Frictions to intranational investment*

Inga Heiland[†] Julian Hinz[‡]

This version: July 30, 2021

Abstract

Despite unhalted technological progress in transport and communication infrastructure over the past century, geographical and cultural distance remain major obstacles to the flow of goods and production factors to date. In this paper, we show that geographical and cultural distance forcefully shape *intranational* investment flows in Norway, preventing an efficient allocation of capital to firms. To that end, we derive a structural gravity equation of investment from a general equilibrium model with multiple locations, multiple assets, and information frictions. Based on the model, we identify frictions related to geographical distance, travel time, administrative borders, and language differences and quantify the loss in terms of portfolio efficiency caused by each individual friction and by gravity as a whole. We also aim to study the impact of major infrastructure developments during the 2000s through the lens of the model: The politically-driven roll-out of broadband internet access across the country and the rapid expansion of the flight route network driven by Norwegian Airlines. Finally, we aim to deliver ex-ante predictions for the effects of a railway line connecting Northern Norway to the country's main rail network, as well as the effects of a change to the speed limit on major road connections.

JEL Classification Codes: F36, G11

Keywords: Gravity, Information Frictions, Investment

[*] *Acknowledgements*:

[†] *Affiliation:* Statistics Norway, University of Oslo, CESifo, CEPR. *Address:* Postboks 1095 Blindern, 0317 Oslo, Norway. *E-Mail:* inga.heiland@econ.uio.no.

[‡] *Affiliation:* Bielefeld University, Kiel Institute for the World Economy & Kiel Centre for Globalization. *Address:* Universitätsstraße 25, 33615 Bielefeld, Germany. *E-Mail:* mail@julianhinz.com.

1 Introduction

The international equity home bias is well documented. But what happens "at home"?

In this paper we study the patterns of *intranational* investment and document how domestic frictions — just like *between* countries — lead to an uneven distribution of equity holdings *within* countries.

We build on two related strands of the literature. First, *gravity*-like patterns of domestic financial flows — across all different types of investors — have been documented. Coval and Moskowitz (1999) show that for US fund managers holdings in 1995 internal distance matters. Similarly, for venture capital investments (Cumming and Dai, 2010) and crowd funding (Lin and Viswanathan, 2016; Guenther, Johan, and Schweizer, 2018) a strong home bias exists and the physical distance between investor and recipient matters. Bank lending has also been documented to follow a strong gravity-like pattern. Grinblatt and Keloharju (2001) document that for Finnish equity holdings and trades of 97 publicly traded companies distance, language, and culture matter, more so for less savvy households and financial institutions. Petersen and Rajan (2002) note that there appears to be a dampening effect over time, as US small businesses over time are located further from their lending banks. *Corporate* investment, too, has been shown to follow these patterns, similar to what has been documented internationally in the literature on foreign direct investment. Giroud (2013) show a strong relationship between proximity to a subsidiary and plant-level investment. Uysal, Kedia, and Panchapagesan (2008) document differences in profitability of local vs non-local takeovers.

Second, this paper builds on theoretical foundations for gravity of financial flows, usually with an international dimension. Coeurdacier and Martin (2009) investigate the geography of asset trade and the Euro, documenting insiders and outsiders. Okawa and Wincoop (2012), to which our theoretical model below is closely related, formulate a "gravity equation for international finance", showing its deviation from the traditional so-called structural gravity equation in international trade. Pellegrino, Spolaore, and Wacziarg, 2020 sketch a theoretical framework for a gravity equation of international capital flows that takes inspiration from Eaton and Kortum, 2002, while departing customary notions of risk-return trade-offs.

Our paper contributes to these strands of the literature along multiple lines: First, we document strong gravity-like patterns in investment decision at the micro-level between investor and firms using highly-detailed Norwegian data. Second, we construct a model that incorporates ... Third, we use this model to evaluate the impact of changes in bilateral frictions.

The remainder of this paper is structured as follows. In section 2 we use detailed data from Norway to give an ad-hoc overview of investment patterns over space. We set up a model in section 3 that rationalizes these stylized facts. We then quantify the model in section 5 and perform a number of counterfactual experiments in section 6. Section 7 concludes.

2 Stylized Facts

Holding the origin location of investment, migration, trade or many other economic exchanges fixed, the spatial distribution is highly uneven. This observation of so-called gravity has been well documented — in particular for interactions between countries. We now use detailed Norwegian micro-data to show that such patterns hold for domestic investments as well.

