Spatial frictions in the market for talent

REUS Workshop — September 29, 2023

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International markets for talent

- Heterogeneous workers, differentiated from each other
- Heterogeneous employers, forming teams of complementary talented workers
- General question: which workers end up at which firms?
- Examples: Academic departments, C-suite (execs), professional sports

Share of non-nationals in football leagues and C-suites

Country	Football (2016/17)		Fortune 500 (2013)*	
	Tier 1	Tier 2	CEOs	Top Mgmt.
Germany	39%	26%	10%	16%
Spain	31%	16%	0%	7%
France	27%	17%	6%	18%
England	49%	32%	42%	34%
Italy	46%	18%	13%	13%

* *Ghemawat & van Trappen (2015), "How Global Is Your C-Suite?"*

What this paper is about

- Strong gravity-like frictions in matching of workers and firms
- Frictions impede clustering of talent in firms / clubs / countries
- Frictions: Policy (“home talent”), geographic and cultural frictions

→ Quantitative model of worker-firm matching with gravity frictions

→ Estimation with standard gravity toolkit: Poisson + fixed effects + frictions

→ Estimate, quantify, simulate with data on universe of professional football players

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Two strands of literature

- Stable Matching models of Marriage: Choo and Siow (2006) is the seminal work
- Salanie, Chiappori, and Galichon are key contributors

→ We apply their tools to non-monogamous matching, with unique data

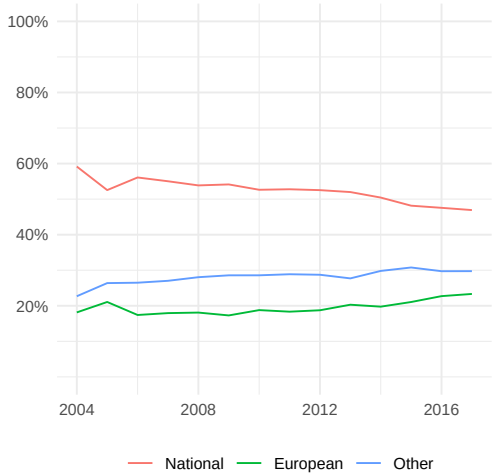
- Gravity: 50 years of estimating roles of geographic frictions on trade, migration, etc

→ Our individual data lets us estimate frictions including country-pair fixed effects

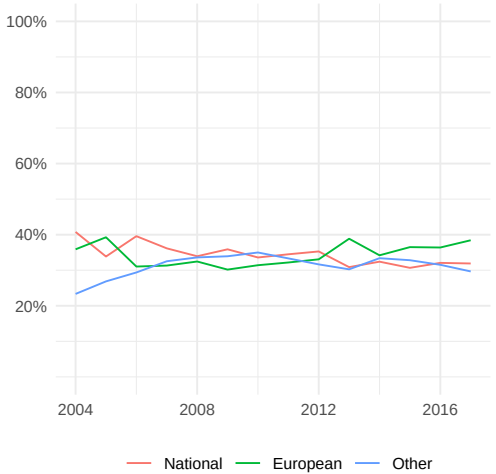
Stylized facts: Gravity frictions impede matching

