No 2020-07– May 2020

Working Paper

CEPII

Grey Zones in Global Finance: the Distorted Geography of Cross-Border Investments

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Highlights

- We employ a standard gravity framework to quantify abnormal stocks of FDI and portfolio securities over 2009-2017 for up to 236 jurisdictions.

- We provide evidence that about 40% of global asset are abnormal stocks and that:

  (a) the bulk of international assets in tax havens are `abnormal', i.e unexplained by standard gravity factors;

  (b) there is a strong heterogeneity among jurisdictions, the bulk of unexplained international investments is concentrated on six jurisdictions, among which five large tax havens;

  c) while Luxembourg is among them, we find that the Luxleaks were paradoxically followed by a rise of unexplained FDI in and from Luxembourg.

* The authors thank Adrien Matray, Gianmaria Milesi-Ferreti, Noemie Pinardon-Touati, Jeromin Zettelmeyer, aswell as participants to the seminars at the Peterson Institute, CEPII, Leda (Dauphine), Banque de France, OFCEfor helpful discussions.

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Abstract

Tax avoidance schemes generate artificially complex cross-border financial structures inflating measured international investment stocks in tax havens. Using a standard gravity framework, we estimate that about 40% of global assets (FDI, portfolio equity and debt) are `abnormal' – unexplained – stocks. Abnormal stocks are increasing over time and concentrated in a limited number of jurisdictions. Six jurisdictions including three European countries are the largest contributors: Cayman, Bermuda, Luxembourg, Hong Kong, Ireland and the Netherlands. Interestingly, the Luxleaks in 2014 do not appear to have diverted cross-border investments away.

Keywords

Cross-Border Investments, Capital Openness, Tax Havens, Gravity Equation.

JEL

F23, G21, H22, H32.

Working Paper

CEPII

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CEPII Working Paper
Contributing to research in international economics

Editorial Director:
Sébastien Jean

Production: Laure Boivin

Published on 02.06.20

No ISSN: 1293-2574

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RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

1 Introduction

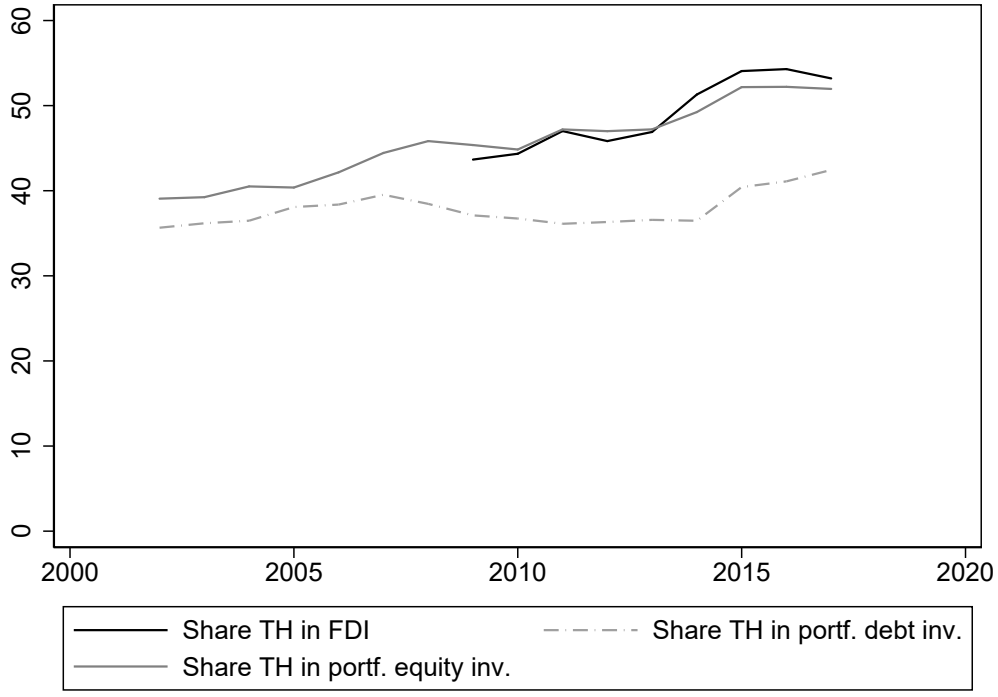
Tax avoidance generates international investment beyond standard factors such as country size and distance and affects the geography of cross-border investment substantially. Figure 1 plots the share of global stocks of foreign direct investment (FDI), debt and equity operated through tax havens. We observe that between 4 and 5 out of 10 dollars of global assets were operated through a tax haven in 2017. As a consequence, these jurisdictions hold very large stocks of assets compared to their country size: on average, FDI stocks and portfolio investments represent 2400% and 1000% of GDP in tax havens respectively versus 44% and 22% of GDP in non tax havens. While it has been already documented for FDI stocks (Haberly and Wójcik (2015) and Damgaard et al. (2019)), similar disproportion have been overlooked for portfolio investments.[1] Yet, reports on tax schemes suggest that portfolio investment as much as FDI are involved in profit and individual wealth shifting.[2]

One chief contribution in this paper is to uncover that tax avoidance distorts global finance geography in all categories of assets, debt and equity as much as FDI stocks and to quantify this distortion. We estimate that about 40% of global asset are *abnormal* stocks, that they are concentrated in a few jurisdictions only, and that this proportion has been on the rise over the last decade.

It is important because the agenda on tax avoidance and global finance might interact more than we expect. If tax avoidance generates disproportionate stocks of securities in certain jurisdictions, then the fight against it might have unintended consequences on global financial balances. For example, the Tax Cuts and Jobs Act (TCJA) passed in the US in December 2017 was followed by a substantial sell-off of offshore funds invested in liquid U.S. fixed-income securities and generated bond price volatility.[3] More generally, OECD has coordinated the

[1] In a different perspective than ours, Coppola et al. (2020) uses data on offshore issuance of traded securities.
[2] "B.R.E.A.M. (Bonds Rule Everything Around Me)", Alexandra Scaggs, FT Alphaville, Feb 2018.
[3] "U.S. Corporations' Repatriation of Offshore Profits: Evidence from 2018", Michael Smolyansky, Gustavo Suarez, Alexandra Tabova, Feds Notes, August 2019 and "The Global Con Hidden in Trump's Tax Reform Law, Revealed",

Figure 1 – Share of tax haven in global stocks



This Figure shows the share to global stocks of stocks for which a tax haven is an origin or a destination (respect. FDI, portfolio debt investment and portfolio equity investment). Author's calculations with IMF CPIS and CDIS data.

discussion of 134 countries in order to try and reform international fiscal rules (OECD, 2019). In this context and the context of shrinking fiscal space after the Covid crisis, it is key to quantify and locate *abnormal* stocks in order to anticipate the overall impact of tax avoidance on global imbalances.

Our strategy relies on two patterns. First, tax avoidance motivated schemes leave trace in international statistics of balance of payments. The dollars of profit and personal wealth shifted to optimize or avoid taxation and regulation are recorded in the balance of payments. Examples of tax planning practices involving FDI and portfolio investment stocks include the strategic location of intellectual property rights and intangibles assets, corporate inversion, i.e. when

Brad Sester, New York Times, Feb 6, 2019.

a subsidiary in a tax haven becomes the parent entity, the allocation of financial assets and liabilities to Special Purpose Entities (SPEs), or the investment by foreign subsidiaries of shifted profit in fixed-income assets.

Second, international economics relies on gravity framework to assess the economic and geographic determinants of international investments. Our empirical strategy infer *abnormal* investment stocks, i.e. the level of investment stocks in tax havens unexplained by economic and geographic factors, from a standard gravity framework applied to cross-border investment stocks. The gravity model, initially developed to explain goods trade across countries (Bergstrand, 1985; Anderson, 1979), has been extended to assets trade: it is now well-documented that bilateral financial transactions rise proportionately with the economic size of both countries – "mass" – and are negatively correlated with resistance – the "distance", either geographical or socio-cultural.[4]

We recover the country specific unexplained asset stock once controlled for standard gravity variables (Head and Ries, 2008) using a two-step procedure. This methodology allows us to disentangle artificial activity driven by country-specific factors (e.g. lenient tax and transparency environment) from unobserved determinants of bilateral stocks related to historical, geographic or institutional proximity between any pair of investing and investor countries (e.g. historical relationships beyond former colonial links). Our empirical strategy relies on bilateral data. They come from the Coordinated Direct Investment Survey and the Coordinated Portfolio Investments Survey of the IMF. The final sample consists of 237 reporting jurisdictions including 42 tax havens over the 2009-2017 period for FDI stocks and 91 jurisdictions reporting their assets to 237 countries including 22 tax havens over 2001-2017 for portfolio investment stocks.[5]

Our results show that a large share of assets operated through tax havens are *abnormal*: on average over 2009-2017, we estimate that 37% of global (predicted) FDI, 42% and 45% of global (predicted) equity and debt stocks are abnormal.[6] Jurisdictions are however very heterogeneous

[4] Portes et al. (2001), Portes and Rey (2005).

[5] Tax havens refer to the jurisdictions listed by Hines and Rice (1994) presented in Appendix (see Table 6).

[6] We dub *abnormal* stocks, these stocks in tax havens not predicted by standard size and bilateral frictions determinants within the gravity framework to emphasize that they are driven by factors without economic and geographic

in their *abnormality*: only a share of the 42 tax havens listed in Hines and Rice (1994) stands out as abnormally big in each asset category, either as an origin or a destination of investments. Six jurisdictions including five tax havens concentrates the bulk of *abnormal* investments: Cayman, Bermuda, Luxembourg, Hong Kong, Ireland and the Netherlands. Paradoxically, we find that the Luxleaks revealed in 2014 have been followed by rising investments to and from Luxembourg.

