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# What is real and what is not in the global FDI network? $\stackrel{\star}{\sim}$

Jannick Damgaard<sup>a,b</sup>, Thomas Elkjaer<sup>b</sup>, Niels Johannesen<sup>c,d,\*</sup>

<sup>a</sup> Danmarks Nationalbank, Denmark

<sup>b</sup> International Monetary Fund, United States

<sup>c</sup> Oxford University Centre for Business Taxation, Saïd Business School, Oxford University, Park End Street, Oxford, OX1 1HP, UK

<sup>d</sup> University of Copenhagen and CEBI, Denmark

## ABSTRACT

Macro statistics on foreign direct investment (FDI) are blurred by offshore financial centers with enormous inward and outward investment positions. This paper uses new data sources, both macro and micro, to estimate the global FDI network while disentangling real investment and phantom investment and allocating real investment to ultimate investor economies. We find that Phantom FDI into corporate shells with no substance and no real links to the local economy accounts for around 40 percent of global FDI. Ignoring Phantom FDI and allocating Real FDI to ultimate investors increases the explanatory power of standard gravity variables by around 25 percent.

## 1. Introduction

Foreign direct investment (FDI) is an important dimension of international economic integration. It enters the most widely used indexes of globalization (Dreher, 2006) and attracting FDI is often an explicit policy objective because of its potential to boost productivity (Javorcik, 2004) and stimulate economic growth (Borensztein et al., 1998) through cross-border transfers of skills, technology and business practices.

However, not all FDI is about real economic integration. For instance, Luxembourg with little more than half a million inhabitants records an inward FDI position of around \$4 trillion, similar to the entire United States and much more than China. Investments of this magnitude hardly reflect productive assets employed in the small local economy. More likely, the bulk of the investments effectively pass through Luxembourg and into larger economies without leaving many real traces in the transit. Consistent with this explanation, Luxembourg records an outward FDI position that roughly matches the inward FDI position.

Fig. 1 highlights that several small economies play an outsized role in the global FDI network: the Netherlands, Luxembourg, Hong Kong SAR, Switzerland, Singapore, Ireland, Bermuda, the British Virgin Islands and the Cayman Islands jointly host more than 40 percent of global FDI although their combined share of global GDP is only around 3 percent. Strikingly, these economies have tax systems that, in one way or another, are useful in the tax planning of multinational firms and most of them are routinely categorized as tax havens (e.g. Hines, 2010; Zucman, 2014). Tax planning is therefore a plausible explanation for the otherwise puzzling size of

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Corresponding author at: Oxford University Centre for Business Taxation, Saïd Business School, Oxford University, Park End Street, Oxford, OX1 1HP, UK. *E-mail addresses:* jdamgaard@imf.org (J. Damgaard), telkjaer@imf.org (T. Elkjaer), niels.johannesen@sbs.ox.ac.uk (N. Johannesen).



Fig. 1. Largest inward FDI positions in 2017. The figure shows the 20 economies with largest inward FDI positions in 2017. For economies reporting to CDIS, the figure shows the reported numbers. For non-reporting economies, the figure shows our estimates.

these FDI positions.<sup>1</sup> Indeed, the concentration of holding and intra-group finance activities in favorable tax environments can lead to FDI positions that are entirely unrelated to the size of the local economy.<sup>2</sup>

While investments through offshore financial centers may have important adverse consequences for public finances in high-tax economies (Tørsløv et al., 2018), they also render standard FDI statistics much less useful for researchers and policymakers. First, FDI data becomes a noisy indicator of global economic integration: an increase in global FDI could reflect that real economic ties are deepening or that multinational firms are adding more layers of empty corporate shells to their ownership chains. Second, FDI data does not depict the true geography of global economic integration: the United Kingdom, for instance, records inward FDI of around \$160 billion from Luxembourg and while it is clear that the vast majority derives from ultimate investors in other economies (or in the United Kingdom itself), standard statistics do not quantify these investment ties.

The main aim of this paper is to estimate the global network of FDI positions while disentangling what we consider *Real FDI*, the relation between an investor in one economy and an active and substantial business in another economy, and what we consider *Phantom FDI*, investments into empty corporate shells with no link to the local real economy. While FDI statistics are intended to capture long-term strategic investment relationships, the operational definition of FDI encompasses all cross-border financial investments between corporations belonging to the same firm, including investments to and from corporations with no real activities and by the economy of the immediate investor (OECD, 2008; IMF, 2009).

We start the paper by developing a three-step methodology to estimate bilateral positions of Real FDI and Phantom FDI. In the first step, we complete the global network of Total FDI to the extent possible based on the IMF's Coordinated Direct Investment Survey (CDIS), where around 110-115 economies report bilateral FDI positions. For non-reporting economies, notably many offshore centers, we rely on mirror reports from counterpart economies.<sup>3</sup> In the second step, we split the Total FDI positions into Real FDI and Phantom FDI. We utilize that a group of OECD economies have recently started reporting inward FDI separately for domestic firms with few or no employees, little or no production, little or no physical presence and no other activities than holding and financing. Investment into such Special Purpose Entities (SPEs) corresponds closely to our concept of Phantom FDI. For these economies, we use the reported statistics on inward FDI into SPEs and non-SPEs directly as measures of Phantom FDI and Real FDI respectively. For other economies, we predict the ratio of Real FDI to Total FDI with the ratio of Total FDI to GDP, as these two ratios exhibit a strong and extremely robust negative correlation in the sample of reporting economies. Presumably, the negative correlation reflects that there is a structural limit to the amount of real investment an economy can absorb whereas phantom investment is not bounded. In the third step, we assign Real FDI to the economies of the ultimate investors. We utilize that a group of OECD economies have recently started to collect data on the ultimate investor economy when they survey firms. For these economies, we use the reported statistics directly to identify ultimate investor economies. For the remaining economies, we take an alternative approach using corporation-level balance sheets and ownership links from the firm database Orbis.

<sup>&</sup>lt;sup>1</sup> Many tax havens are also characterized by low financial transparency and weak regulation (Slemrod, 2008; Schjelderup, 2016), which creates additional incentives for pass-through investment and may therefore contribute to the outsized FDI positions. The aim of this paper is to quantify phantom investment rather than determining how much is driven by tax and non-tax motives.

<sup>&</sup>lt;sup>2</sup> This is not a new proposition: already Hines and Rice (1994) highlighted that U.S. firms allocate valuable assets but few productive resources, such as plant, property, equipment and employees, to "fiscal paradises."

<sup>&</sup>lt;sup>3</sup> For instance, the Cayman Islands does not report inward FDI from Canada (or any other economies); however, Canada reports outward FDI to the Cayman Islands of around \$34 billion and we use this number as an estimate of inward FDI into the Cayman Islands from Canada.

We proceed by describing the characteristics of the estimated FDI network. Total FDI stood at almost \$40 trillion globally in 2017. Around \$15 trillion of these investments were, according to our estimates, phantom investments into empty shell corporations. The share of Phantom FDI in Total FDI has grown steadily in the past years from slightly above 30 percent in 2009 to almost 40 percent in 2017. Most Phantom FDI is hosted by economies often categorized as tax havens because of their role in the tax planning of multinational firms (e.g. Hines, 2010; Zucman, 2014): In both Luxembourg and the Netherlands Phantom FDI exceeds \$3 trillion whereas Hong Kong SAR, the British Virgin Islands, Bermuda, Singapore, the Cayman Islands and Ireland each account for \$0.5-1 trillion. Conversely, Real FDI stood at around \$25 trillion globally in 2017. Real bilateral investment links between the largest economies, like United States, China, United Kingdom, Germany and France, tend to be stronger than investment links in standard statistics where real and phantom investment are conflated. More generally, moving from standard FDI statistics to our estimates of real investment links increases the combined explanatory power of gravity variables like GDP and distance by around 25 percent.

We use the FDI network to consider the *exposure* of individual economies to Phantom FDI. Channeling foreign investment through offshore financial centers provides firms with a range of tax avoidance opportunities, both in the economy that is home to the ultimate investor and in the economy hosting the real investment. While it is beyond the scope of this study to determine to what extent firms make use of these opportunities, the share of an economy's inward FDI coming from empty shells and the share of its outward FDI going to empty shells provide summary measures of exposure. The exposure rates are significant in most major economies, typically in the range 25-50%, which highlights that Phantom FDI is a truly global challenge. Moreover, we find that exposure to Phantom FDI, notably among low-income economies, correlates positively with the corporate tax rate, which is consistent with the notion that at least some Phantom FDI serves tax avoidance purposes.<sup>4</sup>

Finally, we show that the distinction between Real FDI and Phantom FDI has important implications for a classical question in international taxation: the effect of corporate taxation on FDI. In a simple gravity model, we find a significant semi-elasticity of Total FDI with respect to the corporate tax rate of around 2, close to typical estimates in the literature (Feld and Heckemeyer, 2011). However, this estimate conceals considerable heterogeneity across investment types: the tax sensitivity of Total FDI seems to be driven almost entirely by Phantom FDI whereas Real FDI is virtually irresponsive to taxes. This challenges the widespread view that lower business taxes is a way for governments to boost productivity and growth through increased foreign investment in the real economy.

The key contribution of our paper is to combine new data sources, both macro and micro, to make a systematic attempt at disentangling the FDI that represents real economic links and the FDI that does not.<sup>5</sup> This is important from the vantage point of the vast empirical literature that is concerned with the causes (e.g. Hines, 1996; Harding and Javorcik, 2011) and consequences (e.g. Alfaro et al., 2004; Harding and Javorcik, 2012; Javorcik and Poelhekke, 2017) of firm investment across borders. The research questions in most of these papers concern Real FDI and the large share of Phantom FDI in standard FDI data may therefore give rise to significant biases. Our new database is publicly available to allow others to use our estimates of real cross-border investment links in their own research.

Our analysis also contributes to a large literature in public finance documenting how multinational firms allocate a disproportionate share of their financial assets (Clifford, 2019), intangible assets (Dischinger and Riedel, 2011), patents (Karkinsky and Riedel, 2012; Griffith et al., 2014) and business risks (Becker et al., 2018) to low-tax affiliates. While most of this literature uses micro-data, our analysis offers a complementary macro-perspective with estimates of phantom investment at the level of individual economies and the world as a whole. Most similar in spirit is a recent paper estimating the global distribution of firms' profits (Tørsløv et al., 2018).<sup>6</sup>

Finally, our work relates to a recent paper estimating the international network of portfolio investments by linking traded securities issued by shell companies in offshore financial centers to the ultimate parent of the issuer (Coppola et al., 2021). Consistent with their restatements of portfolio investment positions, our methodology involves particularly significant adjustments of the direct investment positions of the United States in large emerging markets: combined FDI in Brazil, Russia, India, China and South Africa (BRICS) from the United States increases by around \$150 billion when we consider estimated real positions rather than the official ones.

The paper proceeds in the following way. Section 2 documents the estimation of a new global database on FDI. Section 3 illustrates key characteristics of the FDI network and reports various sensitivity tests. Section 4 estimates the effect of taxation on FDI. Section 5 concludes.

#### 2. Estimating the global FDI network

This section documents the estimation of a new global database on FDI with four key statistics for each pair of economies: *Total FDI* in host economy h by immediate investors in economy i; *Phantom FDI* in host economy h by immediate investors in economy i; and *Real FDI* in economy h by ultimate owners in economy i. The database is internally consistent by construction: for any pair of economies Real FDI and Phantom FDI sum to Total FDI, and for any

<sup>&</sup>lt;sup>4</sup> This is also consistent with evidence that low-income economies where anti-avoidance rules are less developed and tax enforcement is weaker are more exposed to multinational tax avoidance (Johannesen et al., 2020).

<sup>&</sup>lt;sup>5</sup> This paper supersedes Damgaard and Elkjaer (2017) who disentangle Phantom FDI and Real FDI for a single year and assign Real FDI to ultimate investor economies using reported FDI data.

