China's Intellectual-property Supply Chain and Evidence of Under-reported U.S. to Tax Haven Transactions

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Abstract: This paper identifies mispriced intellectual property transfers to tax-haven countries as they supply intellectual property to China. The analysis relies on unique country-level bilateral data on services trade. We find evidence consistent with a pattern of under-reported intellectual property values that move from the US to a third country and ultimately to China. The proportional distortion is roughly 35%. The sizeable distortion, however, is less apparent when we aggregate to total services, of which intellectual property is a component.

Keywords: multinational enterprises; transfer pricing; misrepresenting intellectual property trade; tax havens

1. Introduction

International trade in intangible activities offer opportunities for multinational enterprises (MNEs) to avoid taxes. Multinational companies operating affiliates in low-tax jurisdictions may transfer intellectual property to their affiliates at a low distorted price. The low transfer price to the affiliate lowers the MNEs source-country tax liability. The affiliate may then collect license fees and royalties in the tax haven where profits are taxed at a low rate. While discussed in the theory of MNEs, there is limited empirical evidence of this behavior, especially in publicly-available trade data.

This paper identifies mispriced intellectual property transfers to tax-haven countries as they supply intellectual property to China. The analysis relies on unique country-level bilateral data on services trade. We find evidence consistent with a pattern of under-reported intellectual property values that move from the US to a third country and ultimately to China. The proportional distortion is roughly 35%. The sizeable distortion, however, is less apparent when we aggregate to total services, of which intellectual property is a component.

There are several cases showing that multinational firms use various methods to relocate their intellectual property. Apple, for example, set up affiliates in Ireland such that its manufacturing partners paid royalties and license fees through

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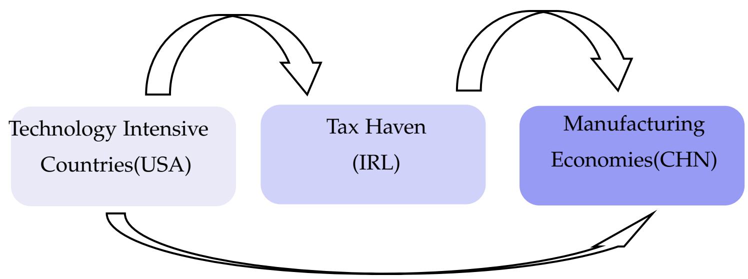

Figure 1. An example of Intellectual Property Transaction Mode

these affiliates, rather than accumulating these revenues in the United States. In this way, Apple recorded the use of intellectual property and charges stemming from these transactions in Ireland (Barrera and Bustamante, 2018; Duhigg and Kocieniewski, 2012). For the scheme to work Apple needs to transfer the value of the intellectual property to its affiliate at a discount to avoid taxation of that full value in the United States. Figure 1 illustrates a general setup where a MNE builds a transaction chain through a tax haven to ultimately sell intellectual property to a destination country, like China, where manufacturing takes place. If the MNE is able to distort (lower) the initial sale price to the tax haven, it will reduce its overall tax liability conditional on the value embodied in the intellectual property.

The issue of profit shifting within multinational enterprises has been discussed in recent years. Most of the literature focuses on the fact that multinational enterprises shift reported earnings into tax haven affiliates to avoid or minimize taxation. Hines and Rice (1994) point out that American companies locate a sizeable fraction of their foreign activity in tax havens. It appears, however, that this fraction includes reported profits that would not normally be earned by the quantities of factors employed by the haven affiliates. Dharmapala (2014) gives a comprehensive survey of the empirical literature on this topic with a cross-country analysis of MNEs' profits on tax rates. These studies support that low-tax jurisdictions attract more profit shifting. Among the existing literature, some discussed that services trade plays a more important role in profit shifting than goods trade. Guvenen et al. (2022) find that profit shifting is concentrated in firms with significant R&D spending. And also, they estimate that the adjusted services trade balance is 2.2 percent of GDP in 2016, which is larger than the unadjusted value, 1.4 percent of GDP. Karkinsky and Riedel (2012) estimate that an increase in the corporate tax rate by 1 percentage point reduces the number of patent applications by 3.8% for European Union countries. There are very few papers related to mispriced services trade in the literature. Hebous and Johannesen (2021) find that trade with affiliates in tax havens is heavily skewed towards imports and the internal service providers in tax havens earn significant excess returns based on German firm-level data. Our analysis adds to the literature that studies mispriced services trade at the aggregated level. A mispriced transfer refers to a situation where the true value of assets being transferred is not accurately reflected in the reported value.