2.1 Data on Financial Asset Holdings

Our variable main variables of interest are derived from Norwegian equity ownership data collected by the country's tax authority. The dataset has information on the number of shares and their nominal value by owner (individual or other legal person), as well as the share's issuer, i.e. the firm, all at the annual level.[1] The data covers the time from 2004 to 2017 and includes around 310,000 firms and around 1.02 million individual owners, covering the universe of domestic financial asset holdings.[2]

The data is supplemented by a number of auxiliary datasets that allow us to geolocate the individual's residence by zip-code and year (Population register), the firm's location, age, subsidiaries, and plants by year (Firm register), as well as the firm's sales, profits, and other balance sheet items (Database of Tax filings). While we observe the data at the micro-level, for the rest of the paper we aggregate the figures at different geographical levels — county (*fylker*), municipality (*kommuner*) and basic statistical unit (*grunnkretser*).[3]

Figure 1 plots the absolute nominal values of investment of the municipalities of Oslo (left), Bergen (center) and Trondheim (right) in all 422 municipalities. Three empirical regularities are visible in plain sight:

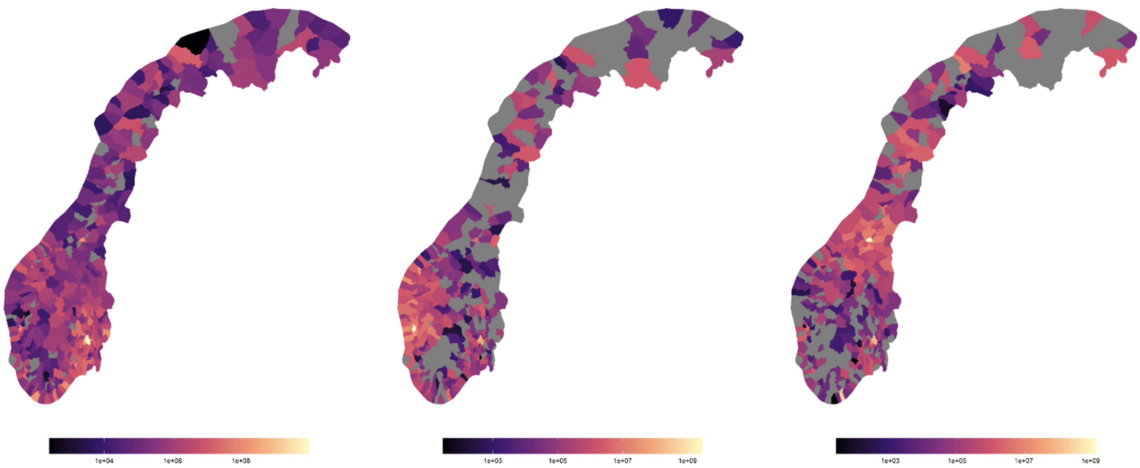
1. *Home bias*: By far the largest investments are recorded in the same municipality. This regularity mirrors the results from the international home bias.
2. *Size*: The largest investments outside the local municipality are observed in the large cities — Oslo, Bergen, Trondheim and Stavanger. This positive elasticity is of city size towards size of investment is one of pillars of the gravity equation.

[1] We disregard firms that are pure financial vehicles, identified as firms that do not report sales in any year in during our sample period.

[2] About 20% of Norwegian nominal share capital is foreign owned. Whereas the (value) share of foreign assets in the average Norwegian household's portfolio, calculated using data from the IMFs CPIS and the Norwegian Tax Authority, was 16% in 2017.

[3] Our analysis predates the 2020 reform of administrative areas that has reduced the number of counties from 19 to 11 and the number of municipalities from 422 to 356. The postal code reform of 1999 takes place before.

Figure 1: Investments from Oslo, Bergen and Trondheim



Note: The maps show the total value of investments in the destination municipality (*kommuner*) from Oslo (left), Bergen (center) and Trondheim (right). Gray-shaded areas have no investment from the respective origin municipality.

3. *Distance*: By and large investments are higher the closer they are located to the investor's location. This negative elasticity of investments to distance is again observed in the related literature on financial flows, trade and migration.

Aside from the physical distance between two locations, other frictions are often observed to inhibit an even spatial distribution of investment, but also trade and migration. The reason why an investor may prefer to invest in one firm over another — abstracting from features of the specific firm — may be related to *bilateral* frictions between the two locations.

Data on Bilateral Frictions

As common in the gravity literature, physical distance between two locations serves as proxy for spatial frictions. E.g., longer travel times between the investor's residence and the firm's location could make it more difficult to observe business dealings. We compute bilateral travel times and road distances by car between these is computed using Open Source Routing Machine and Open Street Map data. Population-weighted great circle distances are computed following Hinz, 2019. The median distance and travel time between municipalities are 367 km and 9 hours, respectively. The maximum distance (travel time) is 1758 km (48.5 hours).

