

Innovation Union: Costs and Benefits of Innovation Policy Coordination

Teodora Borota
University of Uppsala

Fabrice Defever
University of Lille

Giammario Impullitti
University of Nottingham and CEPR

Adam Spencer
University of Bonn

January 7, 2026

Motivation

- ▶ US-China technology war:
 - ▶ Zero-sum game: subsidizing green technologies, semi-conductors, batteries
 - ▶ Other countries respond with their own industrial policy
- ▶ Financial crisis, Covid:
 - ▶ demand for stronger international policy coordination
 - ▶ especially in the EU
- ▶ **Innovation union** (EU 2020 strategy):
 - ▶ What? Single innovation market: grant, tax credit, loans and other innovation policy programs
 - ▶ Why? Promoting growth, closing innovation divide btw. regions
 - ▶ Program has been substantially abandoned!!
- ▶ How costly is a **technology policy war?**

Technology competition vs cooperation

► Technology → knowledge spillovers → dynamic inefficiency

► Why should countries cooperate in innovation policy?

1. **Strategic motive:** shifting profits, wages, jobs

2. **Knowledge spillovers:** innovation drives growth

→ Endogenous growth model is needed to embed these forces

► Need and value of cooperation depend on:

1. **integration:** trade in goods and ideas

2. **asymmetry:** size, technology

→ multi-country model with key asymmetries

What We Do

- (i) Facts on **asymmetries** in innovation, policy, knowledge spillovers in E.U.
- (ii) Develop a two-country **Schumpeterian** growth model:
 - ▶ Firms innovate to compete in quality for market leadership.
- (iii) Calibrate to E.U. data and run policy experiments.
 - ▶ West (old E.U. members) is advanced region and East (new members) laggard
 - ▶ **Technology cooperation I**: harmonised vs observed R&D subsidies
 - ▶ **Technology cooperation II**: harmonised R&D and FDI subsidies vs observed
 - ▶ Steady state and **transition dynamics** exercises.
 - ▶ Extension: 3-country model, West, East EU and Rest of the World (ROW)

Preview of the results

1. Cooperation I: R&D subsidies

- ▶ Observed subsidies: $s^W = 0.12$, $s^E = 0.10$
- ▶ Cooperation (harmonised): $s^W = 0.31$, $s^E = -0.99$
 - ▶ welfare gains for Union: 4.5%
 - ▶ welfare gains: West 4%, East 0.5%
 - ▶ driver: internalising international knowledge spillovers

2. Cooperation II: FDI and R&D subsidies

- ▶ Harmonised R&D subsidies only, Union gains 4.5%
- ▶ Harmonised FDI subsidies only, Union gains 2.3%
- ▶ Harmonised FDI & FDI subsidies, Union gains 9.6%
 - ⇒ trade and innovation policy complementarity
- ▶ ⇒ more equal gains: West 5%, East 4.6%

3. 3-country extension

- ▶ results confirmed
- ▶ more equal gains even with R&D subsidies only: trade diversion

Literature

► New quantitative growth theory

- R&D subsidies in closed economy (e.g. [Acemoglu and Akcigit, 2012](#); [Acemoglu et al., 2018](#); [Akcigit et al., 2022](#)) and open (e.g. [Impullitti, 2010](#); [Akcigit et al., 2018b](#)).
- this paper: policy cooperation, FDI

► FDI in endogenous growth models

- (e.g. [Branstetter and Saggi, 2011](#); [He and Maskus, 2012](#); [Acemoglu et al., 2015](#); [Dinopoulos and Segerstrom, 2010](#))
- this paper: policy cooperation

► Strategic industrial policy

- [Spencer and Brander \(1983\)](#), [Leahy and Neary \(1997\)](#), [Leahy and Neary \(2009\)](#) and [Haaland and Kind \(2008\)](#)
- This paper: does growth matter?

EMPIRICAL MOTIVATION

Fact I: heterogeneous innovation performance in the EU

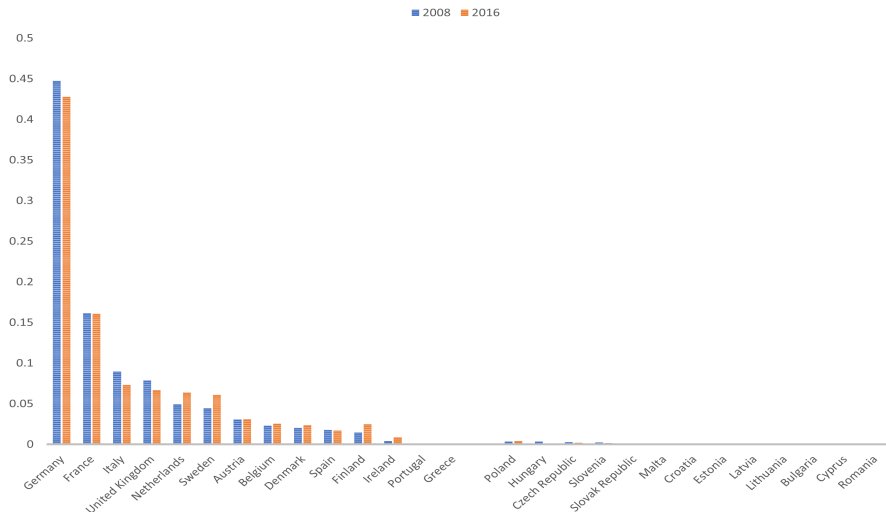
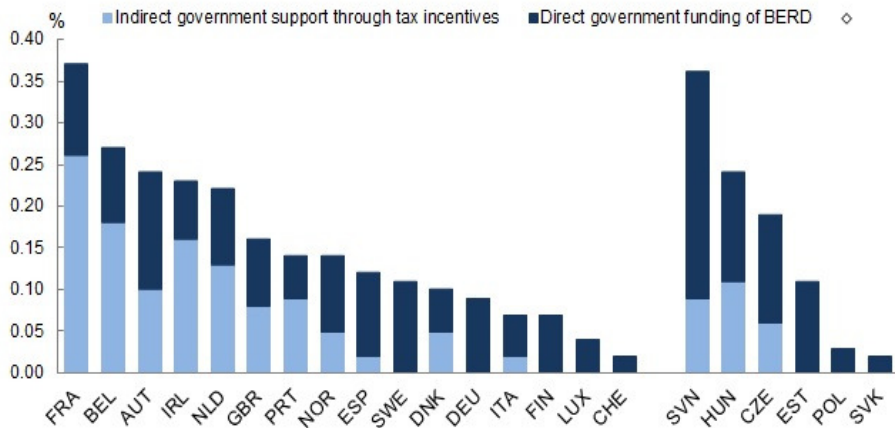


