimensional skill
- Firm- and worker-side assortative matching (one-to-many); esp. relevant with restrictions on migration
- Delayed transition: outcome of individual skill dynamics and fractional integration of labor markets
- Equilibrium dynamics displays wage convergence between but divergence within origin countries

## North and South Korea: A Brief History

- 918-1910: Unified kingdom (Goryeo and Joseon dynasties)
- 1945: Japanese colonial rule
- 1953: Division along the 38th parallel followed by Korean War (1950)
- 1953-: Current border following the Armistice
- 1970s: GDP per capita doubles in both NK and SK; SK overtakes NK in 1972
- 1990s: NK GDP per capita halves during consecutive famines (“Arduous March”). SK’s nearly doubles per decade.
- Today NK back to 70s level, SK approaching BGP



## Data Work

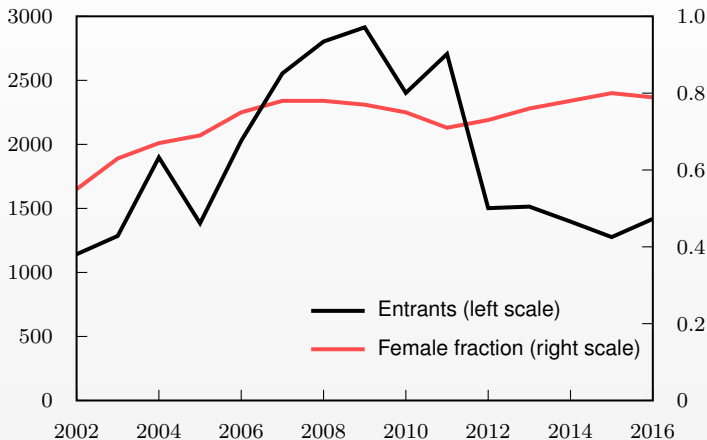
Estimate individual skill level and accumulation from relevant data on NK workers and SK firms:

- NK refugees in SK
- SK firms that operated in Kaesong Industrial Complex

## NK Refugees in SK

- (Near) 100% administrative data exists, but not accessible (we tried)
- 2016 total: approx. 30k (not including 2nd gens born in SK)
- Lower LFPR and higher unemployment (~10% vs. 5% SK); larger difference for men
- Average earnings 60% of SK average (20+ hours per week only)
- Wage and earnings do not show assimilation (or catch-up) with experience in SK
- Occupation and labor contracts improve with SK exp.
- 1/5 students; 6% dropout rate per year (less than 1% SK)

# North Korean Refugees Entering South Korea

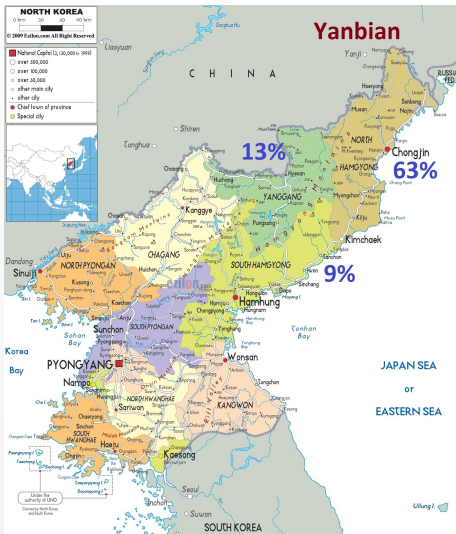


Until 1998: 947 (12% female)

1999–2001: 1,043 (46% female)