Share of origins in leagues

Top 5 leagues

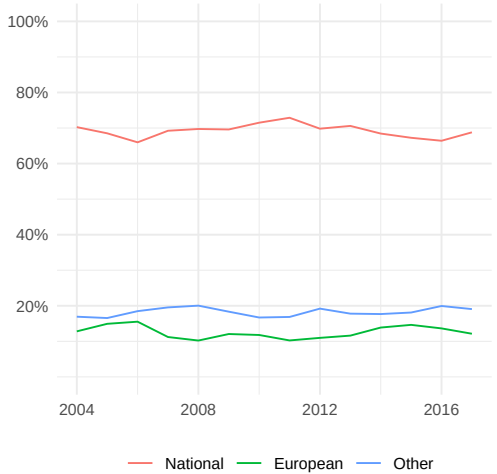


English Premier League

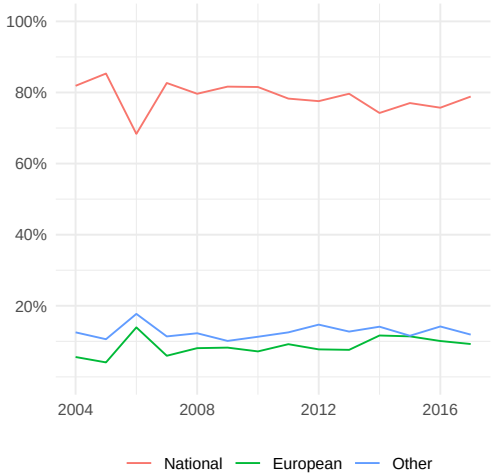


Share of origins in leagues

Second divisions

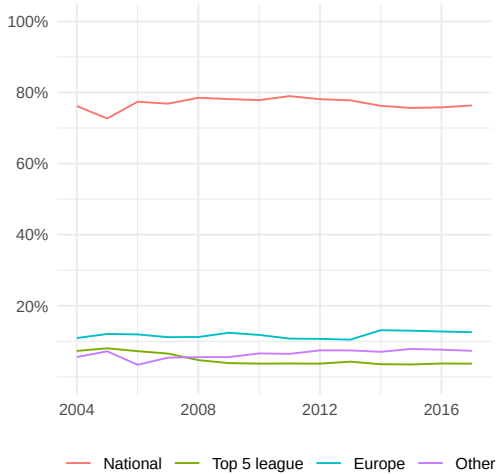


Italian Serie B

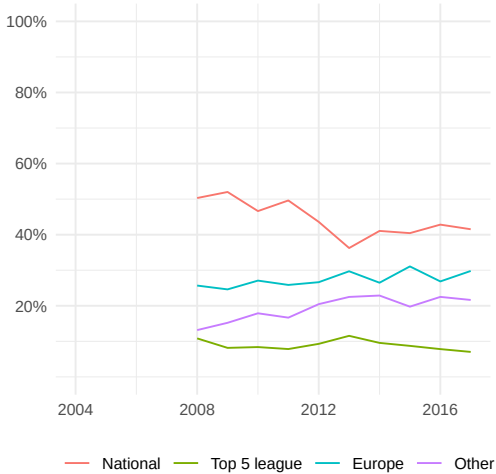


Share of destinations

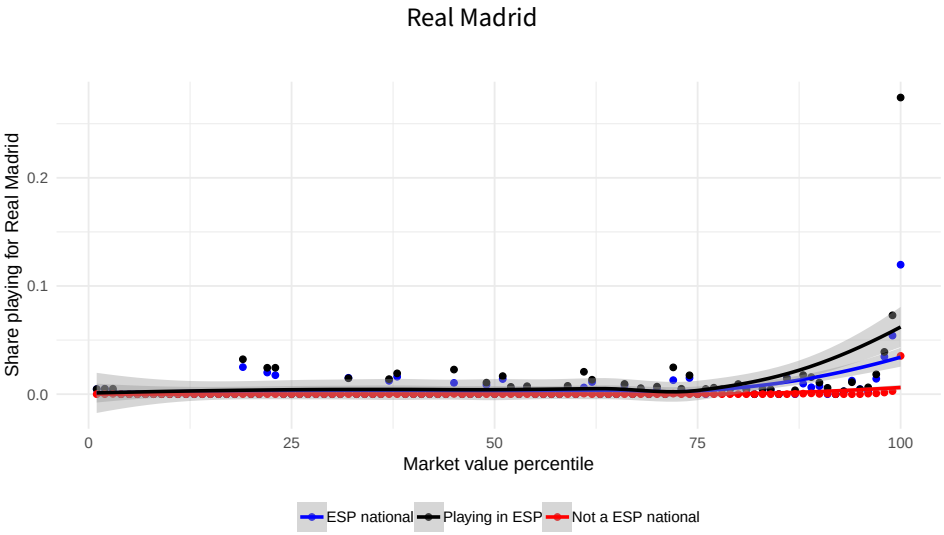
EU nationals



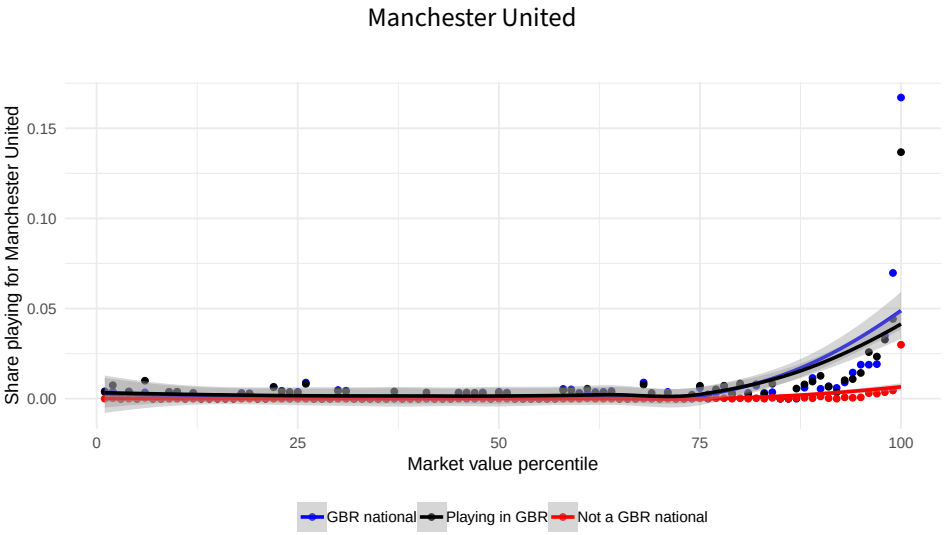
Brazilians



Assortative matching within leagues



Assortative matching within leagues



Model: Individual-level gravity

Setting

- Main idea: Two-sided matching with transferable utility and frictions

→ frictions as in the gravity literature

- Stability condition: Joint surplus maximized
- Separable joint matching surplus à la Galichon and Salanie (2022)

→ Estimation with Poisson estimator

Basic framework for international markets for talent

Firm j

- firm profit: $\pi_j = r(\mathcal{S}_j) - \sum_{h \in \mathcal{S}_j} w_{hj} + F_j$
- roster $\mathcal{S}_j$ is set of workers at firm j
- revenues: $r_j = s(\mathcal{S}_j) + \upsilon_j$
- value added of worker i: $s(\mathcal{S}_{j \cup i}) - s(\mathcal{S}_{j \setminus i})$

→ general purpose talent of worker i

→ idiosyncratic appeal of worker i for firm j

- surplus: $s(\mathcal{S}_{j \cup i}) - s(\mathcal{S}_{j \setminus i}) - w_{ij}$