Related Literature Our paper is most directly related to the literature on international financial integration assessing the role of off-shore finance in the international financial system (e.g. Coppola et al. (2020), Lane and Milesi-Ferretti (2018), Zucman (2013), Palan et al. (2013a), Lane and Milesi-Ferretti (2011)). Relative to this literature, our contribution is to discipline cross-border investment data with the gravity framework to isolate the share driven by economic and geographic factors, rather than working with raw data and statistical ratios. It produces a better-informed ranking of who are the largest contributors to *abnormal* finance: on the one hand, more than two-third of tax havens play a minor role; on the other hand, six jurisdictions including three European countries deserve policy attention.[7] A branch of this literature examines more particularly how offshore centers affect the allocation of Foreign Direct Investment (e.g. Haberly and Wójcik (2015), Damgaard et al. (2019) and Garcia-Bernardo et al. (2017)). A recent paper by Coppola et al. (2020) focuses on the flawed allocation of portfolio investments in offshore centers by identifying the ultimate parents of portfolio stocks. The allocation of FDI and portfolio investments is rarely assessed together and our paper contributes in filling the gap. We show that the largest contributors to abnormal investments are large actors in both FDI and portfolio assets, a result that likely reflects the diversity of tax avoidance schemes. It suggests that different regulations for the two categories of investment may be misleading. Two other branches of the literature use balance of payment and national account data on the one hand ((Alstadsæter et al., 2017; Tørsløv et al., 2018) and firm-level data on the other hand (Vicard, 2019; Bouvatier et al., 2017) to quantify missing corporate profits in high tax countries and pinpoint their location. We differ from them who look at foreign direct investment incomes and

ground.

[7] A derivative contribution is our providing the largest database of gravity factors including 237 jurisdictions.

returns, by focusing on investment stocks and considering all stocks recorded in the balance of payment together.

Section 2 presents our empirical strategy, Section 3 the estimate results, Section 4 quantification and map. Section 5 concludes.

2 Empirical Strategy

2.1 Specification

Our measure of *abnormal* investment is the residuals of a two-step gravity equation on foreign direct investment (FDI) and portfolio holdings (PH). In the first step, we regress bilateral investment stocks on origin and destination fixed effects and a vector of geographic and cultural distance measures:

$$\ln Asset^{k}_{odt} = \theta_{ot} + \theta_{dt} + \beta X_{odt} + \varepsilon_{odt}. \quad (1)$$

The dependent variable, $Asset^{k}_{odt}$, is the bilateral stock of assets, k being alternatively FDI, portfolio debt investment and portfolio equity investment.[8]. θ_{ot} and θ_{dt} are country-and-time fixed effects at origin and destination levels.[9] X_{odt} include a set of geographic and cultural distance factors as suggested in Blonigen and Piger (2014): (log) bilateral distance and binary variables for a common language, a common border, former colonial linkages, a common regional trade agreement, EU membership, a common currency and a same territory (the sources of the data is described in Appendix B). Such formulation of the gravity equation has been consistently used with different categories of investment stocks: FDI (Head and Ries, 2008) and portfolio investment equity and debt (Portes et al., 2001; Portes and Rey, 2005).

[8]Bilateral FDI stocks are investments received by destination country d from origin country o in year t; for portfolio debt and equity investments, the bilateral stock is measured between destination country d (holder of the asset) and origin country o (issuer).

[9]We use the *reghdfe* package (Correia, 2014).

In order to measure abnormal investment stocks at the country-year level, we follow Baker and Fortin (2001) and Head and Mayer (2014) and estimate a second step equation to purge from the country-and-time fixed effects the country specific determinants of investment stocks:

$$\theta_{ot} = \alpha_1 Z_{ot} + \alpha_2 \bar{X}_{ot} + \mu_{ot} \tag{2a}$$

$$\theta_{dt} = \alpha_1 Z_{dt} + \alpha_2 \bar{X}_{dt} + \mu_{dt} \tag{2b}$$

where Z_{ot} and Z_{dt} are country-and-time observable variables, $\bar{X}_o$ and $\bar{X}_d$ includes the average characteristics of countries o and d defined as $\bar{X}_{ot} = \sum_d X_{odt}/N_d$ for each bilateral variable included in X_{odt} in Equation 1. Z_{ot} and Z_{dt} include current GDP and population, the rule of law, insularity and landlocked characteristics. In addition, a discrete market capitalization measure is included in the portfolio estimate, ranked from 1 to 3 in tercile of market capitalization-to-GDP, in order to account for the differences of agglomeration economies among financial centers. In sum, in the bilateral stock of assets held by e.g. the UK in Hong Kong, we are able to isolate the share determined by Hong Kong-specific factors not accounted for in the standard gravity factors (lenient tax and transparency environment) from unobserved determinants related to historical, geographic or institutional proximity between the UK and Hong Kong. Okawa and van Wincoop (2012) show that gravity applies properly to information friction only; therefore, introducing a financial friction such as a tax that reduces the return on foreign investment invalidates the gravity specification. The reason is that bilateral asset holdings are not anymore proportional to the size of the destination country as would be the case in any gravity specification.[10] Yet, tax affects returns and therefore should consistently influence the allocation of asset. Is it a problem for our research objective that gravity does not account for it? On the contrary, we think that it precisely fits our goal. As a matter of fact, the common criteria defining tax haven jurisdictions include low or null tax rate, and aggressive tax competition and opacity (Palan et al., 2013b;

[10]The reason is that gravity in trade models holds under a CES demand system, where demand for goods depends on relative prices. This kind of demand system does not generally hold in portfolio choice, where portfolio demand depends on the inverse of a variance-covariance matrix of returns times a vector of expected excess returns.

Hines and Rice, 1994). Including the statutory tax rates, among which zero or closed to zero tax rates of several jurisdictions, would deny the presence of unfair tax competition.[11] Put it differently, while tax qualifies for an economic factor of stock allocation in a context without unfair tax competition, we argue that including null or extremely low statutory tax rates would blur our analysis. Section 5 presents sensitivity analysis when including corporate tax rates as a determinant of investment stocks. Our conclusions remain unchanged.

The residuals μ_{ot} and μ_{dt} are the unexplained stock of asset, i.e. our country-specific measure of *abnormal* assets. We estimate Equations 2a and 2b on the sample of non tax havens because it has been shown that profit shifting by multinationals inflates GDP per capita in tax havens (Tørsløv et al., 2018), potentially biasing estimated coefficients on Z_{ot} and $\bar{X}_{ot}$. μ_{ot} and μ_{dt} are hence computed from out of sample predictions for tax havens listed in Hines and Rice (1994). Section 5 presents sensitivity analysis when estimating on the full sample and our conclusions remain unchanged.

2.2 Bilateral Investment stocks

We use the statistics on bilateral FDI coming from the Coordinated Direct Investment Survey of IMF (CDIS) (the reference edition of the survey is the IMF CDIS 2019 covering 2009-2017) and we complete and improve some data. To do so, we use two measures of FDI, the Inward Direct Investment Positions, i.e. the stock declared by the destination country of investment, and the mirror Outward Direct Investment Positions, i.e. the stock declared by the origin or investor country. We find noticeable differences between both stocks arising from missing values and from the quality of the data.Similarly, Angulo and Hierro (2017) highlight large bilateral asymmetries between inward and mirror stocks. In total, 126 countries do not report FDI with their partners but their partners do so: approximately 30% of missing inward values have a mirror outward

[11] In 2018, 12 jurisdictions have a zero statutory corporate tax rate and 17 have a tax rate below 12% (https://taxfoundation.org/corporate-tax-rates-around-the-world-2019/).

stock reported (56,855 observations). Therefore, we use the mirror data to complete the FDI database.

In addition, the same mirror data allow us to assess the reporting quality at the country level. We first isolate the largest bilateral asymmetries between reported and mirror inward stocks and then we compare the reporting quality of each country in the pair. We replace the reported data of "bad" reporters with the mirror data reported by "good" reporters (our procedure is detailed in Appendix A and the resulting top and bottom quality ranking of reporting countries is reported in Table5). Doing so, we complete and improve the FDI data for 93 countries including 27 tax havens. The resulting sample consists of 237 reporting jurisdictions including 42 tax havens.

Statistics on bilateral portfolio investments come from the Coordinated Portfolio Investment Survey of the IMF (CPIS) (the reference edition of the survey is the IMF CPIS 2019 covering 2001-2017). The database provides a breakdown between debt and equity assets. The resulting sample consists of 91 jurisdictions reporting their assets to 236 countries including 22 tax havens. Contrary to previously, we can not not exploit mirror data similarly as for FDI because CPIS includes a smaller number of mirror data than CDIS.

3 Results

Table 1 reports the estimated coefficients on geographic and cultural distance determinants of bilateral FDI and portfolio investments from Equation 1. Estimated coefficient signs are consistent with expectation: bilateral assets decrease with distance and increase with contiguity; stocks increase with historical colony linkages and with common language; the European Union is associated with larger cross-members investment assets; similarly, tax treaties between origin and destination are associated with larger stock of bilateral assets. Bilateral investment treaty (BIT) and RTAs are associated with larger FDI only; on the contrary, only debt assets are significantly larger between two partner countries sharing a common currency.

Table 1 – First-step gravity: bilateral determinants

	(1) FDI	(2) Debt	(3) Equity
Log distance	-1.258***	-0.838***	-0.902***
	(0.038)	(0.030)	(0.039)
EU membership dummy	0.882***	0.966***	0.453***
	(0.128)	(0.096)	(0.118)
Tax treaty dummy	0.534***	0.097*	0.197***
	(0.067)	(0.054)	(0.070)
Bilateral investment treaty dummy	0.484***	-0.107**	-0.026
	(0.056)	(0.047)	(0.063)
Common language dummy	1.012***	0.380***	0.748***
	(0.081)	(0.067)	(0.089)
Common border dummy	0.619***	0.352***	0.791***
	(0.120)	(0.127)	(0.160)
Common currency dummy	0.132	0.645***	0.111
	(0.117)	(0.111)	(0.130)
Former colonial relationship dummy	0.998***	0.276***	0.602***
	(0.126)	(0.106)	(0.145)
Same country dummy	-0.085	0.451	-0.002
	(0.365)	(0.327)	(0.375)
RTA dummy	0.635***		
	(0.066)		
Observations	70,022	70,489	65,159
R-squared	0.642	0.723	0.725

This table reports the estimates of the first step of the gravity equation on FDI, portfolio debt and portfolio equity specified in Eq.1. We use an OLS estimator on a full sample. The period of estimation is 2009-2017 for FDI stocks and 2002-2017 for portfolio debt and equity. *** indicates a correlation significant at the 0.01 level.