FIGURE: Patent grants at the European Patent Office (percent of EU total). Source: Eurostat.

Fact II: heterogeneous 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.

Fact III: West FDI and East innovation

► FDI spillovers

- Comparative advantage in the East shaped by low wages and technology transfer
- FDI major vehicle of technology diffusion (Javorcik, 2004, Gorodnichenko et al. 2015)
- Technology diffusion stimulates imitation and innovation

► Data: Business Environment & Enterprise Performance Survey (BEEPS)

- firm-level survey: face-to-face interviews with managers, 2006-2014
- 15,529 firms located in Eastern and Central Europe
- 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

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

TABLE: Domestic firms reporting innovation and foreign presence

Dependent variable:				
Firm-level dummy variable for domestic firms reporting innovation				
Explanatory variable:	Dummy	Dummy	Share	Share
	(1)	(2)	(3)	(4)
Foreign presence	0.038** (0.014)	0.039*** (0.013)	0.237*** (0.068)	0.205*** (0.065)
Control variables	No	Yes	No	Yes
Observations	13,844	10,593	13,844	10,593
R-squared	0.164	0.208	0.164	0.208

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

MODEL

World

- ▶ World with two countries: W and E .
- ▶ Continuous time.
- ▶ Trade in goods.
- ▶ Set of consumed good same across countries.
- ▶ Representative households; populations grow at rate n .

World

- ▶ Horizontal differentiation: continuum of varieties.
- ▶ Vertical differentiation: vintages of each variety (quality ladder)
- ▶ Only the **top** quality vintage consumed in each variety.
 - ▶ Production controlled by firm from **either** W or E .
- ▶ Innovation arrival gives $\lambda > 1$ jump in quality.

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 $j \in \{0, 1, 2, \dots\}$
- ▶ New vintage of ω , quality jumps by $\lambda > 1$
- ▶ Household endowed with a unit of labor supplied inelastically
- ▶ Population grows at rate n

Model

Production

- ▶ Market structure: monopolistic competition
- ▶ Only the top-quality firm produces each ω and sells it globally (patent protection)
- ▶ Quality leader can produce at home or offshore
- ▶ Goods are produced only with labor, with technology

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

where $K = W, E$,

- ▶ Only trade barrier is an iceberg trade cost, τ^K

Innovation technology is:

$$I_i^K(\omega, t) = A^K(\omega, t)^{1-\alpha} \ell_{Ri}^K(\omega, t) L_R^K(\omega, t)^{-\alpha}$$

- ▶ $\ell_{R,i}^K(\omega, t)$, R&D by firm i , region K , variety ω
- ▶ $L_R^K(\omega, t) = \sum_i \ell_{R,i}^K(\omega, t)$, total R&D in ω , $0 \leq \alpha \leq 1$
 - ▶ A^W : Western R&D efficiency; A^M : productivity of adaptive R&D/FDI needed to produce abroad; A^E : Eastern R&D efficiency.
 - ▶ $0 < \alpha < 1$: each firm's instantaneous success probability is decreasing in total (region-specific) R&D in the sector (local congestion/decreasing returns).

R&D efficiency and knowledge spillovers

Local vs global spillovers; complexity

The productivity term $A^\kappa(\omega, t)$ governs both R&D efficiency and knowledge spillovers:

$$\begin{aligned}A^W(\omega, t) &= \gamma^W \left(\frac{q(\omega, t)}{\hat{Q}^W(t)^\phi} \right)^{-1} \\A^M(\omega, t) &= \gamma^M \left(\frac{q(\omega, t)}{\hat{Q}^W(t)^\phi} \right)^{-1} \\A^E(\omega, t) &= \gamma^E \left(\frac{q(\omega, t)}{\hat{Q}^E(t)^\phi} \right)^{-1}.\end{aligned}\tag{1}$$

- **Complexity effect:** higher sectoral quality $q(\omega, t)$ makes further innovation/technology transfer more difficult.
- **Spillovers:** higher aggregate quality raises R&D efficiency via $\hat{Q}^W(t)$ and $\hat{Q}^E(t)$.
- **Local vs global:** $\hat{Q}^\cdot(t)$ blends *local* (region) and *global* (world) knowledge stocks (formalised next).

