How might interprovincial migration affect the impact of China's energy policies?

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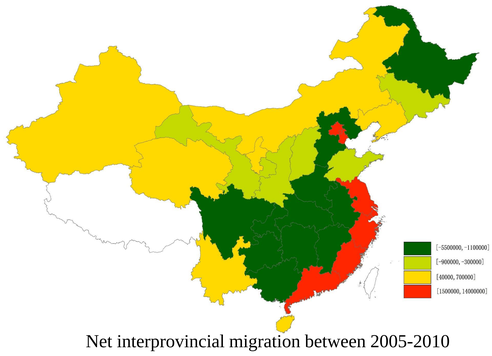
Summary 1

- The Chinese government is considering two potential policy approaches for managing national energy use and associated carbon emissions in future Five-Year Plans (FYP): an energy intensity target and an energy cap. This study is focused on examining the effect of migration on these two policies.
- ➢ China is experiencing large interprovincial migration. (Box 2)
- ➢ Large share of migration is from energy intensive provinces to 'cleaner' provinces. (Box 3)
- ➢ To examine the effect of migration on policies, we combined the China Regional Energy Model (C-REM) with an econometric migration model. (Box 3, 4 & 5)
- ➢ The model predicts future interprovincial migration to rapidly peak by 2015-2020, but remain important. (Box 6)
- ➢ If migration is ignored or underestimated in the design of the policies, the energy cap will put more burden on eastern China and energy intensity targets will put more burden on middle and west. We compare the two policies under uncertain migration and find the energy intensity target to be more robust. (Box 7 & 8)
- ➢ Future work will focus on estimating the impact of urbanisation (Box 9)

Net interprovincial migration 2



Net interprovincial migration between 2005-2010

Largest interprovincial migration flows are from the middle provinces to the eastern coastal provinces.

Migration prediction model 3

$$\ln Migration_{i,o,t} = a_0 + a_1 \ln\left(\frac{Population_{i,t-1}}{Population_{i,t-2}}\right) + a_2 \ln\left(\frac{Population_{o,t-1}}{Population_{o,t-2}}\right) + a_3 \ln\left(\frac{GDPpercapita_{i,t-1}}{GDPpercapita_{i,t-2}}\right) + a_4 \ln\left(\frac{GDPpercapita_{o,t-1}}{GDPpercapita_{o,t-2}}\right) + a_5 \ln Migration_{i,o,t-1}$$

M_t	Coefficient	Std. Err.	t-value	Lower 95%	Upper 95%
p_i	1.249***	0.375	3.33	0.515	1.983
p_o	-0.255	0.670	-0.38	-1.568	1.058
g_i	1.116***	0.256	4.36	0.614	1.617
g_o	-1.976***	0.260	-7.59	-2.486	-1.466
M_{t-1}	0.925***	0.010	91.44	0.905	0.945

Panel dataset: two time periods (2000-2005, 2005-2010), 1740 bilateral migration flows.

R^2=0.9553.

Conclusion: Provinces with a higher GDP per capita growth rate and higher net in-migration shows more attraction for migration.

China Regional Energy Model (C-REM) 4

C-REM is a multi-regional, multi-sector, recursive-dynamic, computable general equilibrium (CGE) model. The model is one of the major analysis tools developed by the China Energy and Climate Project (CECP). The primary goal of the model is to analyze the impact of existing and proposed energy and climate polices of China on technology, inter-fuel competition, the environment, and the economy. The model details 30 provinces of China. Since migration in China is large, combining C-REM with a migration model results in much stronger analytical capacity.

The sectorial and regional aggregation is shown below:

China Regions (Official two letter abbreviation)			Sector	Sector aggregated
BJ (Beijing)	ZJ (Zhejiang)	HI (Hainan)	COL	Coal mining and processing
TJ (Tianjin)	AH (Anhui)	CQ (Chongqing)	CRU	Crude petroleum products
HE (Hebei)	FJ (Fujian)	SC (Sichuan)	GAS	natural gas products
SX (Shanxi)	JX (Jiangxi)	GZ (Guizhou)	OIL	Petroleum refining, coking and nuclear fuels
NM (Mongolia)	SD (Shandong)	YN (Yunnan)	EIS	Energy intensive industries
LN (Liaoning)	HA (Henan)	SN (Shaanxi)	MAN	Other manufacturing industries
JL (Jilin)	HB (Hubei)	GS (Gansu)	ELE	Electricity and heat
HL (Heilongjiang)	HN (Hunan)	QH (Qinghai)	WTR	Water
SH (Shanghai)	GD (Guangdong)	NX (Ningxia)	CON	Construction
JS (Jiangsu)	GX (Guangxi)	XJ (Xinjiang)	TRN	Transport and Post
Other Regions	Regions aggregated		SER	Service
USA	United States		OMN	Metal minerals mining and Non-metal minerals and other mining
EUR	Europe		AGR	Crop cultivation, Forestry, Livestock and livestock products and Fishery
ODC	Other Developed countries: Canada, Australia, New Zealand, Japan and South Korea			
ROW	Rest of the World			

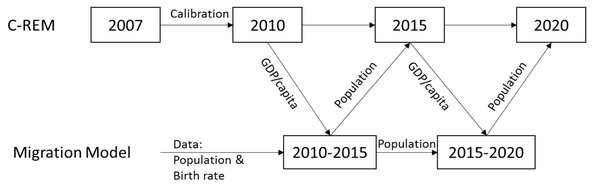
Base year data: 2007 world IO table from GTAP database, provincial IO table, resource and energy data from Chinese National Statistic Bureau.

This study is the first dynamic implementation of the model. The model steps are 2007, 2010, 2015 and 2020. We use 2010 data to calibrate the model.

