A Dynamic Model of Firm's Production Offshoring and Clean Technology Adoptions

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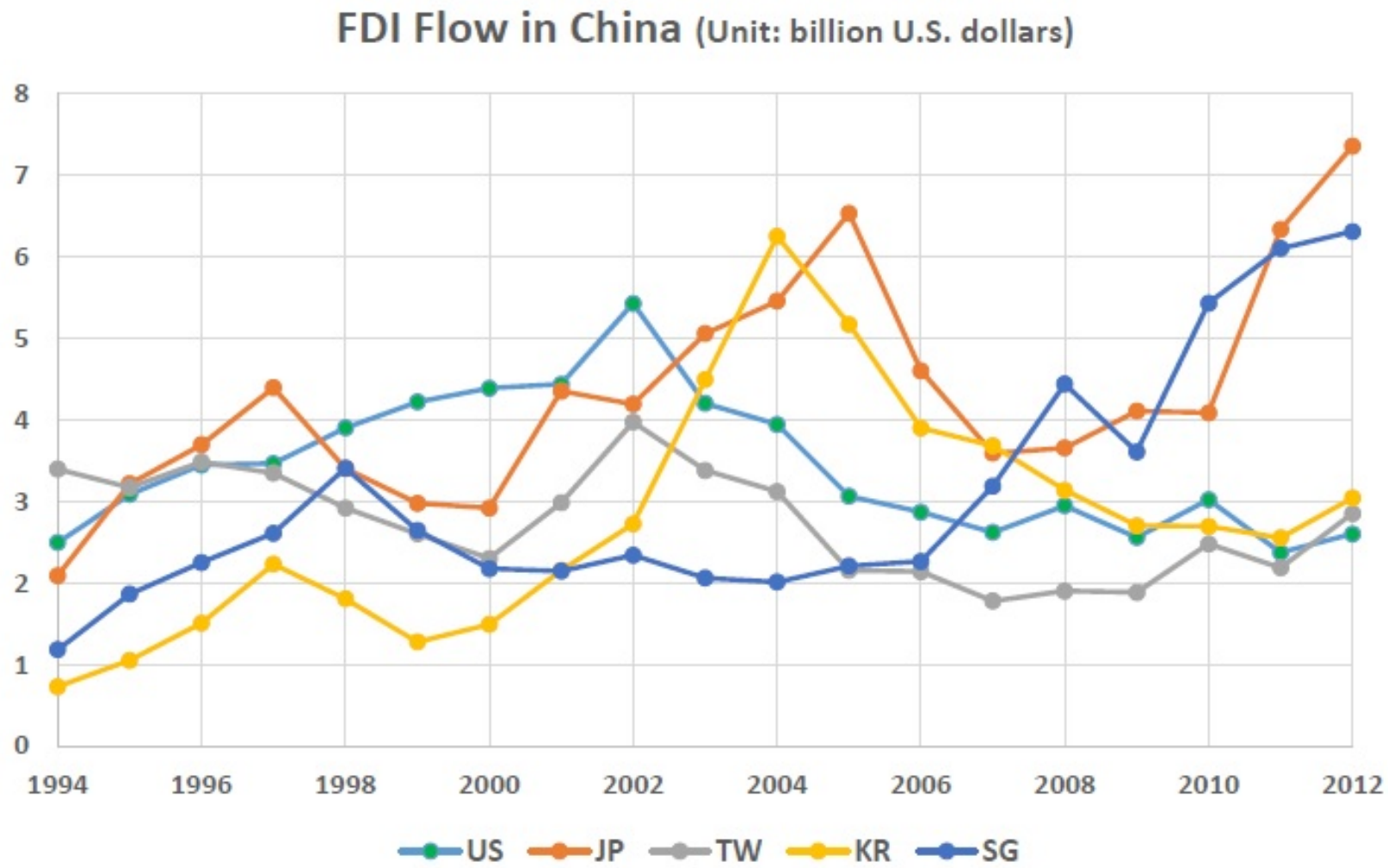
Objectives

- Build a dynamic general equilibrium model of firm's decisions on production offshoring and technology adoption to reduce emission conditional on different labor costs and environmental regulations
- Apply this model to analyze the effects of U.S. firm's offshoring to China and technology adoption decisions on
  - both U.S. domestic workers' and Chinese workers' wages
  - the environmental qualities in both countries.