Assumption 1 (Technology gap)

Structure of spillovers and regional asymmetries

Assumption 1 (Technology gap). R&D efficiency has the following structure:

(a) Western innovation is more productive: $\gamma^W > \gamma^E$.

(b) Western innovation and FDI receive spillovers,

$$\hat{Q}^W(t) = Q^W(t)^{\beta^W} Q(t)^{(1-\beta^W)},$$

$Q^W(t) = \int_{\omega^W} q(\omega, t) d\omega$ is avg quality of secs with Western leader producing in West, ω^W is the share of these sectors. $Q(t) = \int_0^1 q(\omega, t) d\omega$ is aggregate global quality.

(c) Eastern firms receive spillovers,

$$\hat{Q}^E(t) = Q^{E+M}(t)^{\beta^E} Q(t)^{(1-\beta^E)},$$

$Q^{E+M}(t) = \int_{\omega^E + \omega^M} q(\omega, t) d\omega$, is avg quality of secs with production in the East from both Eastern leaders (mass ω^E), and multinationals (mass ω^M).

(d) There is a local bias in knowledge spillovers: $1/2 < \beta^W = \beta^E < 1$.

Assumption 1 (Technology gap)

FDI diffusion, semi-endogenous spillovers, and equilibrium innovation

Assumption 1 (continued).

- (e) Technology diffuses via FDI allowing Eastern firm to start innovating.
- (f) Aggregate spillovers become weaker as the economy grows: $\phi < 1$.
- ▶ **Comparative advantage in R&D:** $\gamma^W > \gamma^E$ plus local-biased spillovers imply higher effective R&D efficiency in the West (and typically $\omega^W > \omega^E$, reinforcing spillovers through Q^W).
- ▶ **FDI as knowledge diffusion:** (i) multinationals' presence in the East gives local firms access to foreign knowledge and expands the set of varieties produced in the East (hence targetable by Eastern innovators); (ii) FDI strengthens local spillovers affecting Eastern firms via $Q^{E+M}(t)$.
- ▶ **Weak aggregate spillovers** ($\phi < 1$): addresses the scale-effect problem; policy affects growth mainly through *transitions* (semi-endogenous growth).
- ▶ **Arrow/replacement effect:** innovation is done by entrants

Free entry in innovation

Expected returns vs. subsidised costs

- ▶ Governments subsidise R&D expenditures at the region-specific rate s^K .
- ▶ Each entrant chooses R&D labour by equating expected benefits and costs.
 - ▶ **Benefit (expected return):** $v^K(\omega, t) I_i^K(\omega, t) dt$, where $v^K(\omega, t)$ is the patent value (discounted profits) and $I_i^K(\omega, t) dt$ is the success probability.
 - ▶ **Cost (subsidised wage bill):** $(1 - s^K) w^K(t) I_{Ri}^K(\omega, t) dt$.

Using the innovation technology to substitute for R&D labour,

$$(1 - s^K) w^K(t) I_{Ri}^K(\omega, t) dt = (1 - s^K) w^K(t) I_i^K(\omega, t) A^K(\omega, t)^{\alpha-1} L_R^K(\omega, t)^\alpha dt.$$

Free entry into R&D races implies (for $(\kappa, K) \in \{(W, W), (E, E), (M, E)\}$):

$$v^K(\omega, t) A^K(\omega, t) I^K(\omega, t)^{\frac{\alpha}{\alpha-1}} = (1 - s^K) w^K(t). \quad (2)$$

Patent values and creative destruction

No-arbitrage in the stock market

A shareholder of the quality leader of type κ in sector ω receives dividend $\pi^\kappa(\omega, t) dt$, experiences capital gains/losses $\dot{v}^\kappa(\omega, t) dt$, and faces displacement (creative destruction) with probability $\hat{I}_\kappa(\omega, t) dt$.

No-arbitrage condition:

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

i.e. dividend yield plus capital gains equals the riskless rate plus a premium for displacement risk.

It follows that the expected firm (patent) value is

$$v^\kappa(\omega, t) = \frac{\pi^\kappa(\omega, t)}{r^K(t) + \hat{I}_\kappa(\omega, t) - \frac{\dot{v}^\kappa(\omega, t)}{v^\kappa(\omega, t)}}. \quad (3)$$

Equilibrium values: W , E , and multinationals

Using the free entry condition (2), equilibrium values of incumbents (patents) satisfy:

$$\begin{aligned}\frac{1 - s^W}{M(I^W(\omega, t))} &= \frac{\pi^W(\omega, t)}{r^W(t) + I^W(\omega, t) - \frac{\dot{v}^W(\omega, t)}{v^W(\omega, t)}} = v^W(\omega, t), \\ &\quad \forall \omega \in \omega^W \\ \frac{(1 - s^E) w^E(t)}{M(I^E(\omega, t))} &= \frac{\pi^E(\omega, t)}{r^E(t) + I^W(\omega, t) + I^E(\omega, t) - \frac{\dot{v}^E(\omega, t)}{v^E(\omega, t)}} = v^E(\omega, t), \\ &\quad \forall \omega \in \omega^E \\ \frac{(1 - s^M) w^E(t)}{M(I^M(\omega, t))} &= \left(\frac{\pi^M(\omega, t)}{r^E(t) + I^W(\omega, t) + I^E(\omega, t) - \frac{\dot{v}^M(\omega, t)}{v^M(\omega, t)}} \right. \\ &\quad \left. - \frac{\pi^W(\omega, t)}{r^W(t) + I^W(\omega, t) - \frac{\dot{v}^W(\omega, t)}{v^W(\omega, t)}} \right) = \tilde{v}^M(\omega, t), \\ &\quad \forall \omega \in \omega^M.\end{aligned}\tag{4}$$