Worker i

- utility: $A_{ij} + w_{ij}$
- amenities (A_{ij})

→ general appeal of firm j

→ idiosyncratic appeal of firm j for i

→ worker-firm frictions

→ joint surplus sums firm surplus and worker utility: $s(\mathcal{S}_{j \cup i}) - s(\mathcal{S}_{j \setminus i}) + A_{ij}$

→ stable matching maximizes joint surplus

Player Stability

- Player i is happier at club j than any alternative: $u_{ij} \geq u_{ik} \quad \forall \quad k \neq j$
- Utility: $u_{ij} = A_{ij} + w_{ij}$

$\rightarrow$ No incentive to move if $A_{ij} + w_{ij} \geq A_{ik} + w_{ik} \quad \forall \quad k \neq j$

Club Stability

- Club j is more profitable with than without player i
- Profit: $\pi_j = r(\mathcal{S}_j) - \sum_{h \in \mathcal{S}_j} w_{hj} + F_j$

$\rightarrow$ Δr_{ij} as incremental contribution

- Best pick if $\Delta r_{ij} - w_{ij} \geq \Delta r_{ik} - w_{ik} \quad \forall \quad k \neq j$

$\rightarrow$ (holding F_j and w_{hj} constant)

Stable Matching

- Re-arrange club stability: $\Delta r_{ij} - \Delta r_{ik} \geq w_{ij} - w_{ik}$
- Re-arrange player stability: $w_{ij} - w_{ik} \geq A_{ik} - A_{ij}$
- Combining, we get: $\Delta r_{ij} + A_{ij} \geq \Delta r_{ik} + A_{ik}$

$\rightarrow$ probability of inequality holding for all $k \neq j$ is probability that j is the argmax for $\Delta r_{ik} + A_{ik}$ for $k \in \mathcal{K}$