Another friction may be related to the language. There are two standards of written Norwegian — Nynorsk and Bokmål — that are clustered geographically. Bokmål is the main language for about 90 % of the population. Language differences by municipality are coded according to official declaration.[4] Similarly, political leanings may be an expression of underlying differences, which

[4]One quarter of Norwegian municipalities have declared Nynorsk as their official language form, accounting for

Table 1: Ad-hoc Gravity Regression

	Dependent variable: Nominal holdings$_{ij,t}$				
	(1)	(2)	(3)	(4)	(5)
log(Population Origin)	0.652***	-	-	-	-
	(0.128)	(-)	(-)	(-)	(-)
log(Population Destination)	0.734***	-	-	-	-
	(0.122)	(-)	(-)	(-)	(-)
Same municipality	2.610***	2.500***	2.511***	-	-
	(0.456)	(0.415)	(0.404)	(-)	(-)
log(Distance)	-1.057***	-1.271***	-1.213***	-0.081	-1.150***
	(0.065)	(0.066)	(0.879)	(0.183)	(0.088)
log(Travel Time)	-	-	-	-1.105***	-
	(-)	(-)	(-)	(0.220)	(-)
Contiguity	-	0.872***	0.879***	0.851***	0.793***
	(-)	(0.186)	(0.181)	(0.181)	(0.175)
Same language	-	-	0.955***	0.285*	0.264*
	(-)	(-)	(0.294)	(0.116)	(0.119)
Same ruling party	-	-	0.357*	0.041	0.068
	(-)	(-)	(0.142)	(0.049)	(0.053)
Fixed effects	1,926,974	it, jt	it, jt	it, jt	it, jt
Sample size	2,493,176	2,493,176	2,493,176	2,486,847	2,486,847

Notes: Intercept in column (1) is suppressed. Standard errors clustered on origin, destination, and year in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

we capture by the political position of a municipality's ruling party — left, center or conservative.[5]

2.2 Ad-hoc Gravity Estimation

We therefore estimate the following "ad-hoc" gravity equation:

$$A_{ij,t} = \exp\left(\mathbf{z}'_{ij,t}\boldsymbol{\beta}_z + \lambda_{i,t} + \psi_{j,t}\right) \tag{1}$$

where $\mathbf{z}_{ij,t}$ is the vector of variables of interest and $\boldsymbol{\beta}_z$ the respective coefficients. $\lambda_{i,t}$ and $\psi_{j,t}$ are origin $\times$ year and destination $\times$ year fixed effects, respectively. We use a customary Pseudo-Poisson Maximum Likelihood estimator following Silva and Tenreyro (2006) and cluster standard errors on origin, destination, and year following Egger and Tarlea (2015).

Table 1 reports the coefficients of estimating equation (1) with different specifications of $\mathbf{z}_{ij,t}$. In column (1) we "replicate" econometrically the three empirical findings from figure 1: We regress the financial holdings from one municipality in another on each location's population, a dummy indicating whether the two locations coincide, as well as the bilateral great-circle

about 12% of the Norwegian population. Source: `https://en.wikipedia.org/wiki/Nynorsk`.

[5] We source these data from Fiva H., Askill H., and Natvik J. (2020).

distance between the two. The coefficients support the prior findings. Investments in the home location are about $\exp(2.61) \approx 13.6$ times higher than a comparable location — pointing to a large home bias. The same holds for size: The larger the two locations in terms of population the higher the bilateral investments. Ceteris paribus, a 10 % larger population of the origin location is associated with a 6.5 % larger investment, 7.3 % larger for a 10 % larger destination location population. Finally, the bilateral distance clearly matters as well: For every % increase in distance from the investor's location, the amount of investment decreases by about 1 %. Hence, the estimated distance elasticity is very much of the same magnitude as those found in the related literature. In column (2) we control for other investor and firm location specifics with origin and destination fixed effects and include another standard gravity control variable, contiguity. As usual, the coefficient is significant and positive, indicating a strong preference of investors for investments in the vicinity of their municipality. The other two remaining coefficients on distance and same municipality remain very similar to the previous specification. We add further customary gravity variables in column (3) by including two indicators for similar cultural traits, namely the whether the two municipalities share their official written standard of Norwegian — Nynorsk or Bokmål, or both — as well as a local government dominated by a party from the same corner of the political spectrum. Both coefficients are positive and significant, albeit only at the 10 %-level for the latter. In column (4) we include road travel times between the two locations, as Norway's mountainous topology often makes short *great-circle* distances cumbersome to cover. And indeed, the coefficient for travel time is highly significant and around -1, while the coefficient for the great-circle distance becomes small and statistically insignificant. The magnitude of the cultural variables drops markedly, with the indicator for the same ruling party becoming insignificant. One caveat of this specification is that within-municipalities are dropped due to a lack of local travel times. In column (5) we therefore re-estimate the specification from column (3) and find that the latter results are in fact driven by the change in the sample, whereas the remarkable change in the distance coefficient is indeed due to the inclusion of travel time.