Motivation

- Bilateral trade between China and US grow dramatically since China joined WTO in 2001(trade volume increased from $95B to $387B).
- A steady growth period for both countries after China joined WTO(2.1% and 8.2% annual growth in GDP-per-Capita for US and China)
- U.S. low-skill workers' wage increases annually by 0.3% while 0.5% for high-skill workers; Chinese workers' wage increase by 9.7% each year.
- From 2000 to 2007, annual labor productivity growth rate in U.S. is 2.6% for nonfarm business sector and 3.7% for manufacturing sector.
- U.S.total factor productivity grows annually by 1.7% from 2000 to 2005
- U.S. is one of the largest FDI source countries for China and total FDI stock held by U.S. firms in China is above $70B since 2012.

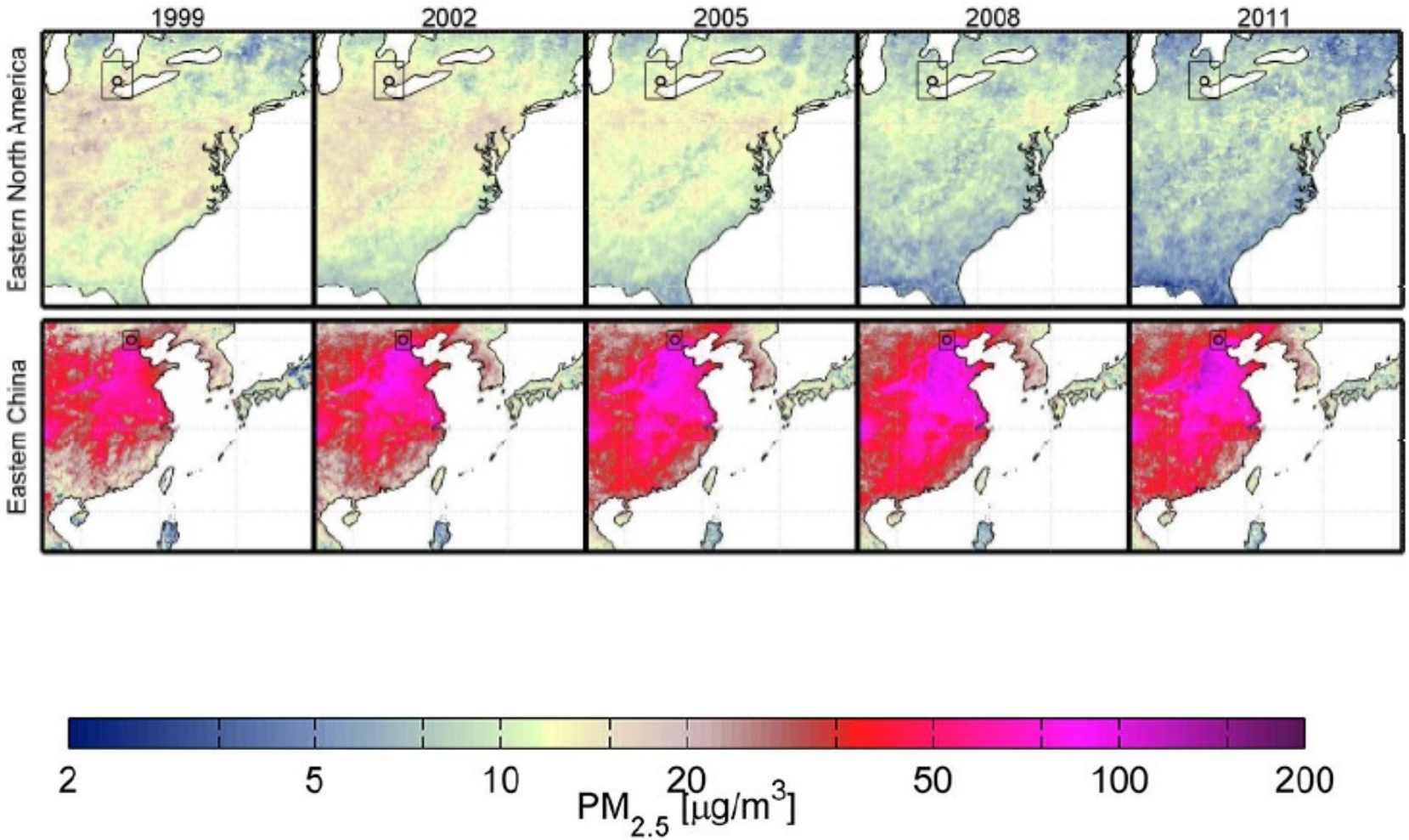
FDI in China by China Statistical Yearbook (1995-2013)