In the second step, we estimate Equations 2a and 2b on the sample excluding jurisdictions listed in Hines and Rice (1994) to prevent artificially inflated national account statistics in tax havens to contaminate our estimates.[12] Results estimates of time-country-specific factors of bilateral FDI and portfolio holdings are reported in Table 2. A larger GDP is associated with larger stocks at both origin and destination level while larger population is mostly associated with lower stocks of assets (the only exception is equity at origin). Countries ruled by the principle of the rule of law display larger stocks of assets as expected; on the contrary landlocked countries display lower stock of FDI and equity (the estimated coefficient is not significant for debt securities). The larger the market capitalization, the larger the stocks of asset (except for debt at origin).

Last, we use this estimate to predict the stocks for our full sample. Our measure of country-specific *abnormal* stock is the residuals of this out-of-sample prediction.

Figure 2 plots the period average *abnormal* stocks at origin and destination levels by country. We observe that *abnormal* stocks operated though a tax havens (orange dots) are differently located than the ones operated through non tax havens (green dots): 1) abnormal stocks in tax havens scatter further away from 0 at both origin and destination; 2) more orange dots lay in the northeast quarter of the figure than green dots meaning that *abnormal stocks* in tax havens are larger; 3) on the FDI figure, most orange dots tend to be located around the first bisector suggesting that the associated jurisdictions stand out as origin and destination levels, i.e. as "platform" jurisdictions; it is to a lesser extent the case for *abnormal* debt stocks; in turn, outliers in equity stocks tend to be located along the y-line, suggesting that these jurisdictions stand out as large equity issuers ; 4) a few tax haven jurisdictions are top outliers in the three asset categories.

In total, the distribution of abnormal stocks is different for tax havens from non tax havens jurisdictions, in all categories of stocks. In the next Section, we examine what these *abnormal*

[12]Excluding tax havens only reduces but does not eliminate the bias because a part of the activity among non tax havens is influenced/diverted by the presence of tax havens. In Section 5 we assess the sensitivity of our results to the inclusion of tax havens jurisdictions in the sample when estimating of Equations 2a and 2a. Our final results remain unchanged

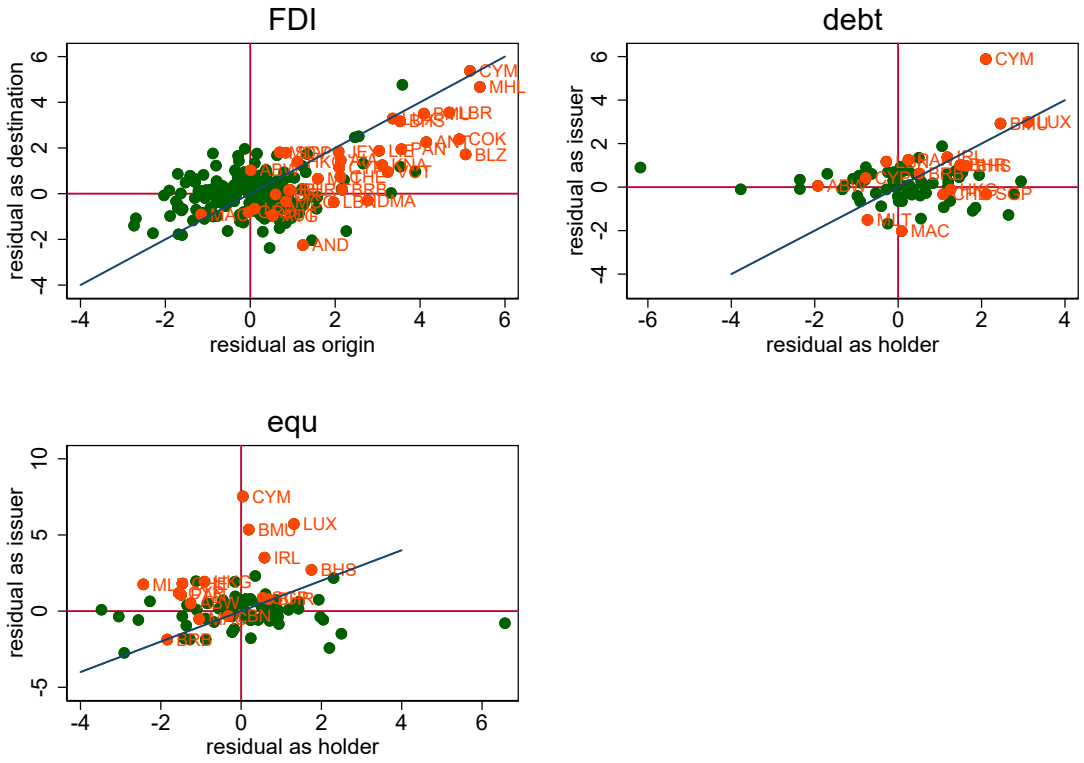
stocks represent to the global financial stocks.

Table 2 – Second-step gravity equation

	(1)	(2)	(3)	(4)	(5)	(6)
	FDI		Portfolio debt		Portfolio equity	
	Origin	Destination	Origin	Destination	Origin	Destination
Log GDP	0.720***	0.779***	0.903***	1.167***	0.619***	1.267***
	(0.033)	(0.039)	(0.036)	(0.084)	(0.042)	(0.088)
Log population	-0.132***	-0.212***	-0.196***	-0.672***	0.098**	-0.798***
	(0.035)	(0.041)	(0.036)	(0.093)	(0.042)	(0.097)
Rule of law	0.178***	0.799***	0.531***	0.358***	0.832***	0.973***
	(0.049)	(0.060)	(0.051)	(0.102)	(0.060)	(0.107)
Landlocked country	-0.351***	-0.587***	-0.114	-0.179	-0.277***	0.657***
	(0.073)	(0.088)	(0.075)	(0.165)	(0.089)	(0.171)
Tertile of capitalization			0.001	0.647***	0.382***	0.958***
			(0.051)	(0.108)	(0.060)	(0.110)
Mean log distance	0.820***	0.939***	1.420***	0.101	1.105***	0.125
	(0.103)	(0.126)	(0.100)	(0.232)	(0.124)	(0.239)
Mean taxt treaty	1.191***	0.886***	0.810***	-0.135	-0.043	0.395
	(0.243)	(0.295)	(0.189)	(0.351)	(0.233)	(0.363)
Mean common EU membership	-1.622**	-1.395*	0.440	-0.606	-1.947***	-2.233***
	(0.631)	(0.766)	(0.370)	(0.762)	(0.467)	(0.794)
Mean BIT	0.210	0.884***	-0.022	-0.618	0.382	-1.083**
	(0.251)	(0.306)	(0.229)	(0.424)	(0.280)	(0.433)
Mean common language	1.910***	1.179***	-0.084	1.057**	-0.032	3.090***
	(0.283)	(0.340)	(0.249)	(0.450)	(0.303)	(0.460)
Mean border	9.087***	2.065	7.839***	-5.816*	13.372***	-1.841
	(1.409)	(1.706)	(1.548)	(3.209)	(1.885)	(3.424)
Mean common currency	2.758***	1.700*	0.213	6.096***	1.105	4.766***
	(0.744)	(0.901)	(0.640)	(1.214)	(0.816)	(1.242)
Mean Colonial relationship	-2.709**	-0.092	3.920***	-5.028**	3.617***	-11.231***
	(1.279)	(1.549)	(1.060)	(2.328)	(1.289)	(2.383)
Mean Territory	37.884***	38.663***	-11.745*	74.978***	12.610	97.264***
	(9.155)	(10.649)	(6.603)	(17.448)	(7.732)	(17.832)
Mean RTA	-0.878***	-2.138***				
	(0.267)	(0.321)				
Constant	-2.885***	-18.193***	-13.160***	-16.511***	-9.884***	-19.024***
	(0.959)	(1.164)	(0.957)	(2.245)	(1.190)	(2.335)
Observations	1,495	1,508	1,989	890	2,098	877
R-squared	0.722	0.745	0.759	0.688	0.708	0.771

This table reports the estimates of the second step of the gravity equation on FDI, portfolio debt and portfolio equity specified in Eq.2a and Eq.2b. The period of estimation is 2009-2017 for FDI stocks and 2002-2017 for portfolio debt and equity. We use an OLS estimator on a sample excluding tax havens. ***, ** indicates a correlation significant at the 0.01 and 0.05 level resp.

Figure 2 – Individual abnormal stocks: breakdown by origin and destination



This Figure shows the *abnormal* stocks of FDI, debt and equity by country at origin and destination levels operated through tax havens (orange dots) and non tax haven jurisdictions (green dots). They are the residuals of Eq. 2a and Eq. 2b estimated out-of-sample. Residuals are averaged over the respective periods of estimation.

4 Global and individual quantification

4.1 Share of abnormal finance operated through tax havens in global finance

We mentioned earlier in introduction that between 4 and 5 out of 10 dollars of global assets were operated through a tax haven in 2017 (see Fig.1). How much of this can be explained by economic and geography factors? Our methodology precisely answers this question.

We compute the share of *abnormal* stocks operated through a tax haven to global predicted stocks.[13] Figure 3 compares this ratio (dashed line) with the share of actual stocks operated through a tax haven to global stock (plain line). We also plot the share of predicted stocks operated though a tax haven (dotted line) in order to account for the predictive accuracy of our estimates. Actual and *abnormal* ratios are closed-by implying that most international investment operated through tax havens go unexplained by gravity factors. More specifically, on average between 2009 and 2017, 48% of FDI have been operated through a tax haven and we estimate that *abnormal* FDI in tax havens have represented 36% of global predicted FDI. Note that this is the average over the period and that in 2017, abnormal FDI represented 45% of the total. We will get back to the rise of abnormal stocks more precisely later. Proportions are similar for equity and debt assets. On average between 2002 and 2017, 45% (38%) of global outstanding equity (debt) were held or issued by a tax haven, and *abnormal* equity (debt) have represented 43% (45%) of global predicted equity (debt) in tax havens. The fact that abnormal debt stocks lay above actual debt stocks is a statistical artefact due to measurement errors. Indeed we observe that our gravity model predictions for portfolio stocks are less accurate than for FDI. In total, we find that about four out of ten dollars of global investment stocks operated through a tax haven is *abnormal* in all categories of assets. In the following we discuss their geography.