Source: MOU, 2017

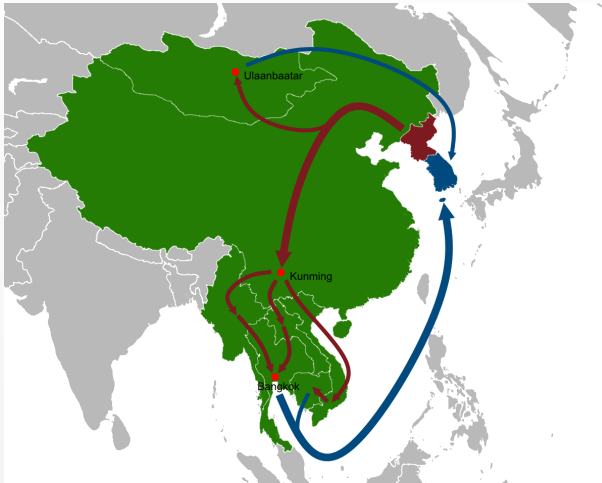
# Province of Origin and Reason for Escape



1. Economic opportunity (47%)
2. Political freedom (32%)
3. Family union (21%)

Source: MOU, 2015

# Resettlement Route



# Age at Entry into the South

## Distribution by Gender

	0–9	10–19	20–29	30–39	40–49	50–59	60–
Male	7.3%	18.2%	27.4%	23.5%	14.4%	5.4%	3.8%
8,362	607	1,526	2,294	1,961	1,206	454	314
Female	3.1%	9.3%	28.5%	32.0%	17.4%	5.3%	4.5%
19,756	608	1,838	5,622	6,327	3,429	1,044	888

Source: MOU, 2016

# Educational Attainment in North Korea

Distribution by Gender, 10 and Older

	None	Elementary	Secondary	Tertiary
Male Refugees	4.5%	9.4%	65.2%	21.0%
Male in NK	0.1%	16.7%	62.5%	20.7%
Female Refugees	2.4%	6.1%	76.1%	15.4%
Female in NK	0.6%	17.0%	67.1%	15.4%

Source: MOU, 2016 and UN, 2008

Caveat: Harder to interpret schooling since the 1990s

# Occupation in North Korea

Distribution by Gender, 16 and Older

	None	Military	Laborer	Professional	Manager
Male Refugees	38.5%	8.0%	46.5%	2.6%	4.4%
Male in NK	18.5%	8.1%	62.1%	9.5%	1.8%
Female Refugees	54.5%	0.5%	42.2%	2.3%	0.6%
Female in NK	34.3%	3.7%	54.9%	6.7%	0.3%

Source: MOU, 2016 and UN, 2008



# Labor Market Outcomes

In South Korea

	SK N	All NK R	Fo.	SK N	Male NK R	Fo.	SK N	Female NK R	Fo.
LFPR (%)	62	54	72	74	64	85	51	51	55
Empl. rate (%)	60	51	68	71	60	82	50	47	51
Hrs./wk.	43.8	48.2	50.4	46.2	50.8	-	40.6	47.1	-
Earnings/mo.*	2.35	1.45	1.87	2.76	1.80	2.01	1.74	1.30	1.61

\* Million KRW (roughly 1,000 USD)

SK N: Korean Natives; NK R: North Korean Refugees; Fo.: Foreigners with work permit

Source: Statistics Korea and Hana Foundation

## Experience Profile

	Empl. rate (%)	Hrs./wk.	Earnings/mo.
1-3 yrs.	41	49.0	1.38
3-5 yrs.	54	49.5	1.47
5-10 yrs.	51	47.5	1.42
10+ yrs.	53	47.5	1.58
NK Refugees Avg.	51	48.2	1.45
SK Natives Avg.	60	43.8	2.35

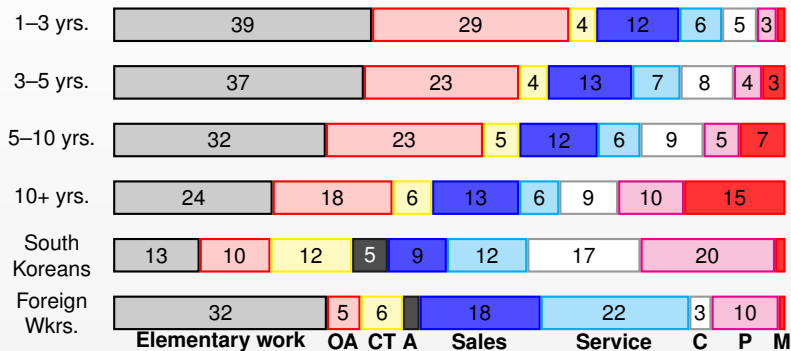
Source: Statistics Korea and Hana Foundation

