# The Market for Technology: Harnessing Creative Destruction

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# Motivation

Innovation through technology transfers...

- Is very important!
  - 50% of U.S. firms (that innovate) report that that their most important innovation originates from an external source (Arora et al., 2016)
- Leads to creative destruction
  - Busniess creation vs. business stealing
- Generates growth only if...
  - Business creation $>$ business stealing
- The effects of creative destruction can be internalized
  - In the market for technology
  - When there are protections for IP

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- Gains from trade increasing in $t$ and $m$ and decreasing in $t \times m$
- Both business creation and business stealing coexist

# Literature

- Related to Bloom et al. (2013), but differences
  - Perfect enforcement vs perfect non-enforcement
  - Identification through matching in the market for technology
  - Technology transfer decision instead of R&D decision
- Supply-side and demand-side literatures
  - Supply: Arora and Gambardella (2010), Arora and Fosfuri (2003)
  - Demand: Ceccagnoli et al. (2010), Ali and Cockburn (2016)
  - Both: Figueroa and Serrano (2013) and Akcigit et al. (2016)
- Efficiency in the market for technology
  - Gans and Stern (2010); Akcigit et al. (2016); Ali and Cockburn (2016)

# Outline

- Model
- Data
- Econometrics
- Results
- Recap

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    - $\varphi(t)$ increasing in $t$
- Reduced form profits: $\Pi^P(T, m)$ and $\Pi^A(T, m)$

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- Assumption 2: $\Pi^A_T(T, m) > 0$ and $\Pi^P_T(T, m) \leq 0$
- Assumption 3: $\Pi^P_T(T, m) = 0$ for $m = 0$ and $\Pi^P_{Tm}(T, m) \leq 0$

- Important: no assumptions on the sign of $\Pi^A_{Tm}(T, m)$!!!

# Model

## Gains from trade

Given our set of assumptions, the technology transfer has a *business creation effect* on the adopter and may have a *business stealing effect* on the provider

$$\Delta^A(t, m) = \Pi^A(\varphi(t), m) - \Pi^A(0, m) > 0$$

$$\Delta^P(t, m) = \Pi^P(\varphi(t), m) - \Pi^P(0, m) \leq 0$$

The gains from trade are

$$G(t, m) = \Delta^A(t, m) + \Delta^P(t, m) - c^P - c^A$$

If $G(t, m) > 0$, the provider transfers the technology to the adopter. The two parties negotiate royalties $R$ to divide total surplus. Bargaining with full information generates a Pareto efficient outcome.

Derivatives

$$G_t(t,m)|_{m=0} = \underbrace{\Delta_t^A(t,m)}_{+}$$

$$G_m(t,m)|_{t=0} \approx \underbrace{\Delta_m^A(t,m)}_{?}$$

$$G_{tm}(t,m) = \underbrace{\Delta_{tm}^A(t,m)}_{?} + \underbrace{\Delta_{tm}^P(t,m)}_{-}$$

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# Data

Dataset on interactions: + 20,000 unique pairings between +4,000 firms

- Interactions in the market for technology
  - Patent trades (USPTO PAD)
  - Licensing (ktMINE, SEC)
  - Cross-licensing (own elaboration, SEC)
  - Licensing within joint ventures (SDC, SEC)
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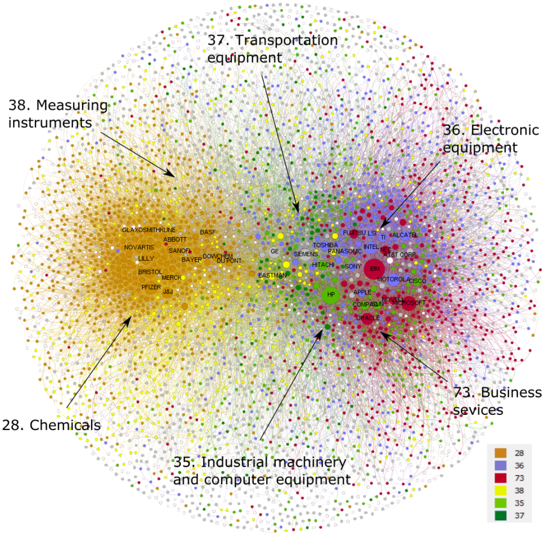
  - R&D alliance (SDC, SEC)
- USPTO Patent Assignment Dataset
- Compustat