4.2 Unpleasant Geography

How are *abnormal* stocks geographically distributed? So far, the literature has treated all tax havens equal by providing lists of jurisdictions without weighting scheme.[14] Given that our sample includes all existing jurisdictions in at least one dimension of the bilateral stocks (origin or destination), we are able to draw an overall geographic comparison across jurisdictions. To do so and convey the heterogeneity of country-specific *abnormal* stocks, we distort the geometry

[13] We work with predicted global stocks instead of actual stocks to limit the effect of potential prediction errors. See Appendix C for the computation details.

[14] Palan et al. (2013a) refer to 11 lists among which Hines and Rice (1994) that we use in this paper.

of a global map by substituting countries' land area by their level of abnormality (see Fig. 4), i.e. each country is represented along their GPS coordinates by a square which size is proportional to the average country-specific measure of abnormal stocks:

$$AbnormalTot_i = [\mu_{FDI,i,o,t} + \mu_{FDIi,d,t} + \mu_{Eq,i,d,t} + \mu_{Debt,i,d,t}]/4$$

where $\mu_{i,t,o}$ and $\mu_{i,t,d}$ are obtained from the estimate of Eq. 2a and Eq.2b. on FDI, equity and debt stocks.[15] In other terms, the larger a country in Fig. 4, the less their stocks are explained by gravity, the more their international financial exchanges are driven by non economic and geographic factors.

In order to visualize heterogeneity, we further emphasize top outliers and top FDI *abnormal* plateforms. Jurisdictions qualify as top outliers if all their abnormal stocks are larger than the sample average by one standard deviation at least over half of the estimation period T:

$$\mu_{i,d,t} > (\overline{\mu_{d,t}} + \sigma_{d,t}) \text{ in } t > \frac{T}{2}$$
$$\mu_{i,o,t} > (\overline{\mu_{o,t}} + \sigma_{o,t}) \text{ in } t > \frac{T}{2}$$

with $\mu_{i,o,t}$ and $\mu_{i,d,t}$ the abnormal stocks of FDI, equity and debt of country i, in time t, at origin and destination levels. In plain English, these jurisdictions are simultaneously large *abnormal* FDI platforms, with large inward and outward FDI, and large holder of equity and debt. Similarly, top *abnormal* FDI platforms are defined as jurisdictions with large measured inward and outward *abnormal* FDI stocks (larger than the sample average by one standard deviation at least over half of the estimation period). This is to visualize jurisdictions that have developed a functional specialization in *conduit* economies defined as "attractive intermediate destinations in the routing of international investments" (e.g. Weyzig (2013)). For these jurisdictions, we substitute the land area by the average country-specific measure of abnormal stocks of FDI[16]

[15] We disregard $\mu_{Eq,i,o,t}$ and $\mu_{Debt,i,o,t}$ here because the sample of reporting countries in CPIS is limited to 91 jurisdictions.

[16] $AbnormalFDI_i = (\mu_{FDI,i,o,t} + \mu_{FDIi,d,t})/2$ where $\mu_{i,t,o}$ and $\mu_{i,t,d}$ are obtained from the estimate of Eq. 2a and Eq.2b.

Fig. 4 plots the distorted global map and suggests that : 1) there is no top outlier in non tax haven jurisdictions, a fact that suggests the relevance of our methodological approach to identify *abnormality* related to tax and regulation avoidance; 2) abnormal stocks are strongly heterogeneous among tax havens: some tax havens are plotted with very large squares (the red and brown ones) while some other tax havens have squares similar to non tax havens (the orange ones); 3) five tax havens are top outliers: Cayman Islands, Marshall Island, Bermuda, Luxembourg and Liberia (ranked by their value of $AbnormalTot_i$); 4) there is at least one top outlier in each continent, except for Asia: Cayman and Bermuda in America, Luxembourg in Europe, Liberia in Africa, Marshall Island in Oceania; 5) 11 jurisdictions are top FDI platforms: Beleze, Cook Island, Panama, Bahamas, Netherland Antilles, Niue, Netherland, Mauritius, Lichtenstein, Saint Kitts and Nevis and Jersey (ranked by the value of $AbnormalFDI_i$); 6) there is a cluster of top *abnormal* FDI platforms in the Caribbean where more than half of the jurisdictions listed as tax havens qualify as conduit; 7) there is a cluster in Oceania with Marshall Islands, Cook Islands and Niue; 8) there is at least one top *abnormal* FDI platform per continent. 9) Netherland, Niue and Mauritius are 3 out of 10 top FDI platforms not listed in Hines and Rice (1994). However, this is consistent with existing evidence pointing their role of pass-through country: Dharmapala and Hines (2009) describes the Netherlands as sharing with tax havens "the pattern of hosting a disproportionately high share of net book income"; in the same vein, Weyzig (2013) points to the role tax treaties as a key determinant of FDI routed through the Netherlands. The work by Beer and Loeprick (2018) on investment hubs and tax treaties points the specialization of Mauritius as an FDI conduit. Last, Niue is located in the archipelago consisting of Cook island listed as tax haven. The finding that non tax jurisdictions ranked in top *abnormal* stocks suggest that our share of abnormal stocks in global finance in the last Section is a lower bound as we did include only abnormal stocks operated through tax havens.

Last, Table 8 in Appendix D summarizes the composition of the different bins that we have explored; in addition to top outliers and top FDI platforms, we identify top debt and equity holders. We find that Antiga is a top debt holder while Ireland, Hong Kong and Bahamas stand

out as top *abnormal* equity holders. Now that we have identified top *abnormal* jurisdictions, we would like to assess their respective weight in tax haven finance.

4.3 Which jurisdictions are the largest contributors to abnormal finance?

We now put the jurisdictions with the largest distortions in perspective to their individual contribution to tax haven finance. Fig. 5 plots the country-specific share of actual international stocks in total tax haven stock in order to convey the relative importance of each tax haven jurisdiction. We plot the countries with a share larger than 1% and we aggregate the rest of the jurisdictions in a category "rest of tax havens". Interestingly, large tax havens are in general large in both stocks of FDI and portfolio assets.

A first observation is that Switzerland, Jersey and Singapore, which are large tax havens, do not stand out as top outliers in the bins presented above. In sum, our estimate suggest that their being large offshore centers is driven by economic and geographic factors. In turn, Luxembourg, Caymans Island and Bermuda are not only large offshore centers but our empirical results suggest that international investments to and from these places are mostly not driven by economic and geographic factors. Beyond these three large actors, Hong Kong and Ireland deserve policy makers attention given their individual share in equity activity and their position in top *abnormal* equity. Last, the share of Netherlands is not displayed in Fig. 5 which excludes non tax havens; however it is worth reminding that they rank in the top *abnormal* FDI platform and that their share in global FDI is 23.5%, much higher than any tax havens. It makes the Netherlands a hot jurisdiction for tackling *abnormal* investments. It is all the more interesting that the rest of *abnormal* FDI platforms identified above are not large offshore centers (i.e. they are included in "other tax havens").

In total, we find large heterogeneity among tax havens and we emphasize six large jurisdictions on which the policy agenda against profit and wealth shifting may want to focus. We are also able to pinpoint jurisdictions by their functional specialization, a fact that may be helpful to

design proper policies at the regional level.

4.4 Time evolution

Fig.3 suggests that aggregate *abnormal* stocks have increased over the period. Now that we have identified the largest contributors of abnormal stocks, we split the time period in three sub-periods, 2009-2011, 2012-2014 and 2015-2017 and we proceed to the same bins exercise as above. The results are stable: Luxembourg, Cayman, Bermuda, Ireland and the Netherlands stand out over the three sub-periods and Hong Kong stand out from 2012 to 2017.

In particular, it is striking that Luxembourg stands out over the entire period marked by the leaks which revealed confidential information about their tax rulings in November 2014.[17] To make sure, we test the significance of a time trend in the residuals of Luxembourg after 2014. We find that it is positively significant for FDI, suggesting that FDI have increased after the leak; and we find that the time-trend is not significant for portfolio stocks, suggesting that these stocks have remained stable after the leak. We also test a time trend in the residuals of their main partners and in largest FDI platforms and we reject the null. In sum, we conclude that the Luxleaks in 2014 not only did not appear to have diverted cross-border investments away from the Luxembourg nor other jurisdictions but appear to have been followed by rising FDI to and from Luxembourg.

5 Robustness

In this Section, we provide sensitivity analyses along four alternative methodological choices and one alternative in the vector of determinants. Our five alternative are: (i) a two-step OLS using the full sample in the second step estimate; (ii) a one-step gravity equation; (iii) a two-step

[17] Luxembourg Leaks Database by the ICIJ

estimation using a Poisson PML estimator; (iv) a two-step estimation using a Poisson PML estimator on positive stocks only; and (v) controlling for corporate tax rate in the second step gravity equation (Equations 2a and 2b).

The correlation between second-step residuals estimated in the baseline and in the alternatives with the associated R^2 are presented numerically in Table 3 and graphically in Figures 6, 7 and 8 in Appendix D. The estimated coefficients of the second step gravity equation (Equations 2a and 2b) are presented in Table 9 in Appendix.

Abnormal stocks estimated in our baseline and the different alternatives are significantly correlated with high levels of R^2 except in one of the ten specification including portfolio debt (column 8). It suggests that overall our findings are not sensitive to different estimation methods and to the inclusion of the corporate tax rate. More specifically:

- Some coefficients estimated on the full sample are different (columns (1), (5), (9), (13), (17) and (21) of Table 9), a fact that confirms that including tax havens biases the coefficients. Indeed, it is interesting to observe that the estimated coefficients on GDP and population are both higher (in absolute terms) in the full sample estimates, a result that reflects the (artificially) high GDP per capita of tax havens economies.
- In the one-step OLS estimate, we compute the average of bilateral residuals at origin and destination levels. The estimated residuals slightly differ because we do not control for unobserved bilateral proximity variables.
- Both PPML estimates with and without zeros yield lower R^2 than the other alternatives.[18] Coefficients differ because PPML imposes more structure to the fixed effects.[19] R^2 remains close to 0.6 except for debt and equity stocks at destination. Note that the inclusion of zero stocks significantly affects the results only for the latter two specifications.