## Experience Profile: Wage

- 2.5% per year till year 5, then slows down. Average of 1.4% per year return on experience over 10 years.
- Avg. SK worker shows 4% per year return on experience between ages 25 and 40.
- Consistent with answers to “recall” questions in the survey (1,010 subjects)
- Important discontinuous *earnings* growth early on (extensive margin)
- The young from the first wave fared better.

# Occupation in South Korea

## Experience Profile



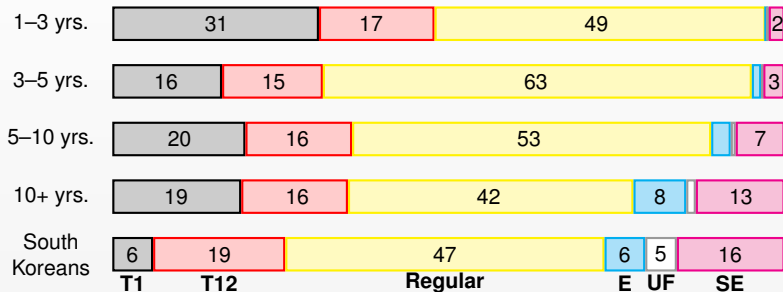
**OA:** machine ops & assembly; **CT:** craft & trade;

**A:** skilled agricultural; **C:** clerk; **P:** professional; **M:** manager (def. different for SK)

Source: Statistics Korea and Hana Foundation

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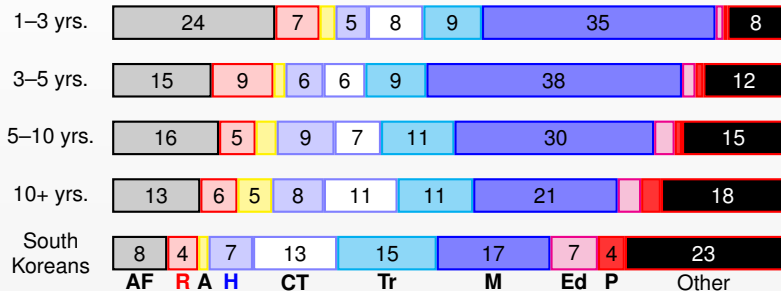
# Type of Employment



**T1:** 1-mo. contract; **T12:** 12-mo. contract; **E:** employer;  
**UF:** unpaid family worker; **SE:** self-employed

Source: Statistics Korea and Hana Foundation

# Employment by Industry



**AF:** accom & food svc; **R:** repair & maint; **A:** arts, ent & rec;  
**H:** hlth & soc svc; **CT:** cons & trans; **Tr:** retail & wh-sale trade;  
**M:** manu; **Ed:** educ svc; **P:** pro/sci/tech svc

Source: Statistics Korea and Hana Foundation

# NK Refugees in the South

## Interim Summary

- Little catch-up in wage and extensive-margin labor supply
- Occupation and labor contracts improve with SK exp.
- Mixed evidence on young arrivals (esp. in school)
- Arrivals since 2014 exhibit positive selection, but not in the expected dimension
- Convergence likely through successive cohorts rather than skill accumulation during work years (cf. Germany)

# Kaesong Industrial Complex



- Production began in 2004
- Appx 120 SK firms, revenue \$3 billion in 2010
- 75%+ textile, sewn apparel, shoes, plastic products
- 800 SK managers and 45k NK production workers
- Annual salary 1,400 USD in 2015 (almost double if include personal sales of in-kind benefits)

\* Closed after NK's 4th nuclear test in Feb. 2016.



