Innovation et Environnement

LSE

CENTRE for ECONOMIC PERFORMANCE

Introduction

- Comment assurer une croissance durable malgré des ressources limitées?
- Comment réconcilier croissance et lutte contre le réchauffement climatique?

Introduction

- Croissance avec ressources limitées….retour forcé vers Malthus?
- Croissance et climat:
  - Stern versus Nordhaus
  - Greenpeace

Introduction

- Dépasser ces débats en introduisant l'innovation
- L'innovation permet en théorie de surmonter les contraintes de ressources limitées et d'assurer une croissance durable
- Comment faire en sorte que l'innovation soit verte?

Introduction

- Est-ce que le marché peut tout seul induire l'innovation verte?
- La réponse est non:
  - dépendance par rapport au passé (path dependence)
  - un individu ou une firme continue d'innover dans ce dans quoi ils excellent le plus

Preuve empirique de la dépendance au passé

- Industries automobiles au niveau mondial
- L'innovation peut être dirigée soit vers les moteurs à combustion soit vers les moteurs électriques
- On montre que les firmes qui ont davantage innové dans les moteurs à combustion dans le passé continuent à faire de même dans le futur

AUTO INDUSTRY PAPER (ADHMV)

- Uses cross-country panel data on innovation in Auto industry
- Shows the existence of path-dependence in the clean versus dirty innovation
- Shows that increase in the fuel price will increases incentives for clean R&D relative to dirty

DATA

- World Patent Statistical Database (PATSTAT) at European Patent Office (EPO)
  - All patents filed in 80 patent offices in world (focus from 1965, but goes further back for some countries)
- Extracted all patents pertaining to "clean" and "dirty" technologies in the automotive industry (Table 1 over follows OECD IPC definition)
- Tracked applicants and extracted all their patents. Created unique HAN firm identifier
  - 4.5m patents filed 1965-2005

INTERNATIONAL PATENT CLASSES (IPC)

Description	IPC code
Electric vehicles	
Electric propulsion with power supplied within the vehicle	B60L 11
Electric devices on electrically-propelled vehicles for safety purposes; Monitoring operating variables, e.g. speed, deceleration, power consumption	B60L 3
Methods, circuits, or devices for controlling the traction- motor speed of electrically-propelled vehicles	B60L 15
Arrangement or mounting of electrical propulsion units	B60K 1
Conjoint control of vehicle sub-units of different type or different function / including control of electric propulsion units, e.g. motors or generators / including control of energy storage means / for electrical energy, e.g. batteries or capacitors	B60W 10/08, 24, 26
Hybrid vehicles	
Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines	B60K 6
Control systems specially adapted for hybrid vehicles, i.e. vehicles having two or more prime movers of more than one type, e.g. electrical and internal combustion motors, all used for propulsion of the vehicle	B60W 20
Regenerative braking	
Dynamic electric regenerative braking	B60L 7/1
Braking by supplying regenerated power to the prime mover of vehicles comprising engine -driven generators	B60L 7/20
Fuel cells	
Conjoint control of vehicle sub-units of different type or different function; including control of fuel cells	B60W 10/28
Electric propulsion with power supplied within the vehicle - using power supplied from primary cells, secondary cells, or fuel cells	B60L 11/18
Fuel cells; Manufacture thereof	H01M 8
Combustion engines	
Combustion engines	F02 (excl. C/G/ K)