Motivation(Con'd)

- Trade induced air pollution: 21% of exporting driven emissions in China were attributed to China-to-US export according to Lin et al.(2014)
- In 1997, U.S. EPA established new standard for PM2.5 and started to monitor it since 2000. The Clean Air Fine Particle Implementation Rule was passed in congress in 2007
- From 2003 to 2012, the reductions of emissions of particulate matter (PM10 and PM2.5) have accounted for about one-half of the total monetized benefits of all significant federal regulations
- China set the standards and started the regulation of PM2.5 emissions in 2012
- Two countries had different environmental quality paths: PM2.5 in U.S. declined by 11.8% while in China increased by 48.8% from 1999 to 2007

PM2.5 in China and US by Donkelaar et al.(2014, 2015)



Literature

- Trade Liberalization and Environment: Antweiler, Copeland and Taylor(2001), Lin et al.(2014) Ren et al.(2014)
- Environmental Regulation in U.S. and Offshoring: Levinson(2009, 2010), Hanna(2010)
- Offshoring Theory: Acemoglu,Gancia and Zilibotti(2015), Grossman and Rossi-Hansberg(2008) and Rodriguez-Clare(2010)

Theoretical Framework

- An infinite-horizon discrete-time model with two countries: west and east
- Immobile and inelastically supplied labor(consumer) is the only production input
- Labor productivity growth path are exogenous(Meng(2015))
- Labor force divided into two groups: low skill and high skill
- Assume only the low-skilled jobs are pollutant and can be offshored
- Pollution tax rates of both countries are fixed
- Tax revenue is not used for pollution abatement and will be returned to the firm's workers.
- Offshored firms will suffer a loss as a fraction of its profit flow each period
- Building on the shoulders of giants technology innovation style:

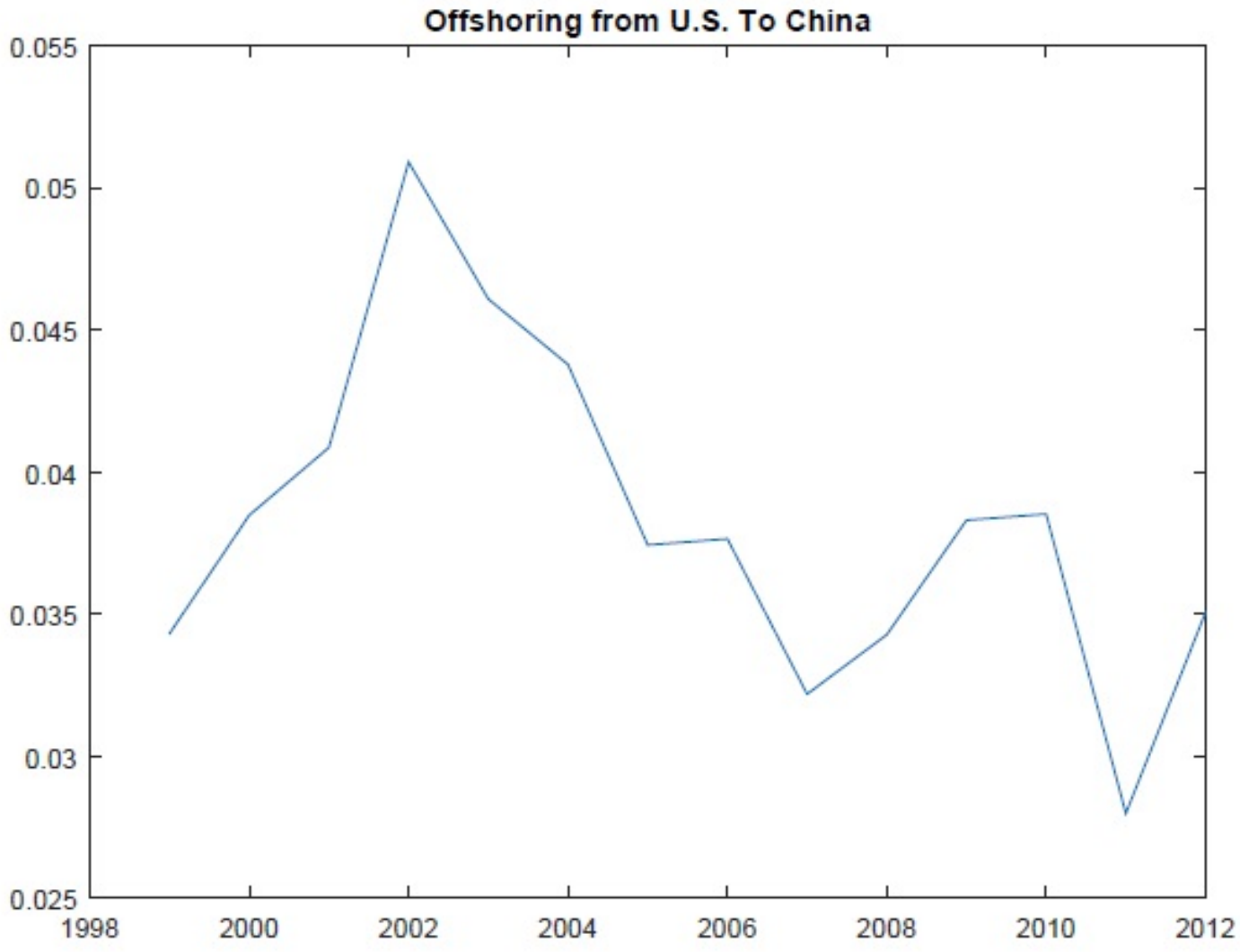
Theoretical Findings

- Increasing the relative production capacity in the west or increasing the offshoring cost will decrease the final offshoring levels
- Decreasing offshoring cost will decrease the final emission level in the west while increasing emission in the east
- Increasing the relative pollution tax ratio between the west and east or decreasing the offshoring cost will decrease the final relative emission in the west
- Final emission level will be lower if people are more patient or domestic pollution tax is higher

Data

- Wage and employment in US: Current Population Survey(CPS) data from year 1999 to 2012
- Labor and employment and FDI data in China: National Bureau of Statistics of China(from year 1994 to 2012)
- GDP for both US and China(from 1960 and forward): World Bank
- PM2.5 concentration data: Atmospheric Composition Analysis Group at Dalhousie University, Canada