Generally, MNEs in service industries are more likely to invest in tax havens (Mutti and Grubert, 2009; Taylor, Richardson, and Lanis, 2015; Gumpert, Hines, and Schnitzer, 2016; Merle, Al-Gamrh, and Ahsan, 2019). In this paper, we assume that technology-intensive MNEs with more intangible assets have a higher possibility of having affiliates in tax havens. Therefore, we emphasize charges for the use of intellectual property instead of total services or any other categories of services trade. As we discussed, the location of the intellectual property determines where the associated income is taxed. MNEs move intangible assets to low-tax affiliates at a price below their true value and charge high-tax affiliates for the use of the intangible assets, which means transfer pricing of intangible-asset services. Our aim in this paper is to examine if this effect exists in the trade data. The paper empirically assesses these estimations based on the gravity equation, widely used in international trade. In this paper, we employ the bilateral services trade data, which WTO publishes instead of using firm-level survey data. We confirm that enterprises located in the U.S. under report the true value when they transfer intellectual property to tax havens. And the proportional distortion is roughly 25%. Moreover, the distortion effect is insignificant in total services.

This paper proceeds as follows. Section 2 summarizes the exisiting studies. Section 3 describes the econometric strategy and hypotheses. The data are detailed in section 4, while the estimation results are discussed in Section 5. Finally, Section 6 concludes.

2. Background and Previous Analysis

2.1 Literature Review

The use of tax havens by MNEs as a tool for profit shifting has attracted increasing attention in recent years. This topic has been analyzed from multiple perspectives, which is critical to understand the role of tax havens as well as the global business operations of MNEs. The notably primary research can be dated back to the early 1990s. Based on aggregated data at the country level, Hines and Rice (1994) and Grubert and Mutti (1991) support that MNEs shift more profits to low tax jurisdictions by setting up affiliates. As the availability of micro-level data increases, there are more studies focusing on affiliate-level analysis of individual MNEs and their affiliates. For example, Laffitte and Toubal (2022) estimate that $66 billion to $85 billion of profits were shifted using sales shifting in 2013, a substantial proportion of the total amount shifted by US firms to tax haven countries. In addition, a multinational can manipulate its transfer prices for international intrafirm transactions. Using a panel of 128 trading pairs over 11 years, Kellenberg and Levinson (2019) find general evidence of tariff evasion effects through underreporting bilateral trade for country pairs who are not members of a regional trade agreement (RTA). The existing micro-level literature, mainly based on the BEA dataset and focused on the United States, finds evidence of profit shifting through the manipulation of transfer prices.Clausing (2003) finds that a tax rate 1% lower in the country of destination/origin is associated with intrafirm export prices that are 1.8% lower and intrafirm import prices that are 2.0% higher, relative to non-intra firm goods. This pattern exists in other countries. This finding has been supported by the following research (Gravelle, 2009; Kellenberg and Levinson, 2019; Guvenen et al., 2022) Cristea and Nguyen (2016) use a firm-level dataset of Danish exports in tangible goods between 1999-2006 and find that Danish multinationals reduce the unit values of their exports to low tax jurisdictions between 5.7 to 9.1 percent compared to the true reference comparable uncontrolled prices that conform with the arm's length principle, which corresponds to a tax revenue loss of 3.24 percent of Danish multinationals' tax revenues. Overesch (2006) uses a panel data of German multinationals and finds a significantly negative impact of the local tax rate on the size of balance sheet items, which suggests that transfer pricing of intrafirm sales constitutes an important channel of companies' profit shifting activities.

More recently, the transfer of intangible assets between different jurisdictions has attracted increasing attention from tax authorities and academics. Department of the Treasury (2007) asserts that there is a large risk of tax revenue erosion through the transfer of high-value intangible assets between related entities located in high/low-tax jurisdictions. Also, the lack of well-established markets and subjective valuations of intangible assets provide firms with the convenience to engage in transfer pricing aggressiveness through the transfer of intangible assets between variably-taxed jurisdictions. Dharmapala (2020) points out that haven affiliates disproportionately receive royalties and license fees based on the U.S. Bureau of Economic Analysis (BEA) datatset. It shows that about two-thirds of the royalty and license fee receipts of the foreign affiliates of US MNEs in 2014 were earned by haven affiliates. Noteworthily, this is driven almost entirely by royalties and license fees paid by foreign non-haven affiliates to haven affiliates instead of by royalty payments from the US parent to haven affiliates (about 90% of haven affiliates' royalty and license fee receipts are from non-US entities). Dischinger and Riedel (2011) find that intangible asset holdings are disproportionately concentrated among affiliates in low-tax jurisdictions with using the balance-sheet item 'intangible fixed assets' from Amadeus data on European affiliates. But there are very few analyses focusing on mispriced intangible asset transfers in the literature.