Overall these reduced form "ad-hoc" gravity estimations underline the picture the raw data has painted: Similar to the international level, *intranational* gravity-like frictions appear to be strong determinants of the spatial distribution of domestic investment. To study the quantitative importance of spatial frictions for the allocation of capital across Norway, we now turn to a structural model of investment.

3 Theory

The model economy is comprised of J regions, indexed by i, j. Every region features a measure of representative firms and a representative investor. Firms' sales are subject to shocks, rendering the return to holding shares stochastic. Capital is the only factor of production and equity is the only form of capital available to firms. Investors may also invest in a risk-free asset.

3.1 The Investor's Optimization Problem

The investor (from location) i chooses investments (the number of shares of the representative firms from j) to maximize lifetime utility

$$U_{i,t} = E\left[\sum_{s=0}^{\infty} \beta^s u(C_{i,t+s})\right] \tag{2}$$

subject to the per-period budget constraint

$$C_{i,t+1} = W_{i,t+1} - \mathbf{a_{i,t+1}}'\mathbf{v_{t+1}} - a^f_{i,t+1}, \tag{3}$$

where $\mathbf{a_{i,t}}' = [a_{i1,t}, ..., a_{ij,t}, ..., a_{iJ,t}]$ is a vector of investments in assets $j = 1, ..., J$ and $\mathbf{v_t} = [v_{1,t}, ..., v_{j,t}, ..., v_{J,t}]$ is the corresponding vector of asset prices and $a^f_{i,1}$ is the risky-free investment, subject to the equation of motion for wealth

$$W_{i,t+1} = \mathbf{a_{i,t}}'\mathbf{s_{t+1}} + a^f_{i,t}R^f_{t+1}, \tag{4}$$

where $\mathbf{s_t} = [s_{1,t}, ..., s_{j,t}, ..., s_{J,t}]$ is the vector of asset payoffs, and subject to the transversality condition. The first-order condition w.r.t. $a^f_{i,t}$ implies

$$E\left[m_{i,t+1}\right] = \frac{1}{R^f_{t+1}} \tag{5}$$

and the first-order condition w.r.t. $a_{ij,t}$ yields the Stochastic Euler equation

$$v_{j,t} = E_t\left[m_{i,t+1}s_{j,t+1}\right] \qquad \text{with} \qquad m_{i,t+1} = \beta\frac{u'(C_{i,t+1})}{u'(C_{i,t})}. \tag{6}$$

Defining (gross) stock returns as

$$R_{j,t+1} = \frac{s_{j,t+1}}{v_{j,t}}, \tag{7}$$

and using (5), Eq. (6) can be written as

$$1 = \frac{E_t\left[R_{j,t+1}\right]}{R^f} + Cov_t\left[m_{i,t+1}, R_{j,t+1}\right] \tag{8}$$

We approximate $m_{i,t+1}$, the stochastic discount (SDF), with a linear function of the portfolio return. I.e.,

$$m_{i,t+1} = \bar{\zeta}_{i,t} + \zeta_{i,t}R^W_{i,t+1} \qquad \text{with} \qquad R^W_{i,t+1} = \alpha^f_{i,t}R^f_{t+1} + \boldsymbol{\alpha'_{i,t}R_{t+1}} \tag{9}$$

where $\boldsymbol{\alpha'_{i,t}} = [\alpha_{i1,t}, ..., \alpha_{ij,t}, ..., \alpha_{iJ,t}]$ is the vector of portfolio shares with typical element $\alpha_{ij,t} = \frac{a_{ij,t}v_{j,t}}{A_{i,t}}$, $\alpha^f_{i,t}$ is the portfolio share of the risk-free investment, and $A_{i,t} = \sum_{j=1}^{J} a_{ij,t}v_{j,t} + a^f_{i,t}$ is the value of the portfolio.[6] Then,

$$Cov\left[m_{i,t+1}, R_{j,t+1}\right] = \zeta_{i,t}\sum_{j'=1}^{J}\alpha_{ij',t}\sigma_{j,j'} \tag{10}$$