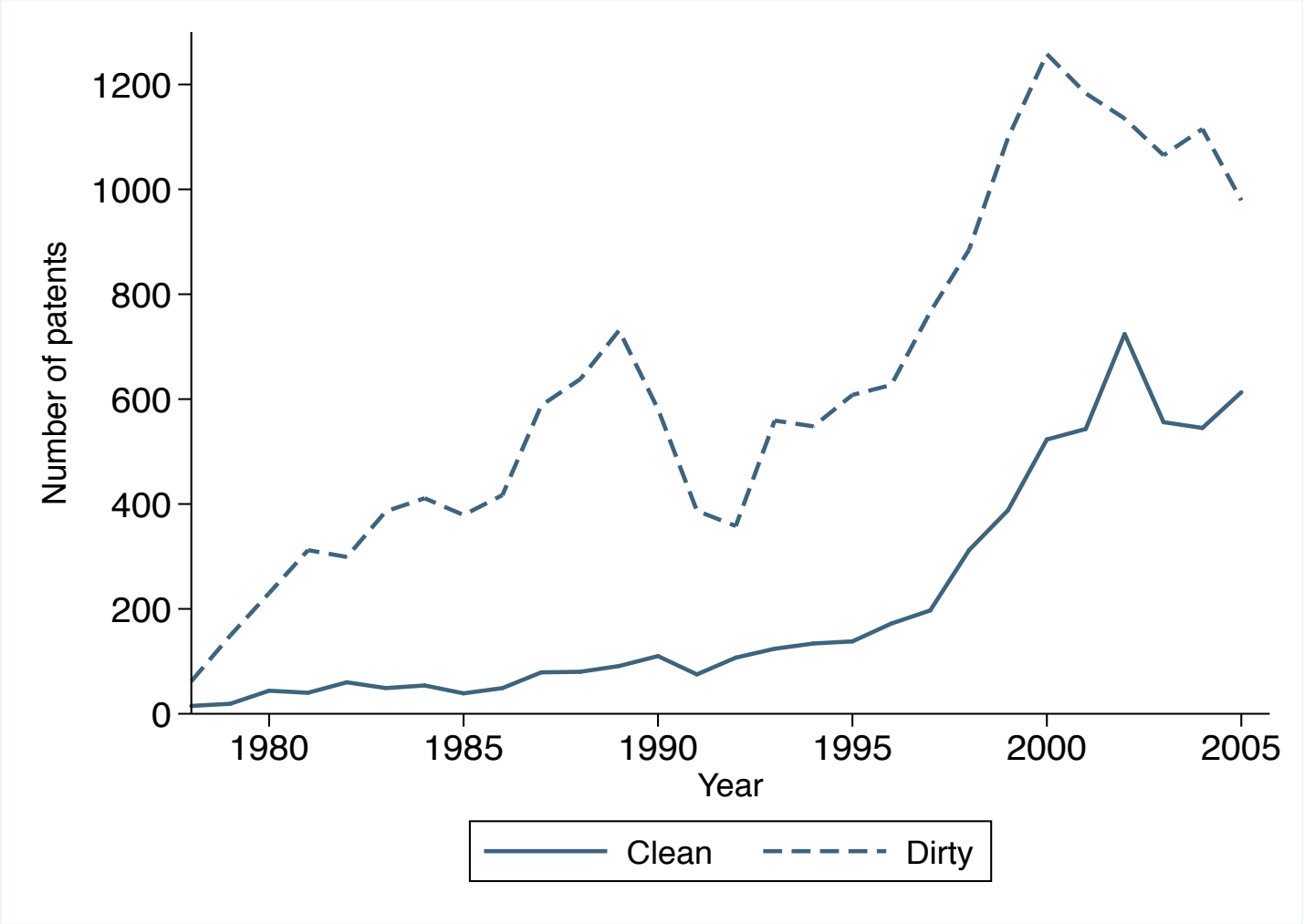
"Clean"

"Dirty"

DATA

- Focus on “triadic” patents filed at all 3 main patent offices: USPTO, EPO & JPO
  - Screens out low value patents
- Over 1978-2005
  - 18,652 patents in “dirty” technologies (related to regular internal combustion engine)
  - 6,419 patents in “clean” technologies (electric vehicles, hybrid vehicles, fuel cells,..)
  - 3,423 distinct patent holders (2,427 firms & 996 individuals)

AGGREGATE TRIADIC CLEAN AND DIRTY PATENTS PER YEAR



POLICY VARIABLES: FUEL PRICES & TAXES

- Fuel prices vary over countries and time (mainly because of different tax regimes)
- Firms are likely to be affected differentially by fuel prices as (expected) market shares different across countries
  - We would like to weight country prices by firm's expected future market shares in different countries
  - Use information on where patents filed (use in pre-sample period & keep these weights fixed)
  - Compare with firm sales by country

TABLE A1: REASONABLE CORRELATION (0.95) BETWEEN GEOGRAPHICAL MARKET SHARES BASED ON SALES VS. PATENT FILINGS: e.g. FORD

1992-2002	Car Sales shares	Patent Weights
US	0.59	0.59
Canada	0.04	0.01
Mexico	0.02	0.00
UK	0.08	0.08
Germany	0.06	0.15
Italy	0.03	0.03
Spain	0.02	0.02
France	0.02	0.04
Australia	0.02	0.00
Japan	0.01	0.05