- ▶ $M(I^\kappa(\omega, t)) = A^\kappa(\omega, t) (I^\kappa(\omega, t))^{\alpha/(\alpha-1)}$, $\kappa \in \{W, E, M\}$, is marginal productivity of research
- ▶ $\tilde{v}^M(\omega, t) = v^M(\omega, t) - v^W(\omega, t)$ is the value gain from producing in E rather than W .

Mechanisms: innovation vs offshoring risks

- ▶ **Innovation incentives** (first two conditions in (4)):
 - ▶ Benefit: patent value v^{κ} (higher profits π^{κ} , lower displacement risk \hat{I}_{κ}).
 - ▶ Productivity: $M(\cdot)$ depends on $A^{\kappa}(\omega, t)$ (spillovers + γ) and curvature α .
- ▶ **Creative destruction differs by leader type:**
 - ▶ If $\omega \in \omega^W$: leaders are Western; Eastern firms innovate only where there is local production $\Rightarrow \hat{I}_W(\omega, t) = I^W(\omega, t)$.
 - ▶ If $\omega \in \omega^E$: Eastern leaders face both Western and Eastern entrants $\Rightarrow \hat{I}_E(\omega, t) = I^W(\omega, t) + I^E(\omega, t)$.
- ▶ **Decreasing returns and diversification:** $\alpha \in (0, 1)$ tempers West's comparative advantage; concentrating all R&D in W may be globally inefficient.
- ▶ **FDI free entry (third condition):** firms trade off
 - ▶ *Wage gap*: lower production costs in E (profits π^M vs π^W),
 - ▶ *Creative-destruction gap*: offshoring raises displacement risk (exposure to $I^W + I^E$ rather than I^W),

balancing cost savings against a higher risk of being leapfrogged due to technology diffusion.

Growth and welfare

Instantaneous utility in region $K \in \{W, E\}$ is real consumption:

$$u^K(t) = \frac{c^K(t)}{p^K(t)}. \quad (5)$$

The price index can be written as

$$P^K(t) = \bar{P}^K(t) Q(t)^{1/(1-\sigma)},$$

$\bar{P}^K(t)$ captures *geography of market leadership* and prices, and $Q(t)$ is aggregate quality.

Geographical component of CPI:

$$\bar{P}^W(t) = \left[q^W(t) p(t)^{W(1-\sigma)} + q^M(t) p(t)^{*M(1-\sigma)} + q^E(t) p^{*E}(t)^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}}, \quad (6)$$

$$\bar{P}^E(t) = \left[q^W(t) p^{*W}(t)^{(1-\sigma)} + q^M(t) p^M(t)^{(1-\sigma)} + q^E(t) p^E(t)^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}}. \quad (7)$$

Relative qualities $q^k(t) = Q^k(t)/Q(t)$ (with $q^W + q^E + q^M = 1$) measure the distribution of leadership across W , E , and multinationals.

Quality growth and utility growth

Innovation-driven growth with FDI sectors

Aggregate quality evolves with cumulative innovations; its growth rate is:

$$\frac{\dot{Q}(t)}{Q(t)} = (\lambda^{\sigma-1} - 1) \left[I^W(t) + (q^E(t) + q^M(t)) I^E(t) \right] \equiv g(t). \quad (8)$$

- ▶ Western innovation $I^W(t)$ occurs in all sectors.
- ▶ Eastern innovation $I^E(t)$ occurs only in sectors with production in the East (mass $q^E + q^M$).
- ▶ Adaptive R&D/FDI does *not* directly raise $Q(t)$; it affects growth indirectly via spillovers/geography.

Since quality growth reduces the price index, utility grows at:

$$\frac{\dot{u}(t)}{u(t)} = \frac{1}{\sigma - 1} \frac{\dot{Q}(t)}{Q(t)}. \quad (9)$$

Households and assets

Budget constraint and home bias

Per-capita budget constraint (assets):

$$\dot{\mathcal{A}}^K(t) = w^K(t) + r^K(t)\mathcal{A}^K(t) - c^K(t) - n\mathcal{A}^K(t) - T^K(t),$$

equivalently nominal expenditure:

$$c^K(t) = w^K(t) + (r^K(t) - n)\mathcal{A}^K(t) - \dot{\mathcal{A}}^K(t) - T^K(t), \quad (10)$$

with lump-sum taxes financing subsidies:

$$T^K(t) = s^K w^K(t) \frac{1}{L^K(t)} \int_{\omega^K} L_R^K(\omega, t) d\omega.$$

Home bias in asset ownership: per-capita assets are

$$\begin{aligned} \mathcal{A}^W(t) &= \int_{\omega^W + \omega^M} \frac{v^W(\omega, t)}{L^W(t)} d\omega + \int_{\omega^M} \frac{\tilde{v}^M(\omega, t)}{L^W(t)} d\omega \\ \mathcal{A}^E(t) &= \int_{\omega^E} \frac{v^E(\omega, t)}{L^E(t)} d\omega. \end{aligned} \quad (11)$$