Numerical Results



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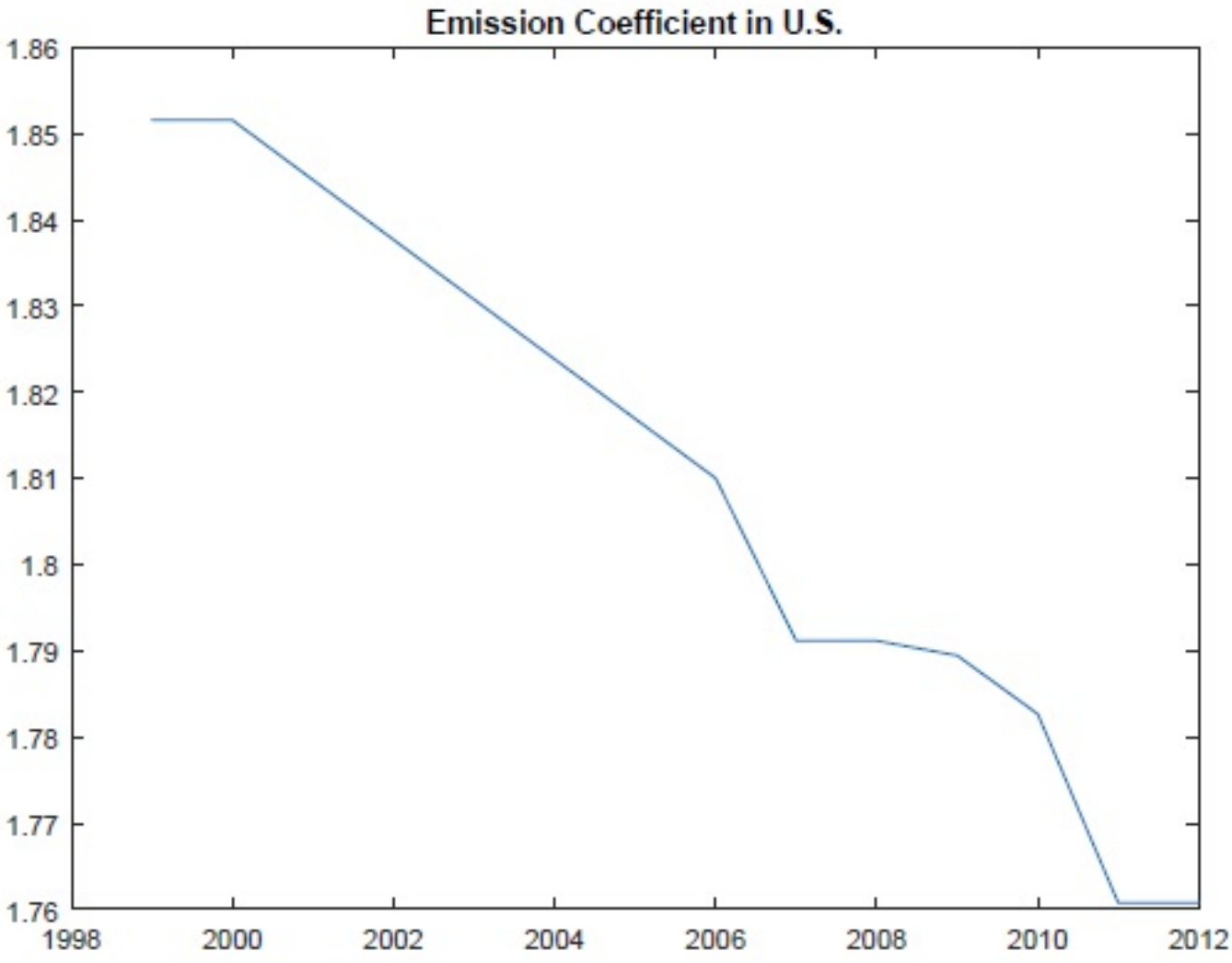