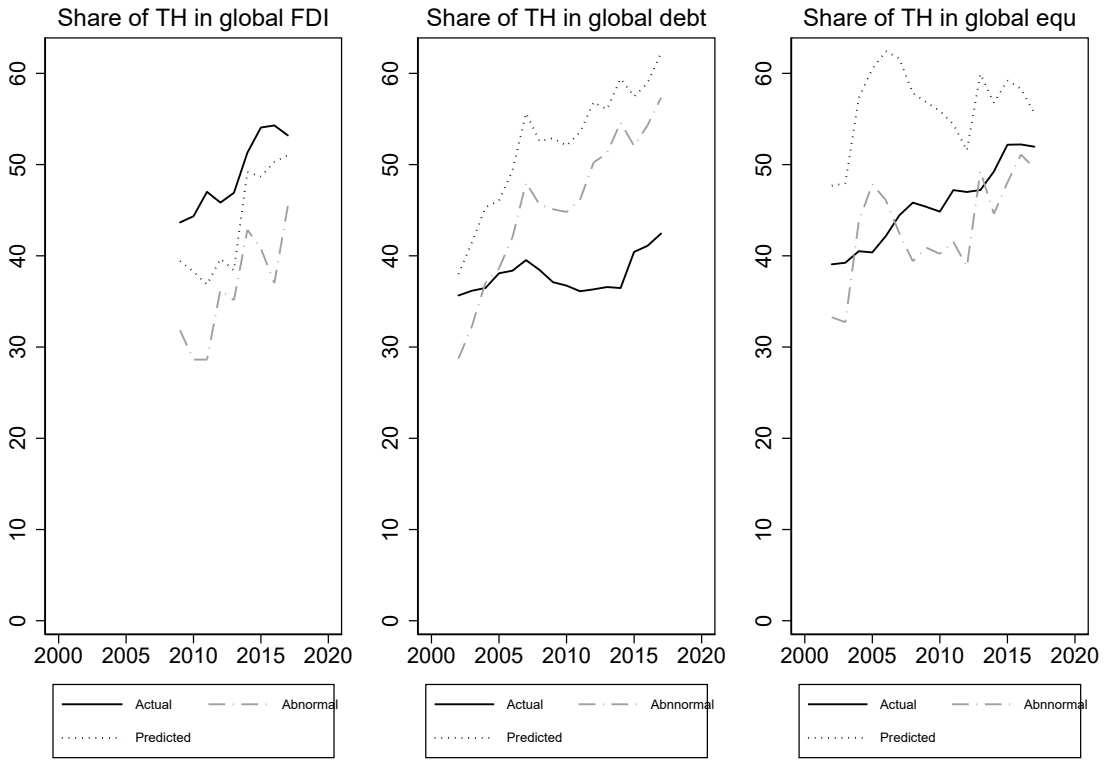
[18] We use the Correia et al. (2019) package.

[19] The Poisson PML has been advocated to estimate gravity equation on trade in goods (Santos Silva and Tenreyro, 2006); Fally (2015) further shows that the PPML estimator imposes fixed effects estimates consistent with restrictions of structural gravity and multilateral resistance terms derived from general equilibrium.

- Including the corporate tax rate as a determinant of investment stocks hardly change our baseline results.[20] The corporate tax stands out as significant only for debt stocks at origin (column (10) of Table 9). This result is consistent with the existing works finding weak economic significance of corporate tax rates on FDI stocks in OECD countries (Blonigen and Piger, 2014).

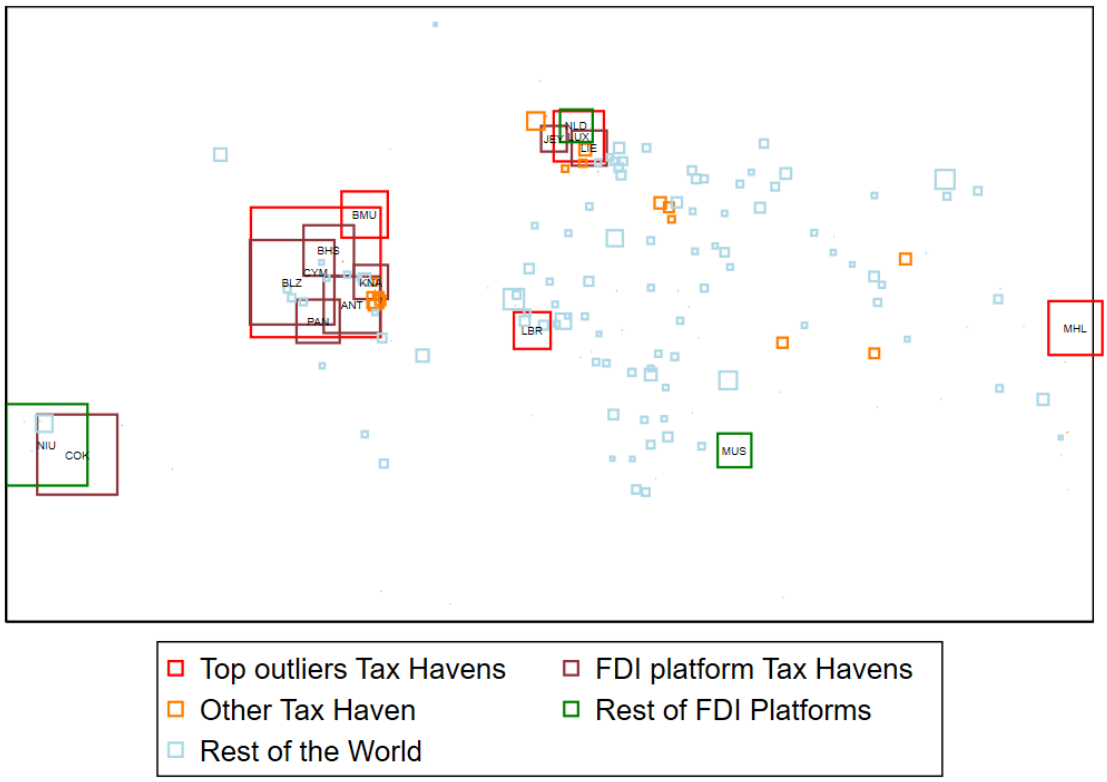
[20] Corporate tax rate are statutory rates from https://taxfoundation.org/corporate-tax-rates-around-the-world-2019/.

Figure 3 – Abnormal stocks operated in Tax Havens as a share of global stocks



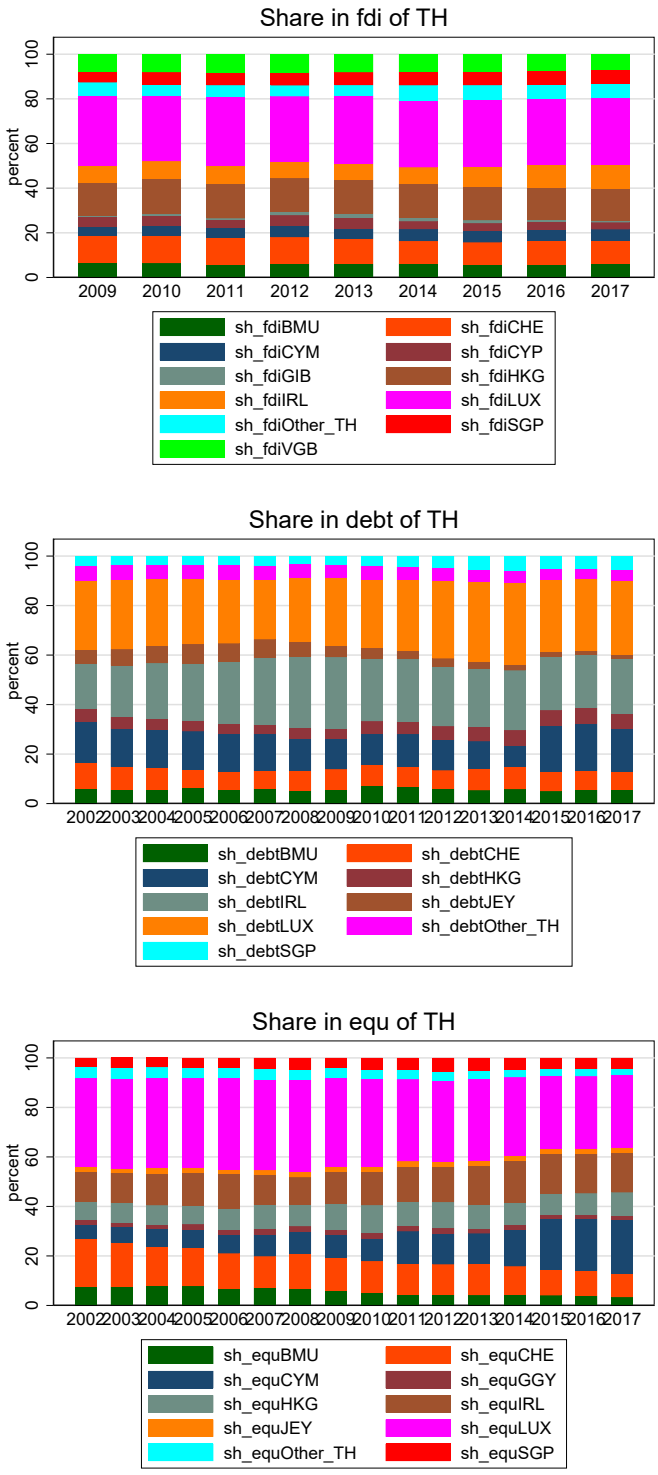
This Figure shows actual stocks operated through a tax haven as a share of global stock for FDI, debt and equity respectively (plain line), *abnormal* investment stocks operated through a tax haven as a ratio of global predicted stocks for FDI, debt and equity respectively broken line) and predicted stocks operated through a tax haven as a share of global predicted stock for FDI, debt and equity respectively (dotted line). The fact that the share of *abnormal* debt can exceed the share of actual debt is due to the fact that the abnormal ratio is calculated with the predicted values of assets.