<sup>&</sup>lt;sup>6</sup> There is also a small related literature on the geography of FDI in offshore financial centers (Haberly and Wójcik, 2015; Garcia-Bernardo et al., 2017).

Data sources and coverage (2016, FDI in \$billions). The table provides an overview of the three macro data sources and the coverage in terms of economies and FDI.

IMF CDIS		OECD FDI stats	OECD FDI stats		
Reporting economies	111	Reporting economies	16	Reporting economies	12
Total inward FDI - allocated to IIE - unallocated	30,960 29,372 1,588	Total inward FDI - to SPEs ("Phantom FDI") - to non-SPEs ("Real FDI")	11,850 6,761 5,089	Total inward FDI - allocated to UIEs - unallocated	6,465 6,384 81

economy Real FDI across immediate owners sums to Real FDI from ultimate owners. In Appendix A, we provide an overview of the framework by presenting the data sources and the estimation steps in a compact way.<sup>7</sup>

## 2.1. Data sources

The IMF's CDIS is the most comprehensive source of information on bilateral FDI positions. The survey, which is conducted annually in 110-115 economies under the auspices of IMF, follows guidelines based on macroeconomic statistical manuals to ensure consistent definitions and similar data collection practices. The survey includes all major economies, representing over 90 percent of global GDP. In each of the participating economies, national authorities combine administrative data and survey information from local firms, and aggregate the information on inward FDI by the economy of the immediate investor and outward FDI by the economy of the immediate investor and outward FDI reported to CDIS.<sup>8</sup>

The *OECD FDI Statistics* include additional information on FDI positions for a subset of OECD economies.<sup>9</sup> First, 30 economies specify how much inward FDI is into SPEs and how much is into other entities (non-SPEs). The statistical manuals describe an SPE as a formally registered legal entity subject to national law that satisfies several criteria: it has few or no employees; it has little or no production in the host economy; it has little or no physical presence; its ultimate owners are foreign residents; its assets and liabilities are mostly vis-a-vis non-residents; and its core business consists of group financing or holding activities (OECD, 2008).<sup>10</sup> FDI into SPEs falls within the standard definition of FDI and is generally included in the FDI reported to CDIS. Second, 16 economies provide information on inward FDI by the economy of the ultimate owner. The ultimate owner is identified by starting from the immediate owner and moving up the ownership chain through the controlling links. The first enterprise in the chain that is not itself controlled by another enterprise (e.g. because it is a listed firm with no single shareholder owning more than 50 percent) is the ultimate owner. If the immediate owner is not controlled by another enterprise, it is itself the ultimate owner.

We summarize the three FDI data sources and their coverage in 2016 in Table 1.<sup>11</sup> Aggregate inward FDI across the 111 economies reporting to the CDIS was just above \$30 trillion, of which around 95 percent was allocated to immediate investor economies. The 16 economies reporting (non-zero) inward FDI in SPEs and non-SPEs separately account for almost 40 percent of the total inward FDI in CDIS whereas the 12 economies further allocating inward Real FDI to ultimate investor economies account for around 20 percent.

Finally, the global firm database Orbis<sup>12</sup> includes accounting information, number of employees and ownership links for millions of corporate entities at the unconsolidated level. We use Orbis to produce estimates of FDI by ultimate investor economy for economies that do not report such statistics directly.

## 2.2. Total FDI by economy of immediate investor

We first construct the bilateral positions of Total FDI: the direct investment in host economy *h* by immediate investors in economy *i*. This network covers all 246 economies in the world from 2009 to 2017.

For the 110-115 economies reporting inward FDI positions to the CDIS, we use these reports without any adjustment. For the 130-135 economies not reporting to the CDIS, mostly small developing economies and offshore financial centers, we estimate FDI

<sup>&</sup>lt;sup>7</sup> The database itself as well as the Stata code documenting how it is built from publicly available data sources are available at https://nielsjohannesen.net/FDIdatabase/.

<sup>&</sup>lt;sup>8</sup> The CDIS dataset is available at http://data.imf.org/CDIS. Another well-established FDI database is UNCTAD's, which also follows international statistical manuals and is mainly sourced from national statical agencies or central banks with gaps filled by various estimations techniques or IMF data. While UNCTAD's database closely aligns for each economy with the aggregated economy data in the CDIS, UNCTAD does not publish bilateral position. Hence, the CDIS is the foundational data source for our database.

<sup>&</sup>lt;sup>9</sup> The OECD and CDIS data follow the same underlying methodology and are consistent, except from differences stemming from the timing of national data revisions or in a very few cases the use of different valuation methods (market value vs. book value) for unlisted equity.

<sup>&</sup>lt;sup>10</sup> The IMF has very recently started collecting FDI data that separately identifies SPEs, but the coverage is not nearly as broad as in the CDIS. This data collection effort is based on a recent international agreed definition of SPEs that codifies current practices. Under this definition, all entities with more than five employees are classified as non-SPEs regardless of the size of the balance sheet or activities (IMF, 2018).

<sup>&</sup>lt;sup>11</sup> Coverage across economies may vary across years for some of the smaller reporters, but this does not affect our results materially.

<sup>&</sup>lt;sup>12</sup> The Orbis database is also used by compilers to detect ownership links and has been used extensively in the literature on international taxation to document how multinational firms allocate assets (Clifford, 2019), liabilities (Huizinga et al., 2008), profits (Huizinga and Laeven, 2008; Johannesen et al., 2020) and risk (Becker et al., 2018) across affiliates in response to tax incentives. Moreover, a recent study combines Orbis and other databases to redraw the map of *portfolio* investment to reflect the location of the ultimate issuer (Coppola et al., 2021).

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positions based on mirror data. For instance, the Cayman Islands does not report inward FDI from Canada; however, Canada reports outward FDI to the Cayman Islands of around \$34 billion and we use this number as an estimate of inward FDI into the Cayman Islands from Canada.<sup>13</sup>

Since mirror positions are only available for counterpart economies reporting to the CDIS, we would systematically underestimate economy-level inward FDI for non-reporting economies if we only relied on mirror positions. For instance, when we estimate the inward FDI position of the Cayman Islands against the rest of the world in 2017, we can only create mirror estimates for 53 economies; the subset of the economies participating in the CDIS that report their outward FDI position to the Cayman Islands. The simple sum of these mirror estimates, \$611 billion, almost certainly underestimates the sum of all inward FDI to the Cayman Islands from the 246 economies in the world.

We address this gap by applying an adjustment factor to the sum of the mirror estimates when we compute economy-level FDI positions for non-reporting economies. The adjustment factor is computed as the ratio between reported inward FDI positions and the sum of mirror positions for the set of economies  $\mathbb{R}$  reporting inward FDI:

$$\gamma_t^{mirror} = \frac{\sum\limits_{h \in \mathbb{R}} FDI_{hi,t}^{own}}{\sum\limits_{i \in \mathbb{R}} FDI_{hi,t}^{mirror}}$$
(1)

where  $FDI_{hi,i}^{own}$  is FDI in *h* from *i* as reported by *h* (i.e. inward FDI) and  $FDI_{hi,i}^{mirror}$  is FDI from *i* to *h* as reported by *i* (i.e. outward FDI). The adjustment factor in 2017 is 1.17 suggesting that, for the aggregate of reporting economies, actual total inward FDI is 17 percent higher than the sum of the mirror positions. We apply the same ratio to each of the non-reporting economies.<sup>14</sup>

For the Cayman Islands, this implies that we estimate economy-level inward FDI at \$712 billion (\$611 billion \* 1.17). We are unable to allocate the adjustment \$101 billion (\$611 billion \* 0.17) to any specific counterpart economy and therefore allocate to the category "Not specified." We compute the adjustment factor for each year in the sample period separately. The adjustments are in the range 1.15-1.25 in every year.

From a global perspective, the bilateral positions of Total FDI in our database are mostly identical to the CDIS data and relies only to a limited extent on inference from mirror positions and estimated adjustments. Specifically, around 90 percent of Total FDI in our database is directly reported to the CDIS, 9 percent is indirectly reported to the CDIS as mirror data while the remaining around 1 percent is estimated.

#### 2.3. Decomposition: real vs phantom investment

In the next step, we decompose each inward position of Total FDI in our database into two parts: Real FDI and Phantom FDI.

## 2.3.1. Economies reporting FDI positions by SPEs and non-SPEs

For the sample of OECD countries reporting by counterpart economy how much inward FDI is into SPEs and non-SPEs respectively, we use this information directly.<sup>15</sup> For instance, the Netherlands reports inward FDI from the United States of around \$750 billion in SPEs and of around \$200 billion in non-SPEs in 2017. These figures enter our database as estimates of Phantom FDI and Real FDI without any adjustments. This split gives a conservative estimate of Phantom FDI as foreign owned corporations with mixed activities, e.g. production to the local market and passive shareholdings in foreign subsidiaries, are classified as non-SPEs, implying that all the foreign investment they embody is classified as Real FDI.

For the sample of OECD countries specifying the decomposition on SPEs and non-SPEs only in the aggregate, we impose the same decomposition across all counterpart economies. For instance, Luxembourg reports aggregate inward FDI of \$3,800 billion in SPEs and less than \$200 billion in non-SPEs, implying that Real FDI and Phantom FDI account for around 4 percent and 96 percent of Total FDI respectively in the aggregate. To estimate Real FDI and Phantom FDI at the bilateral level, we apply these shares apply uniformly to all counterpart economies. For instance, Luxembourg reports Total FDI from Canada of \$194 billion and we thus estimate that Real FDI from Canada is \$9 billion (\$194 billion \* 0.04) whereas Phantom FDI is \$185 billion (\$194 billion \* 0.96).

While 30 OECD economies provide information about FDI into SPEs and non-SPEs, around half of these economies simply report that there is no FDI into SPEs. Most notably, this is the case for the United States despite evidence that the state of Delaware is a leading jurisdiction for incorporation of empty shells. It hosts more than 1 million business entities (Delaware Division of Corporations), many of which allegedly serve tax planning purposes of U.S. as well as non-U.S. firms (Dyreng et al., 2013).<sup>16</sup> In a

<sup>&</sup>lt;sup>13</sup> Damgaard and Elkjaer (2017) find that while there can be significant asymmetries in reported mirror data, there is no systematic overstatement of inward FDI compared to outward FDI, or vice versa. However, data on inward FDI is generally of better quality than on outward FDI as it is easier to obtain information about resident than non-resident firms engaged in FDI from business registers, particularly when they are not listed. For this reason, we use reported inward FDI as our main data source.

<sup>&</sup>lt;sup>14</sup> To the extent that multinational firms have investments in offshore financial centers that they do not report to CDIS, for instance because the investments play a role in tax avoidance or evasion, we may systematically underestimate the FDI positions of these economies by applying a uniform adjustment factor to all nonreporting economies. However, while a large fraction of the offshore assets belonging to households are unrecorded in cross-border investment statistics (Zucman, 2014), firms have much less incentive to conceal foreign investments and regular audits make concealment more difficult.

<sup>&</sup>lt;sup>15</sup> For a few countries, where aggregate inward FDI reported to the OECD FDI Statistics deviates by more than 20 percent from the CDIS, we only use the overall breakdown into SPEs and non-SPEs. This approach does not fundamentally change our findings.

<sup>&</sup>lt;sup>16</sup> A recent micro-analysis suggests that the United States is used as a destination for pass-through capital to a limited extent (Noonan, 2019). According to the Bureau of Economic Analysis, much of the investment in Delaware from foreign parents passes on to operating affiliates in the United States.

survey of the statistical agencies reporting zero FDI into SPEs that we have conducted, a non-trivial share responded that they had not actually collected data supporting this statistic. We therefore only include the 16 economies reporting non-zero values in this part of the analysis. This sample includes some of the world's most important financial centers (e.g. the Netherlands and Luxembourg), advanced economies (e.g. Norway and Spain) and emerging markets (e.g. Poland and Chile), and thus represents a diverse subset of the global economy.

