Innovation Union: Costs and Benefits of Innovation Policy Coordination

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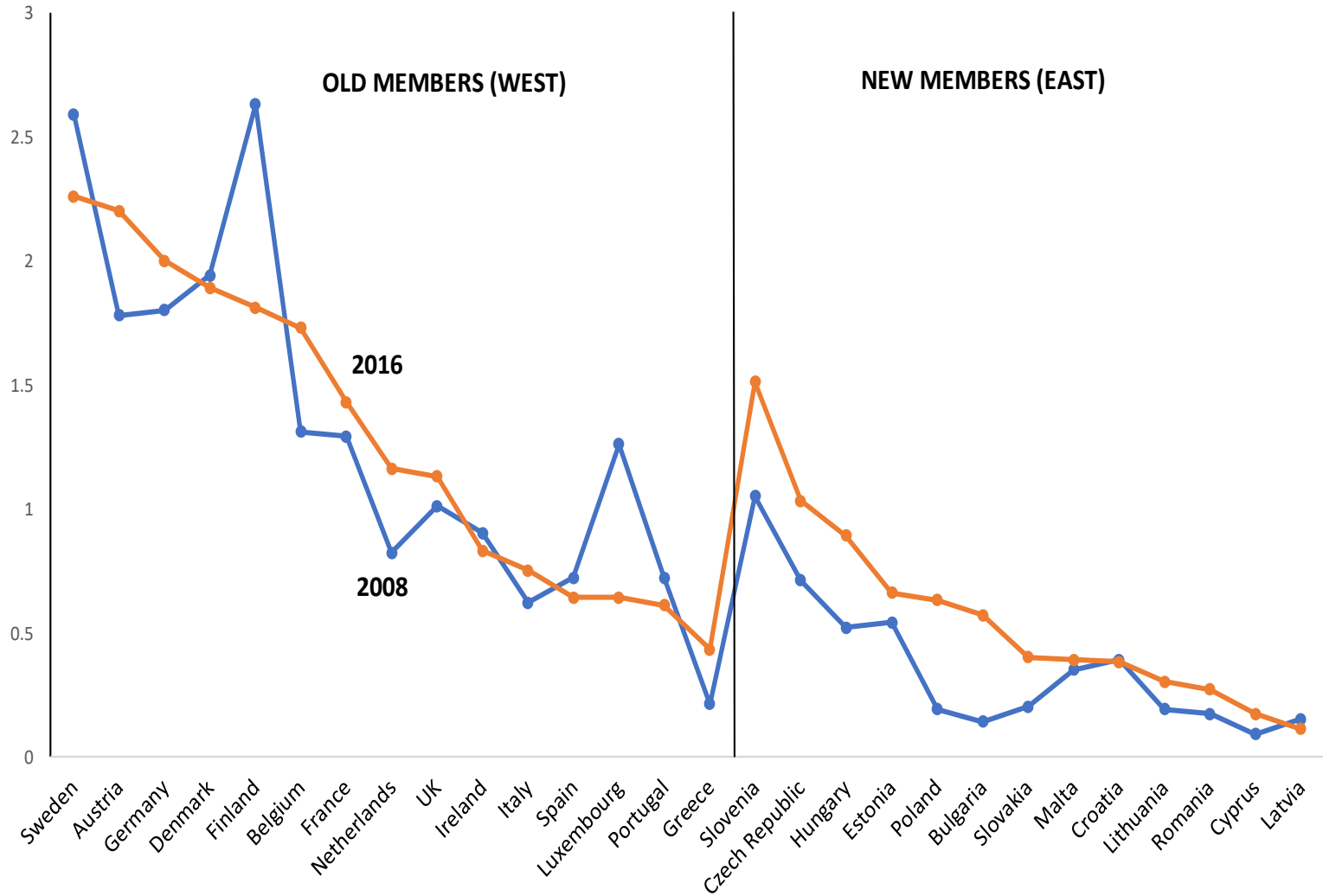
Motivation

- Recent events (e.g. financial crisis):
  - demand for stronger international policy coordination
  - movements toward more policy independence
- EU diverging trends: **ever closer union** (France-Germany) vs. **breakup** (Brexit)
- **Path to further integration**: fiscal, innovation and banking union
- **Innovation union** part of (EU 2020 strategy) key target: 3% R&D/GDP:
  - What? Single innovation market, subsidies and other innovation policy programs
  - Why? Promoting growth, closing innovation divide btw. regions
- Welfare gains/losses of a **common innovation policy in an economic union**
  - Role of countries asymmetries
  - Role of technology transfer via multinationals
  - A tool for promoting cross-country convergence?