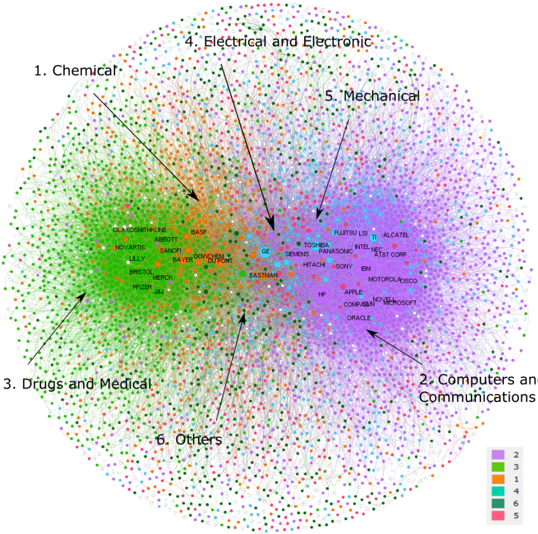
# Visual analysis

## Network of interactions by sector of activiy (SIC2)



# Visual analysis

## Network of interactions by technology field (NBER6)



# Dataset used in econometric regressions

## Panel dataset

- Expansion across firms $N \times (N-1)$.
- Four 5-year periods (1990-1994, ..., 2005-2009)
- Pairs observed during at least two 5-year periods

# Empirical definition proximity metrics

## Panel dataset

**Technological proximity ($t$)**: cosine similarity between the technology vectors of the two firms:

$$t_{AP} = \frac{(T_A T_P')}{[(T_A T_A')^{1/2}(T_P T_P')^{1/2}]}$$

- $T_A = (T_{A1}, T_{A2,...}, T_{A420})$
- $T_{A\tau}$ is the share of patents of firm $A$ in technology class $\tau$.
- Source: USPTO

# Empirical definition proximity metrics

## Panel dataset

**Market proximity ($m$)**: cosine similarity between the sales vectors of the two firms:

$$m_{AP} = \frac{(S_A S_P')}{[(S_A S_A')^{1/2}(S_P S_P')^{1/2}]}$$

- $S_A = (S_{A1}, S_{A2,}..., S_{A1100})$
- $S_{Ak}$ is the share of sales of firm $A$ in the four digit SIC $k$
- Source: Compustat Segment Dataset

# Econometrics

Adopter $A$ and provider $P$ match in period $s$ if

$$y_{APs} = \mathbb{1}\{G_{APs} > 0\}$$

Where

$$G_{APs} = \mu + \sigma[\beta_1 t_{APs} + \beta_2 m_{APs} + \beta_3 t_{APs} m_{APs} + \beta_4 X_{APs} + \phi_{AP} + \varepsilon_{APs}]$$

- $y_{APs}$: dummy variable with value one if $A$ adopts from $P$ at period $s$
- $t_{APs}$: technological proximity
- $m_{APs}$: market proximity
- $X_{APs}$: adopter-specific and provider-specific attributes
- $\phi_{AP}$: adopter-provider fixed effects (Mundlak means)
- $\varepsilon_{APs} \sim N(0, 1)$; $\mu = 0$ and $\sigma = 1$ (probit normalization)

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Parameters of interest

$$\begin{aligned} \beta_1 &= G_t|_{m=0} \\ \beta_2 &= G_m|_{t=0} \\ \beta_3 &= G_{tm} \end{aligned}$$

# Identification

- Proximity metrics non-collinear
- Proximity metrics conditionally uncorrelated with $\varepsilon_{APs}$
  - Control for time varying adopter and provider attributes
  - Control for adopter-provider fixed effects
  - Adopter-provider transitory shocks

# Main results

| | Expansion 1 | | Expansion 2 | | Expansion 3 | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| t | 1.708*** | 0.373*** | 0.597*** | 0.485*** | 0.517*** | 0.668*** |
| | (0.039) | (0.118) | (0.062) | (0.119) | (0.115) | (0.106) |
| m | 0.888*** | 0.204* | 0.454*** | 0.260*** | 0.155*** | 0.351*** |
| | (0.032) | (0.105) | (0.041) | (0.091) | (0.055) | (0.102) |
| t*m | -1.135*** | -0.296** | -0.804*** | -0.385*** | -0.352*** | -0.524** |
| | (0.084) | (0.118) | (0.074) | (0.127) | (0.058) | (0.228) |
| ln(R&D_A) | 0.073*** | 0.051*** | 0.025 | 0.069*** | 0.010 | 0.112*** |
| | (0.016) | (0.017) | (0.015) | (0.026) | (0.018) | (0.042) |
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- $\beta_2 \geq 0$ means that business creation is increasing in $m$
- $\beta_3 < 0$ means that business stealing exists