2.2 Economic incentives for misreporting

There are incentives for under-reporting exports at the U.S. border. The transfer pricing literature suggests that there are incentives to under-price U.S.intra firm exports to low-tax countries. Bernard, Jensen, and Schott (2006) estimate that exports are underreported by $1.9 billion in 2004 with a corresponding tax loss of $666 million. The average U.S. corporate income tax rate through the sampling years was about 35%. But, the affiliates located in Ireland are able to pay taxes at the 12.5 percent Irish corporate rate (or its patent box rate of 6.25 %) when they transfer the use of intellectual property to other destination countries. US tax law treats royalty income received by a foreign affiliate as US-source income (subject to full and immediate US taxation) if "rentals or royalties from property located in the United States or from any interest in such property, including rentals or royalties for the use of or for the privilege of using in the United States patents, copyrights, secret processes and formulas, good will, trade-marks, trade brands, franchises, and other like property.[1]" Since the transaction between haven affiliates and the other countries is more likely to happen multiple times, it will decrease the global tax bills by a large amount to transfer intellectual property to tax havens at a lower price and resell it to other countries at a higher price compared to selling it directly to destination countries at the higher price.

Despite the differential tax rates, why MNEs focus on intangible assets? One possible explanation could be the difficulties faced by the tax authorities to determine and regulate the arm's length price[2]. Even though tax authorities generally put efforts to limit transfer pricing by requiring trade between affiliates to be carried at arm's length prices (Hejazi, 2006), the effectiveness is constrained in the transaction of the intellectual property due to the intangible nature. Brauner (2008) point out that there are three main approaches to value intangible assets. First is the market approach. That is, using market transactions to produce or substantiate values or prices in comparable nonmarket transactions. Second is the cost approach, where input expenditures are used to value intangibles and assess their value. Third is the income approach, which would value the income stream expected from an asset. In application having disparate approaches to asset valuation can be problematic. International transaction inevitably involves at least two jurisdictions for the purpose of transfer pricing, and these jurisdictions may have different approaches to valuing intellectual property. Multinational firms have the flexibility to manipulate the sale of the asset as well as royalty payment assignment for trademarks and patents. Giving them substantial latitude relative to transfer pricing of physical-commodity transactions.

Fundamentally, intangible asset transfers are more difficult to observe by tax authorities than tangible assets. For instance, while a tangible good may be produced, stored, moved, and consumed across the borders of countries, the transaction can be captured at Customs checkpoints. In contrast, intellectual property transfers do not require physical cross-border transactions, implying that the international trading of services is difficult to track and record.

[1] 26 U.S.C. § 861.

[2] Arm's length price principle means that the price charged by one related entity to another must be the same as it would have been if the parties were not related.

3. Model

3.1 Empirical Specification

In this paper, we explain intellectual property imports of China from any number of source countries i, which are either tax havens or not. We including as a key explanatory variable the exports of intellectual property from the United States to country i. The key trade data, exports from the United States and imports by China, are consistently measured by their respective authorities.[3] Furthermore, US-based multinationals seeking to avoid or evade taxes are of primary interest in the transfer pricing literature (e.g., Zucman, 2014), and China as the largest manufacturing economy is a key purchaser of intellectual property originating in the United States. We are able to address our central research question regarding the US to China intellectual-property supply chain while avoiding a major data problem by restricting ourselves to the Chinese import and US export data.

We rely on a typical gravity-regression to analyze the data. Anderson and Van Wincoop (2003) use an Armington (1969) demand system in general equilibrium to develop a theory-consistent gravity equation. Let the value of trade from i to j be given by X_{ij}. Income in region i is Y_i, and global income is the sum of each country's income, $Y^W \equiv \sum_i Y_i$. Bilateral trade costs are represented by the variable t_{ij}, and Anderson and Van Wincoop (2003) develop the theory-consistent country-specific inward and outward indexes of trade resistance P_j and Π_i. The gravity equation is given by

$$X_{ij} = \frac{Y_i Y_j}{Y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}, \tag{1}$$

where σ is the elasticity of substitution between regional varieties.[4] Taking the log of both sides indicates a linear relationship that might be estimated using Ordinary Least Squares (OLS).[5] Empirically, if trade-costs are directly related to bilateral distance, d_{ij}, this suggests a source and destination fixed-effects gravity specification:

$$\ln X_{ij} = \beta_0 + \gamma_i + \delta_j + \rho \ln d_{ij} + \epsilon_{ij}, \tag{2}$$

[3] Exports from the United States are from United States' reporting, and imports by China are from China's reporting. Limiting our trade data to these sources limits the problem of reporting inconsistencies, which are rampant in the BaTiS data. For example, intellectual property exports to China as measured by tax-haven countries is inconsistent with China's measured imports. In section 4 we illustrate the nature of these inconsistencies.

[4] *Yotov et al. (2016)*

[5] Resent authors have advocated the use of Poisson Pseudo Maximum Likelihood (PPML) estimators for the gravity specification (starting with Santos Silva and Tenreyro, 2006). We consider this strategy in section 5.5, and reject it in favor our central OLS specifications. See section 5.5 for more details.

where γ_i controls for $\ln\left(Y_i \Pi_i^{\sigma-1}\right)$ and δ_j controls for $\ln\left(Y_j P_j^{\sigma-1}\right)$. The parameter ρ indicates the distance elasticity, and ϵ_{ij} is the bilateral error. The intercept would be expected to approximate the log of the square of the omitted region's income divided by global income. In application, to a particular good k source income would be replaced with supply of k in region i, and destination income would be replaced with demand of k in region j. Global income would also be replaced by global demand for good k. Running the gravity model at the level of a particular good, however, does not change the basic fixed-effects specification in Equation 2.