Figure 4 – The geographic distribution of abnormal international finance



This Figure shows a map where *abnormal* stocks substitute for land area. Top outliers are simultaneously large *abnormal* FDI platforms, with large inward and outward *abnormal* FDI, and large holder of *abnormal* equity and debt. Red squares represent top outliers listed as a tax haven : Cayman, Marshal Island, Bermuda, Luxembourg and Liberia). Top FDI platforms are jurisdictions with large inward and outward *abnormal* FDI. Brown squares represent jurisdictions identified as top FDI platforms and listed as a tax haven: Beleze, Cook Island, Panama, Bahamas, Netherland Antilles, Lichtenstein, Saint Kitts and Nevis and Jersey; green squares represent top FDI platforms not listed as tax haven: Niue, Netherlands and Mauritius. *Abnormal* stocks are estimated as specified in Eq. 2a and Eq. 2b using out-of-sample OLS estimates.

Figure 5 – Largest tax havens



The Figure shows countries' share in total stocks (respectively FDI, , portfolio debt investment and portfolio equity investment) of tax havens (as origin or destination). Only countries with share in global stocks larger than 1% are represented separately. Authors'calculations with IMF-CPIS and CDIS data.

Table 3 – Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stock	FDI stocks									
Country i as	Origin					Destination				
Specification	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant
μ_{it}^{spe}	1.013***	0.882***	0.697***	0.841***	0.988***	1.023***	0.841***	0.681***	0.797***	0.954***
	(0.034)	(0.022)	(0.032)	(0.038)	(0.012)	(0.025)	(0.029)	(0.038)	(0.045)	(0.017)
Observations	207	207	207	207	197	208	208	208	208	197
R-squared	0.815	0.889	0.698	0.701	0.970	0.889	0.807	0.608	0.607	0.944
Stock	Portfolio debt stocks									
Country i as	Origin					Destination				
Specification	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant
μ_{it}^{spe}	0.983***	0.770***	0.945***	1.031***	1.011***	0.996***	0.690***	0.360***	0.873***	0.914***
	(0.037)	(0.044)	(0.075)	(0.076)	(0.010)	(0.023)	(0.035)	(0.042)	(0.042)	(0.019)
Observations	83	83	83	83	82	190	190	190	190	176
R-squared	0.897	0.788	0.660	0.693	0.992	0.910	0.674	0.281	0.699	0.929
Stock	Portfolio equity stocks									
Country i as	Origin					Destination				
Specification	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant	OLS 2-step full sample	OLS 1-step	PPML 2-step	PPML 2-step (excl. 0)	Incl. Tax as determinant
μ_{it}^{spe}	1.000***	0.591***	0.822***	0.877***	1.006***	0.994***	0.680***	0.532***	0.816***	0.957***
	(0.021)	(0.061)	(0.078)	(0.084)	(0.012)	(0.030)	(0.031)	(0.042)	(0.039)	(0.021)
Observations	83	83	83	83	82	197	197	197	197	183
R-squared	0.966	0.532	0.578	0.572	0.989	0.851	0.716	0.447	0.690	0.922

6 Conclusion

In this paper, we employed a standard gravity framework to quantify abnormal stocks of FDI and portfolio securities over 2009-2017 for up to 236 jurisdictions. We provide evidence that (a) the bulk of international assets in tax havens are 'abnormal', i.e unexplained by standard gravity factors; (b) there is a strong heterogeneity among jurisdictions, the bulk of unexplained international investments is concentrated on six jurisdictions, among which five large tax havens; (c) while Luxembourg is among them, we find that the Luxleaks were paradoxically followed by a rise of unexplained FDI in and from Luxembourg.

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A Appendix: FDI stock data

We proceed in two steps to improve on the raw CDIS data. First, we replace missing inward stock values by the mirror outward stocks declared by the partner country when it is available. Second, we exploit inconsistencies between inward stocks reported by the declaring country (*Inward Direct Investment Positions*) and the mirror outward stocks reported by their partner countries (*Inward Direct Investment Positions, derived*) and identify the largest asymmetries at the country level (top 10 percentile in the sample) when both stocks exist.[21] To do so, we compute the following ratios on bilateral stocks reported by the country and its partner:

$$Ratio_{ot}^{Inward} = \frac{|\sum_o (Inward_{ot} - Inward_{ot}^{derived})|}{\sum_o Inward_{ot}} \tag{3}$$

$$Ratio_{ot}^{Outward} = \frac{|\sum_o (Outward_{ot} - Outward_{ot}^{derived})|}{\sum_o Outward_{ot}} \tag{4}$$

and we take the mean over the period. When $Ratio_o^{inward}$ is high, it means that the amount of FDI reported by the reporting country and all its partners differ substantially. We flag as 'bad' reporters those countries that fall into the top 10% in terms of $Ratio_o^{Inward}$. For those countries, we identify the 'best' reporting country within a country pair by comparing $Ratio_o^{Inward}$ with $Ratio_d^{Outward}$: when $Ratio_o^{Inward} > Ratio_d^{Outward}$, we replace the bilateral inward stock by the mirror outward stock.

Bilateral asymmetries can be substantial. The largest one in our sample is between the United States and Luxembourg in 2015 (about $700,000 millions). The ratio $Ratio_o^{Inward}$ allows comparison across countries controlling for the stock of FDI received by the country. Based on 120 countries, the average ratio is around 5.41 ranged from 0.04 to 495.2. Although most of asymmetries are moderate ($Ratio_o^{Inward} < 1$ for 75% of the sample), some countries report incorrectly inward stocks regardless of the partner. For those countries, considering raw data would be misleading.

Doing so, we improve FDI data for 93 jurisdictions and we complete the data for 27 tax haven jurisdictions as reported in Table 4 which compares the raw data available in the CDIS databasis (*Raw CDIS FDI*) with our measure of inward stocks (*Completed FDI*).

[21] We also test two other thresholds: top 5% and top 25%.

Table 4 – Descriptive statistics on Inward data

Variable	Number of countries	Number of observations	Mean	Std. Dev.	Min	Max
Raw CDIS FDI	120	133,047	1.86e+09	2.03e+10	-5.98e+10	1.24e+12
Completed FDI	237	195,574	1.57e+09	1.95e+10	-5.98e+10	1.61e+12
Raw CDIS FDI TH	16	14,000	4.26e+09	3.28e+10	-5.98e+10	8.57e+11
Completed FDI TH	43	27,410	3.14e+09	2.71e+10	-5.98e+10	8.57e+11

Table 5 – Ranking

	$Ratio^{Inward}$	$Ratio^{Outward}$
Top	Spain	Sweden
	Singapore	Finland
	Sweden	Germany
	Luxembourg	Japan
	Malaysia	Sint Maarten
	France	United States
	Lithuania	France
	Germany	Norway
	Czech Republic	Denmark
	Greece	Spain
Bottom	Cyprus	Philippines
	Uruguay	Bangladesh
	Senegal	Barbados
	Lebanon	Macao
	Kuwait	Mauritius
	Mauritius	Malta
	Malta	Kyrgyz Republic
	Cambodia	El Salvador
	Barbados	Curacao
	Curacao	Mozambique

This table reports the best/worst reporting countries (countries with the lowest/largest differences between FDI stock and mirror flows) amongst countries that report both inward and outward stocks. See Appendix A for more details on computing $Ratio^{Inward}$ and $Ratio^{Outward}$.

B Appendix: Data and sources

Table 6 – The list of tax havens (from Hines and Rice, 1994)

Andorra	Channel Islands (Jersey, Guernsey)	Lebanon*	Montserrat
Anguilla	Cook Islands	Liberia*	Netherlands Antilles (Aruba, Curaçao, Sint Maarten)
Antigua and Barbuda	Cyprus	Liechtenstein	Panama*
Bahamas	Dominica	Luxembourg	Saint Kitts and Nevis
Bahrain	Gibraltar	Macao	Saint Lucia
Barbados	Grenada	Maldives	Saint Martin
Belize	Hong Kong*	Malta	Saint Vincent and the Grenadines
Bermuda	Ireland*	Marshall Islands	Singapore*
British Virgin Islands	Isle of Man	Switzerland*	Turks and Caicos Islands
Cayman Islands	Jordan*	Monaco	Vanuatu

Note: * Population $>$ 2 million.

Table 7 – Data source

Bilateral determinants	FDI	Portfolio	Sources
Distance	X	X	Gravity dataset (CEPII) + authors' calculations
RTA	X		Regional Trade Agreements database (WTO)
EU member	X	X	Regional Trade Agreements database (WTO)
Tax Treaty	X	X	Tax Treaties database (IBFD)
Bil Invt Treaty	X	X	International Investment Agreements (UNCTAD)
Common Langage	X	X	Gravity dataset (CEPII) + CIA factbooks
Common Border	X	X	Gravity dataset (CEPII) + CIA factbooks
Common Currency	X	X	Gravity dataset (CEPII) + CIA factbooks
Former Colony	X	X	Gravity dataset (CEPII) + Colonial Contiguity Data (Correlates of War Project)
Territory	X	X	Gravity dataset (CEPII)
Country-specific determinants			
GDP	X	X	World Development Indicators data (WORLD BANK) + UNCTAD + National sources
Population	X	X	World Development Indicators data (WORLD BANK) + UNCTAD + National sources
Rule of Law	X	X	Worldwide Governance Indicators data (WORLD BANK)
Land-lock	X	X	CIA factbooks
Market Cap Tercile		X	International Financial Statisitcs (IMF) + authors' calculat

C Appendix: Computation of abnormal stocks in Fig. 3

In order to calculate the share of abnormal stocks displayed in Fig. 3, we predict bilateral stocks from equation 1 and we compare them with the predicted stocks minus the estimated residuals from equations 2a and 2b. We then take the sum of these differences when either country o or d is a tax haven and compare it to the total predicted stocks as follows:

$$\begin{aligned} \textit{Share abnormal } \mathrm{TH}_t &= 100 \times \frac{\sum_{od,(o,d \in TH)} (\tilde{Assets}_{odt} - \bar{Assets}_{odt})}{\sum_{od} \tilde{Assets}_{odt}} \\ &= 100 \times \frac{\sum_{od,(o,d \in TH)} \left[\exp(\ln \tilde{Assets}_{odt}) - \exp(\ln \tilde{Assets}_{odt} - \mu_{d,n,t} - \mu_{o,n,t})\right]}{\sum_{od} \tilde{Assets}_{odt}} \end{aligned} \tag{5}$$

where $\ln \tilde{Assets}_{odt}$ are bilateral stocks predicted from the first step gravity equation (Equation 1) and $\bar{Assets}_{odt}$ are predicted stocks without the abnormal component of the country specific fixed effects.