Innovation performance in the EU

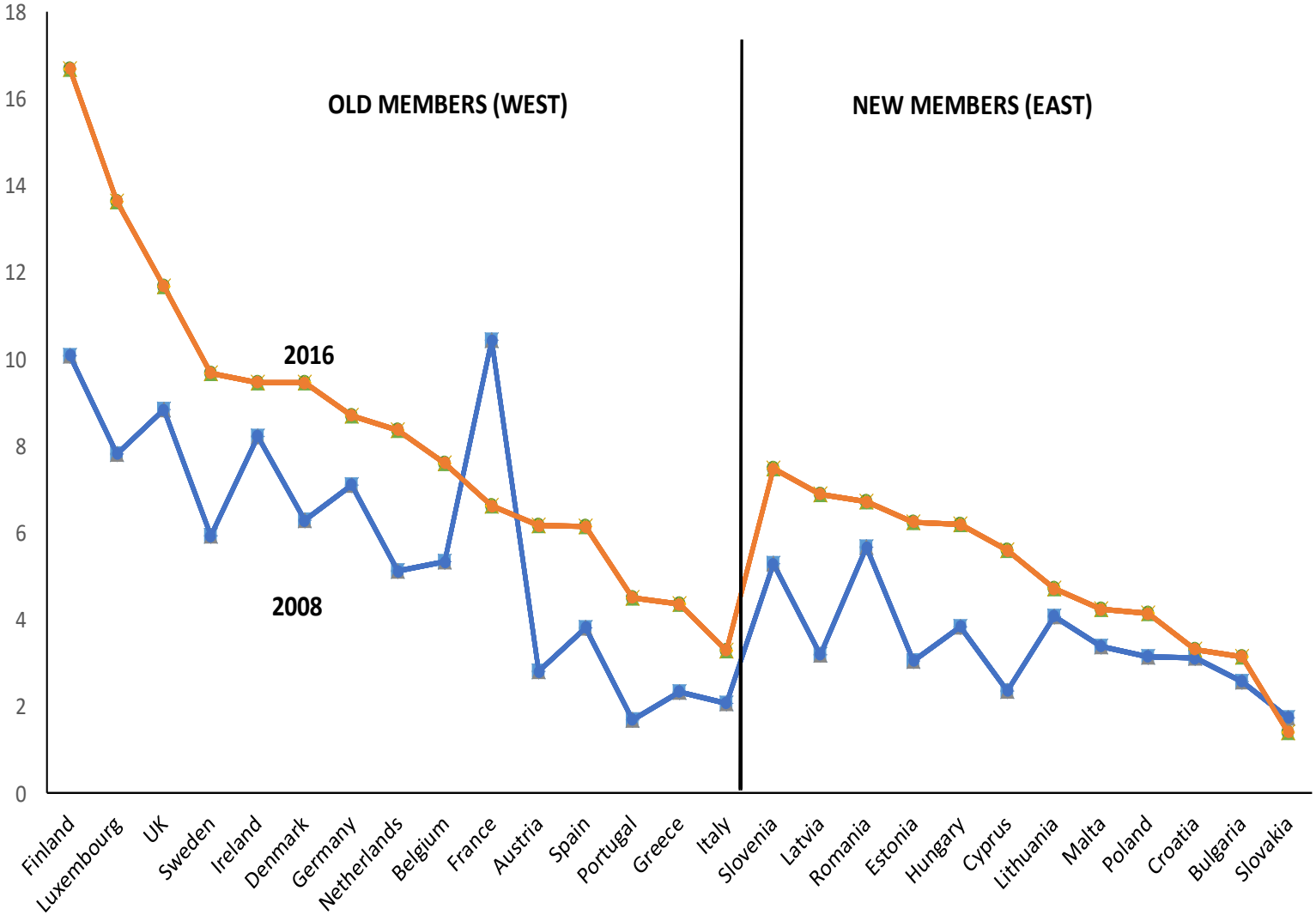
FIGURE: Business Enterprise R&D Expenditure (% of GDP)



Source: Eurostat.

Innovation performance in the EU

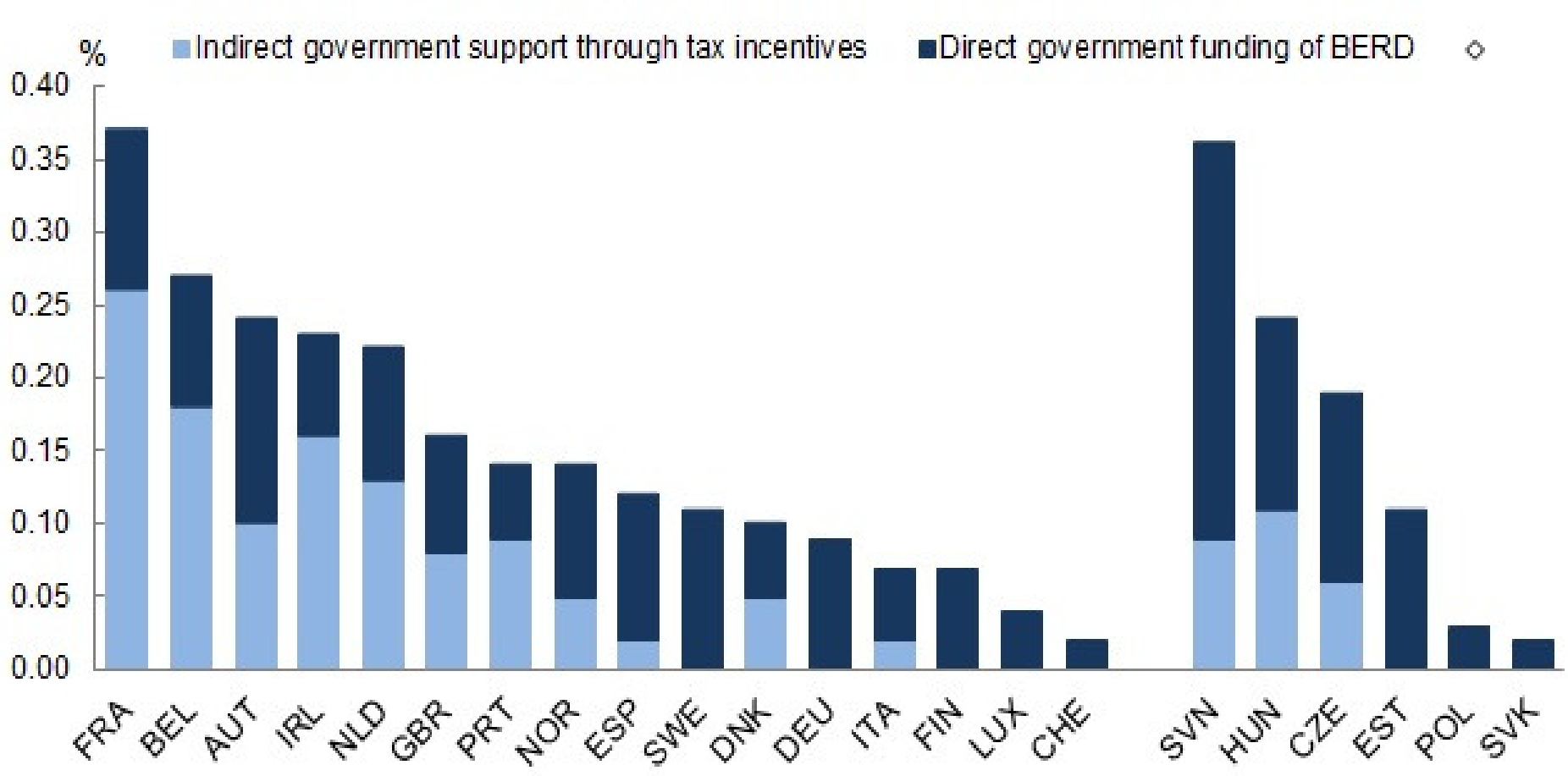
FIGURE: Scientists and Engineers (% of employment in manufacturing sector)