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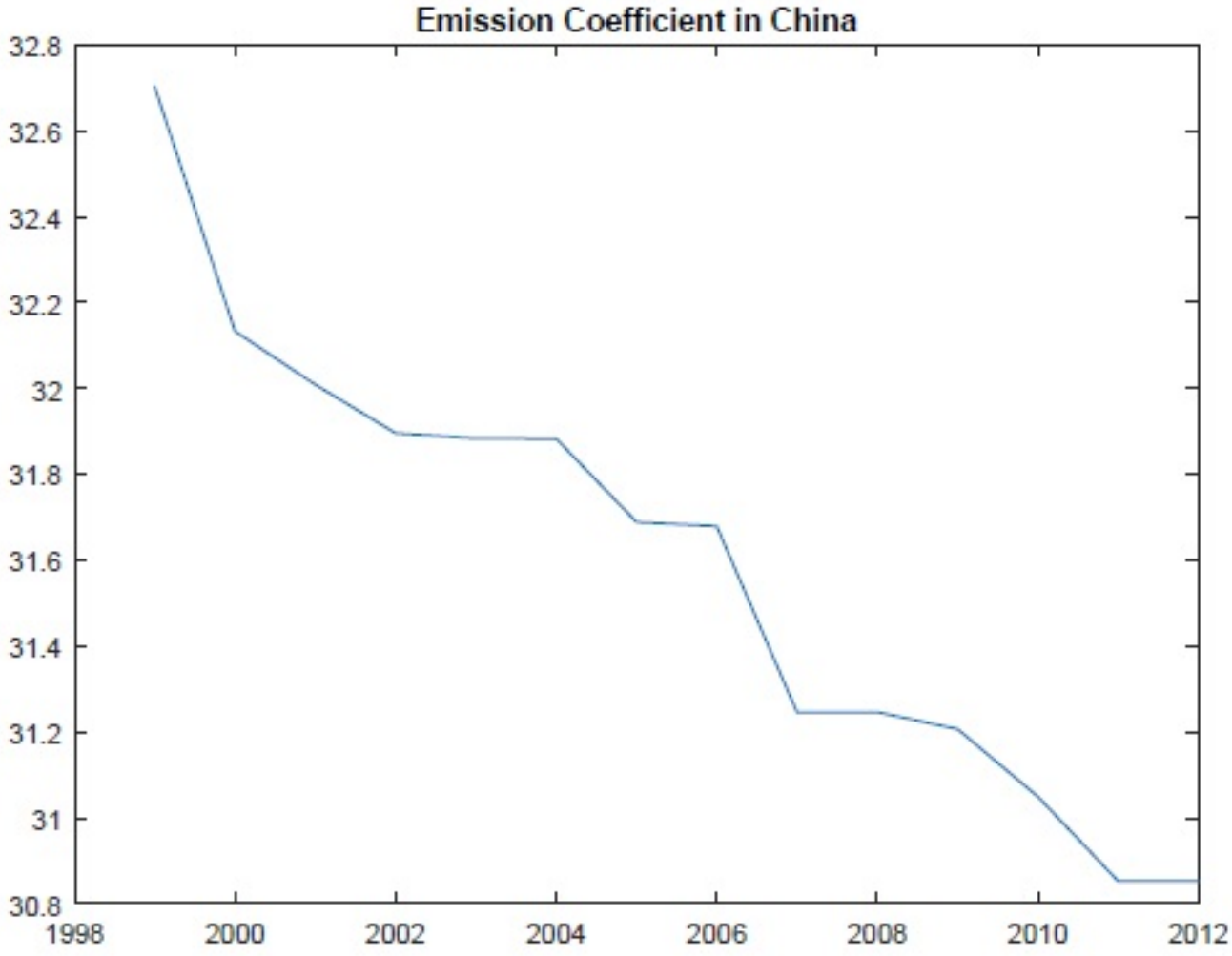