Source: Annual Company Accounts

TABLE 2: REASONABLE CORRELATION BETWEEN GEOGRAPHICAL MARKET SHARES BASED ON AUTO SALES VS. PATENT FILINGS FOR MAJOR VENDORS (CORRELATION = 0.95)

		Car Sales shares	Patent Weights
Toyota	**2003-2005**		
	Japan	0.43	0.42
	North America	0.40	0.34
	Europe	0.17	0.23
VW	**2002-2005**		
	Germany	0.35	0.57
	UK	0.13	0.08
	Spain	0.11	0.03
	Italy	0.09	0.05
	France	0.09	0.09
	US	0.13	0.15
	Mexico	0.05	0.00
	Canada	0.04	0.00
	Japan	0.02	0.02
Ford	**1992-2002**		
	US	0.66	0.61
	Canada	0.04	0.01
	Mexico	0.02	0.00
	UK	0.09	0.08
	Germany	0.07	0.15
	Italy	0.03	0.03
	Spain	0.02	0.02
	France	0.02	0.04
	Australia	0.02	0.00
	Japan	0.01	0.05
Peugeot	**2001-2005**		
	Western Europe	0.82	0.83
	Americas	0.04	0.13
	Asia-Pacific	0.13	0.04
Honda	**2004-2005**		
	Japan	0.28	0.31
	North America	0.62	0.48
	Europe	0.10	0.20

TABLE 1: MAIN RESULTS

	Clean	Dirty
Fuel Price	0.886**	-0.644***
ln(FP)	(0.362)	(0.143)
Clean Spillover	0.266***	-0.058
$SPILL_C$	(0.087)	(0.066)
Dirty Spillover	-0.160*	0.114
$SPILL_D$	(0.097)	(0.081)
Own Stock Clean	0.303***	0.016
K_C	(0.026)	(0.026)
Own Stock Dirty	0.139***	0.542***
K_D	(0.017)	(0.020)
#Observations	68,240	68,240
#Units (Firms and individuals)	3,412	3,412

Notes: Estimation by Conditional fixed effects (CFX), all regressions include GDP, GDP per capita & time dummies. SEs clustered by unit.

ROBUSTNESS TESTS

- Split fuel efficiency innovations out from “dirty”
- Other policy variables – R&D, Emissions regulations
- Fuel taxes instead of prices
- Condition on firms with some positive pre-1985 patents
- Estimate 1991-2005 (instead of 1985-2005) & use weights 1965-1990 (instead of 1965-1985)
- Use biadic patents (or all patents) instead of triadic
- Drop individuals & just estimate on firms
- Cite-weighting patents
- Allow longer dynamics reaction, different depreciation rates, etc.