Source: Eurostat.

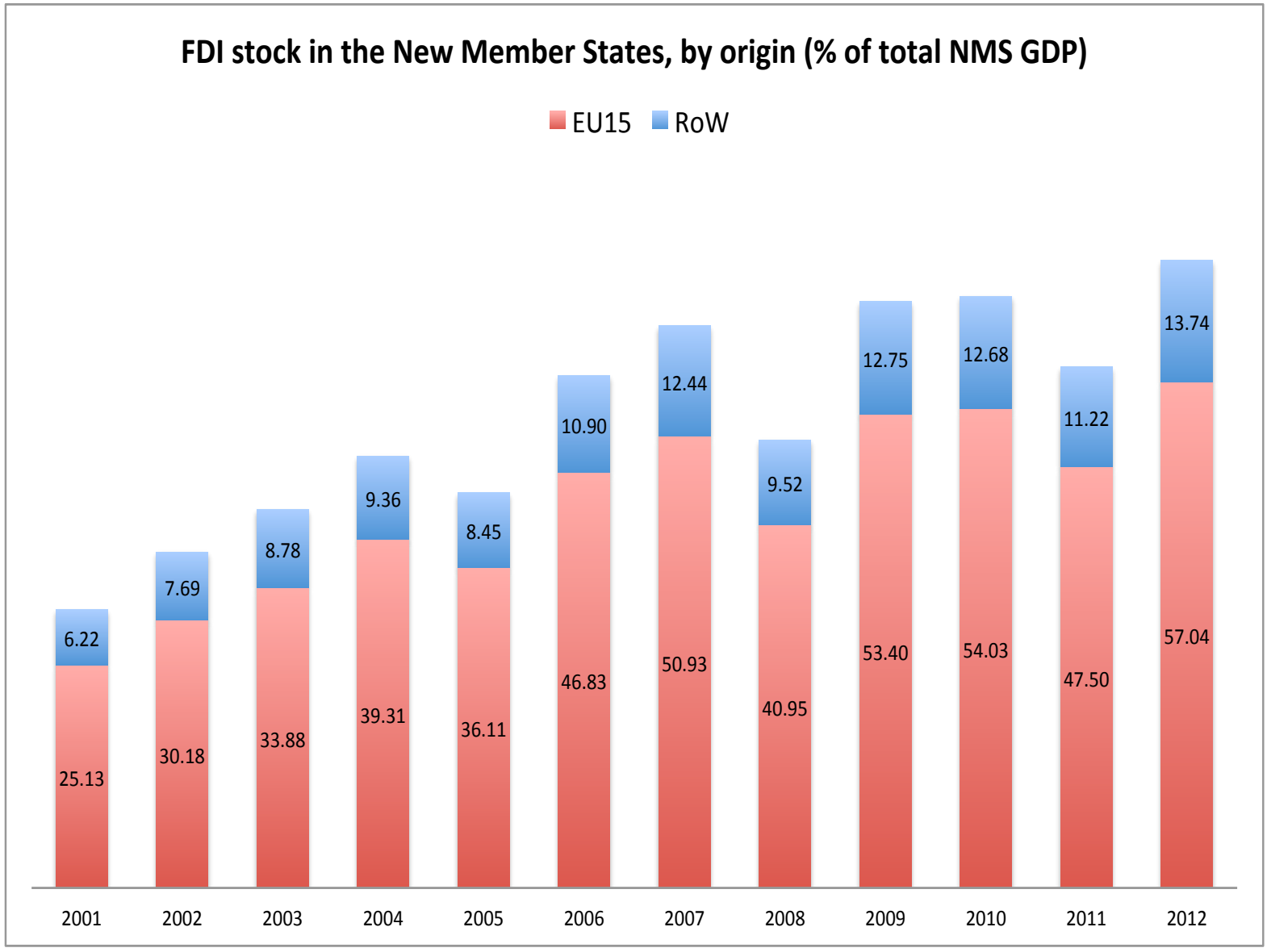
Innovation policy support in the EU

FIGURE: Direct government funding and Indirect support via tax incentives, 2012 (% GDP)



Source: OECD R&D Tax Incentives Indicators.

Foreign direct investment



West FDI and East innovation

- West-East FDI acceleration
  - New Member States (NMS) FDI (stock and flows) increase after 2004
  - Most of NMS FDI comes form old EU members
- FDI spillovers on East innovation
  - Developing countries need technology transfer to innovate
  - FDI are channels of technology transfer (Javorcik, 2004, Gorodnichenko etal. 2015)
- Data: Business Environment and Enterprise Performance Survey (BEEPS)
  - firm-level survey: face-to-face interviews with managers, 2006-2014
  - 15,529 firms located in Eastern and Central European countries
  - Key feature: firm-level innovation and firm ownership
  - Innovation: i) products/services ii) production/supply methods iii) marketing methods iv) organisational/management practices

West FDI and East innovation

- FDI spillovers on local innovation: region/sector level analysis

Dependent variable: Share of Eastern firms reporting innovation at the region-sector level				
	(1)	(2)	(3)	(4)
Share of foreign affiliates	0.701***	0.422***	0.660***	0.401***
	(0.133)	(0.124)	(0.127)	(0.120)
region fixed-effects	No	Yes	No	Yes
Sector fixed-effects	No	No	Yes	Yes
Observations	346	346	346	346
R-squared	0.140	0.817	0.169	0.835

Note. Robust standard error clustered both at the region and at the sector level in brackets. *, **, *** significantly different from 0 at 10%, 5% and 1% level, respectively.