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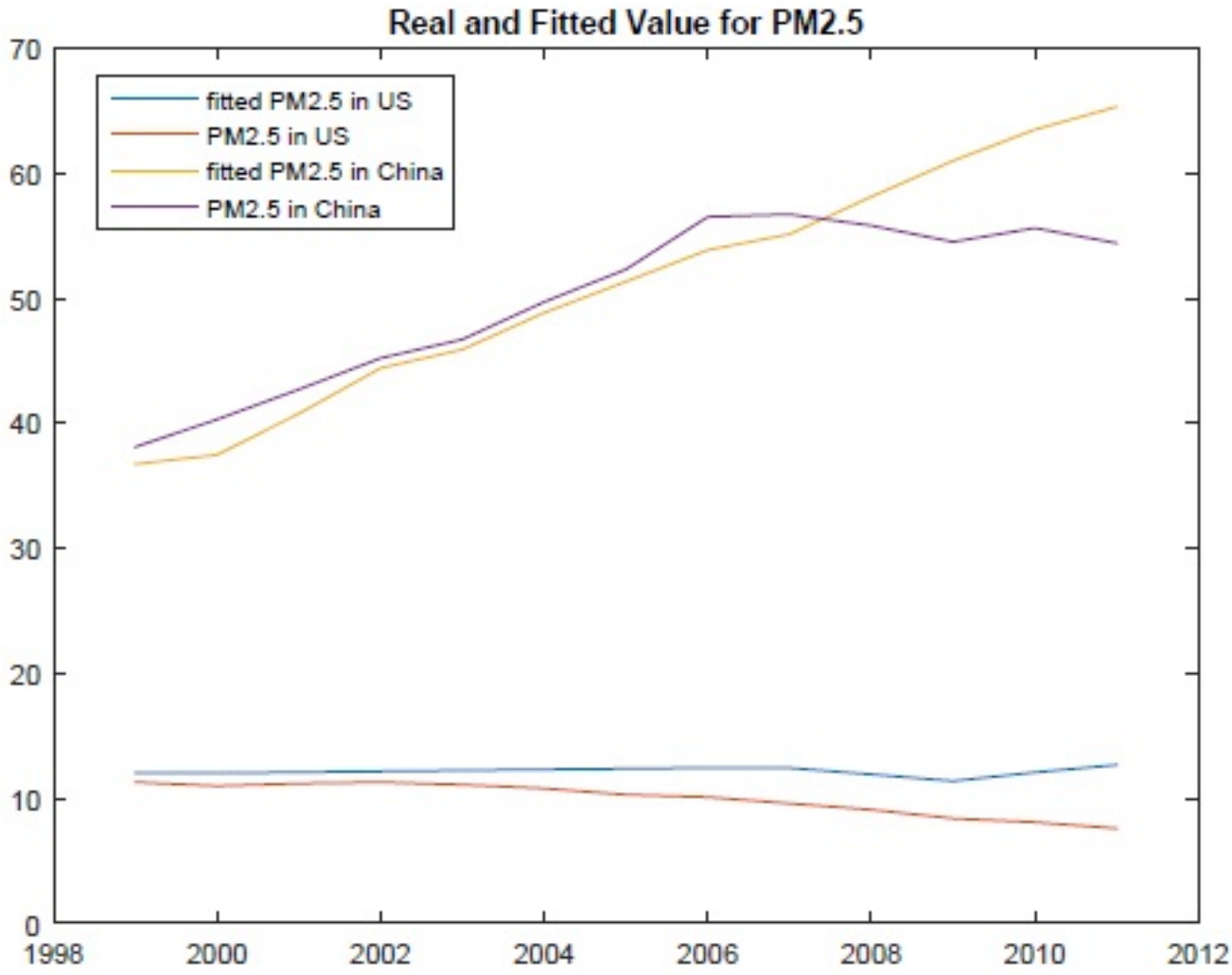