#### 2.3.2. Economies not reporting FDI positions by SPEs and non-SPEs

Based on the information from the 16 economies reporting an actual breakdown of Total FDI into Real FDI and Phantom FDI, we estimate a similar decomposition for the remaining economies in the world. The estimation utilizes a highly salient correlation within the sample of reporting economies between the ratio of Real to Total FDI and the ratio of Total FDI to GDP. For instance, Sweden where Total FDI stands at around 0.7 times GDP, reports that Real FDI accounts for around 95 percent of Total FDI whereas Luxembourg with Total FDI exceeding 60 times GDP, reports that Real FDI accounts for less than 5 percent of Total FDI. There are strong economic reasons to expect this relation to hold more broadly. While the capacity to absorb real investment into firms with employees and productive assets is limited, there are no economic bounds on phantom investment into empty corporate shells with no ties to the local economy. When the Total FDI position is unusually large relative to the size of the economy, it is therefore reasonable to expect that a smaller share of the FDI is real. Our approach is thus to extrapolate the relationship between the ratio of Real FDI to Total FDI, which is unobserved except for the 16 reporting economies, and the ratio of Total FDI to GDP, which can be calculated for virtually all economies in the world.<sup>17</sup>

We adopt a logarithmic functional form due to the highly skewed distribution of the ratio of Total FDI to GDP and thus estimate the following univariate model for the 16 reporting economies and the period 2013-2017:

$$\log\left(\frac{\text{Real FDI}_{h,t}^{OECD}}{\text{FDI}_{h,t}}\right) = \alpha + \beta \log\left(\frac{\text{FDI}_{h,t}}{\text{GDP}_{h,t}}\right) + \varepsilon_{h,t}$$
(2)

where Real  $\text{FDI}_{h,t}^{OECD}$  is inward FDI in non-SPEs in economy *h* in year *t*;  $\text{FDI}_{h,t}$  is all inward FDI in economy *h* in year *t*; and  $\text{GDP}_{h,t}$  is the Gross Domestic Product in economy *h* in year *t*.

Fig. 2 (upper panel) illustrates the in-sample correspondence between actual values (dots) and predicted values (line). The figure highlights the three economies in the sample, which consistently have a low ratio of Real FDI to Total FDI through the sample period: Luxembourg (red dots), Netherlands (blue dots) and Hungary (green dots). The estimated slope is around -0.5 suggesting that increasing the ratio of Total FDI to GDP by 1 percent reduces the predicted ratio of Real FDI to Total FDI by around 0.5 percent. The  $R^2$  of the model is around 0.84.

We use the estimated coefficients from Equation (2) to predict the ratio of Real to Total FDI for all other economies in the world. Fig. 2 (lower panel) shows the *actual* ratios of Real FDI to Total FDI for the 16 reporting economies (green) and *predicted* ratios for the remaining economies (blue), plotted against the ratio of Total FDI to GDP.<sup>18</sup> The figure highlights that the univariate model fits the observations for the reporting economies well and illustrates the implied functional form: the ratio of Real FDI to Total FDI approaches zero as Total FDI to GDP approaches infinity. The predicted ratio of Real FDI to Total FDI is lowest for tiny offshore centers such as the Cayman Islands, Bermuda and Gibraltar.

These results suggest a useful approach to categorizing economies based on their role in the global FDI network: offshore financial centers with very little Real FDI (e.g. Bermuda), real economies with very little Phantom FDI (e.g. Sweden) and mixed economies where both Real FDI and Phantom FDI account for a significant share of the FDI position (e.g. Ireland).

#### 2.3.3. Robustness analysis

We probe the robustness of the estimation results in several ways. First, one may be concerned that the strong correlation in the univariate model is spurious and reflects a correlation between the dependent variable and variables outside the model. We document that adding controls has remarkably little influence on the estimates. As shown in Table 2, the coefficient on the ratio of Total FDI to GDP barely changes when the model is augmented with variables capturing market size (Column 2), economic development (Column 3) and openness (Column 4). This suggests that the strong correlation in the univariate model reflects a genuine economic mechanism that can be expected to hold beyond the economies in the estimating sample. Second, the small estimating sample raises the concern that the results are sensitive to observations from a single economy. We address this concern by conducting a simple exercise where we re-estimate the univariate model removing one economy at a time from the estimating sample. Fig. 3 (upper panel) illustrates the 16 regression lines while highlighting the estimates that result from omitting each of the three outliers, Hungary, the Netherlands and Luxembourg. The results are almost indistinguishable across samples except that the regression line becomes noticeably flatter when Luxembourg is omitted. This suggests that extrapolating from the baseline results may be misleading if Luxembourg has a markedly different ratio of Real FDI to Total FDI than other economies with a similar ratio of Total FDI to GDP. Third, the baseline model pools the years 2013-2017, which could potentially conceal large differences across years. Fig. 3 (lower panel) shows the five regression lines resulting from estimating the baseline model for each of the years separately. The estimates are virtually identical

<sup>&</sup>lt;sup>17</sup> Blanchard and Acalin (2016) suggest that a high correlation between inward and outward FDI is indicative of a low share of Real FDI. Drawing on this insight, we have taken an alternative approach by regressing the Real FDI share on the correlation between inward and outward Total FDI at the quarterly frequency. However, as this model fits the data substantially less well than our baseline model, we have not pursued this approach further.

<sup>&</sup>lt;sup>18</sup> When the model implies that Real FDI accounts for more than Total FDI, we bound this share at unity.



Fig. 2. Prediction model and predictions. *Top panel*: The figure shows the ratio of Total FDI to GDP (x-axis) plotted against the ratio of Real FDI to Total FDI (y-axis) for the OECD countries reporting non-zero Phantom FDI. *Bottom panel*: The figure shows the relation between Total FDI/GDP and Real FDI/Total FDI. For economies reporting non-zero Phantom FDI to the OECD, Real FDI/Total FDI corresponds to the reported values (green dots). For non-reporting economies, Real FDI/Total FDI corresponds to predicted values (blue dots). (For interpretation of the colors in the figure(s), the reader is referred to the web version of this article.)

across the period 2013-2016 and only slightly different for 2017 suggesting that the estimated relation is stable over time. For that reason, we use the time-invariant estimate emerging from the pooled regression to distinguish Real FDI and Phantom FDI in all years.

Fig. 4 (upper panel) summarizes the sensitivity analysis by plotting the baseline predictions against the predictions that result from augmenting the model with a full set of controls (blue), excluding observations for Luxembourg (red) and using only observations from 2017 (green). Adding controls occasionally changes the ranking of economies with a similar ratio of Total FDI to GDP relative to the baseline, but does not systematically change the predicted ratio of Real FDI to Total FDI across the distribution. Excluding observations for Luxembourg (mechanically) retains the ranking of economies, but raises (lowers) the predicted ratio of Real FDI to Total FDI for economies with high (low) ratios of Total FDI to GDP. Relying only on observations from 2017 has the opposite effect although somewhat less pronounced: it slightly lowers (raises) the predicted ratio of Real FDI to Total FDI to Total FDI to GDP.

We conduct a final test to investigate whether the estimated relationship extends beyond the subsample of 16 economies to which it is fitted. We exploit that 10 countries, which are not part of our estimation sample, have very recently started reporting FDI positions with a breakdown on SPEs and non-SPEs to the IMF.<sup>19</sup> These statistics are not fully analogous to the ones reported to the

<sup>&</sup>lt;sup>19</sup> The 10 countries are: Bermuda, Brazil, Canada, Cyprus, Finland, Mauritius, Seychelles, United Kingdom, United States and Uruguay.

**Prediction model.** The table shows the results from a pooled OLS regression for the period 2013-2017. The sample is the OECD countries reporting inward Total FDI positions into SPEs and non-SPEs separately. The dependent variable is Real FDI / Total FDI (in logs) where Real FDI is inward FDI into non-SPEs. The explanatory variables are: *FDI/GDP* is the ratio of the inward Total FDI position to GDP; *Trade* is total foreign trade (imports plus exports) in goods.

	(1) Real FDI / T	(2) 'otal FDI (in le	(3) ogs)	(4)	(5)
FDI / GDP (in logs)	-0.50***	-0.50***	-0.49***	-0.52***	-0.51***
	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)
GDP (in logs)		0.01			0.01
		(0.03)			(0.02)
GDP / capita (in logs)			-0.09*		-0.06
			(0.05)		(0.06)
Trade / GDP (in logs)				0.19**	0.16
				(0.08)	(0.10)
Constant	-0.44***	-0.57*	0.54	-0.39***	0.08
	(0.03)	(0.34)	(0.50)	(0.04)	(0.71)
Observations	75	75	75	75	75
R-squared	0.84	0.85	0.85	0.86	0.86



Fig. 3. Model sensitivity. *Top panel*: The figure illustrates the sensitivity of the estimated univariate relation between Total FDI / GDP and Real FDI / Total FDI to observations from individual economies. Each regression line corresponds to a regression where one economy is removed from the sample. The figure highlights the regression lines corresponding to regressions where Hungary (green), Netherlands (blue) and Luxembourg (red) are removed. *Bottom panel*: The figure illustrates the sensitivity of the estimated univariate relation between Total FDI / GDP and Real FDI / Total FDI to sample period. Each regression line corresponds to a regression with observations from only one year.



Fig. 4. Prediction sensitivity and out-of-sample test. *Top panel*: The figure shows how the predicted values of Real FDI/Total FDI depend on the model used to make the predictions. The figure plots Real FDI/Total FDI predicted by the baseline univariate model on the x-axis against Real FDI/Total FDI predicted by the multivariate model with a full set of controls (blue dots), the univariate model excluding observations for Luxembourg from the estimation sample (red dots) and the univariate model using only observations from 2017 (green dots) on the y-axis. *Bottom panel*: The figure plots actual against predicted values of Real FDI/Total FDI for the 10 economies that are not in the estimation sample (red diamonds) and for the economies in the estimation sample (blue dots). The actual values are for 2020 in the former case and for 2017 in the latter case. The predictions are from the baseline model estimated for the period 2013-2017.

OECD that we use in the paper and they are not available for the period that we study in the paper (until 2017), but only for the most recent years (from 2020). While the new statistics therefore cannot easily be integrated in our main analysis, they lend themselves to an out-of-sample test of the predictive power of the estimated model. Fig. 4 (lower panel) plots actual against predicted Real FDI shares for the 10 economies that are not in the estimation sample (red diamonds) and, for comparison, for the economies in the estimation sample (blue dots). The 10 out-of-sample predictions of the model are extremely good: The 10 observations are generally close to the 45-degree line and regressing predicted Real FDI shares on actual ones for this sample yields an R-squared of around 0.95 (regression output not included).