For our purpose in this paper, we want to both simplify and extend the basic gravity specification while applying it to intellectual property trade. First, we have panel data, so we include a time index and time fixed effects captured in the estimated η_t. Second, we can eliminate the destination index and fixed effects because we only use reported imports into China. Thus the dependent variable is $X_{it} \equiv X_{i,\mathrm{CHN},t}$. Next we extend the set of regressors to controls for source-country characteristics explicitly. In addition to the source country's size, as measured by GDP_{it} and the distance from i to China (d_i), we include a dummy variable that indicates if country i is a tax haven, $TH_i \in \{0,1\}$. We also include country-i's imports of intellectual property from the United States in the variable IMP_{it}, as well as an interaction between these imports and the tax-haven indicator. As further control characteristics of country i in some specifications, we include FDI_{it}, which is total foreign direct investment inflows into i. Our central empirical specification is given by

$$\begin{aligned} ln(X_{it}) &= \beta_0 + \beta_1 ln(GDP_{it}) + \beta_2 ln(d_i) + \beta_3 TH_i + \beta_4 ln(IMP_{it}) \\ &\quad + \beta_5 TH_i * ln(IMP_{it}) + \beta_6 ln(FDI_{it}) + \eta_t + \epsilon_{it} \end{aligned} \tag{3}$$

Where the central independent variable of interest is the interaction between TH_i and $ln(IMP_{it})$.

3.2 Hypotheses

The standard gravity model has predictions of positive and negative GDP and distance coefficients, respectively. In addition, we expect a positive effect of tax-haven and overall imports of intellectual property on the volume of country i's exports of intellectual property to China. That is, we expect $\beta_3 > 0$ and $\beta_4 > 0$.

The central hypothesis is that the sign of the interaction of these two effects would also be positive, $\beta_5 > 0$. To combine the regression equation and the incentive of multinational companies to under-report the true value of intellectual property when they transfer to tax havens. Below, we use a simplified equation (3) to illustrate $\beta_5 > 0$. (Let X and M denote ..., respectively) Let X denote the exports of intellectual property to China and M denote the exports from the United States to country i. We use M^* to represent the true value of imports of charges for the use of the intellectual property and M^R as the reported value of that. The impact of imports on exports can be written as:

$$X = a + b \cdot M^* \tag{4}$$

For non tax havens, we assume that the reported value equals the true value, which means $M^* = M^R$. Assuming k is the ratio of reported value of intellectual property to the corresponding true value for tax havens, the true value of imports and the impacts of imports on exports in a tax haven is given by

$$TH : M^* = \frac{M^R}{k} \quad \text{and} \quad X = a + \frac{b}{k} \cdot M^R + \epsilon \tag{5}$$

Combining the above equations, we can rewrite Equation 4 as:

$$X = a + b \cdot M^R + (\frac{b}{k} - b) \cdot M^R \cdot TH + \epsilon, \tag{6}$$

where TH is a dummy variable indicating whether the country is a tax haven or not.

If the true volume of imports is larger than the reported value, we will expect that we can compute k is less than 1. As a result, $(\frac{b}{k} - b)$ should be positive. We assume that tax havens and non tax havens have the same conversion rate (b). Conversion rates measure the ratio of a country to use 1 unit of import to generate b units of exports. For example, It can capture the difference between different countries to use the imports from the United States to generate more exports to China. Even though b might be different for tax havens and non tax havens in reality, it is more likely that tax havens have lower b parameters, which means tax havens have less local production ability(See e.g., Palan, Murphy, and Chavagneux (2010)). In this case, k would be smaller than when b is identical for tax havens and non tax havens, which means our conclusion of under-reporting is strengthened.

(more discussion on what country fundamentals determine b)

In Figure 2, on the vertical and horizontal axis, we plot exports and imports separately. According to the hypotheses, the slope for non tax haven is β_4, which is depicted in the black solid line. The red dashed line represents the relationship for tax havens with the slope as the sum of β_4 and β_5. As shown in the figure, given the export level, tax havens have lower reported imports compared to non tax havens. The difference between IMP and IMP^{TH} is tax havens' distortion. We measure the ratio of mismeasurement in tax havens μ as:

$$\mu = \frac{M^* - M^R}{M^*} = 1 - k = 1 - \frac{\beta_4}{\beta_4 + \beta_5} = \frac{\beta_5}{\beta_4 + \beta_5} \tag{7}$$

proposition

4. Data

The primary data source for trade in services, including specifically intellectual property is the Balanced Trade in Services Datasets (BaTiS) published by the