## Kaesong Industrial Complex

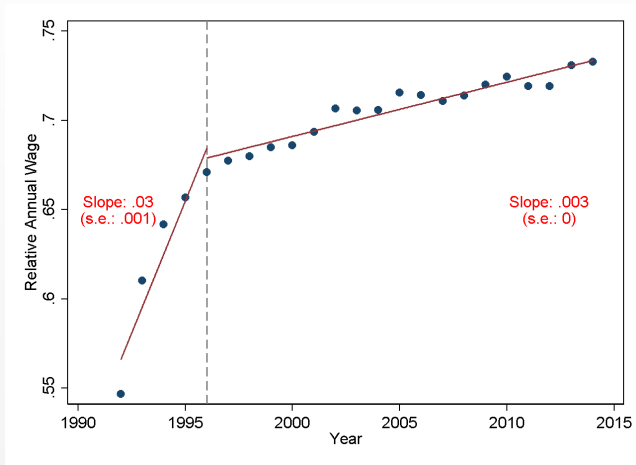
- Industries (2-digit) with negligible value added shares and below-median labor productivity and capital intensity among SK manufacturing sectors (2012)
- Anonymized firm-level data (linked by taxpayer ID) shows KIC firms' SK plants in the bottom quintile by value added per establishment even within respective 2-digit sectors (with important exceptions)

## Next Steps

- Calibrate Model to Data (SK workers, NK refugees, KIC)
- Simulate more scenarios and policies
- Enhance model features? (*maybe another paper...*)
  - Occupation switching costs
  - Lifecycle and OJT effects
  - Extensive margin labor supply (home production, transfer...)
  - Capital accumulation dynamics (adjustment costs, incomplete markets...)

**THANK YOU!**

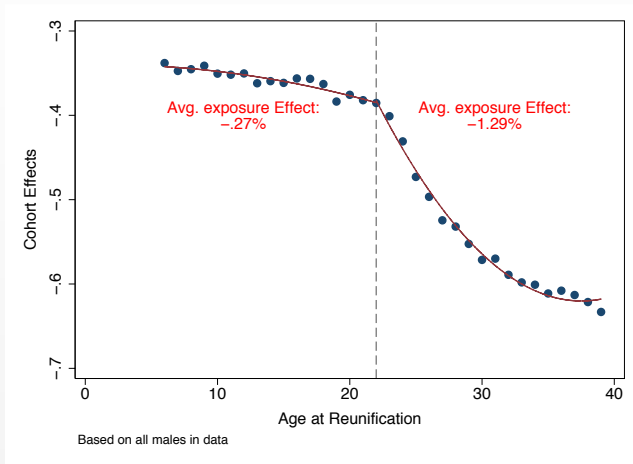
# German Wage Convergence over Time



Source: SIAB (25-55 old males each year)

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# German Wage Convergence by Cohort



## A Tribute to Angus Maddison

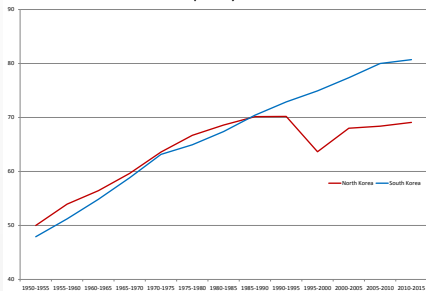
	Male (20-50 y.o.)		Female (20-50 y.o.)	
	Height	Weight	Height	Weight
South Koreans	173 cm	68 kg	160 cm	52 kg
North Koreans	167 cm	61 kg	155 cm	53 kg

Source: Statistics Korea and MOU, 2010

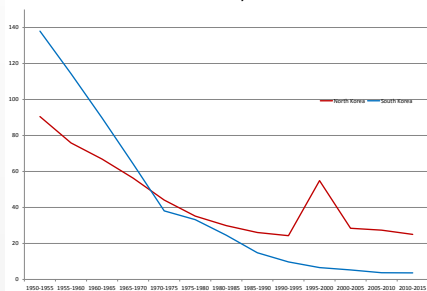
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# Health Outcomes

Life Expectancy at Birth



Infant Mortality Rate



Source: UN

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