$\rightarrow$ can also be written as a linear program

Estimation

- Specify $A_{ik} = \alpha_k + \beta \mathbf{X}_{ik} + \epsilon_{ik}$

$\rightarrow$ $\mathbf{X}_{ik}$ vector of amenity loss determinants, $\epsilon_{ik} \sim$Gumbel(scale = $1/\theta$)

- Probability j is stable for i is

$$\pi_{ij} = \frac{\exp[\theta\alpha_j + \theta\Delta r_{ij} + \theta\beta\mathbf{X}_{ij}]}{\sum_{k\in\mathcal{K}} \exp[\theta\alpha_k + \theta\Delta r_{ik} + \theta\beta\mathbf{X}_{ik}]} = \exp(\alpha_j - \theta \text{IU}_i + \theta\Delta r_{ij} + \beta\mathbf{X}_{ij})$$

- Galichon et al. (2022): stable matching can be estimated with Poisson estimator and fixed effects

$\rightarrow$ but: need to specify squad $\mathcal{S}_j$

Worker-firm gravity

$$\mathbf{Pr}(y_{ij} = 1) = \frac{\exp\left(A_{ij} + s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i})\right)}{\overline{u}_i \cdot \overline{v}_j}$$

- Probability of *i* joining *j* can be decomposed into (structural) gravity components
- Worker-specific characteristics: $\overline{u}_i$
- Firm-specific characteristics: $\overline{v}_j$
- Bilateral components: Amenities, A_{ij}, value added, $s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i})$

Firm strength

- CES specification of firm j's strength à la Card et al. (2001)

$$s_j = \left(\sum_p \lambda_p V_{jp}^{\nu} \right)^{1/\nu} \quad \text{with} \quad V_{jp} = \left(\sum_{i \in \mathcal{S}_{jp}} v_i^{\nu_p} \right)^{1/\nu_p}$$

- λ_p input share of a position in overall strength
- $\nu = 1 - (1/\sigma)$ where σ is the elasticity of substitution across positions
- $\nu_p = 1/(1 - \sigma_p)$ where σ_p is the elasticity of substitution within position across workers

$\rightarrow$ $\nu_p \to +\infty$ only best workers matters

Estimation: Value added and gravity frictions

Strategy

1. Estimate parameters for firm strength production function

   $\rightarrow$ data on revenues for Top 5 league teams and player market values

2. Compute strength with and without workers, i.e. $s(\mathcal{S}_{j \cup i}) - s(\mathcal{S}_{j \setminus i})$

3. Estimate gravity equation

   $\rightarrow$ construct worker-specific frictions

Data

- Labor market: Professional football players
- Transfermarkt: Extremely detailed data on player careers

→ Top 5 leagues and second divisions, other important leagues

→ 8516 players, 343 clubs, 17 leagues

- Wikidata: Supplementary player data

→ Birthplace, spoken languages, multiple nationalities

- Club revenue for estimating team strength function

→ Financial reports by leagues, Deloitte Football Money League

Elasticities

	ν	σ
Positions	-0.09	0.92
Goalkeeper	3.63	-0.38
Defense	0.64	2.77
Midfield	0.30	1.43
Forwards	0.80	4.92

$\rightarrow$ recall $\nu_p = 1/(1-\sigma_p) \Leftrightarrow \sigma_p = 1 - 1/\nu_p$

Poisson estimation of gravity equation

- Recall worker-firm gravity:

$$\mathbf{Pr}(\mu_{ij} = 1) = \frac{\exp\left(A_{ij} + s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i})\right)}{\overline{u}_i \cdot \overline{v}_j}$$

- Multinomial logit, can be estimated with Poisson ML estimator and fixed effects:

$$\mathbf{1}_{ij} = \exp\left(\Gamma_i + \Upsilon_j + \theta[s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i})] + \boldsymbol{\delta} \cdot \boldsymbol{\tau}_{ij}\right)$$