Welfare under transition

Decomposition of welfare components

Lifetime welfare:

$$\begin{aligned}
\overbrace{U^K}^{\text{Lifetime utility}} &= \int_0^\infty e^{-(\rho-n)t} \left(\log \overbrace{c^K(t)}^{\text{Nominal expenditure}} - \log \overbrace{P^K(t)}^{\text{CPI}} \right) dt \\
&= \underbrace{\int_0^\infty e^{-(\rho-n)t} \log c^K(t) dt}_{\text{Business stealing}} - \underbrace{\int_0^\infty e^{-(\rho-n)t} \log \bar{P}^K(t) dt}_{\text{Consumer surplus}} \\
&\quad + \underbrace{\frac{1}{1-\sigma} \int_0^\infty e^{-(\rho-n)t} \left(\int_0^t g(\hat{t}) d\hat{t} \right) dt}_{\text{Intertemporal spillovers}}
\end{aligned}$$

since

$$P^K(t) = \underbrace{\bar{P}^K(t)}_{\text{Detrended CPI}} \quad Q(t)^{\frac{1}{1-\sigma}} = \bar{P}^K(t) Q(0)^{\frac{1}{1-\sigma}} \exp\left(\frac{1}{1-\sigma} \int_0^t g(\hat{t}) d\hat{t}\right).$$

Welfare in steady state

Semi-endogenous growth and welfare levels

Semi-endogenous steady-state growth:

$$g = \frac{n}{1 - \phi}. \quad (12)$$

In steady state, \bar{P}^K and c^K are constant, so lifetime welfare simplifies to

$$U^K = \frac{\log c^K}{\rho - n} - \frac{\log \bar{P}^K}{\rho - n} + \frac{n}{(1 - \phi)(\sigma - 1)(\rho - n)^2}. \quad (13)$$

- ▶ Long-run growth g is exogenous — policies affect only levels, not trend growth.
- ▶ Innovation subsidies influence welfare through:
 - ▶ nominal income and consumption c^K ,
 - ▶ the geographical component of the price index \bar{P}^K .
- ▶ Transitional dynamics generate additional welfare gains via the *intertemporal spillover* term.

Innovation externalities: closed economy

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**
 - ▶ dynamic component: **intertemporal knowledge spillover** or growth effect
- ▶ Reduce incumbent profits in same variety and indirectly on other incumbents
 - ▶ **business-stealing effect** → Tax R&D

Innovation externalities: open economy

Open economy: non-cooperative

- ▶ **strategic motive** → subsidise R&D

Open economy: cooperative

- ▶ **strategic motive** → tax
- ▶ **international knowledge spillovers** → subsidise
- ▶ **diversification**: congestion

Quantitative Analysis

- ▶ 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 summary

TABLE: Calibration summary

External parameters	Value	Source
Interest rate ($r = \rho$)	0.04	Eurostat, 2001–2013
Population growth rate (n)	0.44%	Eurostat, 1961–2013
R&D subsidy, West (s^W)	12.3%	OECD, 2011
R&D subsidy, East (s^E)	9.75%	OECD, 2011
Relative labour size, West (l^W)	0.80	Eurostat, 2015
Utility parameter (σ)	3.21	Feenstra et al. (2018)
Calibrated parameters	Value	
Innovative R&D productivity, West (γ^W)	0.52	
Innovative R&D productivity, East (γ^E)	0.41	
Innovative R&D productivity, MNE (γ^M)	0.28	
Manufacturing productivity, East (a^E)	1.21	
Manufacturing productivity, MNE (a^M)	1.56	
Spillover parameter (β)	0.50	
Quality jump size (λ)	2.03	
Decreasing returns (α)	0.56	
Spillover (ϕ)	0.70	
Moments	Data (Model)	Source
East relative wage (w^E)	0.57 (0.60)	Eurostat, 2015
MFP growth rate	0.66% (0.66%)	OECD, 2005–2016
Share of sectors, Western leadership (ω^W)	91% (90%)	OECD, 2005–2016
Share of sectors, Eastern leadership (ω^E)	7% (5%)	OECD, 2005–2016
Share of sectors, MNE leadership (ω^M)	2% (5%)	OECD, 2005–2016
West R&D expenditure/GDP	3.74% (2.35%)	Eurostat, 2015
East R&D expenditure/GDP	1.98% (1.58%)	Eurostat, 2015
West labour share in R&D	3.13% (3.11%)	Eurostat, 2015
East labour share in R&D	2.22% (3.48%)	Eurostat, 2015
West innovation elasticity to s^W	[0.70, 3.50] (0.70)	Akcigit et al. (2018a)
East innovation elasticity to s^E	[0.70, 3.50] (3.50)	Akcigit et al. (2018a)

Optimal policy cooperation

Harmonised subsidies

Harmonised subsidies: a union-wide policymaker chooses *separate* innovation subsidy rates for West and East to maximise joint welfare.

$$(s_{co}^W, s_{co}^E) = \arg \max \left\{ U^{EU}(s_{co}^W, s_{co}^E) \right\}, \quad U^{EU} = U^W + U^E.$$

- ▶ We rule out ex-post side payments and compare to **observed** subsidies.
- ▶ Baseline: **no FDI subsidy** ($s^M = 0$); the additional instrument is introduced later.
- ▶ In *all* experiments, welfare accounts for the **full transition path** after the reform.