## 2.3.4. Results

We use the baseline predictions to decompose inward FDI positions into Real FDI and Phantom FDI for economies where this decomposition is not directly available in reported statistics. For a given economy, we apply the same prediction uniformly to all counterpart economies. For instance, we predict that Total FDI into the Cayman Islands is 95 percent Phantom FDI and 5 percent Real FDI. Applying these shares to our estimate of Total FDI into the Cayman Islands from Canada of \$34 billion, we set Phantom FDI at \$32.5 billion and Real FDI at \$1.5 billion. Applying the same ratios to FDI into the Cayman Islands from other economies, we decompose the entire inward FDI position of the Cayman Islands. We proceed similarly to decompose the inward FDI positions of



**Fig. 5. Predicted Real FDI shares and validation of ultimate owner estimation.** *Top panel*: The figure shows the estimated Real FDI/Total FDI by economy. Economies where the ratio is unity are not shown. The figure distinguishes between economies belonging to a broad set of offshore financial centers (red) and other economies (blue). *Bottom panel*: The figure illustrates the results from a test of our approach to estimating FDI by ultimate investor economy using micro-data from Orbis. For each pair of economies where the value of real investments in Orbis accounts for at least 50 percent of the Real FDI position and where the host country self-reports Real FDI by ultimate investor economy, the figure plots the conversion factor computed with Orbis data (i.e. the ratio of Real Orbis FDI in *h* by ultimate investors in *i* as defined in Equation (6)) against the equivalent ratio in self-reported FDI data. Observations are weighted by the value of Real FDI. The regression line illustrates the parameters of the (weighted) univariate regression.

other economies.<sup>20</sup> When no information on GDP is available, we are unable to calculate the ratio of Total FDI to GDP and therefore cannot predict the ratio of Real to Total FDI. In these rare cases, we apply the ratio corresponding to the simple average across the reporting OECD economies (i.e. 78 percent of Total FDI is Real FDI).<sup>21</sup> Fig. 5 (upper panel) shows the estimated share of Real FDI in Total FDI for all economies where this share is not unity. We distinguish between a broad set of offshore financial centers (red bars) and other economies (blue bars).<sup>22</sup> Strikingly, almost all the economies with the lowest ratio are offshore financial centers and largely overlap with the list of sink and conduit offshore financial centers identified in Garcia-Bernardo et al. (2017) although the methodologies are quite different.

We note that both of the decomposition methods ensure that Real FDI and Phantom FDI sum to Total FDI at the bilateral level. For economies where we use the OECD statistics directly, this is ensured by the internal consistency of the OECD source data.

<sup>&</sup>lt;sup>20</sup> Figure A3 in the Online Appendix empirically assesses the assumption of uniform ratios across counterpart economies for the sample of economies where ratios are reported for each counterpart economy separately.

<sup>&</sup>lt;sup>21</sup> Information on GDP is unavailable for 12 small territories and islands with at most a few thousand inhabitants. They have no material impact on the FDI network as they only account for a mere 0.0005 percent of global FDI but are included for completeness.

<sup>&</sup>lt;sup>22</sup> The set of offshore financial centers is from Johannesen and Zucman (2014) augmented with the Netherlands (Weyzig, 2013) and Puerto Rico (Grubert and Slemrod, 1998).

For economies not reporting to the OECD statistics, it is ensured by the fact that we predict a single parameter for each economy expressing in what proportions Total FDI is composed of Real FDI and Phantom FDI respectively.

#### 2.4. Real FDI by economy of ultimate investor

The final step in the estimation of the FDI database is to break down inward Real FDI by the economy of the *ultimate* investors. This completes the attempt to look through chains of Phantom FDI and capture the genuine cross-border investment links: from real investment in productive assets in one economy to the investors who ultimately control the assets in another economy.

#### 2.4.1. FDI statistics by economy of ultimate investor

For the sample of OECD countries reporting Real FDI by the economy of the ultimate investor, we generally use this information directly. For instance, Germany reports inward FDI of \$51 billion from ultimate owners in Luxembourg in 2016. This compares to \$143 billion of inward FDI from immediate owners in Luxembourg reported to the CDIS and thus suggests that significant foreign investment into Germany is channeled through Luxembourg by firms in third economies. In the few cases where the reported FDI positions by ultimate investor economies are incomplete or inconsistent with the FDI positions by immediate investor economies reported to the CDIS, we ignore them and proceed as if no breakdown by ultimate investor economy were available.<sup>23</sup> The reporting of FDI by ultimate investor economy started in 2013, so our global FDI network only covers this dimension for the period 2013-2017.

## 2.4.2. Orbis data by economy of ultimate owner

For all other economies, we start from the estimates of Real FDI by immediate investor economy obtained in the previous step and adjust using Orbis information. To illustrate, consider a multinational group comprising a listed parent company in Canada, an intermediate holding company in Luxembourg and an operating subsidiary in Spain. For the Spanish entity, the Orbis database would indicate that the immediate owner is the Luxembourg company and the ultimate owner is the Canadian company (both with a 100 percent shareholding). For the Luxembourg company, it would indicate that the Canadian company is both the immediate and the ultimate owner (with a 100 percent shareholding). The example suggests that inward FDI in Spain by immediate investors in Canada should be adjusted upwards to arrive at FDI in Spain by ultimate investors in Canada; conversely, FDI in Spain by immediate investors in Luxembourg should be adjusted downwards to arrive at FDI in Spain by ultimate investors in Luxembourg. It also suggests that the information in Orbis may guide the adjustments.

An important constraint is Orbis' partial coverage (e.g. Tørsløv et al., 2018): in any given economy only a subset of corporations is represented in the database, and coverage varies considerably across economies and over time. Therefore, we do not attempt to capture levels of FDI with the Orbis data, but rather use Orbis to measure the *relative* size of FDI by immediate and ultimate investors in a given economy. Thus, the key assumption is not that coverage is complete, but that ownership patterns observed in the Orbis sample are representative of the wider economy. This assumption is more likely to be accurate when a large part of the bilateral FDI is represented in the database.

Conceptually, we start from the estimates of Real FDI by immediate investor economy obtained in the previous step and apply a conversion factor  $\delta_{hi}$  to arrive at estimated Real FDI by ultimate investor economy. The conversion factor expresses, for a given host economy *h* and a given investor economy *i*, the estimated ratio between real investment in *h* by *ultimate* investors in *i* in year *t* (i.e. Real FDI-UI<sub>*hi*,*i*</sub>) and real investment in *h* by *immediate* investors in *i* in year *t* (i.e. Real FDI-II<sub>*hi*,*i*</sub>). Intuitively, the conversion factor captures how much a given counterpart economy is used as a conduit for investments originating from other economies (which decreases  $\delta_{hi}$ ) relative to how much it uses other economies as conduits for its own foreign investments (which increases  $\delta_{hi}$ ). With these conversion factors, Real FDI by ultimate investor economy follows from the following simple formula:

Real FDI-UI<sub>*hi*,*t*</sub> = 
$$\delta_{hi,t}$$
 · Real FDI-II<sub>*hi*,*t*</sub>

(3)

To estimate the conversion factors, we rely on firm-level data from Orbis.<sup>24</sup> We use data for 2016, the year with the most comprehensive coverage in our version of the database, and the estimates are therefore time-invariant:  $\delta_{hi,t} = \delta_{hi}$  for all *t*. The estimation proceeds in the following steps.

First, we construct the sample of corporate entities in Orbis receiving Real FDI. Specifically, we extract accounting and ownership information for all corporations where at least one immediate investor with an ownership share of at least 10 percent is located in a foreign economy. The 10 percent threshold is conventionally used to delineate direct investment and portfolio investment in external sector statistics. To focus on Real FDI, we drop corporations with characteristics resembling SPEs: at most five employees and assets per employee exceeding \$10 million.<sup>25</sup>

<sup>&</sup>lt;sup>23</sup> Specifically, we ignore the breakdown on ultimate investor economies reported to the OECD in two very rare types of cases with incomplete or inconsistent data: (i) when less than 50 percent of Real FDI is allocated to specific ultimate investor economies to ensure that OECD data are only used when the allocation to ultimate investor economy is comprehensive; (ii) when the discrepancy between aggregated FDI positions across all counterpart economies by *ultimate* investor economy and by *immediate* investor economy exceeds 20 percent, which can happen in rare cases due to exceptional revisions or the use of different valuation methods (market value vs. book value) for unlisted equity in the data reported to the CDIS and the OECD.

 $<sup>^{24}</sup>$  To our knowledge, the present study is the first to use micro data to allocate FDI by ultimate investor economy. A previous version (i.e. Damgaard and Elkjaer, 2017) used aggregate investment patterns from reporting OECD countries whereas Casella (2019) takes a probabilistic approach.

<sup>&</sup>lt;sup>25</sup> With this definition, around 8 percent of Total FDI covered by Orbis is Phantom FDI, which compares to our estimate of around 40 percent based on FDI statistics. The difference plausibly reflects the known shortcoming of Orbis that coverage is particularly low in offshore financial centers where accounting information is

Second, we estimate the value of the shareholders' investment in each of the corporations. Conceptually, FDI can take the form of equity or debt. We measure equity investments in a corporation as shareholders' capital, including retained earnings. We cannot directly infer the value of investments by the owners in the form of debt in Orbis since the database does not distinguish between external debt (from banks and other unrelated investors) and internal debt (from affiliates). Instead, we apply the ratio of internal debt to total debt is 0.2 in all non-financial corporations and that internal debt comes from the owners in proportion to their shareholdings in the corporation. The ratio is calibrated so that our aggregates roughly match the ratio between FDI investment in the form of debt and equity respectively in official FDI statistics. Hence, for each non-financial corporation we estimate the value as the sum of shareholders' capital and 20 percent of the total debt. For financial corporations, we only include shareholders' capital as most debt between affiliated financial corporations is not classified as FDI according to macroeconomic statistical manuals.

Third, using the ownership information from Orbis, we define  $\theta_{c,hi}$  as the share of corporation *c* in economy *h* controlled by ultimate investors in economy *i* and  $\lambda_{c,hi}$  as the share of corporation *c* in economy *h* owned by immediate investors in economy *i*. With these definitions, we can estimate Orbis-based measures of Real FDI by the economy of the ultimate and immediate owners respectively:

Real FDI-UI<sub>hi</sub><sup>Orbis</sup> = 
$$\sum_{c \in \mathbb{H}} \theta_{c,hi} \cdot investment_{c,h}$$
 (4)  
Real FDI-II<sub>hi</sub><sup>Orbis</sup> =  $\sum_{c \in \mathbb{H}} \lambda_{c,hi} \cdot investment_{c,h}$  (5)

where  $\mathbb{H}$  is the set of corporations in economy *h* in our Orbis sample and *investment*<sub>*c*,*h*</sub> is the estimated value of the shareholders' investment in corporation *c* located in economy *h*.

To provide a sense of the overall comparability of the firm data in Orbis and official FDI statistics, we note that aggregating the Orbis-based FDI measures across all economies yields a measure of global Real FDI of around \$8.4 trillion in 2016. This compares to the estimate of global Real FDI of around \$22 trillion that emerges from our analysis of official FDI statistics in the previous subsection. Presumably, most of the discrepancy is due to the incomplete coverage of the Orbis database but may also to a lesser extend derive from differences in valuation principles: Orbis uses book values from firms' financial reports and while FDI statistics recommend to use market values whenever possible, in practice, FDI statistics also use book values extensively because often only this information is available.<sup>26</sup>

Finally, we use the Orbis-based measures of FDI to produce the conversion factors  $\delta_{hi}$ . For pairs of economies where the Orbis data deviate less than 50 percent from our estimate of Real FDI and where we therefore expect ownership links in Orbis to be reasonably representative of all FDI, we compute conversion factors that are specific to the pair<sup>27</sup>:

$$\delta_{hi} = \frac{\text{Real FDI-UI}_{hi}^{Orbis}}{\text{Real FDI-II}_{hi}^{Orbis}} \quad if \quad \frac{\text{Real FDI-II}_{hi}^{Orbis}}{\text{Real FDI-II}_{hi}} \in \left[\frac{1}{2}, \frac{3}{2}\right]$$
(6)

The conversion factor simply expresses the ratio, as observed in Orbis, between Real FDI in h from ultimate and immediate owners in *i* respectively. Multiplying the conversion factor on Real FDI in h by immediate owners in *i*, as estimated from the official FDI statistics, yields an estimate of Real FDI in h by ultimate owners in *i*. The implicit assumption is that the ratio between Real FDI in h by ultimate and immediate owners in *i* is the same for investment covered and not covered in Orbis. We will probe this assumption below.<sup>28</sup>

We illustrate the mechanics with a concrete example. We estimated above, based on official FDI statistics, that Spain's Real FDI from immediate owners in the United States is around \$23 billion. We observe around \$13 billion of this investment in Orbis; hence, the coverage ratio exceeds 50 percent and we proceed to compute a pair-specific conversion factor. The Orbis sample includes investment in Spain from ultimate owners in the United States of around \$29 billion; hence, Equation (6) yields a conversion factor of 2.2 (i.e. \$29 billion/\$13 billion). Applying Equation (3), we arrive at an estimate of Real FDI in Spain from ultimate owners in the United States of just over \$50 billion (i.e. \$23 billion\*2.2).