$\rightarrow$ Γ_i worker fixed effect, Υ_j firm fixed effect

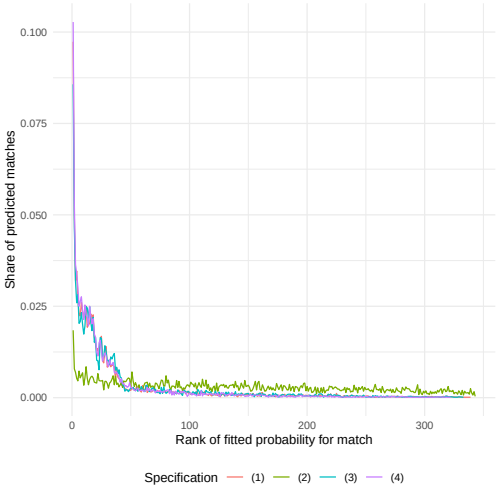
$\rightarrow$ $\boldsymbol{\tau}_{ij}$ vector of bilateral frictions and $\boldsymbol{\delta}$ respective coefficients

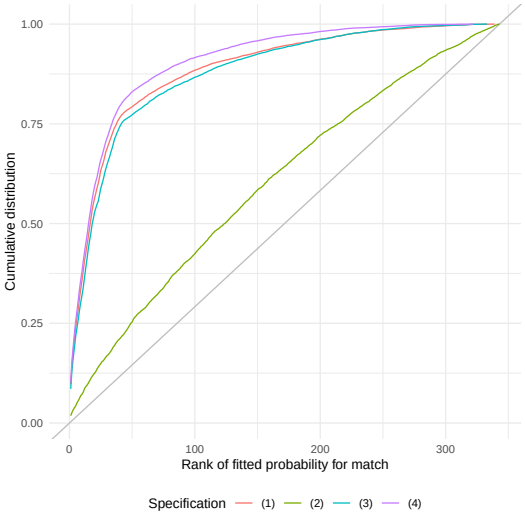
	Dependent variable: Match			
	(1)	(2)	(3)	(4) *od* FE
Value added$_{ij}$ $[s_j(i) - s_j(-i)]$	0.08^a	0.08^a		0.09^a
Hometown$_{ij}$	0.19^a		0.17^b	0.30^a
Home league$_{o(i)d(j)}$	1.30^a		1.27^a	
log(Distance hometown - club)$_{ij}$	-0.56^a		-0.55^a	-0.51^a
Share players with common language$_{ij}$	0.51^a		0.53^a	0.01
Share players with common nationality$_{ij}$	1.86^a		1.90^a	1.53^a
Common official language$_{o(i)d(j)}$	0.41^a		0.39^a	
Contiguity$_{o(i)d(j)}$	0.27^a		0.28^a	
Former colony$_{o(i)d(j)}$	0.37^a		0.36^a	
EU$_{o(i)d(j)}$	0.21^b		0.21^b	
Observations	2,920,988	2,920,988	2,920,988	2,288,185
Pseudo R^2	0.22763	0.01484	0.21464	0.22076

Player and club fixed effects in all specifications.

Clustered (Player) standard-errors in parentheses. Signif. Codes: a: 0.01, b: 0.05, c: 0.1

Predicted matched player - club





Counterfactual scenarios: Work in progress

- Bosman ruling: prevents barriers to intra-EU player movement
- Brexit: exempts British clubs from Bosman
- Frictionless world: What if there were only assortative matching motives and idiosyncratic shocks?

  $\rightarrow$ Inter-league dominance?

  $\rightarrow$ Intra-league dominance?

Conclusion

- Strong gravity forces for high-skilled, highly specialized workers
- Model: Matching/assignment with gravity frictions
- Estimation: Standard gravity toolkit
- Counterfactual results: next time

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Heterogeneous share of non-nationals in football

Country	Tier	Average	Max	Min
England	1	49%	71%	15%
England	2	32%	71%	5%
France	1	27%	54%	11%
France	2	17%	32%	4%
Germany	1	39%	52%	10%
Germany	2	26%	46%	4%
Italy	1	46%	71%	11%
Italy	2	18%	36%	4%
Spain	1	31%	76%	0%
Spain	2	16%	39%	0%

Linear Programming Formulation

- Objective: Maximize $\sum_{(i,j)} v_{ij} x_{ij}$.
- Subject to player and club constraints.
- $x_{ij} \in \{0, 1\}$ for i, j.
- Integer linear program.
- Total surplus is the objective function.