[6]Eq. (9) is the key equation of the classical conditional Capital Asset Pricing Model. There are several combinations of assumptions on the distribution of returns and/or the utility function that are consistent with Eq. (9); see Cochrane (2000).

where $\sigma_{j,j'}$ is a typical element of the covariance matrix of returns $\mathbf{\Sigma_t}$. Rewriting (8) in matrix notation and using (10), we have

$$\mathbf{1} = \frac{1}{R^f} E_t \left[\mathbf{R_{t+1}}\right] + \zeta_{i,t} \boldsymbol{\Sigma_t} \boldsymbol{\alpha_{i,t}}, \tag{11}$$

which can be solved for the portfolio shares as

$$\boldsymbol{\alpha_{i,t}} = \frac{1}{-\zeta_{i,t}} \boldsymbol{\Sigma_t}^{-1} \left(\frac{1}{R^f} E_t \left[\mathbf{R_{t+1}}\right] - \mathbf{1} \right). \tag{12}$$

3.2 The Firm's Optimization Problem

Firms choose inputs in order to maximize their shareholder value net of the current cost of operating the firm. The shareholder value is given by the share price multiplied by the number of shares per firm, which we normalize to one.

Let $\pi_{j,t+1}$ denote the dividend paid by firm j, which equals the profit of firm j provided that the firm distributes all of its profit to shareholders. Then, the payoff from owning a share of firm j, $s_{j,t+1}$, may be written as

$$s(k)_{j,t+1} = \pi(k)_{j,t+1} + v(k)_{j,t+1}. \tag{13}$$

Substituting (13) into (6) and iterating forward, we may write the share price as the discounted value of all future profits:

$$v(k)_{j,t} = \mathrm{E}_t \left[\sum_{s=0}^{\infty} \beta^s m_{i,t+s} \pi(k)_{j,t+s} \right]. \tag{14}$$

The firm's maximization problem reads

$$\max_k v(k)_{j,t} - b(k)_{j,t} \tag{15}$$

where k is the capital input and $b(k)_{j,t}$ denotes the cost of operating firm j at scale k. We use $b_{j,t}$ to denote the optimum cost corresponding to the optimal input k_t^*. Likewise, $\pi_{j,t+s}$ and $s_{j,t+s}$ denote the optimum payoff and the optimum profit.

3.3 General Equilibrium

Let the measure of representative firms in region j be denoted by $N_{j,t}$. Then, market clearing for equity requires

$$N_{j,t} = \sum_i a_{ij,t} \qquad \Leftrightarrow \qquad N_{j,t} v_{j,t} = \sum_i \alpha_{ij,t} A_{i,t}. \tag{16}$$

Equilibrium with free entry. Free entry implies that the net present value of creating a firm is zero. That is, the free entry requires that the value of a firm's equity, reflecting shareholders' willingness to pay for ownership of the firm, be equal to the cost of operating the firm. That is,

$$v_{j,t} - b_{j,t} = 0. \tag{17}$$

Hence, share prices in the free-entry equilibrium are determined by a firm's optimum cost. The number of firms is determined by the market clearing condition (16).

Equilibrium with fixed numbers of firms. In an equilibrium with a fixed number of firms, asset prices are jointly determined by investors' FOCs (6) and the market clearing condition (16).

4 Implementing Gravity Frictions

We introduce information frictions similar to Okawa and Wincoop (2012) as a bilateral add-on to the variance of an asset from j, with the add-on reflecting additional noise induced by a lack of information about the asset from region i on the part of investor j. We denote the information friction with τ_{ij}. Like Okawa and Wincoop (2012), we assume that the variance of asset j from investor i's point of view is $\sigma^i_{jj} = \tau^2_{ij}\sigma_{jj}$, where σ_{jj} is the actual variance of R_j. Moreover, extending Okawa and Wincoop (2012), we allow for arbitrary correlations between all countries' returns, measured by the covariance matrix $\mathbf{\Sigma}$. Let $\sigma_{jk} = \rho_{jk}\sqrt{\sigma_{jj}}\sqrt{\sigma_{kk}}$ denote the actual covariance between R_j and R_k, where ρ_{jk} is the correlation coefficient. Then, alike an asset's variance, its covariance as perceived by investor i is augmented by information frictions. That is, $\sigma^i_{jk} = \tau_{ij}\tau_{ik}\sigma_{jk}$. The covariance matrix of returns from i's point of view is then