Robustness and placebo checks

- Robust to estimation by modes of exchange
- Robust to estimation by linear models
- Robust to alternative levels of aggregation of technological fields and markets
- Robust to Mahalanobis expansion
- Robust to alternative definitions of market proximity

# Summary of the results

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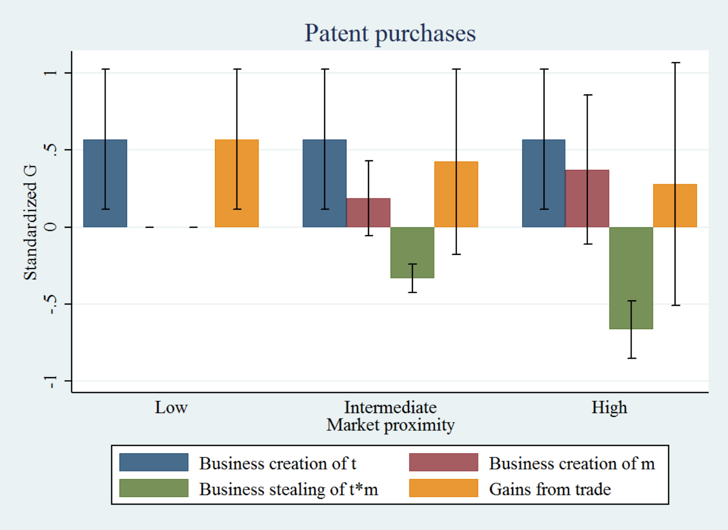
- Robust to placebo checks using geographical proximity instead of market proximity

# Summary of the results

## Effect of technological and market proximity on gains from trade



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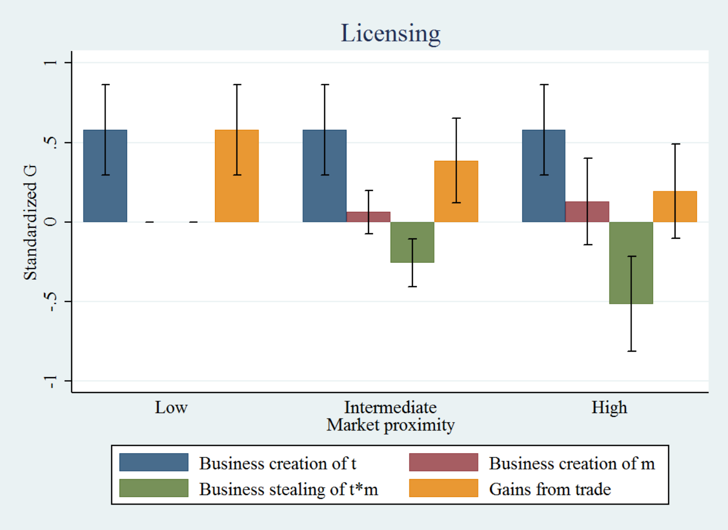

# Summary of the results

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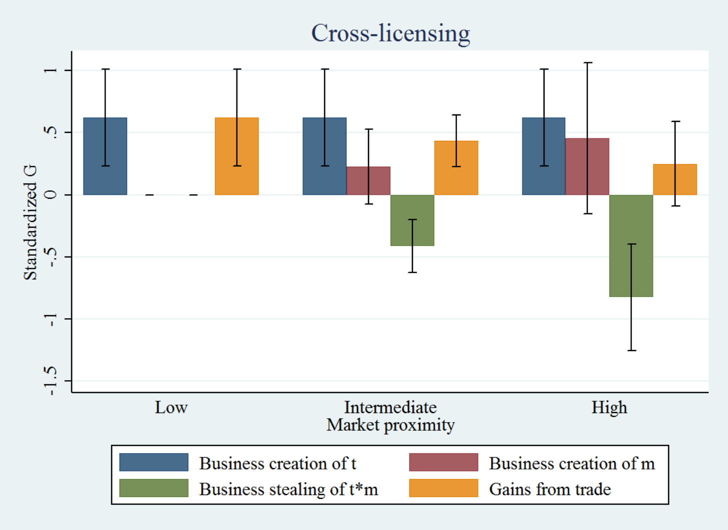

# Recap

- Model of technology transfer that provides the necessary conditions for identifying business creation and business stealing
- New dataset on which to estimate the model
- Findings: business creation and business stealing coexist