Worker

- Maximizes utility by joining firm j:

$$\max_j \left\{ A_{ij} + w_{ij} + \epsilon_{ij} \right\}$$

- A_{ij} amenities, w_{ij} wage by i in j
- ϵ_{ij} is a random utility shock

Firm

- Firm j recruits n_j workers weighing value added and wage of employing worker i:

$$\max_i \left\{ \left(s(\mathcal{S}_{j \cup i}) - s(\mathcal{S}_{j \setminus i}) - w_{ij} + \kappa_{ij} \right\} \right.$$

- $s(\mathcal{S}_{j \cup i})$ strength with having worker i on roster, $s(\mathcal{S}_{j \setminus i})$ without

Joint probability

- Probability of worker i choosing firm j and j choosing to employ i:

$$
\begin{aligned}
n_j \cdot \frac{u_i(j)}{\overline{u}_i} \cdot \frac{v_j(i)}{\overline{v}_j} &= \frac{\exp\left(A_{ij} + w_{ij}\right)}{\sum_q \exp\left(A_{iq} + w_{iq}\right)} \cdot \frac{n_j \cdot \exp\left(s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i}) - w_{ij}\right)}{\sum_k \exp\left(s(\mathcal{S}_{j\cup k}) - s(\mathcal{S}_{j\setminus k}) - w_{kj}\right)} \\
&= \frac{\exp\left(A_{ij} + w_{ij}\right) \cdot \exp\left(s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i}) - w_{ij}\right)}{\overline{u}_i \cdot \overline{v}_j} \\
&= \frac{\exp\left(A_{ij} + s(\mathcal{S}_{j\cup i}) - s(\mathcal{S}_{j\setminus i})\right)}{\overline{u}_i \cdot \overline{v}_j}
\end{aligned}
$$

$\rightarrow$ wages paid from firm j to worker i — transferable utility — cancels out

Firm strength

- CES specification of firm j's strength à la Card et al. (2001)

$$s_j = \left(\sum_p \lambda_p V_{jp}^{\nu} \right)^{1/\nu}$$

- V_{jp} aggregate value of workers at a given position p
- λ_p input share of a position in overall strength
- $\nu = 1 - (1/\sigma)$ where σ is the elasticity of substitution across positions

Firm strength

- V_{jp} is strength of j's roster in position p, denoted $\mathcal{S}_{jp}$
- Rosters comprise workers with values v_i:

$$V_{jp} = \left(\sum_{i \in \mathcal{S}_{jp}} v_i^{\nu_p} \right)^{1/\nu_p}$$

- $\nu_p = 1/(1 - \sigma_p)$ where σ_p is the elasticity of substitution within position across workers

$\rightarrow$ $\nu_p \to +\infty$ only best workers matters

Why use football data

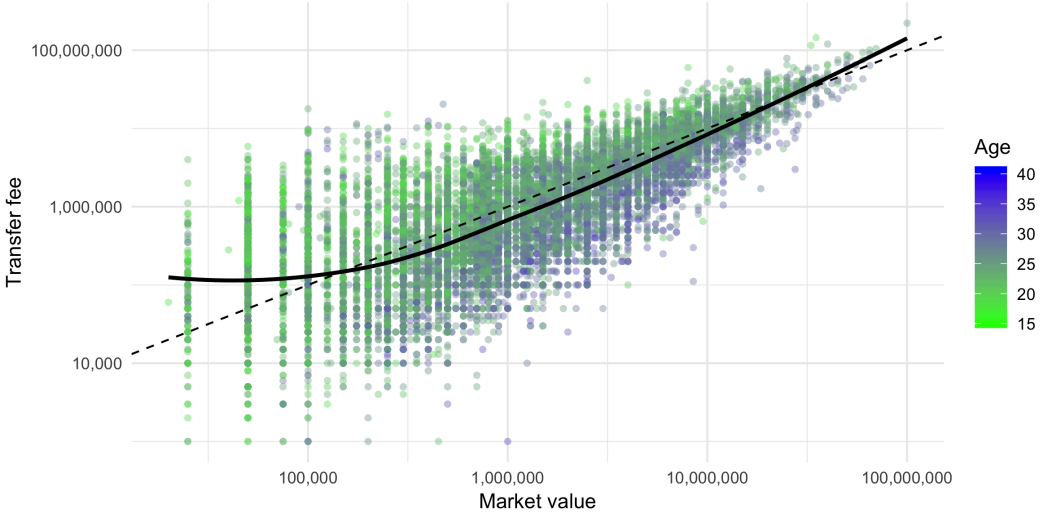
- We know the “transfer value" of all the players