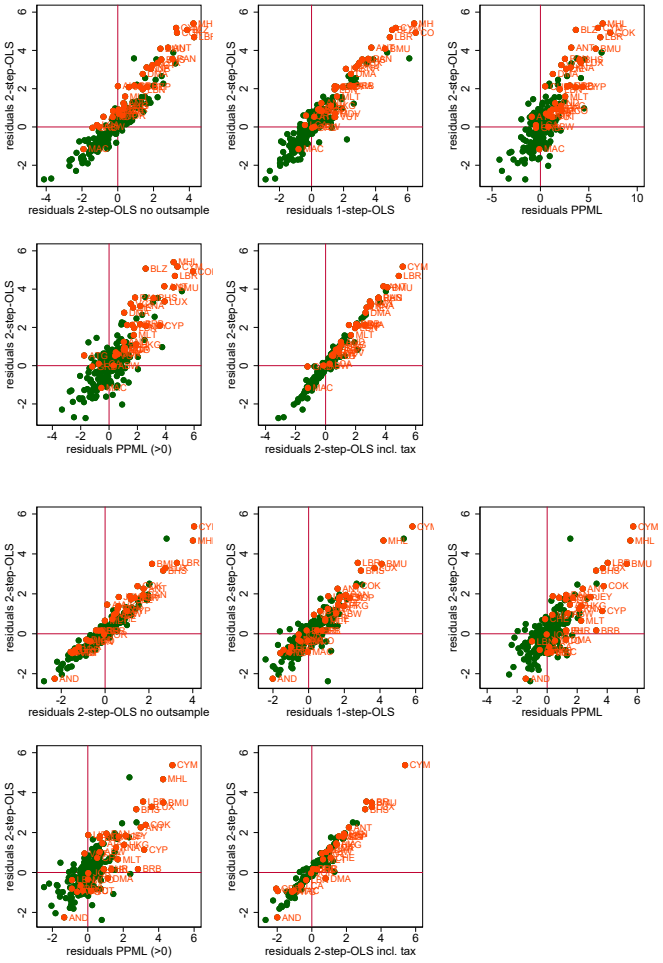
D Appendix: Additional tables, Figures and Robustness

Table 8 – Which jurisdictions have the largest abnormal stocks by category of stocks?

Top outliers	Top FDI platforms	Top debt holders	Top equity holders
Caymans	Beleze	North Korea	Gambia
Marshall Island	Cook Island	Kiribati	Ireland
Luxembourg	Panama	Djibouti	American Samoa
Bermuda	Bahamas	Burundi	Libya
Liberia	Netherland Antilles	USA	Grenada
	Niué	Afghanistan	Mauritius
	Netherland	Swaziland	Hong Kong
	Mauritius	Antiga	Albania
	Lichtenstein		Bahamas
	Saint Kitts and Nevis		USA
	Jersey		

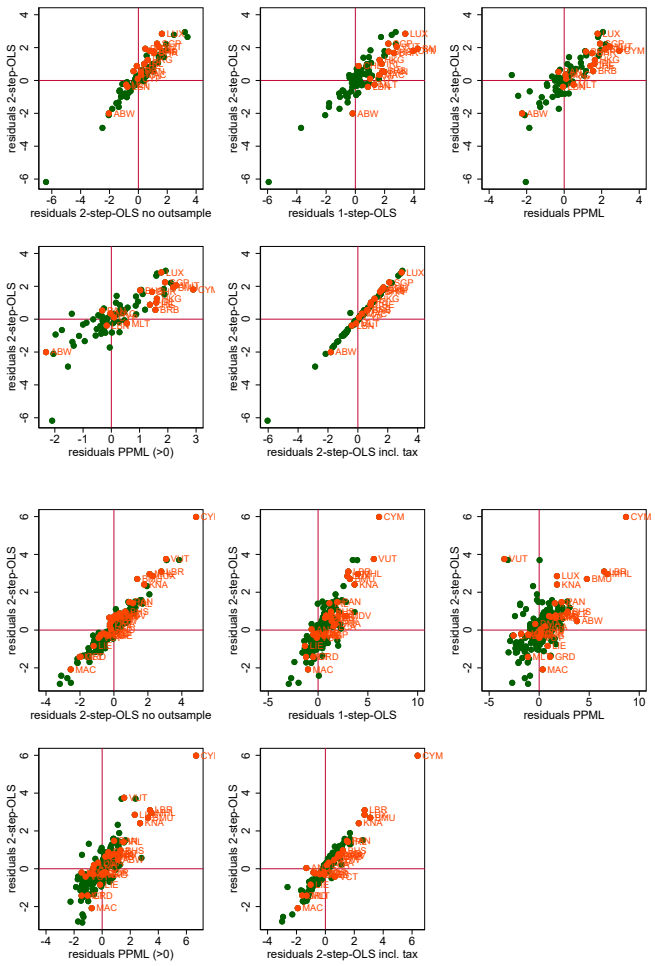
This table reports the list of jurisdictions with average abnormal stocks larger than the sample average by one standard deviation. They are ranked by their value of abnormal stocks. Top outliers are large in FDI, debt and equity, top FDI platforms are large in FDI stocks both at origin and destination levels. Tax haven jurisdictions are emphasized in red.

Figure 6 – Robustness: FDI



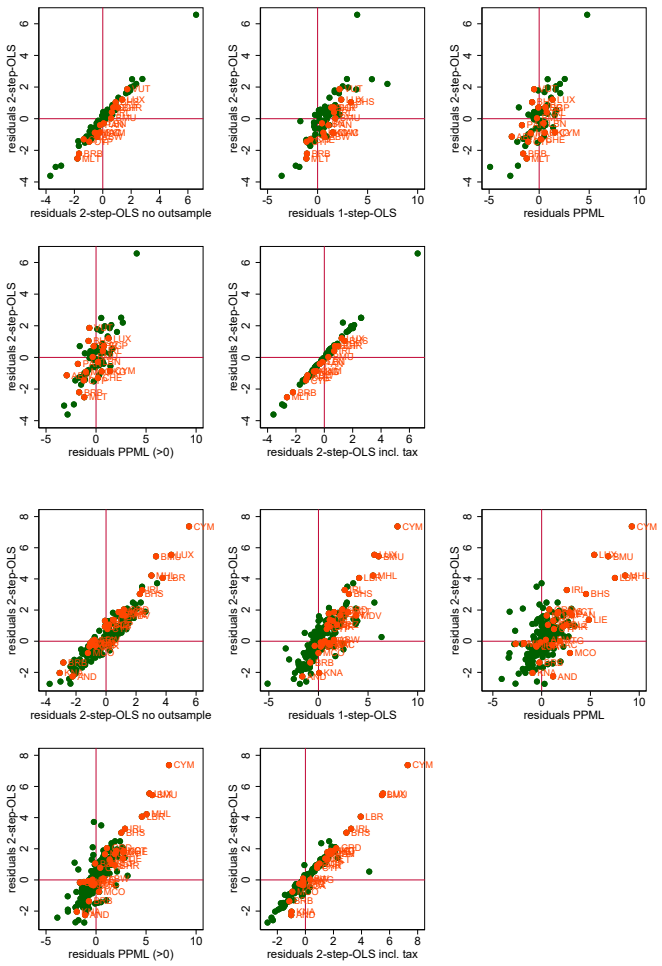
This Figure plots the residuals of a gravity estimate on FDI along alternative methodologies: (i) a two-step OLS using the full sample in the second step estimate; (ii) a one-step gravity equation; (iii) a two-step estimation using a Poisson PML estimator; (iv) a two-step estimation using a Poisson PML estimator on positive stocks only; and (v) controlling for corporate tax rate in the second step gravity equation. *Abnormal* stocks are estimated as specified in Eq. 2a and Eq. 2b. Orange dots represent tax haven jurisdictions whereas green dots represent orange dots.Most dots are located on the first bisector line, suggesting that alternative methods yield similar values of residuals.

Figure 7 – Robustness: Portfolio debt



This Figure plots the residuals of a gravity estimate on portfolio debt along alternative methodologies: (i) a two-step OLS using the full sample in the second step estimate; (ii) a one-step gravity equation; (iii) a two-step estimation using a Poisson PML estimator; (iv) a two-step estimation using a Poisson PML estimator on positive stocks only; and (v) controlling for corporate tax rate in the second step gravity equation. *Abnormal* stocks are estimated as specified in Eq. 2a and Eq. 2b. Orange dots represent tax haven jurisdictions whereas green dots represent orange dots.Most dots are located on the first bisector line, suggesting that alternative methods yield similar values of residuals.

Figure 8 – Robustness: Portfolio equity



This Figure plots the residuals of a gravity estimate on portfolio equities along alternative methodologies: (i) a two-step OLS using the full sample in the second step estimate; (ii) a one-step gravity equation; (iii) a two-step estimation using a Poisson PML estimator; (iv) a two-step estimation using a Poisson PML estimator on positive stocks only; and (v) controlling for corporate tax rate in the second step gravity equation. *Abnormal* stocks are estimated as specified in Eq. 2a and Eq. 2b. Orange dots represent tax haven jurisdictions whereas green dots represent orange dots.Most dots are located on the first bisector line, suggesting that alternative methods yield similar values of residuals.