Measuring welfare gains

Compensating variation and policy horizon T

Welfare gains from cooperation are reported as compensating variation (CEV). If cooperation is implemented at $t = 0$, χ is the permanent change in real consumption such that:

$$\int_0^T e^{-(\rho-n)t} \log \left(\frac{c_{co}^K(t)}{P_{co}^K(t)} \right) dt = \int_0^T e^{-(\rho-n)t} \log \left((1 + \chi) \frac{c_o^K(t)}{P_o^K(t)} \right) dt, \quad (14)$$

- ▶ o : non-cooperation (observed subsidy rates); co : cooperative (harmonised) policy.
- ▶ T is the policy evaluation horizon: transition analysis allows **short**, **medium**, and **very long** horizons.
- ▶ We first report results for $T = \infty$, then study how outcomes vary with shorter horizons.

Cooperative policy: key quantitative results

Gains from policy cooperation ($T = \infty$)

TABLE: Gains from policy cooperation

	Baseline (γ^M)			$2\gamma^M$			$3\gamma^M$		
	s^W	s^E	s^M	s^W	s^E	s^M	s^W	s^E	s^M
Observed (s_o^W, s_o^E)	0.12	0.10	0.00	0.12	0.10	0.00	0.12	0.10	0.00
Harmonised (s_{co}^W, s_{co}^E)	0.31	-0.99	0.00	0.41	-0.97	0.00	0.43	-0.81	0.00
	W	E	EU	W	E	EU	W	E	EU
Welfare gains	0.040	0.005	0.045	0.046	0.021	0.066	0.046	0.031	0.078
Strategic motive	-0.009	-0.044	-0.052	-0.017	-0.043	-0.060	-0.020	-0.035	-0.054
Consumer surplus plus Intertemporal spillovers	-0.002	-0.002	-0.003	-0.003	-0.003	-0.006	-0.003	-0.003	-0.007
	0.050	0.050	0.101	0.066	0.066	0.132	0.070	0.070	0.139

Notes. All calculations take transitional dynamics into account. Welfare effects are compensating variation as in (14) with $T = \infty$. The FDI subsidy is kept constant at zero in all scenarios. Numbers are reported prior to multiplication by 100.

What does the cooperative planner do?

Four outcomes and why

Four outcomes emerge from the harmonised-subsidy problem (Table 3):

- i. **Subsidise West, tax East:** e.g. $s_{co}^W = 0.31$ and a large negative $s_{co}^E = -0.99$.
- ii. **Union welfare rises:** EU CEV = 0.045 (i.e. 4.5%); the West captures a larger share for long horizons.
- iii. **Main driver: intertemporal knowledge spillovers** (growth engine dominates).
- iv. **FDI makes coordination more valuable:** higher γ^M raises EU gains and shifts optimal rates (higher s^W , less negative s^E).

Intuition: *Assumption 1 implies the West is the most R&D-efficient region and the main source of cross-border idea flows via FDI. Concentrating R&D is costly due to local decreasing returns (α), but spillover gains dominate.*

- ▶ FDI carries international spillovers \Rightarrow Western innovation is more valuable for union welfare.
- ▶ Internalising these spillovers dominates internalising the strategic motive.

Mechanism and transition

Why cooperation tilts innovation toward the West

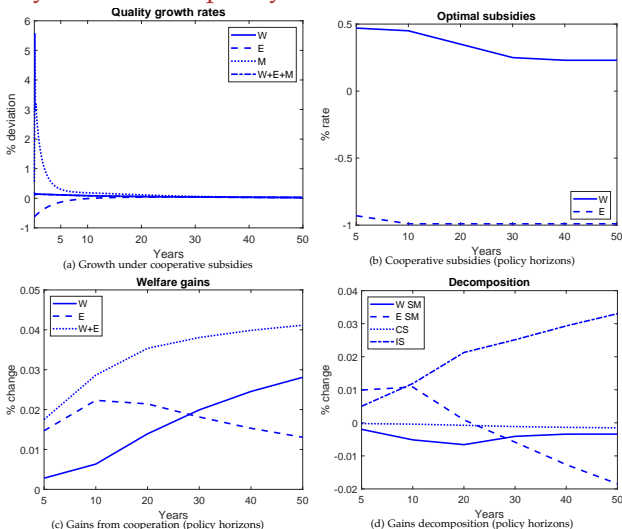
- ▶ **Planner's tilt:** subsidise Western innovation, tax Eastern innovation.
 - ▶ **structural asymmetry** (Assumption 1): W is the most R&D efficient region and main source of cross-border idea flows via FDI, \implies W innovation particularly valuable for union welfare.
- ▶ **Why “more growth”?**
 - ▶ Since W is large, raising s^W increases the *weighted* subsidy in the union, boosting innovation and **temporarily** accelerating aggregate quality growth along the transition.
 - ▶ Higher s^W raises the growth of Q^W and (via offshoring) Q^M ; taxing E slows the growth of Q^E . Over the transition, faster growth in Western-led industries dominates.
- ▶ **Transition is the action:** in the semi-endogenous model long-run growth is pinned down by population growth, so policy affects welfare mainly through **transitional growth** and the induced reallocation of market leadership (and thus profits/FDI) across regions.