We validate the approach by comparing the conversion factors  $\delta_{hi}$  emerging from Orbis with the actual ratio between Real FDI in h by ultimate owners in i and Real FDI in h by immediate owners in i for pairs of economies where both are available: when the host economy belongs to the OECD countries reporting Real FDI by ultimate investor economy and Orbis has sufficient coverage. Fig. 5 (lower panel) plots the ranks of the two variables. The rank-rank correlation when observations are weighted with Real FDI is 0.72, suggesting that our approach creates sensible measures of FDI by ultimate investor economies in the aggregate. The unweighted correlation is 0.43 (not shown) suggesting that the approach yields larger errors for pairs of economies with lower levels of bilateral FDI.

For pairs of economies where Orbis data deviates more than 50 percent from Real FDI, it is an important concern that ownership links in the Orbis sample may not be representative of foreign investment more broadly. To address this concern, we do not use

generally not publicly available from corporate registers (Tørsløv et al., 2018). Moreover, information about number of employees is frequently missing in Orbis, which makes it difficult to identify all SPEs.

<sup>&</sup>lt;sup>26</sup> Applying other valuation methods, e.g. price-to-book value or price-to-earnings, can have a significant impact on reported data (Damgaard and Elkjaer, 2014). Economies are encouraged to report book values to the CDIS to enhance comparability.

<sup>&</sup>lt;sup>27</sup> We also require that both the numerator and denominator of the ratio defining  $\delta_{hi}$  exceed \$1 million; when this requirement is not met, we proceed as if Orbis deviated more than 50 percent from Real FDI.

 $<sup>^{28}</sup>$  To avoid extreme conversions,  $\delta_{hi}$  is capped between 0.05 and 10.

conversion factors that are specific to the pairs of economies when coverage is low, but rather use information from all host economies to compute conversion factors that are specific to the investor economy (and uniform across host economies with low coverage)<sup>29</sup>:

$$\delta_{hi} = \frac{\sum_{h \in \mathbb{W}} \text{Real FDI-UI}_{hi}^{Orbis}}{\sum_{h \in \mathbb{W}} \text{Real FDI-II}_{hi}^{Orbis}} \quad if \quad \frac{\text{Real FDI-II}_{hi}^{Orbis}}{\text{Real FDI-II}_{hi}} \notin \left[\frac{1}{2}, \frac{3}{2}\right]$$
(7)

where  $\mathbb{W}$  is the set of host economies in Orbis. The conversion factor simply expresses the ratio, as observed in Orbis, between global Real FDI from ultimate and immediate investors in *i* respectively. Again, the conversion factor is applied to Real FDI in *h* by immediate investors in *i*, as estimated from the official FDI statistics, to obtain an estimate of Real FDI in *h* by ultimate investors in *h*.

Once again, we illustrate the mechanics with a concrete example. We estimated above, based on official FDI statistics, that Russia's Real FDI from immediate owners in the Netherlands is around \$41 billion. We observe around \$19 billion of this investment in Orbis. Hence, the coverage ratio falls below 50 percent and we therefore do not apply a conversion factor specific to the pair Russia-Netherlands, but rather one that is specific to the investor economy the Netherlands. In Orbis, we observe global Real FDI from ultimate investors in the Netherlands of around \$294 billion and global Real FDI from immediate investors in the Netherlands of around \$597 billion. Hence, Equation (7) yields a conversion factor of around 0.5 (i.e. \$294 billion/\$597 billion). Applying Equation (3), we arrive at an estimate of Real FDI in Russia from ultimate owners in the Netherlands of \$21 billion (i.e. \$41 billion\*0.5).<sup>30</sup>

#### 2.4.3. Round-tripping and final adjustments

According to the new FDI statistics from reporting OECD countries as well as the Orbis database, a considerable share of FDI in an economy is assigned to ultimate investors in the same economy. Such *round-tripping* can be motivated by many reasons including tax planning. For instance, China's tax system for many years favored foreign investors over domestic investors, which induced many Chinese investors to channel their investments in China through corporations in Hong Kong SAR or other offshore financial centers (Qun, 2008).<sup>31</sup>

To estimate round-tripping FDI for a given economy, i.e. Real FDI in economy *h* by ultimate investors in economy *h*, we cannot apply the conversion factor to Real FDI-II<sub>*hh*</sub>, as we do to estimate FDI for other ultimate investor economies in Equation (3), since Real FDI-II<sub>*hh*</sub> is zero by construction. Instead, we rely on the following equation:

$$\operatorname{Real} \operatorname{FDI-UI}_{hh} = \frac{\operatorname{Real} \operatorname{FDI-UI}_{hh}^{Orbis}}{\sum_{i} \operatorname{Real} \operatorname{FDI-UI}_{hi}^{Orbis}} \cdot \sum_{i} \operatorname{Real} \operatorname{FDI-II}_{hi}$$
(8)

We refer to the ratio on the right-hand side as the *round-tripping factor*: it expresses the share of Real FDI in economy *h* where the ultimate investor is also in economy *h* as observed in Orbis. To obtain an estimate of round-tripping Real FDI in economy *h* we multiply this factor with the aggregate inward Real FDI position of economy *h* as estimated in Section 2.3.<sup>32</sup> To illustrate, in our Orbis sample, 22 percent of inward FDI in China is by ultimate investors in China. Applying this round-tripping factor to China's total inward FDI position of \$2.7 trillion, we estimate aggregate round-tripping FDI in China at \$0.6 trillion (adjusted to \$0.7 trillion below).<sup>33</sup>

Finally, we adjust FDI positions by ultimate investor economy to make the FDI network internally consistent in the sense that an economy's inward Real FDI, aggregated over immediate investor economies, matches the economy's inward Real FDI, aggregated over ultimate investor economies (including the economy itself to account for round-tripping). Generally, self-reported FDI by ultimate investor economy is almost consistent with FDI by immediate investor economy; the mostly minor discrepancies are likely due to trivial reasons such as the use of different data vintages. However, when we estimate FDI by ultimate investor economies in Equation (3), using CDIS data on FDI by immediate investor economies and conversion factors estimated from Orbis, some inconsistencies may arise because the Orbis sample is not fully representative of the population of firms with foreign investors and investments.

For each economy in the database, we therefore adjust our raw estimates of inward Real FDI by ultimate investor economy proportionally to ensure internal consistency: Each economy's inward Real FDI aggregated over immediate investor economies must equal the economy's inward Real FDI aggregated over ultimate investor economies.<sup>34</sup> For instance, aggregating Spain's inward Real FDI over immediate investor economies yields a total of \$624 billion whereas aggregating over ultimate investor economies yields a total of \$545 billion. To achieve consistency, we multiply all the raw estimates of Spain's Real FDI by ultimate investor economies

<sup>&</sup>lt;sup>29</sup> We require that both the numerator and denominator of the ratio defining  $\delta_{hi}$  exceed \$50 million; when this requirement is not met, we set  $\delta_{hi} = 1$ .

<sup>&</sup>lt;sup>30</sup> We show the raw ratio between ultimately owned FDI and immediately owned FDI at the economy level, as observed in Orbis and before any adjustments (see below), for the 50 largest investor economies in the world in Figure A1 in the Online Appendix.

<sup>&</sup>lt;sup>31</sup> Similarly, there is evidence that the considerable portfolio investment into the United States from offshore financial centers, at least to some extent, reflects round-tripping by U.S. individuals engaged in tax evasion (Hanlon et al., 2015) and that investment into high-end property markets in the United Kingdom from offshore financial centers reflects round-tripping by U.K. individuals (Johannesen et al., 2022).

<sup>&</sup>lt;sup>32</sup> For economies where  $\sum_{i}$  Real FDI-II<sub>*hi*</sub> is below \$50 million, we apply a global round-tripping factor, defined as global round-tripping FDI in Orbis as a share of global FDI in Orbis rather than the economy-specific round-tripping factor in Equation (8). The economy-specific round-tripping factors are capped at 0 and 0.25 to prevent extreme factors in economies with low Orbis coverage.

<sup>&</sup>lt;sup>33</sup> We show the raw round-tripping factor, the ratio between inward Real FDI ultimately owned by investors in the economy itself and aggregate inward Real FDI in the economy, as observed in Orbis and before any adjustments (see below), for the 50 largest economies in the world (by inward Real FDI) in Figure A2 in the Online Appendix.

<sup>&</sup>lt;sup>34</sup> This is akin to the adding-up constraint in Coppola et al. (2021).

Summary statistics (2017). The table provides an overview of the data sources ultimately used to construct the database. The first panel breaks down observations of inward Total FDI by immediate investor economy (ILE) into pairs where the value is reported to CDIS and pairs where the value is inferred from mirror data or based on our estimates. The second and third panels break down observations of inward Phantom FDI and inward Real FDI by immediate investor economy (ILE) into pairs where the value is reported to the OECD and pairs where the value is estimated from the prediction model. The fourth panel breaks down observations of inward Real FDI by ultimate investor economy (ULE) into pairs where the value is reported to the OECD and pairs where the value is setimated from the Det D and pairs where the value is near the output is estimated from the OECD and pairs where the value is near the output is reported to the OECD and pairs where the value is reported to the OECD and pairs where the value is reported to the OECD and pairs where the value is estimated from model. In all cases, we report both the number of economy pairs and aggregate inward FDI (in \$billion).

	Pairs of economies	Inward FDI
Inward Total FDI by IIE	23,062	38,566
- Reported to CDIS	16,230	34,563
- Mirror data	6,693	3,435
- Own estimate	139	568
Inward Phantom FDI by IIE	23,062	14,653
- Reported to OECD	2,393	7,436
- Estimated	20,669	7,217
Inward Real FDI by IIE	23,062	23,912
- Reported to OECD	2,393	4,610
- Estimated	20,669	19,302
Inward Real FDI by UIE	23,032	23,913
- Reported to OECD	1,598	5,220
- Detailed Orbis	625	4,296
- Aggregate Orbis	14,128	12,965
- No adjustment	6,681	1,432

with the factor 1.14 (i.e. \$624 billion / \$545 billion). Globally, the adjustments we make to achieve consistency between FDI positions by ultimate and immediate investor economies amount to around \$2.8 trillion or around 8 percent of global FDI.

#### 2.5. Summary statistics

We summarize the data sources ultimately used to estimate the database in Table 3. Around 90 percent of the inward Total FDI in the database is reported to the CDIS while the remaining 10 percent is inferred from mirror data or based on our own estimates (first panel). The decomposition into Phantom FDI and Real FDI relies much more on our own estimates: around 50 percent of the global Phantom FDI and 80 percent of Real FDI is estimated from the prediction model. Finally, around one quarter of the allocation of Real FDI to ultimate investor economies derives from reports to the OECD FDI statistics and three quarters are estimated by applying conversion factors based on Orbis data.