Trade between regions follows the Armington assumption (including electricity transport).

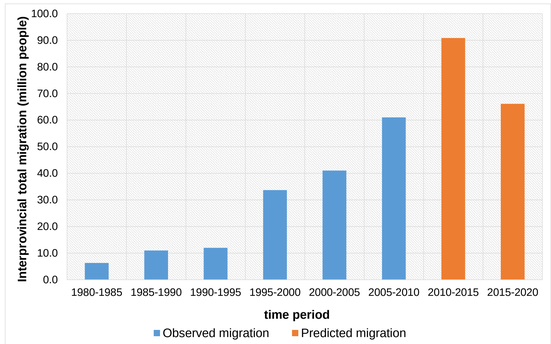
Energy consumption is defined as direct secondary energy use.

Combination of the two models 5

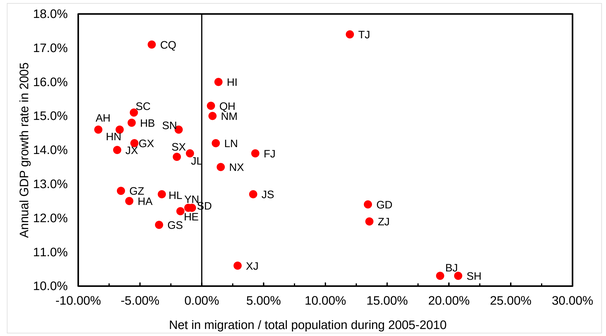


The combination of the two models uses a recursive dynamic mechanism. Changes in population predicted by the migration model will determine the labor supply in the economic model. Because of limited data availability, we assume migration does not affect the average labor productivity and labor participation.

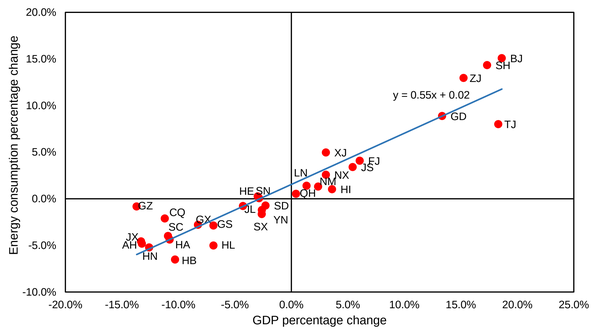
Migration results 6



Total interprovincial migration will peak in 2010-2015 at around 90 million. The predicted decline in total migration is caused by diminishing wage differentials, as the GDP growth rates in out-migration provinces are higher than in the in-migration provinces (shown below).



Migration affects both energy and GDP 7



Migration will affect both the energy consumption and GDP in each province, but changes in GDP are larger. Thus it will impact both energy cap and energy intensity policies. Energy intensity is predicted to decrease in the in-migration provinces of the east and increase in the out-migration provinces. More burden will put on the east under an energy cap, whereas an intensity target puts more burden on the west.

Policy robustness analysis 8

We define three scenarios to compare the robustness of the policies:

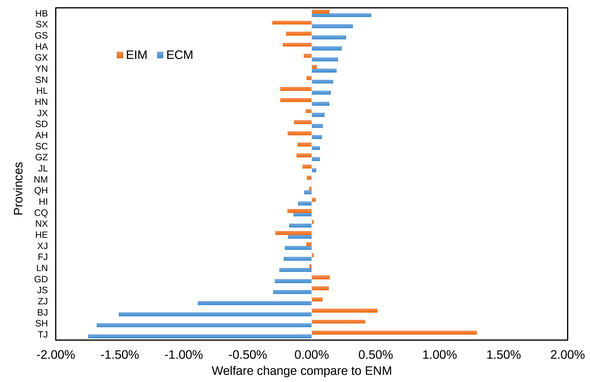
1. No Migration (ENM). We design both the energy cap and energy intensity policies such that they are identical if no migration takes place, and reflect the 12th FYP.
2. Energy Cap policy With Migration (ECM). This scenario imposes the same provincial energy caps as in (1) and adds migration.
3. Energy Intensity policy with Migration (EIM). This scenario imposes the same provincial energy intensity targets as in (1) and adds migration.

Year	2007	2010	2015			2020		
Scenarios	Data	Data	ENM	ECM	EIM	ENM	ECM	EIM
GDP (billion 2007$)	3644	5148	7116	7192	7193	9453	9505	9520
Energy consumption (million tce)	2474	3296	3867	3867	3864	4356	4356	4319
Energy Intensity	0.68	0.64	0.54	0.54	0.54	0.46	0.46	0.45
EI reduction over five years (%)		5.67	15.12	15.12	16.11	15.21	15.21	15.53
Welfare change relative to 2010(%)			-0.42	-0.55	-0.44	-1.69	-2.02	-1.78

At national level: Energy intensity targets will lead to higher GDP and lower energy consumption, and thus dominates the energy cap overall. There are several reasons for this:

1. Fixed energy resources are mostly located in the out-migration middle and west. Energy intensive industries will not move out of these provinces as fast as the migrants.
2. The east is richer than middle and west. If facing a tough target, it will have a better chance to move its heavy industries to the middle and west, which is against the original intention of the policy design.
3. The industrial structure of middle and east is different. If people move to the east, they will more likely work in a less energy intensive sector, e.g. service sector.
4. Energy use reductions are cheaper in the middle and west.

At provincial level: Comparing the welfare change between these two scenarios, we find that the energy intensity targets lead to smaller deviations and are thus more robust than caps (see below)



Future research 9

- ➢ Changes in household energy consumption patterns associated with migration and income changes.
- ➢ Investigate the impact of the urbanization process on energy consumption and energy policy design.

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The 37th IAEE International Conference, 15-18 June 2014, New York City