Distribution of gains and horizon effects

Who gains, and why it depends on T

- ▶ **Both regions gain from cooperation**, but the split depends on the policy horizon T .
- ▶ **Short and medium horizons (roughly $T < 30$ years):** E gains more because subsidy financing is regional. Western households bear the fiscal cost of subsidising domestic innovators.
- ▶ **Long horizons:** W gains more. Higher W innovation increases its market leadership and profits, and cooperation induces more offshoring: Over time, the accumulation of quality and market shares shifts gains toward W.
- ▶ **Takeaway:** steady-state comparisons are misleading here—the welfare ranking and regional split are driven by the **transition path** and the policymaker's horizon.

Transitional dynamics and policy-maker horizon



Takeaway: Cooperative subsidies and the **regional split of gains** vary with the policy horizon. Longer horizons place more weight on **intertemporal spillovers**; growth is temporarily higher along the transition.

Optimal innovation and FDI subsidies

Why add an FDI instrument?

- ▶ So far: cooperative **innovation policy** via region-specific R&D subsidies s^W, s^E .
- ▶ But **offshoring (FDI) decisions** generate **cross-border knowledge spillovers** that firms do not internalise.
- ▶ \Rightarrow potential **underinvestment in technology transfer** via FDI.
- ▶ Introduce an **FDI subsidy** s^M targeting *adaptive R&D* needed to move production abroad.
 - ▶ s^M is closer to *trade policy*: it lowers the cost of multinational activity.
 - ▶ Adaptive R&D does **not** directly raise growth (it affects growth only via spillovers).
- ▶ Our framework allows a **joint analysis** of innovation and trade/FDI policy, and a decomposition of their welfare contributions.

Gains from cooperation: R&D vs. FDI subsidies

	Subsidy instrument scenario		
	(1) R&D only	(2) FDI only	(3) Jointly
s^W	0.310	0.120	0.261
s^E	-0.990	0.100	-0.782
s^M	0.000	0.590	0.886
W welfare gains	0.040	0.007	0.050
Strategic motive	-0.009	0.000	-0.005
Consumer surplus	-0.002	-0.001	-0.008
Intertemporal spillovers	0.050	0.008	0.063
E welfare gains	0.005	0.017	0.046
Strategic motive	-0.044	0.010	-0.009
Consumer surplus	-0.002	-0.001	-0.008
Intertemporal spillovers	0.050	0.008	0.063
EU welfare gains	0.045	0.023	0.096
Strategic motive	-0.052	0.010	-0.015
Consumer surplus	-0.003	-0.002	-0.016
Intertemporal spillovers	0.101	0.016	0.126

Notes. (1) Cooperative choice of s^W, s^E only. (2) Cooperative choice of s^M only, holding s^W, s^E at observed values. (3) Joint cooperative choice of s^W, s^E, s^M . All gains are relative to observed subsidies, account for transitional dynamics, $T = \infty$, and are prior to multiplication by 100.

Mechanism and takeaways

Policy complementarity and distribution of gains

- ▶ **Policy complementarity:** jointly choosing (s^W, s^E, s^M) yields much larger gains than either policy alone.
 - ▶ EU gains: **0.045** (R&D only) vs **0.023** (FDI only) vs **0.096** (joint).
 - ▶ Joint gains exceed the sum of separate gains \Rightarrow diffusion raises the productivity of innovation (especially in E).
- ▶ **Why does s^M matter?** Firms do not internalise cross-border spillovers from offshoring.
 - ▶ Subsidising FDI strengthens knowledge diffusion, boosting the **intertemporal spillover** component.
 - ▶ It also reallocates production toward the East, raising E income without proportionally reducing W welfare (*an “efficient” business-stealing margin*).
- ▶ **Distribution:** cooperative FDI subsidies benefit the East disproportionately.
 - ▶ E gains from FDI-only (0.017) exceed W (0.007), and joint policy lifts both regions substantially (W : 0.050, E : 0.046).
- ▶ **Taking stock:** the key driver is the growth engine (knowledge spillovers), and an additional FDI instrument lets the planner subsidise *both* knowledge creation (R&D) and diffusion (FDI).

A three-region extension

Motivation and setup

- ▶ Baseline model: EU as two regions (W and E), abstracting from trade with the rest of the world.
- ▶ Two concerns:
 - (i) How does **trade with a third region** affect incentives to cooperate within Europe?
 - (ii) What if the relevant technological competitor is a **similar advanced region** (e.g. US/China) rather than E ?
- ▶ Add a third region: **Rest of the World (RoW)**.
 - ▶ RoW is identical to W *except* its firms **do not offshore production**.
 - ▶ This isolates **strategic cooperation** among similarly developed regions while keeping the model close to the baseline.
- ▶ Quantification: RoW aggregates USA, Canada, Japan and China, accounting for **66% of world R&D** (2015). Three regions account for **88% of world R&D** and **87% of patents** (2015).
- ▶ We run two exercises:
 - (1) Repeat W – E cooperative subsidy experiment in the 3-region environment.
 - (2) Global planner chooses subsidies cooperatively across $\{W, E, RoW\}$.