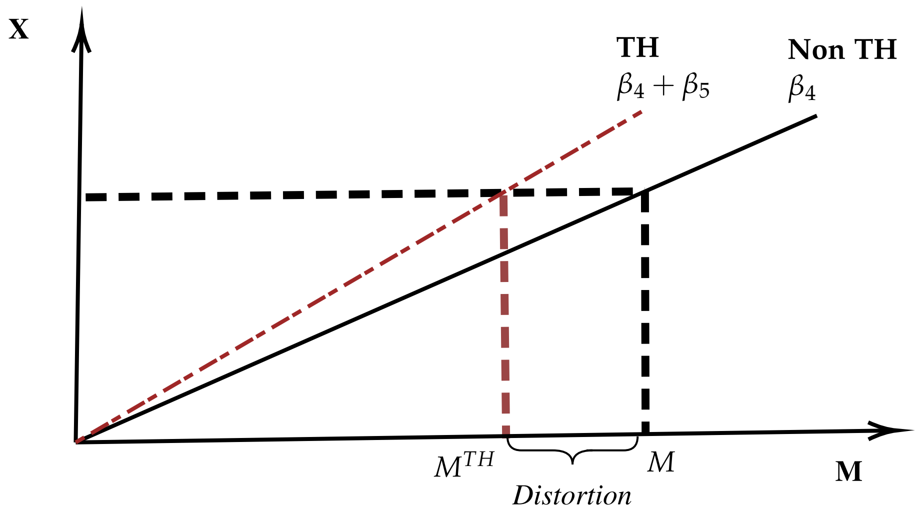

Figure 2. Graphical Explanation of Under Reported Transfers to Tax Havens

OECD and the WTO. The BaTis data cover about 200 source and destination countries from 2005 to 2019 for 12 categories in addition to total services. These data have been analyzed primarily to consider the question of modes of international services provision.[6] To our knowledge, these data have not been used to explore the impact of profit shifting on trade statistics.

For each pair of country i and j BaTis reports export to j as published by country i's authority, and also import from i as published by country j's authority. In our central regressions, we focus on explaining country i's exports of intellectual property to China as reported by China. The variable X_{it} is the value of intellectual property trade from country i to China in time period t. We also utilize BaTis data to control for county i's imports of intellectual property from the United States as reported by the United States. Imports if intellectual property by country i from the United States is denoted IMP_{it}. We rely on the United States's report of trade flows to country i, and China's report of inflows to avoid the issue of systematically unreliable reporting by tax havens relative to countries that are not tax havens. To illustrate the problem consider the differences in country i's exports to China as reported by country i versus the same trade flow as reported by China. In Figure 3 the trade reported by tax havens is much smaller than what China records, whereas for the six non-tax-havens countries with the largest intellectual property exports to China there is more consistent reporting[7].

To characterize tax havens (TH_i), we use the definition proposed by Guvenen et al. (2022), which includes the following nine countries: Ireland, Luxembourg, Netherlands, Switzerland, Barbados, Bermuda, Hong Kong, Singapore,

[6] *See e.g.(Tajoli, Airoldi, and Piccardi, 2021; Visagie and Turok, 2021; van der Marel, 2022)*
[7] Six non-tax-havens countries with the largest intellectual property exports to China: France, Germany, Japan, South Korea, Sweden, and the United States.

and United Kingdom Islands. Hines and Rice (1994) define tax havens as follows:

> In general, tax havens are locations with low Lax rates, and as such they are attractive to business. However, since rational Firms maximize after-tax profits – which is not the same thing as minimizing taxes (the latter, for example, satisfied by making losses) – low tax rates alone do not make successful havens. The business literature usually describes tax havens in terms of four attributes that, taken together, make a location particularly desirable: (i) low corporate or personal tax rates; (ii) legislation that supports banking and business secrecy; (iii) advanced communications facilities; and (iv) sell-promotion as an offshore financial center.

Throughout the paper, we choose to rely on the binary tax haven indicator rather than a continuous tax rate variable because of the difficulties associated with the measurement of effective taxation in tax havens. Also, Hines and Rice (1994) point out that a tax haven must have a legal system allowing banking secrecy and a good communication infrastructure, and it must seek to promote itself as a center for financial offshoring, in addition to a low tax rate. TH_i was assigned the value 1 for the nine identified countries listed above.

Regressors also included other source-country i and country i to China controls which were informed by data other than BaTis. First, the economic size of country i is proxied by nominal GDP (GDP_{it}) sourced from the World Bank's World Development Indicators. Second, the distance from country i to China (d_i) is sourced from the CEPII GeoDist database on bilateral distances. We use a measure of weighted distance as described by Mayer and Zignago (2011).[8]. Arguably, this offers more precise measurements than physical distance between the relevant agents of the countries. We also include the Foreign Direct Investment (FDI) inflows into country i as a regressor. These data are from the World bank.