## 3. Characteristics of the global FDI network

#### 3.1. The nature of global FDI

In our estimated global FDI network, Total FDI in 2017 was almost \$40 trillion with Real FDI accounting for around \$25 trillion and Phantom FDI accounting for around \$15 trillion (Fig. 6). Over the period 2009-2017, Total FDI increased by around 70 percent reflecting that Phantom FDI almost doubled whereas Real FDI increased by a more modest 50 percent. The share of Phantom FDI in Total FDI increased from just above 30 percent in 2009 to just below 40 percent in 2017.<sup>35</sup>

We conduct a number of sensitivity tests of the estimate of global Phantom FDI in Fig. 7 (upper panel). First, we estimate Phantom FDI for economies that do not self-report FDI in SPEs and non-SPEs separately based on a model that does not include Luxembourg (green line). Within the sample of reporting economies, Luxembourg exhibited by far the largest share of Phantom FDI in Total FDI and we noted in Section 2.3 that the parameters of the prediction model were quite sensitive to whether Luxembourg was included or not. Our estimates of global Phantom FDI, however, are very robust to excluding Luxembourg from the prediction model. Second, we aggregate Phantom FDI across the economies that self-report FDI in SPEs only (blue line). Only relying on self-reported statistics effectively makes the extreme assumption that Phantom FDI is zero in all economies that do not self-report FDI in SPEs (e.g. the British Virgin Islands, Bermuda and the Cayman Islands) and thus provides a lower bound. Even in this extreme scenario, Phantom FDI amounted to around 7.4 trillion globally in 2017. Third, we adopt an *ad hoc* approach to approximating Phantom FDI in constitutes 90 percent of Total FDI in SPEs by assuming that Phantom FDI constitutes 90 percent of Total FDI in

<sup>&</sup>lt;sup>35</sup> This is consistent with studies showing that FDI positions vis-a-vis offshore financial centers have grown faster than other FDI positions since the global financial crisis (Lane and Milesi-Ferretti, 2018).



Fig. 6. Global Real and Phantom FDI. The figure shows the evolution of inward FDI positions aggregated over all economies in the world over the period 2009-2017. Total FDI is decomposed into Real FDI (blue bars) and Phantom FDI (red bars).

offshore centers and 0 percent in other economies (red line). This yields an estimate of global Phantom FDI of around \$20 trillion in 2017, considerably higher than the baseline estimate of around \$15 trillion.

While the sensitivity analysis highlights that the incomplete coverage of reported data on FDI in SPEs creates significant uncertainty about the true magnitude of Phantom FDI at the global level, it also illustrates that this uncertainty goes both ways. On the one hand, if one believes that all of the FDI in non-reporting offshore centers like the British Virgin Islands, Bermuda and the Cayman Islands represent real investment with substantial links to the local economies, one may think that \$7.4 trillion, or around 20 percent of Total FDI, is the most sensible global estimate of Phantom FDI. On the other hand, if one holds the view that the vast majority of the FDI positions of offshore centers reflect pass-through investment, \$20 trillion, or around 50 percent of Total FDI, may be a more accurate number than our baseline estimate of \$15 trillion.

Finally, we note that our estimates of Phantom FDI are sensitive to the particular definition of SPEs applied by national statistical authorities. Since there is currently no strictly harmonized international SPE definition, national compilers have some flexibility (as described in Section 2.1). To illustrate the issue, Ireland does not currently report a breakdown of Total FDI into SPEs and non-SPEs in official OECD statistics, but a recent publication from Ireland's Central Statistics Office (2019) estimates that FDI into SPEs only accounts for 5 percent of inward FDI. By contrast, Galstyan (2019) estimates that distortions to Irish FDI account for 47 percent of Ireland's inward FDI, which is roughly consistent with our estimate that Phantom FDI accounts for 62 percent of Total FDI into Ireland. The low estimate in Central Statistics Office (2019) is based on the SPE definition recently proposed by the international statistical community (IMF, 2018), which is more restrictive than the description in the current manuals. For instance, it applies a cap of five employees, and therefore categorizes fewer entities as SPEs. In the case of Switzerland, our model estimates that Phantom FDI accounts for 50 percent of Total FDI compared to an SPE share of only 13 percent in official Swiss statistics. In this context, the Swiss National Bank (2017) underscores that their relatively narrow definition of SPEs leads to underestimation of pass-through FDI as significant FDI passes through entities that are categorized as non-SPEs.

## 3.2. Phantom FDI, real FDI and round-tripping by economy

We describe how the \$15 trillion of Phantom FDI is distributed across economies in Fig. 7 (lower panel). The global leader is Luxembourg with a Phantom FDI position of around \$3.8 trillion, closely followed by the Netherlands with around \$3.3 trillion. These positions are self-reported by the national statistical authorities (indicated with dark red bars) and therefore not subject to the uncertainties associated with our estimation method. The following five economies are known offshore financial centers - Hong Kong SAR, the British Virgin Islands, Bermuda, Singapore and the Cayman Islands - each accounting for Phantom FDI around \$0.5-1 trillion. These positions are estimated using the method developed above (indicated with light red bars) and therefore subject to some uncertainty.

Next, we turn to the distribution of the global \$25 trillion of Real FDI in Fig. 8 (upper panel). We plot both Real FDI hosted in the economy (blue bars) and Real FDI ultimately controlled by investors in the economy (green bars) for the 20 economies with the largest inward Real FDI position. The United States has the largest inward and outward positions; it hosts Real FDI of around \$4 trillion and ultimately owns Real FDI of around \$3.6 trillion. Many large economies have highly unbalanced Real FDI positions: China's inward position exceeds its outward position by around \$1.2 trillion whereas the three largest European economies (i.e. Germany, the United Kingdom and France) have a joint outward position that exceeds the joint inward position by around \$1.5 trillion. A handful of the economies with the largest Real FDI positions also appeared among the economies with the largest Phantom FDI positions. It is noteworthy that at least some of these economies (e.g. the Netherlands, Singapore and Hong Kong SAR) have strikingly balanced Real FDI positions, which is suggestive that the Real FDI estimates for these economies include a large element



Fig. 7. Phantom FDI. Top panel: the figure compares our baseline estimates of global Phantom FDI over the period 2009-2017 (black line) to three alternative scenarios: assuming zero Phantom FDI in economies that do not self-report FDI in SPEs and non-SPEs separately so that the Phantom FDI estimate only reflects self-reported FDI in SPEs (blue line); estimating the share of Phantom FDI in Total FDI based on a model that does not include Luxembourg (green line); assuming that Phantom FDI in non-reporting economies constitutes 90 percent of Total FDI in offshore centers and that Phantom FDI is zero in other economies. *Bottom panel*: the figure shows inward Phantom FDI positions in 2017 for the 20 economies, the figure shows our estimates (explained in the main text).

of pass-through investment. Possibly, some pass-through investment is handled by corporate entities that also have real activities, in which case the entities are categorized as non-SPEs and the investment as real.

We highlight the important distinction between FDI in the form of equity and debt in Fig. 8 (lower panel). A simple form of tax avoidance where low-tax affiliates are capitalized with equity and pass on the funds to high-tax affiliates in the form of debt suggests an asymmetry in the FDI structure of offshore financial centers with a larger share of equity in inward FDI than in outward FDI (Huizinga et al., 2008). While the first columns show some evidence of such an asymmetry, it is not quantitatively important: The equity share is only slightly higher in inward FDI than in outward FDI for the group of offshore financial centers overall whereas the opposite pattern prevails in other economies. The asymmetry is more pronounced in specific offshore financial centers such as Singapore.<sup>36</sup>

Finally, we illustrate the economic significance of *round-tripping* in Fig. 9 (upper panel). For each of the 20 largest economies in the world, the figure shows the share of real inward FDI ultimately owned by investors in the economy itself. For some economies, the round-tripping share is based on FDI data by ultimate investor economies reported by the national statistical authorities (indicated with dark red bars). For others, it is based on the Orbis database and therefore subject to more uncertainty (indicated with light

 $<sup>^{36}</sup>$  The reason why equity shares are sometimes above unity is due to the directional principle whereby a parent company receiving, for instance, a loan from a foreign subsidiary is recorded as negative FDI.



Fig. 8. Real FDI and financial instrument. *Top panel*: the figure shows inward Real FDI positions in 2017 for the 20 economies in the world with the largest such positions (blue bars). For OECD economies reporting these statistics, the figure shows the reported numbers. For non-reporting economies, the figure shows our estimates (explained in the main text). For each economy, the figure also shows the outward Real FDI position, i.e. sum of Real FDI in foreign economies ultimately owned by investors in the economy. *Bottom panel*: the figure shows, for each of the aggregate of offshore financial centers (OFC), the aggregate of all other economies as well as for the 10 largest economies in the world in terms of FDI positions, the share of the inward positions (blue bar) and outward positions (red bars) constituted by equity.

red bars). There is considerable variation in the significance of round-tripping across economies. In transition economies like China and Russia, around 25 percent of Real FDI is ultimately owned by domestic investors whereas the share is far below 10 percent, and sometimes negligible, in most developed economies.

#### 3.3. Real bilateral investment links

Standard FDI statistics may misrepresent the strength of cross-border investment links by confounding real and phantom investment and by defining investment ties in terms of immediate rather than ultimate ownership. We illustrate this point in Fig. 9 (lower panel) for the five largest economies in world: the United States, China, Japan, Germany and the United Kingdom. For each pair of economies, we plot both our measure of the real link, the value of Real FDI in one economy ultimately owned by investors in the other economy (blue bars), and the measure of the FDI link available in standard statistics, the value of Total FDI in one economy immediately owned by investors in the other economy (green bars). For almost all of the 20 pairs, the real FDI link is underestimated in standard FDI statistics and sometimes very substantially so. For instance, FDI in China from the United States is around \$70 billion according to CDIS whereas our analysis suggests a Real FDI link of almost \$130 billion. The likely explanation is that a large share of the direct investments made by U.S. multinationals in China is channeled through offshore financial centers, which conceals the real strength of the investment links. Our methodology generally involves highly significant adjustments to the FDI positions of the United States in large emerging markets. Specifically, the combined FDI in Brazil, Russia, India, China and South Africa (BRICS) from



**Fig. 9. Round-tripping and Real FDI links.** *Top panel:* the figure shows the round-tripping factors (i.e. the share of inward Real FDI in economy *h* ultimately owned by investors in economy *h*) for the 20 largest economies in the world (by GDP). *Bottom panel:* the figure also shows for each combination of the five largest economies in the world (by GDP). *Bottom panel:* the figure also shows for each combination of the five largest economies in the world (by GDP). Joint (CHN), Japan (JPN), Germany (DEU) and United Kingdom (GBR), the estimated Real FDI position capturing links between ultimate investors and real investments (blue bars) and the FDI position observed in standard FDI statistics (green bars).

the United States increases by around \$150 billion when we consider estimated real positions by ultimate investing economy rather than the official ones.

We make this point more generally by showing how gravity factors shape different types of bilateral FDI positions in Table 4. We first estimate the following simple gravity model with OLS<sup>37</sup>:

$$log(FDI_{hit}) = \alpha + \beta_1 log(GDP_{hi}) + \beta_2 log(GDP_{it}) + \beta_3 log(Distance_{hi}) + \gamma X'_{hit} + \epsilon_{hit}$$
(9)

where X is a vector of dummies including contiguity, common language, colonial links etc. and where h denotes the host economy, i the investor economy and t the year. The model yields elasticities of Total FDI with respect to the GDPs of the host economy and the immediate investor economy far below unity, suggesting that the relative importance of foreign investment decreases quickly with market sizes, and an R-squared of 0.266 (Column 1). Estimating the same model for Phantom FDI and Real FDI separately yields very different results. Most strikingly, the elasticity of Phantom FDI with respect to host economy GDP is *negative*, suggesting that smaller economies attract more Phantom FDI in absolute terms, whereas the elasticity of Real FDI with respect to host economy GDP is positive and somewhat larger than for Total FDI (Columns 2-3). Finally, including the characteristics of the ultimate investor economy yields larger coefficients than the baseline model on real variables such as market size and distance and an R-squared of 0.334 (Column 4).

<sup>&</sup>lt;sup>37</sup> Okawa and Van Wincoop (2012) provide a useful introduction to gravity models in international finance.