TABLE 3: FUEL TAXES INSTEAD OF FUEL PRICES

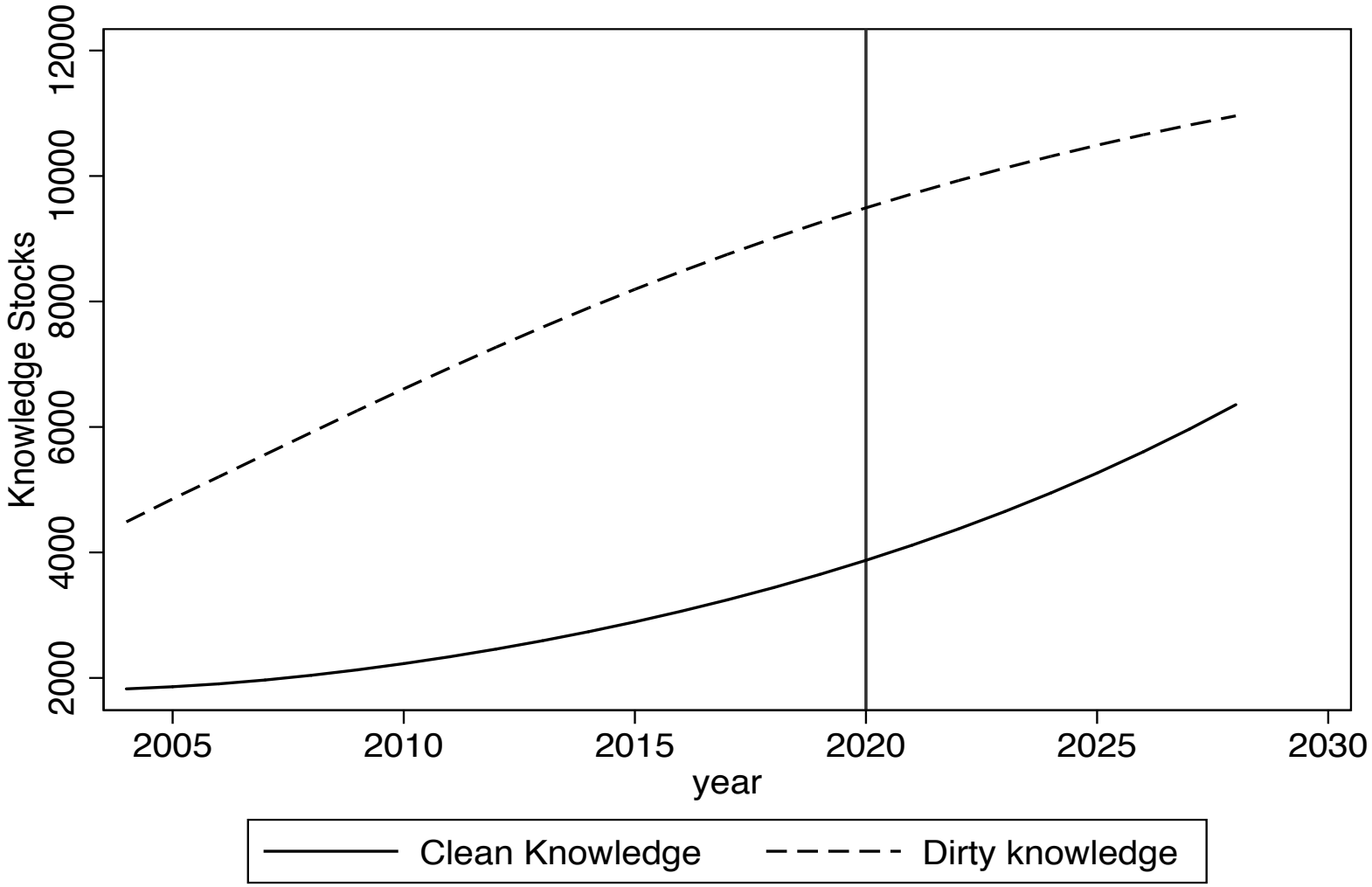
	Clean	Dirty
Fuel Tax	0.421**	-0.226**
	(0.184)	(0.091)
Clean Spillover	0.387***	-0.146***
	(0.085)	(0.048)
Dirty Spillover	-0.312***	0.228***
	(0.079)	(0.054)
Own Stock Clean	0.500***	0.197*
	(0.091)	(0.108)
Own Stock Dirty	0.247***	0.612***
	(0.050)	(0.071)
Observations	68,240	68,240
Firms	3,412	3,412

Notes: Estimation by Conditional fixed effects (CFX), All regressions include GDP, GDP per capita, R&D & emission policies & time dummies. SEs clustered bv unit.