→ Sufficient statistic for general-purpose worker talent

→ Crowd-sourced by football fans

- Player information allows for individualized friction data, rather than just country-to-country data

Market values



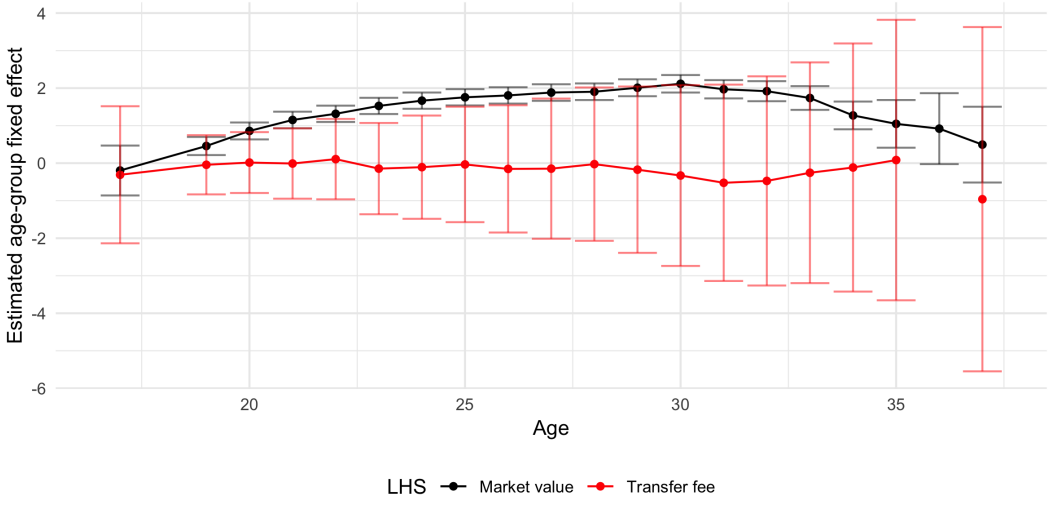
Market values

	log(market value)	log(transfer fee)
positionFW	0.34***	
	(0.03)	
positionGK	−0.30***	
	(0.05)	
positionMF	0.27***	
	(0.03)	
footleft	−0.05	
	(0.05)	
footright	−0.05	
	(0.04)	
log(market_value)		0.65***
		(0.06)
Num. obs.	7090	6056
R^2 (full model)	0.66	0.99
R^2 (proj model)	0.23	0.44

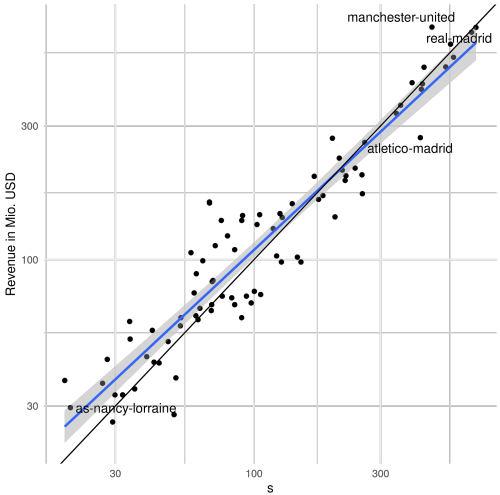
$^{***}p < 0.001, ^{**}p < 0.01, ^{*}p < 0.05$

- Reference player: defense, two-footed
- Age group, time-left-on-contract group, season and destination-club fixed effects
- Transfer fee regression: also player fixed effects

Market values



Fit of prediction



- Very good fit for revenue: $R^2 = 0.98$
- Pretty good for Soccer Power Index: $R^2 = 0.64$

Bilateral frictions

- Hometown: $\leq$ 15km distance between player birthplace and club location
- Distance: Birthplace to club location
- Home league: Player from club country
- Share of players with common language
- Share of players with common nationality
- Common official language: Player speaks club country's official language
- Contiguity, former colony, EU