$$\mathbf{\Sigma^{\boldsymbol{i}}} = \boldsymbol{T_i}\mathbf{\Sigma}\boldsymbol{T_i}$$

where $\boldsymbol{T_i}$ is a diagonal matrix with element (j,j) equal to τ_{ij}. Let $\boldsymbol{S} = \mathbf{\Sigma^{-1}}$. Then, the portfolio shares with an i-specific covariance matrix are

$$\boldsymbol{\alpha_{i,t}} = \frac{1}{\zeta_{i,t}R^f_{t+1}}(\mathbf{\Sigma}^{\boldsymbol{i}}_{\boldsymbol{t}})^{-1}\left(E_t\left[\mathbf{R_{t+1}}\right] - \mathbf{R^f_{t+1}}\right) = \frac{1}{\zeta_{i,t}R^f_{t+1}}\boldsymbol{T_i}^{-1}\boldsymbol{S}\boldsymbol{T_i}^{-1}\left(E_t\left[\mathbf{R_{t+1}}\right] - \mathbf{R^f_{t+1}}\right). \quad (18)$$

where $(\mathbf{\Sigma^{\boldsymbol{i}}})^{-1} = \boldsymbol{T_i}^{-1}\boldsymbol{S}\boldsymbol{T_i}^{-1}$ and $\boldsymbol{T_i}^{-1}$ is a diagonal matrix with element (j,j) equal to $1/\tau_{ij}$. Total bilateral investment then follows as

$$A_{ij} = \alpha_{ij}A_i = \frac{1}{\zeta_i R_f}\frac{1}{\tau_{ij}}c_{ij}A_i,$$

where $c_{ij} = \sum_k \frac{s_{1k}R^e_k}{\tau_{ik}}$. That is, we arrive at a gravity-style equation, featuring *two* bilateral terms: Direct frictions τ_{ij} and frictions related to the covariance of j's return with all other countries' returns.[7] The presence of c_{ij} and its correlation with τ_{ij} implies that standard gravity equations for investment, alike the ones we estimate in Section 2, are generally not consistent with a structural model for investment if asset returns are correlated across destinations. Only in the special case of zero covariances considered by Okawa and Wincoop (2012), c_{ij} collapses to c_j, such that bilateral shareholdings are log-linearly related to the frictions τ_{ij}. In what follows,

[7]The impact of bilateral frictions on the bilateral investment and the structure of the covariance component $c_{ij,t}$ is straightforward to see in a two-country example with $i = 1, 2$. Total bilateral investment from i to 1 is then

$$A_{i1} = \alpha_{i1}A_i = \frac{1}{\zeta_i R_f}\frac{1}{\tau_{i1}}c_{i1}A_i.$$

we thus use a non-linear estimator together with data on the distribution of payoffs to estimate the frictions.

5 Quantification

5.1 Model-based Quantification of Bilateral Frictions

We use Eq. (6) together with data on the number of bilateral share holdings and the empirical distribution of sales across regions to identify the bilateral frictions. Along the way, we also solve for share prices and a vector of scaling coefficients.

Let's rewrite the Euler equation (6) in terms of share prices and payoffs instead of returns as

$$v_{j,t} = \frac{E\left[s_{j,t+1}\right]}{R^f_{t+1}} + \text{Cov}^i_t\left[m_{i,t+1}, s_{j,t+1}\right] \tag{19}$$

where $\text{Cov}^i_t\left[m_{i,t+1}, s_{j,t+1}\right]$ is based on $\boldsymbol{\Omega^i} = \boldsymbol{T_i \Omega T_i}$, the actual covariance matrix of payoffs augmented with bilateral uncertainty due to information frictions. Also, let's write the SDF as

$$m_{i,t+1} = \bar{\zeta}_{i,t} + \zeta_{i,t}\frac{W_{i,t+1}}{W_{i,t}} = \bar{\zeta}_{i,t} + \zeta_{i,t}\left(a^f R^f + \mathbf{a}_{i,t}\mathbf{s_{t+1}}\right), \tag{20}$$

with the risk-free investment separated from the risky assets. Then we can express (19) as

$$v_{j,t} = \frac{E\left[s_{j,t+1}\right]}{R^f_{t+1}} + \frac{\zeta_{i,t}}{W_{i,t}}\sum_{j'} a_{ij',t}\tau_{ij}\tau_{ij'}\omega_{jj'} \tag{21}$$

where ω_{ij} is the (i,j)th element of Ω.[8] Under the assumption that the bilateral frictions are symmetric, i.e. $\tau_{ij} = \tau_{ji}\ \forall i,j$, we calculate $J*(J+1)/2$ bilateral frictions together with J share prices $v_{j,t}$ and J $\zeta_{i,t}, W_{i,t}$ such as to best fit the set of $J \times J$ equations given (21).[9]