West FDI and East innovation

- FIrm-level analysis
- Dummy: presence of a foreign firm in same region, same 2-digit sector
- Count: n. of foreign firms within the same sector-region

Dependent variable:				
Firm-level dummy variable for domestic firms reporting innovation				
Explanatory variable:	dummy	dummy	count	count
	(1)	(2)	(3)	(4)
Foreign presence	0.034**	0.035***	0.014***	0.012***
	(0.014)	(0.013)	(0.003)	(0.003)
Control variables	No	Yes	No	Yes
Observations	14,877	11,466	14,877	11,466
R-squared	0.167	0.209	0.168	0.209

All regressions include region, sector and year fixed effects. Regressions (2) and (4) include firm-level controls: firms' log of sales, dummies for state-owned enterprises, exporting firms, importing firms. Robust standard error clustered both at the region and at the sector level in brackets. *, **, *** significantly different from 0 at 10%, 5% and 1% level, respectively.

▸ Sample splits/robustness

To tackle these questions...

- **Model:**
  - Open economy Schumpeterian growth model
  - Two large economies trading freely: West (advanced) and East (developing)
  - Firms compete in quality (via innovation) leadership
  - West can do FDI and produce in the East
  - West FDI spillovers allows East firms to imitate and innovate
  - Policies: R&D and FDI subsidies
- **Quantitative analysis**
  - Calibrate to West-East EU
  - Nash vs. Unified innovation subsidy $\rightarrow$ welfare and convergence
  - Decomposition: static and dynamic gains
  - Innovation and FDI policy

Literature

- Strategic trade and industrial policy:
  - Strategic industrial policy: Spencer-Brander (1985), Leahy-Neary, (1997, 2009), Haaland-Kind (2006, 2007), Grossman-Lai (2004), Kondo (2013)
  - Strategic trade policy: Eaton-Grossman (1986), Maggi (1996), Brander (1995), Felbermayr-Jung-Larch (2013), Nocco-Ottaviano-Salto (2019)
  - Quantitative strategic trade-industrial policy: Ossa (2011, 2014, 2016, 2018)
  - **Our contribution**. Dynamics/growth, general equilibrium, MNA, quantitative.
- Innovation policy evaluation in New Quantitative Growth theory
  - Closed economy: Akcigit-Kerr (2016), Acemoglu-Akcigit-Bloom-Kerr (2013), Akcigit-Hanley-Stantcheva (2016), Atkeson-Burstein (2016)
  - Open Economy: Impullitti (2010), Akcigit-Impullitti-Ates (2018)
  - **Our contribution**. Strategic policy analysis, MNA
- MNA, innovation and growth
  - Theory: Dinopoulos-Segerstrom (2010), Acemoglu-Gancia-Zilibotti (2015)
  - Quantitative: Arkolakis-Ramondo-Rodriguez-Clare-Yeaple (2018)
  - **Our contribution**. Strategic policy analysis

Preview of the results

1. Gains from a Unified R&D subsidy are large:
   - Internalizing **growth effect** more important (dynamic)
   - Internalizing **strategic motive** less important (static)

2. **FDI alleviate strategic motive** increasing gains from policy coordination:
   - more integrated regions $\rightarrow$ lower rewards for a subsidy war
   - FDI $\rightarrow$ technology transfer $\rightarrow$ stronger knowledge spillovers $\rightarrow$ R&D subsidies more effective

3. Separating FDI and innovation policy:
   - larger gains from cooperation
   - **FDI-R&D subsidies complementarity** driven FDI knowledge spillovers

MODEL

Model

Households

- Two regions: West (Old members) and East (New members)
- Households have same preferences over a set of goods $\omega \in [0,1]$.

$$U = \int_0^{\infty} L_0 e^{-(\rho - n)t} \log u(t) dt$$

with instantaneous utility

$$u(t) \equiv \left(\int_0^1 \left[\sum_{j=0}^{j^{\max}(\omega,t)} \lambda^{j(\omega,t)} d(j,\omega,t) \right]^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}$$

- $d(j,\omega,t)$, per-member consumption of good ω, of quality $j \in \{0,1,2,...\}$
- New vintage of ω, quality jumps by $\lambda > 1$
- Household endowed with a unit of labor supplied inelastically
- Population grows at rate n

- **Assumption 1.** *Trade is free*
- Market structure: monopolistic competition
- In variety ω only top-quality firm produces and sells globally (patent protection)
- **Assumption 2.** *West quality leader can produce at home or offshore to East*
- Goods are produced only with labor, with technology

$$y^K(\omega, t) = a^K \ell_p^K(\omega, t)$$

$K = W, E, M$ are the three types of firms:

i. Western firms (W): produce in West
ii. West multinational firms (M): produce in East
iii. Eastern firms (E: produce in East

- Global innovation races shape market leadership
- **Assumption 2.** *Western firms innovates in all sectors, East innovate only in sectors that with West FDI.*
  - *adaptive R&D (FDI) needed to produce in East*
  - *technology transfer (FDI spillovers) allow Eastern firms to innovate*
- Innovation technology is:

$$I_i^K(\omega,t) = \frac{A^K(\omega,t)\ell_{i,r}^K(\omega,t)}{X(\omega,t)},$$

$\ell_{i,r}^K(\omega,t)$ labor devoted to innovation by firm i, type K, variety ω

$X(\omega,t) = 2\kappa L(t)$ is innovation complexity (kills scale effects!)