**Gravity models.** The table shows the results from pooled OLS regressions (Columns 1-4) and pooled Poisson regressions (Columns 5-8) for the period 2013-2017. The dependent variable is a measure of inward FDI: *Total FDI* (Columns 1 and 5); *Phantom FDI* (Columns 2 and 6); and *Real FDI* (Columns 3-4 and 7-8). The explanatory variables are: *Host economy GDP* is the GDP of the economy hosting the investment; *Immediate investor economy GDP* is the GDP of the economy of the inmediate investor; *Ultimate investor economy GDP* is the GDP of the economy of the ultimate investor; *Bilateral distance* is the Euclidean distance between the economy of the investor and the economy of the investment; *Contiguity* is a dummy indicating whether the economy of the investor share a border; *Common language* is a dummy indicating whether the economy of the investment and the economy of the investor share a border; *Common language* is a dummy indicating whether the economy of the investment and the economy of the investor share a colony is a dummy indicating whether the economy of the investment and the economy of the investor or vice versa; *Former same country* is a dummy indicating whether the economy of the investment and the economy of the investor or vice versa; *Former same country* is a dummy indicating whether the economy of the investment and the economy of the investor or vice versa; *Former same country* is a dummy indicating whether the economy of the investment and the economy of the investor were formerly part of the same country. For the OECD economies reporting inward Total FDI are estimated (explained above).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS poole	OLS pooled cross-section			Poisson pooled cross-section			
	All FDI	Phantom FDI	Real FDI	Real FDI	All FDI	Phantom FDI	Real FDI	Real FDI
Host economy GDP	0.53***	-0.15	0.62***	0.67***	0.53***	0.15***	0.82***	0.81***
	(0.03)	(0.14)	(0.02)	(0.02)	(0.04)	(0.05)	(0.01)	(0.02)
Immediate investor economy GDP	0.65***	0.72***	0.66***		0.56***	0.56***	0.57***	
	(0.02)	(0.03)	(0.02)		(0.02)	(0.04)	(0.02)	
Ultimate investor economy GDP				0.69***				0.78***
-				(0.01)				(0.02)
Bilateral distance (in logs)	-0.82***	-0.76***	-0.87***	-0.85***	-0.68***	-0.80***	-0.66***	-0.62***
_	(0.04)	(0.12)	(0.04)	(0.04)	(0.06)	(0.10)	(0.06)	(0.04)
Contiguity	0.14	0.41	0.18*	0.27***	-0.57***	-1.74***	-0.10	-0.15
	(0.10)	(0.26)	(0.10)	(0.09)	(0.20)	(0.21)	(0.19)	(0.12)
Common language (official)	1.98***	3.89***	1.90***	1.82***	1.10***	1.11***	0.96***	0.98***
	(0.10)	(0.34)	(0.08)	(0.08)	(0.12)	(0.23)	(0.09)	(0.06)
Former colony	1.30***	1.27***	1.34***	1.30***	0.52***	0.48***	0.56***	0.53***
	(0.10)	(0.42)	(0.09)	(0.09)	(0.10)	(0.13)	(0.08)	(0.06)
Formerly same country	-0.06	0.02	0.05	0.02	1.34***	1.72***	1.20***	0.88***
	(0.13)	(0.37)	(0.13)	(0.13)	(0.08)	(0.14)	(0.09)	(0.09)
Constant	-4.13***	-0.86	-5.16***	-6.29***	-0.62	4.21***	-5.44***	-8.47***
	(0.42)	(2.09)	(0.40)	(0.40)	(0.73)	(0.86)	(0.43)	(0.46)
Observations	37,343	16,365	37,327	36,324	93,579	93,579	93,579	92,228
R-squared	0.27	0.14	0.30	0.33	-	-	-	-

Estimating gravity models in log-levels with OLS may lead to biased estimates because observations with zero FDI are dropped (Silva and Tenreyro, 2006). When we estimate the model on its multiplicative form with a Poisson estimator to retain zero observations, we obtain even more striking results: the coefficient on the market size variables increases from around 0.55 when considering Total FDI by immediate investor economy (Column 5) to around 0.80 when considering our estimates of Real FDI by ultimate investor economy (Column 8). This is consistent with the notion that standard FDI statistics systematically underestimate the real investment links between large economies because much of the investment is channeled through small offshore financial centers.

Many existing studies of FDI positions acknowledge the challenge posed by offshore financial centers and address it by excluding these economies from the analysis. Our approach has several conceptual advantages. First, as shown in Fig. 9, standard FDI statistics systematically underestimate the bilateral investment links between large economies because much of the Real FDI is channeled through offshore financial centers. Our Real FDI network accounts for these investments whereas simply excluding offshore financial centers does not. Second, some economies, e.g. Hong Kong SAR, the Netherlands and Singapore, combine large positions of Real FDI and Phantom FDI. Our approach accounts explicitly for this duality whereas the common practice of simply excluding offshore financial centers does not.

#### 3.4. Exposure to tax avoidance opportunities

Phantom corporations in low-tax economies give multinational firms a number of opportunities to avoid taxes in the high-tax economies where the real investments and the ultimate investors are located. First, phantom corporations may be the notional owners of financial assets (Clifford, 2019), intangible assets (Dischinger and Riedel, 2011) and patents (Karkinsky and Riedel, 2012), which generate income that would otherwise be booked and taxed in affiliates with real activities. Second, they may facilitate the use of hybrid financial instruments (Johannesen, 2014; Hardeck and Wittenstein, 2018), which artificially create deductible interest expenses to offset taxable business income. Third, they allow firms to accumulate and manage profits earned on foreign activities and thus postpone repatriation taxes in the ultimate investor economies (Foley et al., 2007). Fourth, they may serve to reduce or eliminate taxes on cross-border capital flows inside the firm by exploiting tax treaty networks (Weyzig, 2013; Arel-Bundock, 2017; van't Riet and Lejour, 2018) and other international tax agreements (Johannesen, 2012).

We attempt to quantify the exposure to these types of tax avoidance opportunities, by estimating, for each economy in the world, the share of its outward FDI where a foreign phantom corporation receives the investment and the share of its inward FDI where a foreign phantom corporation is the investor.

To estimate exposure to tax avoidance through outward FDI, we often need to assume that, for a given economy, the share of inward Total FDI into phantom corporations is the same for all counterpart economies. For instance, when Luxembourg reports



Fig. 10. Exposure to tax avoidance opportunities. Top panel: the figure shows for the 20 largest economies in the world (by GDP) the estimated share of outward Total FDI where the immediate investment is a foreign phantom corporation. Bottom panel: the figure shows for the 20 largest economies in the world (by GDP) the estimated share of inward Total FDI where the immediate investor is a foreign phantom corporation.

that around 95 percent of inward Total FDI is Phantom FDI, we assume that this share applies to all economies' outward FDI to Luxembourg. Similarly, when Sweden reports that only around 5 percent of inward Total FDI is Phantom FDI, we assume that this share applies to all economies' outward FDI to Sweden. Cross-sectional differences in our measure of exposure therefore, to a large extent, reflect differences in the counterpart economies of outward FDI. For instance, we will estimate a higher exposure for economies investing relatively more in Luxembourg than for economies investing relatively more in Sweden.

We illustrate estimated exposure to tax avoidance through outward FDI in Fig. 10 (upper panel) for the 20 largest economies in the world (by GDP). The cross-sectional variation is very significant: exposure ranges from less than 10 percent in Spain to more than 80 percent in Brazil. The relatively high estimated exposure for the United States (dark bar) is consistent with the argument that U.S. firms face particularly strong incentives to channel foreign investments through low-tax economies (Altshuler and Grubert, 2005).

To estimate exposure to tax avoidance through inward FDI, we need to make two types of assumptions. First, for economies not self-reporting FDI in SPEs and non-SPEs separately, we need an estimate of outward Phantom FDI. In self-reporting economies, we observe that the ratio between outward and inward Phantom FDI is close to unity in the aggregate.<sup>38</sup> Presumably, this reflects that the vast majority of phantom corporations are "pass-through" entities with inward and outward investment positions matching almost perfectly. We assume that the pattern is the same for non-reporting economies. Therefore, starting from the estimates of *inward* Phantom FDI obtained in section 3.3, we produce an estimate of *outward* Phantom FDI by applying the observed ratio between outward and inward Phantom FDI in the aggregate of reporting economies. Second, mirroring the assumption made above for inward FDI, we assume that, for a given economy, the share of outward Total FDI coming from phantom corporations is uniform

<sup>38</sup> The precise ratio varies between 1.15 and 1.18 over the period 2009-2017 reflecting that SPEs can also receive other types of financing, e.g. portfolio investment.

Exposure to tax avoidance opportunities. The table shows the results from OLS regressions for 2016. The dependent variable is the share of outward Total FDI where the immediate investment is a foreign phantom corporation (Columns 1-2) and the share of inward Total FDI where the immediate investor is a foreign phantom corporation (Columns 3-4). The explanatory variables are the headline corporate tax (Corp tax rate) and GDP per capita (GDP per cap).

	(1) (2) Share of outward FDI to SPE		(3) (4) Share of inward FDI from SP	
Corp tax rate	0.60**	0.68***	-0.02	0.01
	(0.26)	(0.26)	(0.16)	(0.17)
GDP per cap (in logs)		0.07		0.06*
		(0.05)		(0.04)
Corp tax rate $\times$ GDP per cap (in logs)		-0.35*		-0.23*
		(0.19)		(0.13)
Constant	0.14**	-0.52	0.26***	-0.27
	(0.06)	(0.48)	(0.04)	(0.32)
Observations	105	104	123	122
R-squared	0.05	0.09	0.00	0.03

across counterpart economies. For instance, Luxembourg reports that 95 percent of outward Total FDI is Phantom FDI, and we assume that this share applies uniformly to all economies' inward FDI from Luxembourg.<sup>39</sup>

We illustrate estimated exposure to tax avoidance through inward FDI in Fig. 10 (lower panel) for the 20 largest economies in the world (by GDP). The cross-sectional variation is somewhat smaller than for exposure through outward FDI: the estimates range from around 15 percent in Australia to around 60 percent in Russia. For the United States (dark bar), the contrast to Fig. 9 (upper panel) is striking: while more than half of its outward FDI is channeled through phantom corporations, only a bit more than one quarter of its inward FDI derives from such corporations.

Finally, we estimate how the estimated exposure to tax avoidance correlates with corporate tax rates and levels of economic development in the cross-section of economies. We estimate the following equation:

$$Y_h = \alpha + \beta 1 \operatorname{Tax}_h + \beta 2 \operatorname{GDPcap}_h + \beta 3 \operatorname{Tax}_h \times \operatorname{GDPcap}_h + \epsilon_h$$
(10)

where  $Y_h$  is a measure of exposure to tax avoidance in economy h, through outward and inward FDI respectively;  $Tax_h$  is the corporate tax rate in economy h and  $GDPcap_h$  is GDP per capita in economy h (measured relative to the sample mean so that *beta*2 can be interpreted as the local effect of taxes when GDP per capita is at the sample mean).

As shown in Table 5, exposure through outward FDI is significantly higher in economies with higher corporate tax rates: raising the tax rate by 10 percentage points is associated with an increase in exposure through outward FDI of more than 5 percentage points (Column 1). This is consistent with earlier literature highlighting the importance of taxation in the investor economy for the decision to operate through low-tax economies (Desai et al., 2006). The tax gradient is significantly steeper in less developed economies: at the lowest levels of GDP per capita, raising the tax rate by 10 percentage points is associated with an increase in exposure through outward FDI of more than 15 percentage points (Column 2). This is consistent with evidence that profit shifting responds more strongly to tax incentives in less developed economies where tax enforcement is weaker (Johannesen et al., 2020). Similar relationships emerge, but somewhat less clearly, for exposure through inward FDI (Columns 3-4).