SIMULATIONS

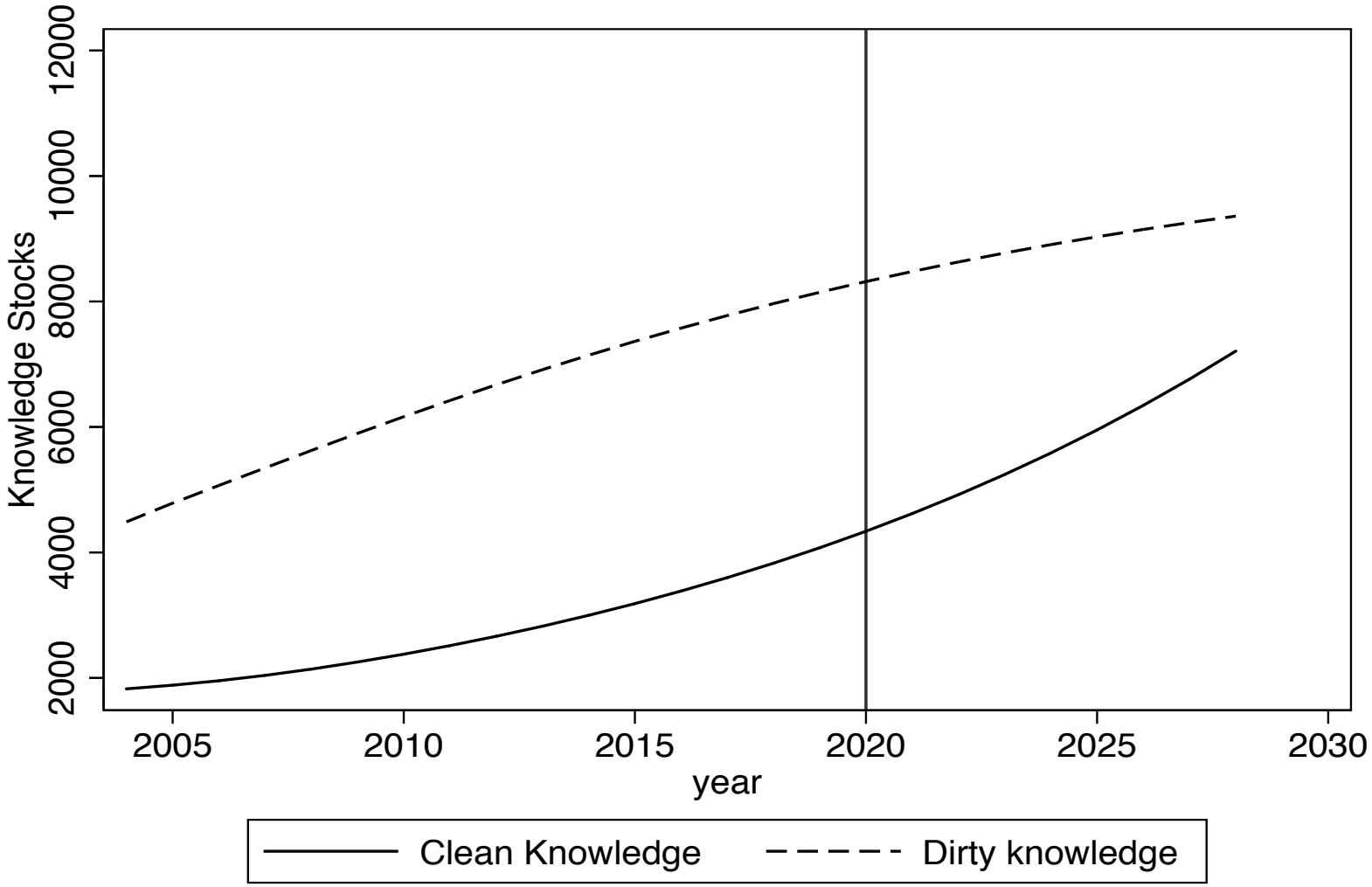
- Take estimated model to simulate the effect of changes in fuel tax compared to baseline case
- At what point (if ever) does the stock of clean innovation exceed stock of dirty innovation