Model

Innovation

- Quality of good ω at time t is $q(\omega,t) = \lambda^{j(\omega,t)(\sigma-1)}$
- **Assumptions 3 (Knowledge spillovers):** R&D productivity is,

$$A^W(\omega,t) = \gamma^W \left(\frac{q(\omega,t)}{Q(t)}\right)^{-1} \text{ for } \omega \in \omega^W \text{ (West lead)},$$

$$A^M(\omega,t) = \gamma^M \left(\frac{q(\omega,t)}{Q(t)}\right)^{-1} \text{ for } \omega \in \omega^M \text{ (West MNA)},$$

$$A^E(\omega,t) = \gamma^E \left(\frac{q(\omega,t)}{Q^{E+M}(t)}\right)^{-1} \text{ for } \omega \in \omega^E \text{ (East lead)}.$$

  - West: global spillovers, $q(\omega,t)/Q(t)$,

$$Q(t) = \int_0^1 q(\omega,t)d\omega$$

  - East: local spillovers, $q(\omega,t)/Q^{E+M}(t)$,

$$Q^{E+M}(t) = \int_{\omega^E+\omega^M} q(\omega,t)d\omega,$$

Model

Equilibrium: innovation

- Free entry in innovation

$$\underbrace{\frac{\pi^K(\omega,t)}{r(t)+I(\omega,t)-\frac{\dot{v}(\omega,t)}{v(\omega,t)}}}_{v^K(\omega,t)}\underbrace{\frac{A^K\ell^K_{i,r}(\omega,t)}{X(\omega,t)}}_{I^K_i(\omega,t)}=(1-s^K)w^K\ell^K_{i,r}$$

R&D subsidy directly reduce cost of innovation

- Value of a firm (patent)

$$v^K(\omega,t)=\frac{\pi^K(\omega,t)}{r(t)+I(\omega,t)-\frac{\dot{v^K}(\omega,t)}{v^K(\omega,t)}}$$

$I^k(\omega,t)$ Poisson arrival rate of an innovation, Schumpeterian creative destruction

▸ Pricing and profits

Model

Steady-state: innovation

- Steady state equilibrium innovation:

$$1 - s^W = \frac{B_1}{\rho + I^W - n + g} \quad \text{for } \omega \in \omega^W,$$

$$(1 - s^E)w^E = \frac{B_2 w^{E(1-\sigma)}}{\rho + I^W + I^E - n + g} \quad \text{for } \omega \in \omega^E,$$

$$(1 - s^E)w^E = B_3 \left(\frac{a^{M(1-\sigma)} w^{E(1-\sigma)}}{\rho + I^W + I^E - n + g} - \frac{a^{W(1-\sigma)}}{\rho + I^W - n + g} \right) \quad \text{for } \omega \in \omega^M.$$

- **FDI choice**: value of W quality leader producing in E - value producing in W:
  - difference in labor cost promotes MNA
  - difference in creative destruction discourages MNA

▸ More equilibrium details

Model

Steady-state: Welfare

- Utility: $u^K(t) = c^K/P(t)$, price index $P(t) = \bar{P}Q(t)^{\frac{1}{1-\sigma}}$
  - $\bar{P} = \left[q^W p^{W(1-\sigma)} + q^M p^{M(1-\sigma)} + q^E p^{E(1-\sigma)}\right]^{\frac{1}{1-\sigma}}$, $q^j = Q^j(t)/Q(t)$ relative qualities
  - quality grows in steady state at rate

$$\frac{\dot{Q}(t)}{Q(t)} = (\lambda^{\sigma-1} - 1)\left[I^W + \left(1 - q^W\right) I^E\right] = g$$

- Steady state welfare decomposition

$$\begin{aligned} U^K &= \int_0^\infty N_0 e^{-(\rho-n)t}(\log c^K(t) - \log P(t))dt \\ &= \frac{\log c^K}{\rho - n} - \frac{\log \bar{P}}{\rho - n} + \frac{g}{(\sigma-1)(\rho-n)^2}. \end{aligned}$$

  - Static: consumption, c^K, and global leadership distribution, $\bar{P}$
  - Dynamic: quality growth, g

External effects of innovation I

Innovation externalities in Schumpeterian models (Aghion-Howitt, 1992):

- Consumers benefit immediately and via spillovers on future innovations → Subsidise R&D
  - static component: **consumer surplus effect** (*CRE*)
  - dynamic component: intertemporal knowledge spillover or **growth effect** (*GRE*).
- Reduce incumbent profits in same variety and indirectly on other incumbents
  - **business-stealing effect** (*BSE*) → Tax R&D

External effects of innovation II

- Open economy → **strategic motive**:
  - steal foreign business: positive effects on domestic wages and profits
  - **international business-stealing** effect (*IBSE*) → Subsidise R&D (Eaton-Grossman,1985)

- **FDI tame** strategic motive for subsidy:
  - WEST: ↑ I^W (creative destruction) → ↑ FDI
    - negative effect on W profit and wages → Tax R&D (weaker *IBSE*)
    - stronger international knowledge spillovers → Subsidise R&D (stronger *GRE*)
  - EAST: ↑ I^E (creative destruction) → ↓ FDI
    - negative effect on E profits and wages → Tax R&D (weaker *IBSE*)
    - weaker international knowledge spillovers → Tax R&D (weaker *GRE*)

Quantitative Analysis

Calibration

- Focus on EU27
- WEST is EU15 (old members): Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Denmark, Ireland, U.K., Greece, Portugal, Spain, Austria, Finland, Sweden
- EAST is EU12 (new members): Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania

▸ Calibration details

Calibration

TABLE: Calibration summary

External parameters	Value	Source
Interest rate ($r = \rho$)	0.049	Eurostat, 2001-2013
Utility f-n parameter (σ)	4.5	Bundesbank, 2017
Population growth rate (n)	0.508%	Eurostat, 1961-2013
R&D subsidy, West (s^W)	15.6%	OECD, 2011
R&D subsidy, East (s^E)	14.2%	OECD, 2011
Relative labor size, West (l^W)	0.802	Eurostat, 2015
Calibrated parameters	Value	
Innovative R&D productivity parameter, West (γ^W)	0.61	
Innovative R&D productivity parameter, East (γ^E)	2.56	
Adaptive R&D productivity parameter (γ^M)	1.30	
Manufacturing productivity, East (a^E)	1.91	
Manufacturing productivity, MNE's subsidiaries (a^M)	2.03	
Quality jump size (λ)	1.2	
Calibration targets	Data (Model)	Source
MFP growth rate	0.66% (0.51%)	OECD, 2005-2016
Share of sectors, Western leadership (ω^W)	88.96% (89.48%)	Eurostat, 2010
Share of sectors, Eastern leadership (ω^E)	6.63% (3.31%)	Eurostat, 2010
West/East R&D as a share of GDP	1.86% (1.40%)	Eurostat, 2015
Scientists & engineers labor share, West	8.04% (8.18%)	Eurostat, 2015
Scientists & engineers labor share, East	4.86% (5.31%)	Eurostat, 2015

Non cooperative game: Nash subsidies

- 2-stage policy game:
  1. governments set subsidy
  2. firms choose R&D and production to maximize profits, households choose utility-maximizing consumption and saving
- Governments set their subsidy according to best-response functions,

$$s_n^W(s_n^E) = \arg\max \left\{ W^W(s_n^W, s_n^E) \right\},$$

$$s_n^E(s_n^W) = \arg\max \left\{ W^E(s_n^W, s_n^E) \right\}.$$

- Subsidies are **strategic complements**

▸ Best responses

Policy cooperation: unified subsidy

- Reasons for policy coordination:
  - Internalising growth & consumer surplus effect $\rightarrow s_{uni} > s_{Nash}$
  - Internalising international business-stealing effect $\rightarrow s_{uni} < s_{Nash}$
- Unified subsidy set to maximise welfare in both regions:

$$s_{uni} = \arg\max \left\{ W^{EU}(s_{uni}) \right\},$$

W^{EU} is total EU welfare,

$$W^{EU} = W^W + W^E = \frac{1}{\rho - n} \left(\log c^W + \log c^E - 2 \log \bar{P} + 2 \frac{g}{(\sigma - 1)(\rho - n)} \right).$$

Policy cooperation: unified subsidy

TABLE: The effect of cooperation

	s^W	s^E	W^W	W^E	W^{EU}	*growth*
Observed (s_n^W, s_n^E)	0.1560	0.1420	37.3565	17.5022	54.8587	0.5135
Nash (s_n^W, s_n^E)	**0.4585**	**0.3037**	37.4183	18.9469	56.3652	**0.9924**
Unified (s_{uni})	**0.7779**	**0.7779**	37.4509	20.2087	57.6597	**2.3135**
No subsidies ($s^W = s^E = 0$)	0	0	37.3655	17.3054	54.6709	0.3650
Welfare gains						
Unified vs. no subsidy			0.0038	0.1275	0.1313	
Unified vs. observed			0.0041	0.1189	0.1230	
Unified vs. Nash			**0.0015**	**0.0555**	**0.0570**	
International business stealing			-0.3044	-0.2504	-0.5548	
Consumer suplus			0.0051	0.0051	0.0102	
Growth			0.3008	0.3008	0.6016	

Convergence	w^E/w^W	$\mathcal{A}^E/\mathcal{A}^W$	c^E/c^W	ω^E	ω^W	ω^M	I^E	I^W	I^M
Observed	0.4520	0.1757	0.4181	0.0331	0.8948	0.0722	0.0092	0.0200	0.0023
Nash	0.4576	0.0477	0.4443	0.0063	0.8485	0.1452	0.0017	0.0397	0.0071
Unified	0.4390	0.1986	0.4689	0.0350	0.9046	0.0604	0.0517	0.0894	0.0094

Policy cooperation: the mechanisms

- Observed subsidy closer to Nash than cooperation
- Welfare gains:
  - United vs. Nash: 5.7%
  - United vs. Observed: 12.3%
  - United vs. no Subsidy: 13.1%
- Sources?
  - If internalization of *IBS* prevails, $s_{uni} < s_{Nash}$
  - If internalization of *GRE* and *CSE* prevails, $s_{uni} > s_{Nash}$
  - $s_{Uni} > s_{Nash} \rightarrow$ *GRE* is the key channel!
- Static gains via consumer surplus (e.g Eaton and Grossman, 1986, Leahy and Neary, 1997, Ossa, 2019), small
- Dynamic gains via growth substantially larger

$\Longrightarrow$ key role of cooperation internalise knowledge spillovers!