#### 4. An application: the effect of taxation on FDI

Finally, we use the new database to revisit a canonical question in international taxation: the effect of a country's corporate tax rate on foreign direct investment in the country. There is a large literature investigating this question in many different contexts and using a range of empirical methodologies (e.g. Swenson, 1994; Hines, 1996; Mutti and Grubert, 2004).

We study whether our distinction between Real FDI and Phantom FDI matters for the answers to this question. Employing a gravity model similar to the one developed above, we investigate whether the estimated effect of corporate taxes differs across specifications that use standard FDI data and our measures of real FDI links.

As shown in Table 6, the estimates suggest that corporate taxes in the host economy have a large negative effect on its Total FDI: raising the tax rate by 10 percentage points is associated with a decrease in inward FDI of around 20% (Column 1). The point estimate is similar when estimating the model on its multiplicative form, but standard errors increase (Column 4). These estimates are in line with typical findings in the literature: a recent meta-study reports a median semi-elasticity of FDI with respect to the corporate tax rate of -2.49 based on 704 primary estimates (Feld and Heckemeyer, 2011).

The question arises whether this sizeable effect is driven primarily by *real responses* to taxation, foreign firms investing more in productive activities when taxes are low, or by *avoidance responses*, foreign firms concentrating more activities related to international tax planning (e.g. holding, financing, cash management) in low-tax economies. This is important for policy makers as it is plausibly

<sup>&</sup>lt;sup>39</sup> Figure A4 in the Online Appendix empirically assesses the assumption of uniform ratios across counterpart economies for the sample of economies where ratios are reported for each counterpart economy separately.

Tax rates and FDI. The table shows the results from pooled OLS regressions (Columns 1-3) and pooled Poisson regressions (Columns 4-6) for the period 2013-2017. The dependent variable is a measure of inward FDI: *Total FDI* (Columns 1, 3, 4 and 6) and *Real FDI* (Columns 2 and 5). The main explanatory variable is the corporate tax rate in the host country. The model also includes the following standard gravity controls (coefficients not reported): Host economy GDP, Immediate investor economy GDP (Columns 1, 2, 4 and 5), Ultimate investor economy GDP (Columns 3 and 6), Bilateral distance, Contiguity, Common language, Former colony, Former same country. The sample all includes economies with available data (Columns 1, 2, 4 and 5) or excludes offshore financial centers with a population below one million (Columns 3 and 6).

	(1) OLS poole	(2) d cross-sectio	(3) m	(4) Poisson p	(5) ooled cross-se	(6) ection
VARIABLES	All FDI	Real FDI	Exclude Small OFCs	All FDI	Real FDI	Exclude Small OFCs
Corporate tax rate	-1.95** (0.90)	-0.27 (0.68)	-1.55* (0.83)	-1.62 (1.36)	0.05 (0.49)	-2.90*** (0.80)
Standard gravity controls Observations R-squared	YES 31,968 0.28	YES 30,962 0.33	YES 30,128 0.29	YES 71,450	YES 70,248	YES 67,524

only the former responses that affects productivity and growth, although Phantom FDI could have a positive impact on public finances in low-tax economies.

The results indicate that the effect of corporate taxes almost vanishes when we restrict attention to Real FDI: raising the tax rate by 10 percentage points is associated with a decrease in FDI of around 2.7%, which is not significantly different from zero (Column 2). When estimating the model on its multiplicative form, the point estimate is almost precisely zero (Column 5). The results suggest that lower taxes only to a limited extent, if at all, attract real foreign investment into active businesses.

We also take an alternative and simpler approach to addressing the challenge posed by Phantom FDI: Using standard data for Total FDI while excluding small offshore financial centers where Phantom FDI is expected to be of particular importance from the estimating sample.<sup>40</sup> This approach produces significantly negative estimates in roughly the same range as the baseline (Columns 3 and 6).

While the estimating framework is crude and the results therefore do not represent conclusive evidence, the analysis suggests that the economically important effect of corporate taxes on inward FDI found in many previous studies may largely be driven by phantom rather than real investment responses. The results also suggest that the simplest approach to isolating real investment responses - excluding offshore investment centers from the estimation sample - does not effectively achieve this goal.

#### 5. Conclusion

Standard FDI statistics are distorted by offshore centers with enormous inward and outward investment positions. The first part of the paper documents the estimation of the global FDI network with a decomposition of Total FDI into Real FDI, relations between ultimate investors in one economy and substantial business activities in another, and Phantom FDI, investment into empty corporate shells with no substance and no real links to the local economy. The second part describes key features of the estimated FDI network. Our estimates imply that Phantom FDI has grown at a faster pace than Real FDI over the last decade and accounts for around \$15 trillion, almost 40 percent of Total FDI, globally. Most of the world's Phantom FDI is in a small group of well-known offshore centers: Luxembourg (\$3.8 trillion), the Netherlands (\$3.3 trillion), Hong Kong SAR (\$1.1 trillion), British Virgin Islands (\$0.8 trillion), Bermuda (\$0.8 trillion), Singapore (\$0.8 trillion) and the Cayman Islands (\$0.7 trillion). The real FDI links between the largest economies in the world are much higher than implied by standard FDI statistics based on immediate ownership because a significant share of FDI is channeled through offshore centers.

## CRediT authorship contribution statement

Jannick Damgaard, Thomas Elkjaer and Niels Johannesen have contributed equally to all parts of the paper.

## Appendix A. Method overview

#### Macro source variables:

- FDI<sub>bit</sub>: inward FDI position in economy h vis-a-vis immediate investors in economy i in year t reported by h (CDIS)
- $FDI_{bit}^{mirror}$ : inward FDI position in economy h vis-a-vis immediate investors in economy i in year t reported by i (CDIS)
- Real  $FDI_{ht}^{OECD}$ : inward FDI position in economy h in non-SPEs in year t across all investor economies (OECD)
- Real FDI-II  $_{hit}^{OECD}$ : inward FDI position in economy h in non-SPEs in year t vis-a-vis immediate investors in economy i (OECD)
- Real FDI-UI $_{hit}^{OECD}$ : inward FDI position in economy h in non-SPEs in year t vis-a-vis ultimate investors in economy i (OECD)

<sup>&</sup>lt;sup>40</sup> The classification of offshore financial centers follows Section 2.3. Small refers to economies with a population less than 1 million.

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## Micro source variables:

- *investment*<sub>c,h</sub>: value of the investment in corporation c located in economy h in 2016 (Orbis)
- $\theta_{c,hi}$ : share of corporation c located in economy h controlled by ultimate investors in economy i in 2016 (Orbis)
- $\lambda_{c,hi}$ : share of corporation c located in economy h controlled by immediate investors in economy i in 2016 (Orbis)

## Data coverage:

- $\mathbb{R}$ : Set of economies reporting bilateral FDI positions to CDIS
- Q<sup>bil</sup>: Set of economies reporting bilateral FDI into SPEs and non-SPEs to the OECD Statistics
- Qagg: Set of economies reporting aggregate FDI into SPEs and non-SPEs to the OECD Statistics
- ℤ: Set of economies reporting FDI in non-SPEs by ultimate investor economy to the OECD Statistics
- $\mathbb{H}$  is the set of corporations located in economy *h* covered in the Orbis database
- $\mathbb{W}$  is the set of corporations located anywhere in the world covered in the Orbis database

## Step (1): Bilateral positions of Total FDI

$$FDI_{hi,t} = \begin{cases} FDI_{hi,t}^{own} & \text{if } h \in \mathbb{R} \\\\ \gamma_t \cdot FDI_{hi,t}^{mirror} & \text{if } h \notin \mathbb{R} \text{ and } i \in \mathbb{R} \end{cases}$$
(11)

where

$$\gamma_t = \frac{\sum_{h \in \mathbb{R}} \text{FDI}_{hi,t}^{uon}}{\sum_{i \in \mathbb{R}} \text{FDI}_{hi,t}^{mirror}}$$
(12)

Step (2): Decompose Total FDI into Real FDI and Phantom FDI

$$\operatorname{Real} \operatorname{FDI-II}_{hi,t} = \begin{cases} \operatorname{Real} \operatorname{FDI-II}_{hi,t}^{OECD} & \text{if } h \in \mathbb{Q}^{bil} \\ \omega_{h,t} \cdot \operatorname{FDI}_{hi,t} & \text{if } h \in \mathbb{Q}^{agg} \\ \omega_{h,t} \cdot \operatorname{FDI}_{hi,t} & \text{if } h \notin \mathbb{Q}^{agg}, \mathbb{Q}^{bil} \end{cases}$$
(13)

Phantom FDI-II<sub>$$hi,t$$</sub> = FDI <sub>$hi,t$</sub>  – Real FDI-II <sub>$hi,t$</sub>  (14)

where

$$\omega_{h,t} = \frac{\text{Real FDI-II}_{h,t}^{OECD}}{\text{FDI}_{h,t}} \text{ if } h \in \mathbb{Q}^{agg}$$
(15)

$$\omega_{h,t} = \exp\left[\hat{\alpha} + \hat{\beta}\log(\frac{\text{FDI}_{h,t}}{\text{GDP}_{h,t}})\right] \text{ if } h \notin \mathbb{Q}^{agg}, \ \mathbb{Q}^{bil}$$
(16)

and where  $\hat{\alpha}$  and  $\hat{\beta}$  are obtained from estimating:

$$\log\left(\frac{\text{Real FDI}_{h,t}^{OECD}}{\text{FDI}_{h,t}}\right) = \alpha + \beta \log\left(\frac{\text{FDI}_{h,t}}{\text{GDP}_{h,t}}\right) + \varepsilon_{h,t}$$
(17)

## Step (3): Allocate Real FDI to ultimate owner economies

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$$\text{Real FDI-UI}_{hi,t} = \begin{cases} \text{Real FDI-UI}_{hi,t}^{OECD} & \text{if } h \in \mathbb{Z} \\ \zeta_{h,t} \cdot \delta_{hi} \cdot \text{Real FDI-II}_{hi,t} & \text{if } h \notin \mathbb{Z} \text{ and } h \neq i \end{cases}$$
(18)

$$\zeta_{h,t} \cdot \sigma_h \cdot \sum_j \text{Real FDI-II}_{hj,t} \quad \text{if } h \notin \mathbb{Z} \text{ and } h = h$$

where the conversion factor  $\delta_{hi}$  is defined as:

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$$\delta_{hi} = \begin{cases} \frac{\sum_{c \in \mathbb{H}} \theta_{c,hi} \ investment_{c,h}}{\sum_{c \in \mathbb{H}} \lambda_{c,hi} \ investment_{c,h}}} & \text{if } \frac{\sum_{c \in \mathbb{H}} \lambda_{c,hi} \ investment_{c,h}}{\text{Real FDI-II}_{hi,t}} \in \left[\frac{1}{2}, \frac{3}{2}\right] \\ \frac{\sum_{c \in \mathbb{W}} \theta_{c,hi} \ investment_{c,h}}{\sum_{c \in \mathbb{W}} \lambda_{c,hi} \ investment_{c,h}}} & \text{if } \frac{\sum_{c \in \mathbb{H}} \lambda_{c,hi} \ investment_{c,h}}{\text{Real FDI-II}_{hi,t}} \notin \left[\frac{1}{2}, \frac{3}{2}\right] \end{cases}$$
(19)

where the round-tripping factor  $\sigma_h$  is defined as:

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$$\sigma_{h} = \frac{\sum_{c \in \mathbb{H}} \theta_{c,h} investment_{c,h}}{\sum_{c \in \mathbb{H}} \lambda_{c,i} investment_{c,h}}$$
(20)

and where  $\zeta_{h,t}$  is a final correction factor ensuring that

$$\sum_{i} \text{Real FDI-UI}_{hi,t} = \sum_{i} \text{Real FDI-II}_{hi,t} \quad \text{for all } h, t$$
(21)

#### Appendix B. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jimonfin.2023.102971.

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