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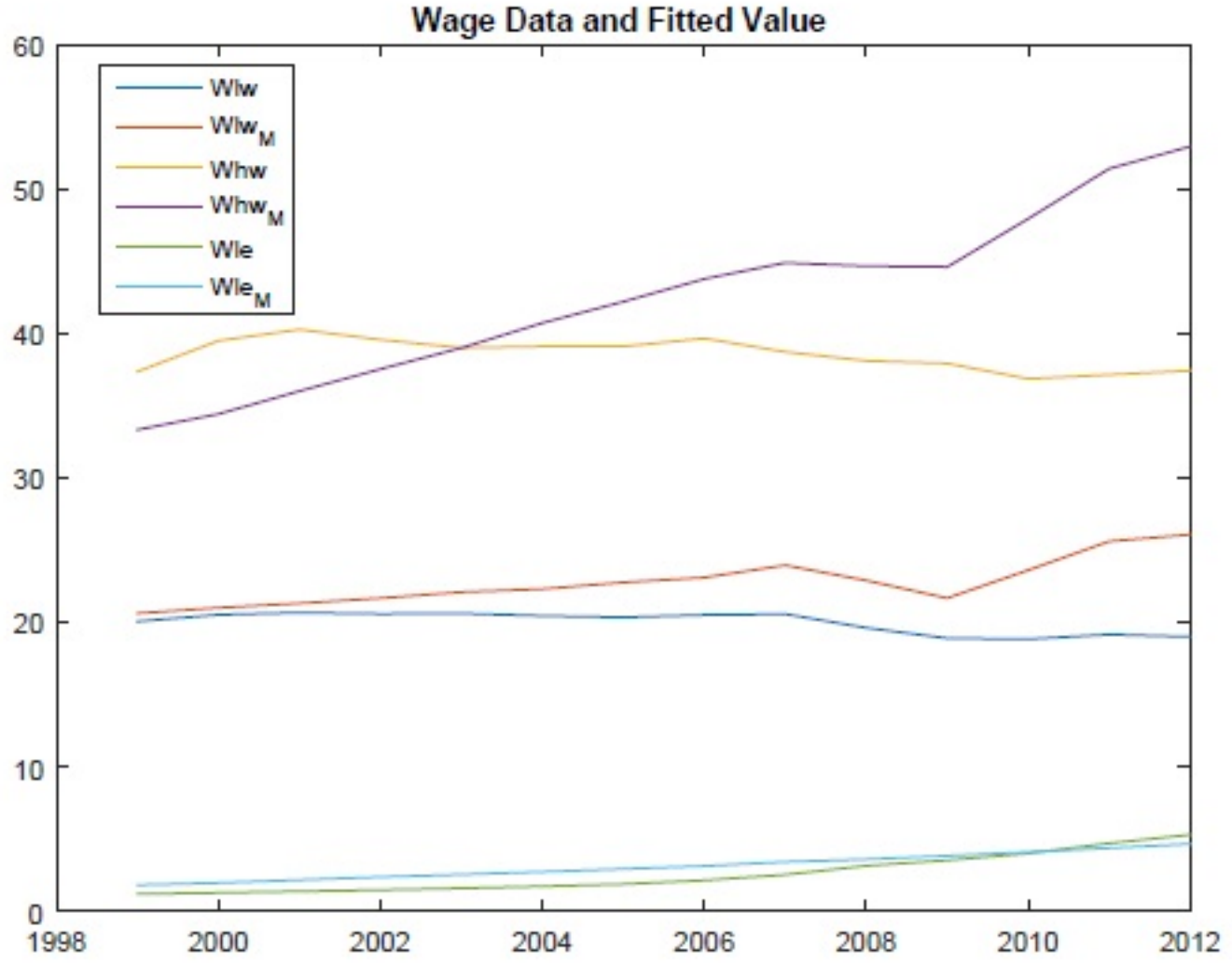

Conclusions

- This paper proposes a new framework to analyze how the different production factor costs and environment regulations will influence firms' production allocations
- Meanwhile, firms will make different dynamic decisions on clean technology adoptions when facing different environmental policies
- Explain how production offshoring and endogenous technology change will shape related countries' income growth and environmental quality curve
- Apply the model to the case of China and U.S.and provide policy implications to EPA for the PM2.5 regulations.

Thank you!