4.1 summary statistics

1) Do tax havens export more IP to China than non-tax-havens after normalizing the size? For each country (such as Ireland and France), calculate IP export / manufacturing export to China.
2) DO tax havens import more IP from the US than non-tax-havens after

[8] The weighted distance is computed based on the two larges cities for the countries and using city-level data to assess the geographic distribution of the population(in 2004) inside each nation based on the equation

$$d_{ij} = (\sum_{k \in i}(pop_k/pop_i)(\sum_{l \in i}(pop_l/pop_i)d_{kl}^{\theta})^{1/\theta} \quad (8)$$

The weighted distance can avoid the mechanic upward bias in the border effect estimate resulting from any overestimate of the internal/external distance ratio.

normalizing the size?

3) It might be possible to see that relative to how much they export to China, they import much less from the US. From (1) you might see that TX exports (IP/manu) 50% more to China, but only imports 30% (IP/manu) from the US.
4) When showing the summary statistics, calculate the TH and NTH's menas for IP trade and IP/manu trade.

5. Results

In this section, we report evidence that intellectual property flows to tax havens are under-reported. The dependent variable in our empirical regressions is, again, the value of China's imports from a source country. The key independent variables of interest are the U.S. exports to the source country IMP_{it} and its interaction with the designation of the source country as a tax haven. In subsection 5.1 we present our central set of results. In subsequent subsections, we explore the fragility of these results. In subsection 5.2 we show that our coefficients of interest become insignificant when we regress on total services (rather than the specific category of intellectual property). In subsection 5.3 we consider expanding the definition of IMP_{it} to include the exports of intellectual property from OECD countries (rather than focusing on the U.S.), and we consider expanding the definition of the dependent variable to include manufacturing-oriented economies beyond China.[9] When we expand the country coverage we lose power in the data, but our central coefficients are still marginally significant. Finally, in subsection 5.4 we consider the effect of altering the sample period to include the years following the U.S. tax reform of 2017. When we expand to include the tax reform years, again, we lose power and our central coefficients are only marginally significant.

5.1 Baseline specification

Table 1 shows the results of the central specification. Year fixed effects and the gravity controls of distance to China and source-country income are always included, as well as the tax-haven dummy variable. In column (2) we add imports of intellectual property from the United States. In column (3), we include the interaction, and in column (4), we add source-country FDI inflows.

The coefficients on the gravity controls of income and distance are consistent with expectations.[10] Tax-haven designation increases the propensity of China to

[9] Country list: China, United States, Japan, Germany, Korea, Italy, India, France, United Kingdom, Brazil, Russia, Mexico, Indonesia, Canada, Spain, Turkey, Thailand, and Australia. and see section 5.3 for an explanation.

[10] Head and Mayer (2014) provide the mean estimates of typical gravity variables based on a large set of papers. The mean coefficient on the origin GDP is 0.98, while the mean coefficient on distance is -0.93. The magnitude of our estimates on distance is less than the average distance elasticity, indicating we find weaker distance effects focusing on

Table 1. Central Regression Results

Dependent variable: China's imports of intellectual property	(1)	(2)	(3)	(4)
GDP_{it}	0.735***	0.781***	0.776***	0.190***
	(0.042)	(0.043)	(0.044)	(0.085)
$Weighted\ distance_i$	-0.445***	-0.390***	-0.387***	-0.460***
	(0.155)	(0.147)	(0.148)	(0.154)
$TaxHaven_i$	6.677***	3.859***	2.461***	0.337
	(0.183)	(3.859)	(2.461)	(1.258)
$IMP_{it}(fromUS)$		0.595***	0.595***	0.566***
		(0.025)	(0.025)	(0.027)
$TH_i * IMP_{it}$			0.193***	0.304**
			(0.111)	(0.150)
$FDI\ Inflows_{it}$				0.699***
				(0.080)
Year FE	YES	YES	YES	YES
N	1984	1984	1984	1876
R-sq	0.404	0.557	0.557	0.569

*Note: Standard errors are clustered at country level in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)*

import intellectual property across the specifications. We also find that U.S. exports of intellectual property to the source country, $\ln(IMP_{it})$, increase the propensity of China to import intellectual property from that source country, columns (2–4). These results are consistent with our hypothesis that countries with higher imports of intellectual property are more likely to export more intellectual property. The interaction between TH_i and $ln(IMP_{it})$ is shown to be significant and positive in column (3). The indication is that MNEs in the U.S. under-report the value of intellectual property when they sell to tax havens. As measured in column (3), β_4 is 0.60 and β_5 is 0.19. Using equation (7) we can calculate the proportional distortion for the U.S. to source-country i to be $0.25 = 0.19/(0.60 + 0.19)$ or 25%. That is, the estimated reported value of exports from the U.S. to tax havens is roughly 75% of the true value.