5.2 Calibration

We use the data from Section 2.1 to calibrate the baseline of our model to a given base year t. To calculate nominal the bilateral share holdings at the municipality level, we aggregate up the nominal share holdings from the investor-firm level. Since the nominal share holdings measure an investor's claim to the total payoff (sales) generated in the destination region, we weight the

Using R^e_j as a shorthand for $\text{E}[R_j] - R^f$ and dropping time indices for simplicity, the portfolio shares are equal to

$$\alpha_{i1} = \frac{1}{\zeta_i R_f}\left(\frac{1}{\tau^2_{i1}}s_{11}R^e_1 + \frac{1}{\tau_{i1}}\frac{1}{\tau_{i2}}s_{12}R^e_2\right) = \frac{1}{\zeta_i R_f}\frac{1}{\tau_{i1}}\left(\frac{1}{\tau_{i1}}s_{11}R^e_1 + \frac{1}{\tau_{i2}}s_{12}R^e_2\right)$$

$$\alpha_{i2} = \frac{1}{\zeta_i R_f}\left(\frac{1}{\tau_{i1}}\frac{1}{\tau_{i2}}s_{21}R^e_1 + \frac{1}{\tau^2_{i2}}s_{22}R^e_2\right) = \frac{1}{\zeta_i R_f}\frac{1}{\tau_{i2}}\left(\frac{1}{\tau_{i1}}s_{21}R^e_1 + \frac{1}{\tau_{i2}}s_{22}R^e_2\right).$$

and the covariance component is $c_{i1} = \frac{1}{\tau_{i1}}s_{11}R^e_1 + \frac{1}{\tau_{i2}}s_{12}R^e_2$.

[8]The advantage of expressing the Euler equation in this way is that the distribution of *payoffs* (sales) is straightforward to observe for non-listed firms. Similarly, a_{ij}, the number of shares, is straightforward to observe compared to the portfolio share in terms of value, α_{ij}.

[9]For the number of equations to exceed the number of unknowns, we need $J > 7$.

Table 2: Regression of Model-based Frictions

	Dependent variable: $\tau_{ij,t}$			
Year	2010			2016
	(1)	(2)	(3)	(4)
Same municipality	-	-	-	-
	(-)	(-)	(-)	(-)
log(Distance)	-	-	-	-
	(-)	(-)	(-)	(-)
log(Travel Time)	-	-	-	-
	(-)	(-)	(-)	(-)
Contiguity	-	-	-	-
	(-)	(-)	(-)	(-)
Same language	-	-	-	-
	(-)	(-)	(-)	(-)
Same ruling party	-	-	-	-
	(-)	(-)	(-)	(-)
Fixed effects	-	it	-	it
Sample size	171	171	171	171

Notes: Intercept is suppressed. Standard errors clustered on origin and destination in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

firm-level holdings with the firm's sales in order account for differences in the composition (in terms of firms in the destination) of the portfolio held by investors from different origins. That is, we calculate the bilateral holdings as $a_{ij,t} = \frac{\sum_{f\in\mathcal{F}_j} a_{if,t}s_{f,t}}{\sum_{j\in\mathcal{F}_j} s_{j,t}}$, where $a_{if,t} = \sum_{o\in\mathcal{O}_i} a_{of,t}$ sums shares of a given firm across all owners from i. Furthermore, we need data on the expected sales per region and the covariance matrix of sales across regions. We compute these moments of the sales distribution over a period of ten years preceding year t, the base year of our counterfactual.

Given this calibration, we obtain the model-implied share prices in j, $v_{j,t}$, the vector $\zeta_{i,t}/W_{i,t}$ denoting risk aversion and wealth of the representative investor in i, as well as the (symmetric) matrix of bilateral frictions between all locations $\tau_{ij,t}$.

5.3 Frictions and Gravity

Additionally, we can relate the model-implied bilateral frictions to the customary bilateral gravity variables also employed above in the "ad-hoc" estimation of the gravity equation. Specifically, we estimate

$$\tau_{ij,t} = \exp\left(\mathbf{z}'_{ij,t}\boldsymbol{\beta}_z + \lambda_{i,t}\right) \tag{22}$$

where $\mathbf{z}_{ij,t}$ is again a vector of variables of interest and $\boldsymbol{\beta}_z$ the vector of corresponding coefficients and $\lambda_{i,t}$ is an origin fixed effect. We include the latter as ...
Table 2 displays the results.