Separating FDI and Innovation policies

- FDI subsidy: a typical **trade policy**
  - no direct implications for innovation $\rightarrow$ no creative distruction
  - direct impact on technology transfer
- R&D subsidy: a typical **innovation policy**
  - targets innovation directly
  - no direct impact on technology transfer
- Usually analysed separately, in separate literatures
- Our framework allows a joint analysis (see also Akcigit et al. (2018))

Optimal FDI vs. R&D subsidies

TABLE: Welfare gains of different policy regimes

Welfare gains	(1) Cooperative two instruments	(2) Unified one instrument	(3) Cooperative two instruments	(4) Cooperative FDI only	(5) Cooperative R&D only (3)-(4)
West	0.0022	0.0015	0.0044	−0.0008	0.0052
International business stealing	−0.3259	−0.3044	−0.4513	−0.0006	−0.4507
Consumer suplus	0.0051	0.0051	−0.0010	−0.0046	0.0036
Growth	0.3230	0.3008	0.4567	0.0044	0.4523
East	0.0788	0.0555	0.1568	0.0319	0.1249
International business stealing	−0.2493	−0.2504	−0.2989	0.0321	−0.3310
Consumer suplus	0.0051	0.0051	−0.0010	−0.0046	0.0036
Growth	0.3230	0.3008	0.4567	0.0044	0.4523
EU	**0.0810**	0.0570	**0.1612**	0.0311	0.1301
International business stealing	−0.5752	−0.5548	−0.7502	0.0315	−0.7817
Consumer suplus	0.0102	0.0102	−0.0020	−0.0046	0.0026
Growth	0.6461	0.6016	0.9133	0.0089	0.9044

▸ Details

Optimal FDI vs. R&D subsidies

Separate FDI subsidies and R&D subsidies

1. Cooperative unified R&D subsidy and FDI subsidy (vs. Nash)
   - gains larger than benchmark → growth channel is driver
   - FDI-R&D subsidies complementarity: more FDI → stronger international knowledge spillovers → stronger growth effect of R&D subsidies
   - Stronger wage and consumption convergence
2. Decomposing gains from cooperative R&D subsidy and FDI (vs. no subsidies)
   - R&D subsidy alone: same as total benchmark gain
   - FDI adds extra gains: FDI-R&D subsidies complementarity
   - Gains from FDI < gains from R&D subsidies

Conclusion

- DGE of an economic union with FDI and endogenous technical change
- Creative destruction key for FDI incentives
- Study innovation policy war and gains from cooperation
- Three key results:
  - **FDI tame gains from policy war and increases gains from cooperation**
  - **Dynamic gains from cooperation substantially larger than static**
  - **Policy complementarity btw. R&D and FDI subsidies**
- Work in progress: trade and FDI costs, transitional dynamics
- Technology dynamics in open economy is still in its infancy but...

> *" The static one-shot gains or losses from trade policy changes that are estimated in strategic trade policy models are larger than in traditional trade policy models, but still seem to be of modest size. It is possible that the effect of trade policy on growth might be more important still."*
>
> **Brander** (1995), "Strategic Trade Policy", HIE

Sample splits

Dependent variable: Dummy variable for domestic firms reporting innovation				
Explanatory variable	dummy	count	dummy	count
	(1)	(2)	(3)	(4)
	Manufacturing		Service	
Foreign presence	0.034**	0.021***	0.023	0.007**
	(0.013)	(0.004)	(0.019)	(0.003)
Observations	4,612	4,612	6,853	6,853
R-squared	0.234	0.234	0.219	0.219
	Private firms		State-owned firms	
Foreign presence	0.035***	0.012***	-0.019	-0.019
	(0.013)	(0.003)	(0.176)	(0.176)
Observations	11,328	11,328	96	96
R-squared	0.207	0.207	0.686	0.686
	Sales above median		Sales below median	
Foreign presence	0.044**	0.012**	0.030**	0.013***
	(0.018)	(0.005)	(0.014)	(0.003)
Observations	5,676	5,676	5,602	5,602
R-squared	0.219	0.218	0.221	0.222
	Exporters		Non-exporters	
Foreign presence	0.038**	0.014*	0.032*	0.009**
	(0.018)	(0.007)	(0.017)	(0.003)
Observations	2,516	2,516	8,941	8,941
R-squared	0.236	0.236	0.209	0.209
	Importers		Non-importers	
Foreign presence	0.035	0.031**	0.027*	0.008**
	(0.023)	(0.013)	(0.015)	(0.003)
Observations	2,560	2,560	8,903	8,903
R-squared	0.225	0.226	0.203	0.203

Back

Model

Equilibrium: pricing and profits

- Leader charges monopoly pricing,

$$p^K(\omega, t) = \frac{\sigma}{\sigma - 1} a^K w^K(t).$$

- Profits of global quality leaders are

$$\pi^K(\omega, t) = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} (a^K w^K(t))^{1-\sigma} q(\omega, t) \frac{c(t)L(t)}{P(t)^{1-\sigma}}.$$

  for $K = W, E$ in sector ω and

$$\pi^M(\omega, t) = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} (a^M w^E(t))^{1-\sigma} q(\omega, t) \frac{c(t)L(t)}{P(t)^{1-\sigma}}.$$

  for MNA in sector ω

- If $w^W > w^E$, West incentives to MNA
- Set numeraire $w^W = 1$.

Back

Model details

- West consumption expenditure,

$$c^W = 1 + (\rho - n)\mathcal{A}^W - \tau^W,$$
$$c^E = w^E + (\rho - n)\mathcal{A}^E - \tau^E,$$

  τ^W, τ^E, lump-sum tax to finance R&D subsidies

- Assets is total stock market value of West firms

$$\mathcal{A}^W = \int_{\omega^W + \omega^M} v^W(\omega)d\omega$$
$$\mathcal{A}^E = \int_{\omega^E} v^E(\omega)d\omega + \int_{\omega^M} (v^M - v^W)(\omega)d\omega.,$$

  - West receive profits of MNA (royalties)
  - East receive surplus profits of MNA: difference btw. profits of MNA and royalties