In column (4), we add the important control for FDI inflows to the source country. A source country with more FDI will be expected to sell more intellectual property to China, where FDI is a proxy for MNE penetration. The coefficient on FDI inflows to the source country is shown to be highly significant. As one might expect FDI inflows are correlated with U.S. exports of intellectual property to the source country, although the correlation is small. Adding FDI decreases the coefficient on IMP_{it} by less than 5%. Furthermore, FDI is inversely correlated with the interaction of U.S. exports and tax haven status. The implied proportional distortion on reported U.S. exports of intellectual property rises to 35% when we include FDI inflows as a regressor.

5.2 Does the Tax Haven Bias Extend Beyond Narrowly Defined Intangible IP?

To determine if the bias in reported transfer pricing to tax havens extends beyond narrowly defined intellectual property, we examine the total services trade.[11] In Table 2 we run a set of regressions analogous to our central specification, but we use the aggregate category of total services. The data is from the same source with intellectual property as a component of total services. In addition to intellectual property there are more tangible services, such as maintenance and repair services, and transportation services.

In Table 2, the coefficients on $TH_i * ln(IMP_{it})$ are insignificant and indistinguishable from zero. In line with the assumptions of the model, the comparison of intellectual property and total services reveals that the distortionary impact of tax havens is less apparent. This finding is consistent with the argument made by Guvenen et al. (2022) that intangible assets are the most important source of profit shifting.

intellectual property transactions.

[11] The value of total services are comprised of the value of bilateral service transactions in the transportation, communications, construction, insurance, finance, royalties and license fees, other business services, personal, cultural and recreational services, and government services for each trading pair in the sample.

Table 2. Main Regression Results of Total Services

Total Services	(1)	(2)	(3)	(4)
GDP_{it}	0.491***	0.552***	0.551***	0.369***
	(0.024)	(0.025)	(0.025)	(0.031)
$Weighted\ distance_i$	-0.921***	-0.845***	-0.853***	-0.877***
	(0.051)	(0.046)	(0.046)	(0.043)
$TaxHaven_i$	1.618***	0.820***	0.390	0.174
	(0.108)	(0.121)	(1.102)	(1.032)
$IMP_{it}(fromUS)$		0.376***	0.376***	0.368***
		(0.030)	(0.030)	(0.030)
$TH_i * IMP_{it}$			0.049	0.045
			(0.117)	(0.109)
$FDI\ Inflows_{it}$				0.201***
				(0.021)
Year FE	YES	YES	YES	YES
N	2194	2194	2194	2078
R-sq	0.808	0.826	0.826	0.837

Note: Standard errors are clustered at country level in parentheses
*(*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)*

5.3 Does the bias persist if we look at different supply-chain patterns?

In Table 3 and 4 we consider alternatives to the U.S. to China intellectual property supply chain. In these extensions the trade partners included in IMP_{it} and the dependent variable include additional countries. In Table 3, we redefine IMP_{it} to include exports from developed countries (OECD less the tax havens: Switzerland and Netherlands) to country i. This is intended to consider if other developed countries utilize profit shifting as is found for the United States. In Table 4, we expand the sample of destination countries including the top 20 countries in terms of value added in manufacturing.[12] This is intended to explore the pattern of profit shifting as it relates to manufacturing-based economies beyond China.

The pattern of results are similar to our central specification that considers the specific supply chain from the United States to country i and ultimately to China. In each case, however, we lose explanatory power. The coefficient on the interaction of interest are only marginally significant. So while the supply chain from the U.S. to China shows a strong result, including other countries weakens the pattern (and this is despite a large increase in the sample size for Table 4).

5.4 Did the U.S. tax reform of 2017 impact the observed bias in IP Transfers?

In the baseline results, we focus on the 2005-2016 period because the Tax Cuts and Jobs Act (TCJA) was adopted in 2017. The TCJA was, at least partially, intended to better balance the tax treatment of the intellectual property of U.S. companies held by foreign subsidiaries. For multinational corporations, the TCJA greatly reduced the corporate tax rate and made fundamental changes to taxing international income. First, the corporate tax rate was permanently reduced to a 21% flat tax rate from 35%. Second, two policies adopted in tax reform might change the incentives for companies deciding where to put their intellectual property. One is Global Intangible Low Tax Income (GILTI) which taxes earnings from intellectual property owned by U.S. companies by the U.S. regardless of where it might be outside U.S. borders. Another policy was the Foreign Derived Intangible Income (FDII) provision. Under this provision U.S. companies that maintained their intellectual property in the U.S. or brought it back from overseas could benefit from a lower tax rate on that income (13.125%). Considering the potential effects resulting from U.S. tax policy, Table 5 includes an additional interaction to control for the TCJA period: $TH_i * ln(IMP_{it}) * AfterTCJA$, where $AfterTCJA$ is a dummy variable indicating if year t is after 2016. The empirical specification is

[12] Top 20 countries with the largest manufacturing value added: China, United States, Japan, Germany, Korea, Italy, India, France, United Kingdom, Brazil, Russia, Mexico, Indonesia, Canada, Spain, Turkey, Switzerland, Thailand, Netherlands, and Australia. We exclude Switzerland and Netherlands from the samples since they both are tax havens.