FIGURE 5A: BASELINE: NO FUEL PRICE INCREASE



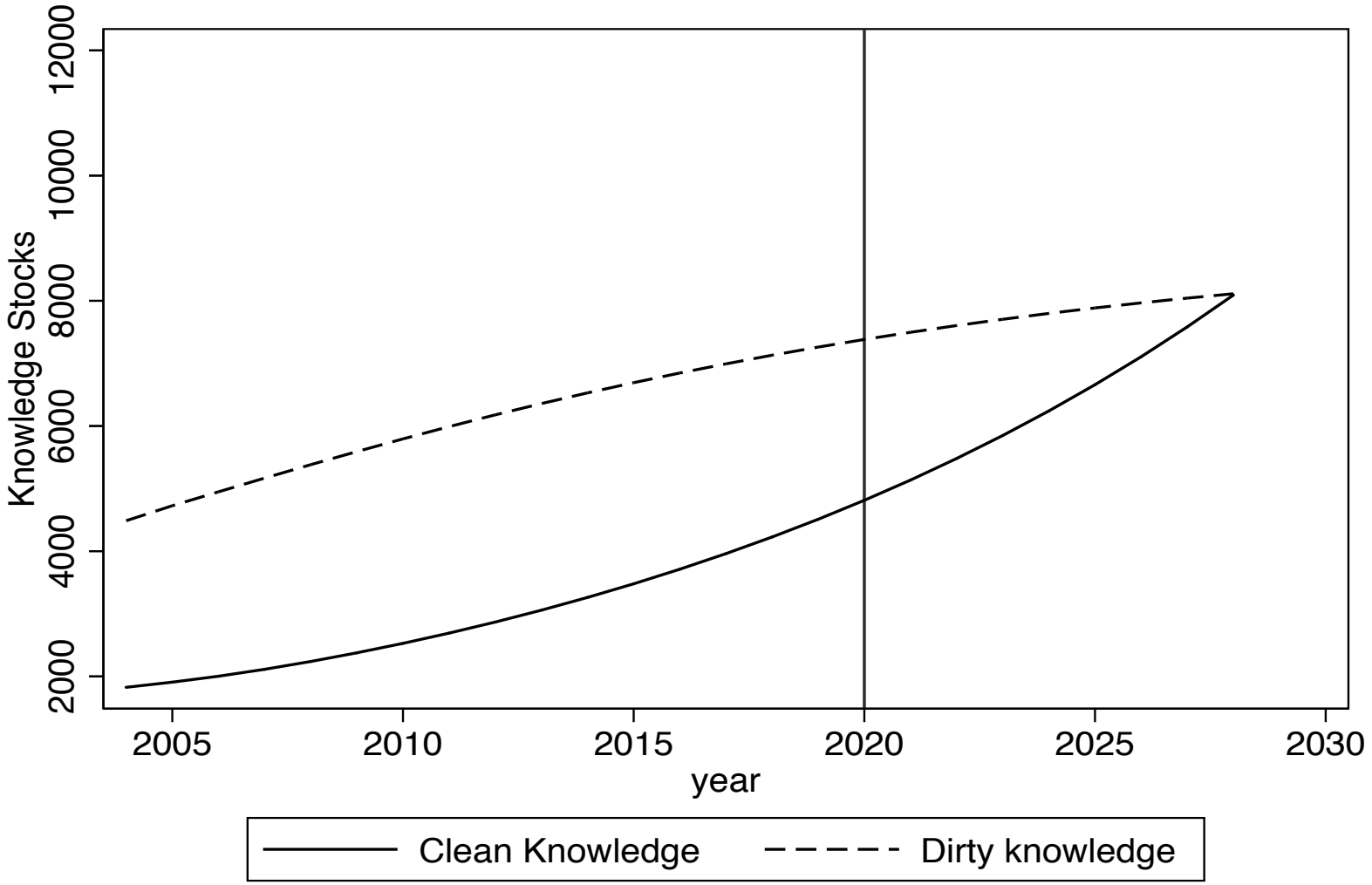
Price increase of 0%

FIGURE 5B: BASELINE: 10% INCREASE IN FUEL PRICE



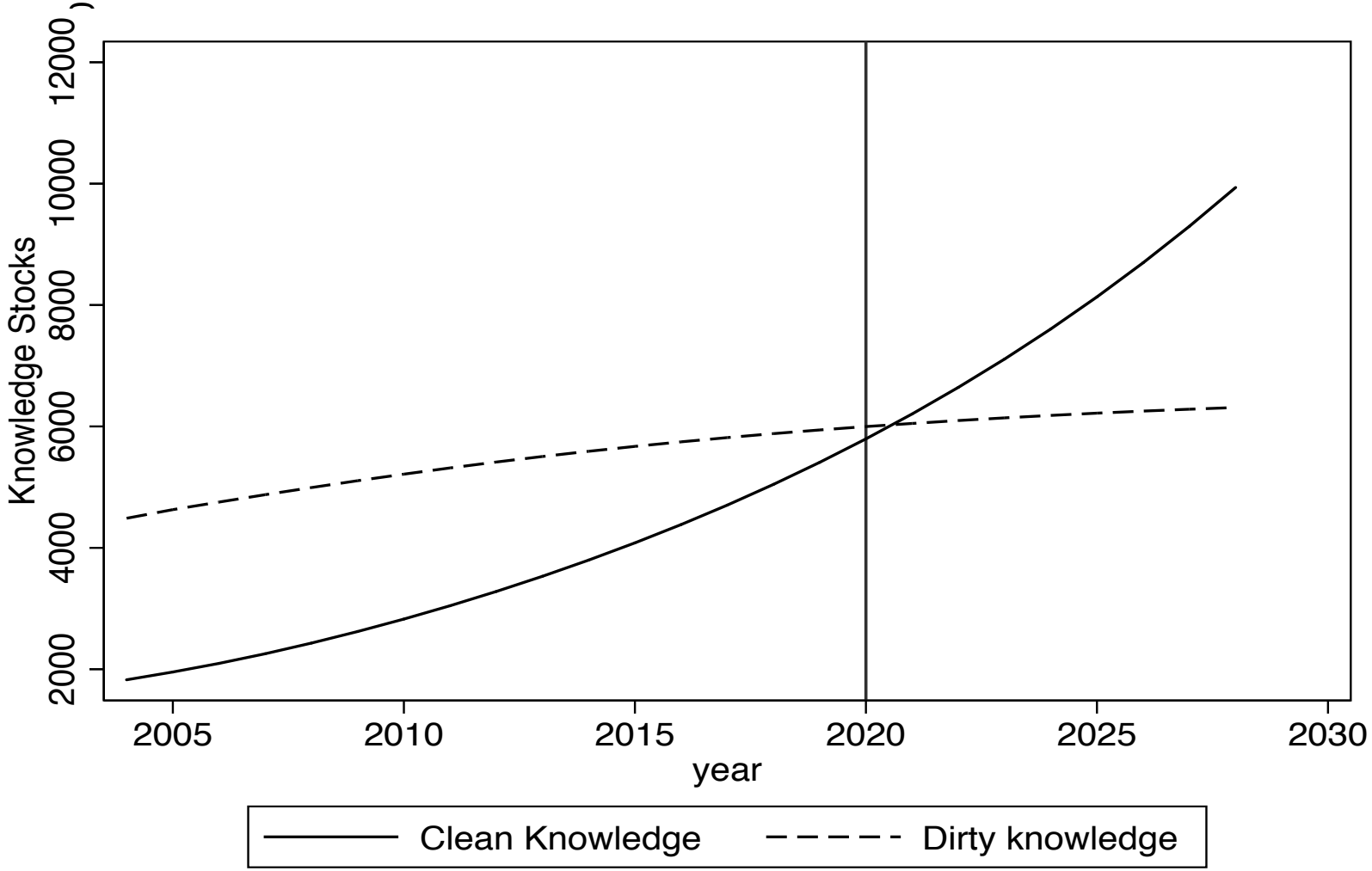
Price increase of 10%

FIGURE 5B: BASELINE: 20% INCREASE IN FUEL PRICE



Price increase of 20%

FIGURE 5D: BASELINE: 40% INCREASE IN FUEL PRICE



Price increase of 40%

CONCLUSIONS

- Le changement technique peut être “dirigé” vers l’innovation verte à travers notamment le mécanisme des prix
- Dépendance au passé:
  - Justifie l’intervention de l’Etat pour rediriger le changement technique
- Les simulations suggèrent des hausses de taxe carbone très substantielles pour atteindre les objectifs climatiques, ce qui suggère d’utiliser un mix d’intruments

AABH MODEL

- Final output produced with clean and dirty inputs
- Dirty input production depletes the environment
- Each input produced with labor and machines
- Innovation improves productivity of machines, can be directed towards machines producing “clean” or “dirty” inputs

AABH MODEL

- Two main externalities:
  - Environmental externality
  - Knowledge externality: innovators build on the giant's shoulders in their own sectors

AABH MODEL

- Main findings:
  - If initially “dirty” machines are much more productive than “clean” machines and clean and dirty inputs are sufficiently close substitutes in producing final output, then the economy under laissez-faire will run into environmental disaster
  - Delaying intervention can be very costly
  - Disaster can be avoided through combining a carbon tax and subsidies to clean research

CONCLUSIONS

- Implication de politique
  - Agir maintenant
  - Utiliser plusieurs instruments
  - Une intervention temporaire peut être suffisante
- Nord-Sud
  - Le Nord doit être le leader
  - Problème des paradis de pollution
- Transition énergétique
  - Sous quelles conditions est-il souhaitable de recourir à des sources d'énergie intermediaires (nucléaire, gaz de schiste) ?