Model details

Global leadership distribution

- Share of sectors with W leaders

$$\omega^W = \frac{I^W}{I^M + I^W}.$$

- Share of sectors with E leaders

$$\omega^E = \frac{I^M}{I^M + I^W} \frac{I^E}{I^E + I^W}.$$

- Share of sectors with production by multinationals, M

$$\omega^M = \frac{I^M}{I^M + I^W} \frac{I^W}{I^E + I^W}.$$

Back

Calibrating sectorial leadership

Appendix

- We use GDP share and FDI flows to calibrate the leadership shares:

$$\omega^W = \frac{GDP^W - FDI^{E,W}}{GDP^{EU}}$$

$$\omega^E = \frac{GDP^E - FDI^{W,E}}{GDP^{EU}}$$

$$\omega^M = \frac{FDI^{W,E}}{GDP^{EU}}$$

Back

Non cooperative game: Nash subsidies

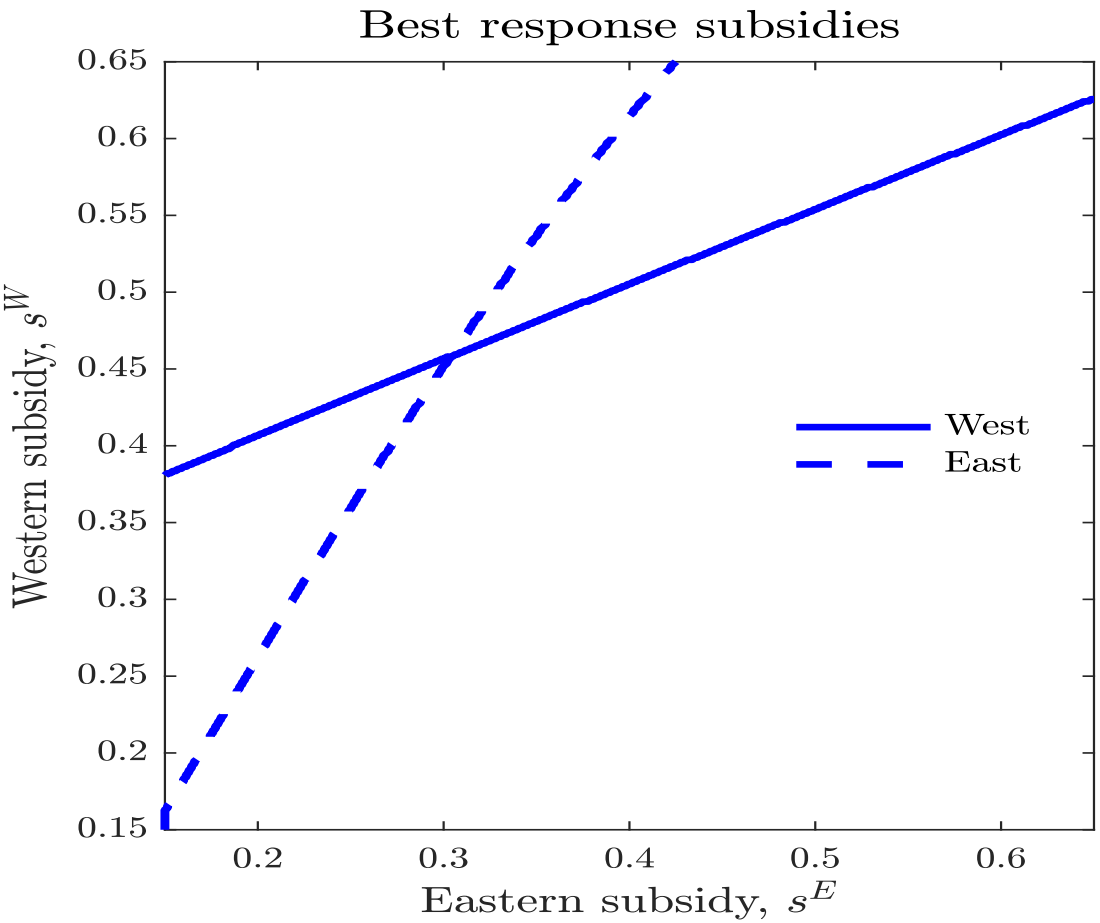


FIGURE: Nash equilibrium subsidies

Back

Optimal FDI vs. R&D subsidies

	s^W	s^E	s^M	W^W	W^E	W^{EU}	*growth*
Nash subsidies (s_n^W, s_n^E, s_n^M)*	0.4252	0.3581	1	37.4158	19.0801	56.4959	0.9520
Cooperative policy (s_{uni}, s_{coop}^M)**	0.7793	0.7793	1	37.4655	20.8752	58.3407	2.3707
Welfare gains							
Cooperative policy (s_{uni}, s_{coop}^M) **vs. Nash** (s_n^W, s_n^E, s_n^M)				0.0022	0.0788	0.0810	
International business stealing				−0.3259	−0.2493	−0.5752	
Consumer suplus				0.0051	0.0051	0.0102	
Growth				0.3230	0.3230	0.6461	

Convergence	w^E/w^W	$\mathcal{A}^E/\mathcal{A}^W$	c^E/c^W	ω^E	ω^W	ω^M	I^E	I^W	I^M
Nash	0.4834	0.0995	0.4470	0.0287	0.8350	0.1363	0.0079	0.0374	0.0074
Unified R&D subsidies	0.4654	0.1886	0.4826	0.0432	0.8751	0.0817	0.0481	0.0910	0.0130
Welfare gains									
Cooperative policy (s_{uni}, s_{coop}^M) **vs. Unified all** (s_{uni})***				0.0006	0.0293	0.0299			
International business stealing				−0.0082	0.0205	0.0123			
Consumer suplus				−0.0042	−0.0042	−0.0085			
Growth				0.0130	0.0130	0.0261			

Convergence	w^E/w^W	$\mathcal{A}^E/\mathcal{A}^W$	c^E/c^W	ω^E	ω^W	ω^M	I^E	I^W	I^M
Unified all (s_{uni})	0.4390	0.1986	0.4689	0.0350	0.9046	0.0604	0.0517	0.0894	0.0094
Cooperative policy (s_{uni}, s_{coop}^M)	0.4654	0.1886	0.4826	0.0432	0.8751	0.0817	0.0481	0.0910	0.0130

Back