TO BE COMPLETED

6 Counterfactuals

TO BE COMPLETED

7 Conclusion

TO BE COMPLETED

References

Cochrane, John H (2000). *Asset pricing*. Princeton University Press.

Coeurdacier, Nicolas and Philippe Martin (2009). “The geography of asset trade and the euro: Insiders and outsiders”. In: *Journal of the Japanese and International Economies* 23.2, pp. 90–113.

Coval, Joshua D. and Tobias J. Moskowitz (1999). “Home Bias at Home: Local Equity Preference in Domestic Portfolios”. In: *The Journal of Finance* 54.6, pp. 2045–2073.

Cumming, Douglas and Na Dai (2010). “Local bias in venture capital investments”. In: *Journal of Empirical Finance* 17.3, pp. 362–380.

Eaton, Jonathan and Samuel Kortum (2002). “Technology, Geography, and Trade”. In: *Econometrica* 70.5, pp. 1741–1779.

Egger, Peter H. and Filip Tarlea (2015). “Multi-way clustering estimation of standard errors in gravity models”. In: *Economics Letters* 134.C, pp. 144–147.

Fiva H., Jon, Halse Askill H., and Gisle Natvik J. (2020). “Loval Government Dataset”. In: *unpublished manuscript*.

Giroud, Xavier (2013). “Proximity and investment: Evidence from plant-level data”. In: *The Quarterly Journal of Economics* 128.2, pp. 861–915.

Grinblatt, Mark and Matti Keloharju (2001). “How Distance, Language, and Culture Influence Stockholdings and Trades”. In: *The Journal of Finance* 56.3, pp. 1053–1073.

Guenther, Christina, Sofia Johan, and Denis Schweizer (2018). “Is the crowd sensitive to distance? How investment decisions differ by investor type”. In: *Small Business Economics* 50.2, pp. 289–305.

Hinz, Julian (2019). “The view from space: Theory-based time-varying distances in the gravity model”. In: November, pp. 1–37.

Lin, Mingfeng and Siva Viswanathan (2016). “Home bias in online investments: An empirical study of an online crowdfunding market”. In: *Management Science* 62.5, pp. 1393–1414.

Okawa, Yohei and Eric van Wincoop (2012). “Gravity in International Finance”. In: *Journal of International Economics* 87.2, pp. 205–215. ISSN: 0022-1996.

Pellegrino, Bruno, Enrico Spolaore, and Romain Wacziarg (2020). “Barriers to Global Capital Allocation”. In: *unpublished manuscript*.

Petersen, Mitchell A. and Raghuram G. Rajan (2002). “Does Distance Still Matter? The Information Revolution in Small Business Lending”. In: *The Journal of Finance* 57.6, pp. 2533–2570.

Silva, JMC Santos and Silvana Tenreyro (2006). “The log of gravity”. In: *The Review of Economics and statistics* 88.4, pp. 641–658.

Uysal, Vahap B, Simi Kedia, and Venkatesh Panchapagesan (2008). “Geography and acquirer returns”. In: *Journal of Financial Intermediation* 17.2, pp. 256–275.

A Estimations

Table 3: Ad-hoc Gravity Regression with Shares

	Dependent variable: Share of holdings$_{ij,t}$				
	(1)	(2)	(3)	(4)	(5)
log(Population Origin)	0.285***	-	-	-	-
	(0.081)	(-)	(-)	(-)	(-)
log(Population Destination)	0.864***	-	-	-	-
	(0.127)	(-)	(-)	(-)	(-)
Same municipality	2.426***	1.644***	1.657***	-	-
	(0.410)	(0.301)	(0.298)	(-)	(-)
log(Distance)	-1.192***	-1.970***	-1.933***	-0.365**	-1.926***
	(0.071)	(0.075)	(0.075)	(0.132)	(0.103)
log(Travel Time)	-	-	-	-1.635***	-
	(-)	(-)	(-)	(0.120)	(-)
Contiguity	-	0.736***	0.750***	0.610***	0.572***
	(-)	(0.146)	(0.141)	(0.101)	(0.093)
Same language	-	-	0.523*	0.200	0.215
	(-)	(-)	(0.292)	(0.230)	(0.225)
Same ruling party	-	-	0.162	-0.133	-0.084
	(-)	(-)	(0.160)	(0.184)	(0.185)
Fixed effects	-	it, jt	it, jt	it, jt	it, jt
Sample size	1,926,974	2,493,176	2,493,176	2,486,847	2,486,847

Notes: Intercept in column (1) is suppressed. Standard errors clustered on origin, destination, and year in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$