Three-region model: cooperation results

	W-E cooperation				W-E-RoW cooperation			
	s^W	s^E	s^M	s^{RoW}	s^W	s^E	s^M	s^{RoW}
Observed (s_o^W, s_o^E, s_o^{RoW})	0.12	0.10	0.00	0.13	0.12	0.10	0.00	0.13
Harmonised ($s_{co}^W, s_{co}^E, s_{co}^{RoW}$)	0.59	-0.91	0.00	0.13	0.36	-0.68	0.00	-0.78
	W	E	EU	RoW	W	E	EU	RoW
Welfare gains	0.073	0.110	0.184	0.007	0.262	0.234	0.496	0.081
Strategic motive	-0.064	-0.027	-0.091	-0.131	0.002	-0.027	-0.025	-0.179
Consumer surplus	0.074	0.074	0.148	0.074	0.264	0.264	0.527	0.264
Intertemporal spillovers	0.064	0.064	0.127	0.064	-0.003	-0.003	-0.006	-0.003

Notes. All calculations take transitional dynamics into account. Welfare effects are compensating variation as in (14) with $T = \infty$. Numbers are reported prior to multiplication by 100.

Mechanisms in the three-region model

Trade diversion, consumer surplus, and global cooperation

► **W-E cooperation (with *RoW* present).**

- Optimal policy remains: **subsidise *W* innovation, tax *E* innovation.**
- Gains become **larger more balanced: trade diversion**
- *RoW* gains little because EU cooperation generates **trade diversion/business stealing**: EU leadership expands at the expense of *RoW*, raising the **strategic-motive loss** for *RoW*.
- **Consumer surplus channel** becomes more important: manufacturing reallocates from *RoW* to *E* via multinationals

► **Global cooperation (*W-E-RoW*).**

- Planner subsidises *W* and taxes both *E* and *RoW*.
- EU gains are **much larger** than under EU-only cooperation (0.496 vs 0.184).
- Interpretation: aligning with an advanced competitor mitigates **harmful strategic policies** and produces larger **consumer-surplus gains** (stronger reduction in the quality-adjusted price index).

► **Caveat:** these results assume *RoW* does not retaliate in response to EU policy changes.

Conclusion

What we learn about “technology wars”

- ▶ How costly is technology competition, and how valuable is innovation-policy cooperation?
- ▶ In an integrated union, non-cooperative innovation policy is costly because it ignores **cross-border knowledge spillovers** and distorts the **geography of market leadership**.
- ▶ **Quantitatively, cooperation pays:**
 - ▶ Harmonising **R&D subsidies** delivers sizable gains (EU CEV around **4.5%** in the baseline).
 - ▶ Adding an **FDI subsidy instrument** roughly **doubles** the gains (EU CEV around **9.6%**), revealing strong **policy complementarity** between innovation (creation) and FDI (diffusion).
 - ▶ Allowing for a Rest-of-the-World competitor preserves the main message: **trade diversion** \implies **even larger** gains for Europe.
- ▶ **Core mechanism:** the **growth engine** dominates. Cooperation mainly internalises **intertemporal knowledge spillovers**, while static channels (consumer surplus / strategic motive) play a secondary role in the baseline calibration.

- Acemoglu, Daron and Ufuk Akcigit**, "Intellectual Property Rights Policy, Competition And Innovation," *Journal of the European Economic Association*, 2012, 10 (1), 1–42.
- , **Gino Gancia, and Fabrizio Zilibotti**, "Offshoring and Directed Technical Change," *American Economic Journal: Macroeconomics*, 2015, 7 (3), 84–122.
- , **Ufuk Akcigit, Harun Alp, Nicholas Bloom, and William R. Kerr**, "Innovation, Reallocation and Growth," *American Economic Review*, 2018, 108 (11), 3450–3491.
- Akcigit, Ufuk, Douglas Hanley, and Stefanie Stantcheva**, "Optimal Taxation and R&D Policies," *Econometrica*, 2022, 90 (2), 645–684.
- , **John Grigsby, Tom Nicholas, and Stefanie Stantcheva**, "Taxation and Innovation in the 20th Century," 2018. NBER Working Paper 24982.
- , **Sina T. Ates, and Giammario Impullitti**, "Innovation and Trade Policy in a Globalized World," 2018. NBER Working Papers 24543.
- Branstetter, Lee. and Kamal Saggi**, "Intellectual Property Rights, Foreign Direct Investment and Industrial Development," *Journal of International Economics*, 2011, 55 (121), 1161–1191.
- Dinopoulos, Elias and Paul Segerstrom**, "Intellectual property rights, multinational firms and economic growth," *Journal of Development Economics*, 2010, 92 (1), 13–27.

- Feenstra, Robert C., Philip Luck, Maurice Obstfeld, and Katheryn N. Russ**, "In Search of the Armington Elasticity," *The Review of Economics and Statistics*, 2018, 100 (1), pp. 135–150.
- Haaland, Jan I. and Hans Jarle Kind**, "R&D Policies, Trade and Process Innovation," *Journal of International Economics*, 2008, 74 (1), 170–187.
- He, Yin and Keith Maskus**, "Southern Innovation and Reverse Knowledge Spillovers: A Dynamic FDI Model," *International Economic Review*, 2012, 1 (53), 281–304.
- Impullitti, Giammario**, "International Competition and US R&D Subsidies: A Quantitative Welfare Analysis," *International Economic Review*, 2010, 51 (4), 1127–1158.
- Leahy, Dermot and J. Peter Neary**, "Public Policy towards R&D in Oligopolistic Industries," *American Economic Review*, 1997, 87 (4), 642–662.
- **and Peter Neary**, "Multilateral subsidy game," *Economic Theory*, 2009, 41 (1), 41–66.
- Spencer, Barbara J. and James A. Brander**, "International R&D Rivalry and Industrial Strategy," *Review of Economic Studies*, 1983, 50 (4), 707–722.