Table 9 – Robustness: second step estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	FDI								Portfolio debt								Portfolio equity					
	Origin				Destination				Origin				Destination				Origin				De	
Specification	OLS full	OLS tax	PPML	PPML excl.0	OLS full	OLS tax	PPML	PPML excl.0	OLS full	OLS tax	PPML	PPML excl.0	OLS full	OLS tax	PPML	PPML excl.0	OLS full	OLS tax	PPML	PPML excl.0	OLS full	OLS tax
Log GDP	0.801***	0.634***	0.864***	1.022***	0.882***	0.860***	0.953***	1.241***	0.893***	1.040***	1.142***	0.742***	1.426***	1.214***	1.546***	1.545***	0.692***	0.712***	0.717***	0.583***	1.453***	1.272***
	(0.035)	(0.032)	(0.026)	(0.031)	(0.042)	(0.040)	(0.038)	(0.045)	(0.036)	(0.036)	(0.038)	(0.025)	(0.073)	(0.090)	(0.058)	(0.055)	(0.045)	(0.043)	(0.034)	(0.030)	(0.078)	(0.092)
Log population	-0.313***	-0.085**	-0.129***	-0.121***	-0.513***	-0.296***	-0.260***	-0.327***	-0.349***	-0.289***	-0.107***	-0.005	-1.053***	-0.699***	-1.076***	-1.059***	-0.175***	0.066	0.294***	0.161***	-0.895***	-0.829***
	(0.036)	(0.035)	(0.028)	(0.033)	(0.042)	(0.043)	(0.040)	(0.047)	(0.035)	(0.035)	(0.038)	(0.026)	(0.072)	(0.094)	(0.063)	(0.060)	(0.043)	(0.042)	(0.035)	(0.030)	(0.075)	(0.096)
Rule of law	0.049	0.258***	0.158***	0.247***	0.627***	0.827***	0.716***	0.755***	0.345***	0.444***	0.991***	0.639***	0.181**	0.340***	-0.049	-0.087	0.633***	0.792***	1.258***	0.754***	0.916***	0.989***
	(0.055)	(0.047)	(0.040)	(0.048)	(0.065)	(0.059)	(0.058)	(0.068)	(0.053)	(0.049)	(0.056)	(0.038)	(0.085)	(0.104)	(0.070)	(0.067)	(0.065)	(0.059)	(0.052)	(0.044)	(0.089)	(0.107)
Landlocked country	-0.330***	-0.509***	-0.113*	-0.036	-0.515***	-0.412***	-0.588***	-0.559***	-0.097	-0.106	-0.101	-0.178***	0.161	-0.241	0.025	0.085	-0.127	-0.237***	-0.698***	-0.544***	0.738***	0.562***
	(0.082)	(0.072)	(0.060)	(0.071)	(0.096)	(0.090)	(0.085)	(0.101)	(0.078)	(0.073)	(0.079)	(0.053)	(0.136)	(0.168)	(0.113)	(0.108)	(0.095)	(0.089)	(0.072)	(0.063)	(0.141)	(0.170)
Mean log distance	0.820***	0.954***	0.379***	0.169*	0.945***	0.929***	0.431***	0.429***	1.488***	1.271***	0.696***	0.921***	0.340*	0.187	1.101***	1.067***	1.201***	1.048***	0.353***	0.640***	0.402**	0.225
	(0.109)	(0.104)	(0.083)	(0.099)	(0.130)	(0.129)	(0.120)	(0.141)	(0.103)	(0.099)	(0.110)	(0.073)	(0.204)	(0.235)	(0.155)	(0.149)	(0.132)	(0.124)	(0.101)	(0.089)	(0.212)	(0.239)
Mean tax treaty	1.732***	1.145***	0.111	0.122	1.314***	0.675**	-0.160	0.185	0.278	0.621***	0.934***	0.706***	-0.078	-0.143	-0.605**	-0.660***	-0.273	-0.190	0.440**	-0.056	0.182	0.413
	(0.273)	(0.229)	(0.200)	(0.239)	(0.323)	(0.284)	(0.289)	(0.341)	(0.198)	(0.177)	(0.232)	(0.144)	(0.298)	(0.351)	(0.238)	(0.229)	(0.254)	(0.222)	(0.214)	(0.176)	(0.306)	(0.358)
Mean common EU membership	0.138	-1.646***	-0.598	-0.631	-0.472	-2.230***	-2.070***	-0.941	0.613	-0.217	-0.055	0.663**	-0.787	-0.426	0.553	0.383	-0.541	-2.148***	-0.336	-1.247***	-2.891***	-1.648**
	(0.684)	(0.599)	(0.519)	(0.617)	(0.811)	(0.744)	(0.749)	(0.882)	(0.377)	(0.347)	(0.474)	(0.290)	(0.656)	(0.772)	(0.519)	(0.498)	(0.490)	(0.444)	(0.435)	(0.355)	(0.665)	(0.791)
Mean BIT	0.178	0.223	0.631***	0.601**	1.107***	1.231***	0.642**	0.908**	0.174	0.331	3.400***	-0.016	-0.081	-0.477	0.013	-0.009	0.681**	0.726***	0.972***	-0.272	-0.671*	-0.818*
	(0.280)	(0.251)	(0.206)	(0.246)	(0.333)	(0.311)	(0.298)	(0.352)	(0.240)	(0.229)	(0.266)	(0.169)	(0.371)	(0.429)	(0.291)	(0.279)	(0.305)	(0.280)	(0.243)	(0.206)	(0.382)	(0.431)
Mean common language	2.850***	1.527***	1.106***	1.427***	2.950***	1.264***	1.202***	1.299***	0.528**	-0.166	1.338***	-0.729***	2.689***	1.210**	-0.612**	-0.549*	1.671***	-0.031	0.183	-1.343***	3.342***	2.932***
	(0.306)	(0.281)	(0.228)	(0.271)	(0.358)	(0.348)	(0.330)	(0.388)	(0.252)	(0.245)	(0.281)	(0.185)	(0.369)	(0.474)	(0.309)	(0.296)	(0.319)	(0.306)	(0.257)	(0.222)	(0.362)	(0.478)
Mean border	7.902***	9.993***	4.628***	7.914***	0.562	1.878	7.300***	9.102***	7.123***	6.043***	2.318	7.368***	-5.592*	-5.491*	0.844	-0.461	8.689***	9.324***	7.640***	8.987***	-0.7	-1.031
	(1.639)	(1.365)	(1.155)	(1.374)	(1.937)	(1.698)	(1.663)	(1.964)	(1.675)	(1.480)	(1.810)	(1.159)	(2.915)	(3.215)	(2.187)	(2.097)	(2.118)	(1.853)	(1.661)	(1.397)	(3.112)	(3.381)
Mean common currency	0.676	2.607***	1.516**	0.555	0.924	1.501	2.670***	0.544	-0.075	1.557**	1.580**	1.643***	5.130***	5.939***	6.045***	6.034***	-0.888	1.091	-3.354***	-0.749	5.215***	3.356***
	(0.795)	(0.739)	(0.612)	(0.721)	(0.942)	(0.920)	(0.880)	(1.031)	(0.587)	(0.628)	(0.802)	(0.489)	(1.053)	(1.276)	(0.832)	(0.797)	(0.756)	(0.785)	(0.718)	(0.597)	(1.084)	(1.282)
Mean Colonial relationship	-9.519***	-1.007	-1.329	-1.803	-6.005***	-0.044	0.111	-3.500**	1.092	4.596***	-1.705	2.265***	-3.314*	-5.090**	1.082	1.282	-1.985	2.241*	-0.573	3.794***	-4.571***	-10.953***
	(1.380)	(1.240)	(1.019)	(1.217)	(1.650)	(1.541)	(1.494)	(1.740)	(1.121)	(1.003)	(1.202)	(0.788)	(1.861)	(2.331)	(1.576)	(1.511)	(1.423)	(1.249)	(1.104)	(0.948)	(1.912)	(2.354)
Mean Territory	86.093***	26.471***	19.675***	1.593	71.038***	34.848***	13.973	13.429	10.487	-21.397***	-33.833***	-1.463	49.225***	73.246***	42.281***	39.814***	37.811***	22.182***	12.485*	26.763***	44.020***	95.106***
	(9.036)	(9.100)	(7.135)	(8.522)	(10.484)	(11.305)	(10.365)	(12.184)	(6.744)	(6.300)	(7.154)	(4.772)	(12.739)	(17.457)	(11.909)	(11.419)	(8.347)	(7.666)	(6.570)	(5.686)	(13.082)	(17.601)
Mean RTA	-0.989***	-1.396***	0.136	0.949***	-1.099***	-1.688***	-0.904***	0.040														
	(0.275)	(0.259)	(0.217)	(0.259)	(0.325)	(0.320)	(0.313)	(0.370)														
Tertile of capitalization									0.290***	-0.087*	0.237***	0.188***	0.778***	0.650***	0.568***	0.510***	0.693***	0.302***	0.938***	0.407***	0.704***	1.001***
									(0.048)	(0.048)	(0.059)	(0.038)	(0.081)	(0.108)	(0.074)	(0.071)	(0.060)	(0.058)	(0.054)	(0.045)	(0.085)	(0.110)
Statutory corporate tax rate		-0.053				0.480				0.912**				-0.937				-0.434				1.091
		(0.402)				(0.504)				(0.380)				(0.957)				(0.475)				(0.961)
Constant	-3.380***	-3.041***	-16.152***	-16.721***	-18.996***	-19.200***	-18.743***	-22.499***	-13.700***	-13.216***	-24.604***	-20.832***	-20.259***	-17.571***	-29.426***	-30.278***	-11.371***	-9.859***	-20.458***	-17.848***	-22.340***	-19.901***
	(1.029)	(0.945)	(0.776)	(0.920)	(1.210)	(1.174)	(1.125)	(1.315)	(0.997)	(0.945)	(1.071)	(0.705)	(1.960)	(2.294)	(1.495)	(1.453)	(1.278)	(1.185)	(0.992)	(0.856)	(2.047)	(2.313)
Observations	1,790	1,345	1,534	1,549	1,804	1,346	1,536	1,549	2,423	1,847	2,721	2,312	1,138	886	900	899	2,540	1,951	2,737	2,419	1,123	874
R-squared	0.635	0.726	0.844	0.851	0.668	0.774	0.780	0.806	0.695	0.789	0.838	0.850	0.698	0.689	0.827	0.832	0.631	0.737	0.868	0.804	0.76	0.779

This table reports the estimates of the second step of the gravity equation along alternative estimation methods on FDI, portfolio debt and portfolio equity specified in Eq.2a and Eq.2b. The period of estimation is 2009-2017 for FDI stocks and 2002-2017 for portfolio debt and equity. ***, ** indicates a correlation significant at the 0.01 and 0.05 level resp.