Table 3. Results of Intellectual Property(Aggregated imports from Non Tax Haven OECD Countries)

Charges for the use of intellectual property	(1)	(2)	(3)	(4)
GDP_{it}	1.550***	0.759***	0.755***	0.198***
	(0.037)	(0.043)	(0.044)	(0.083)
$Weighted\ distance_i$	-0.252	-0.206	-0.203	-0.281*
	(0.191)	(0.149)	(0.149)	(0.155)
$TaxHaven_i$	6.651***	3.850***	2.382***	0.639
	(0.182)	(0.222)	(0.945)	(1.214)
$IMP_{it}(OECDNTH)$		0.616***	0.617***	0.587***
		(0.025)	(0.025)	(0.027)
$TH_i * IMP_{it}$			0.186*	0.250*
			(0.102)	(0.133)
$FDI\ Inflows_{it}$				0.699***
				(0.079)
Year FE	YES	YES	YES	YES
N	1996	1996	1996	1888
R-sq	0.416	0.574	0.574	0.585

Note: Standard errors are clustered at country level in parentheses
*(*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)*

Table 4. Results of Intellectual Property to Main Manufacturing Economies

Charges for the use of intellectual property	(1)	(2)	(3)	(4)
GDP_{it}	1.485***	0.678***	0.670***	0.189***
	(0.009)	(0.011)	(0.011)	(0.019)
$Weighted\ distance_i$	-0.819***	-0.751***	-0.742***	-0.685***
	(0.035)	(0.028)	(0.028)	(0.029)
$TaxHaven_i$	6.651***	3.850***	2.382***	0.639
	(0.182)	(0.222)	(0.945)	(1.214)
$IMP_{it}(OECDNTH)$		0.616***	0.617***	0.581***
		(0.006)	(0.006)	(0.006)
$TH_i * IMP_{it}$			0.311*	0.334*
			(0.032)	(0.035)
$FDI\ Inflows_{it}$				0.604***
				(0.018)
Year FE	YES	YES	YES	YES
Destination FE	YES	YES	YES	YES
N	32011	32011	32011	30323
R-sq	0.461	0.614	0.614	0.623

Note: Standard errors are clustered at country level in parentheses
*(*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)*

as follows:

$$\begin{aligned} ln(X_{it}) &= \beta_0 + \beta_1 ln(GDP_{it}) + \beta_2 ln(d_i) + \beta_3 TH_i + \beta_4 ln(IMP_{it}) \\ &+ \beta_5 TH_i * ln(IMP_{it}) + \beta_6 TH_i * ln(IMP_{it}) * AfterTCJA) \\ &+ \beta_7 Z_{ijt} + t + \lambda_i + \epsilon_{ij} \end{aligned} \quad (9)$$

After expanding the sample period to include the years following the U.S. tax reform of 2017, the coefficients on $TH_i * IMP_{it}$ are only marginally significant. In columns (4) and (5), we find that the adoption of the TCJA has no obvious effect on the pattern of under-reporting the value of intellectual property transfers to tax havens since the coefficients on $TH_i * IMP_{it} * AfterTCJA$ are insignificant and almost zero. There are two potential explanations. First, the adjusted tax rate (21%) in the United States is still larger than that of Tax Havens. Second, the responses to the tax changes are not immediate.

5.5 The Treatment of Zeros

In the results thus far we use a typical log-linearized OLS specification of the gravity model. This means that we have to drop observations with zero trade flows. In this subsection we consider alternative treatments and argue that our OLS approach is appropriate.

Recent authors (starting with Santos Silva and Tenreyro, 2006) have advocated the use of Poisson Pseudo-maximum Likelihood (PPML) estimators of the non-linear gravity equation, which accommodates the zero observed trade flows.[13] Given that we add an interaction of the tax haven indicator and country-i's imports of intellectual property from the United States in the variable IMP_{it}, log-linearized OLS directly indicates the slope shift central to our primary hypothesis. We compare the different slopes for tax havens and non tax havens to test the proportional underreporting distortion in tax havens. The non-linear PPML estimator will not indicate a *slope* shift, and might yield biased interaction coefficients based on its special distributional function. We have run PPML on our sample and find it difficult to interpret these results relative to our central regressions. The PPML coefficient on the interaction between tax haven and U.S. imports of intellectual property is negative and significant regardless of the inclusion or exclusion of zeros.[14] This finding runs contrary to the fundamental correlations in the data, as indicated in the OLS regressions. We conclude that the PPML estimators are

[13] In addition to the problem of zeros the PPML estimator is advocated because it solves a general problem of heteroskedasticity in gravity regressions. Heteroskedasticity indicates a problem with the measured errors on the estimated coefficients not the location of the point estimates. In our central specifications, we adjust for the heteroscedasticity by calculating the robust standard errors.

[14] The coefficient on the interaction is still positive and significant for pure tax havens, which are countries with lower local production abilities, such as, Bermuda, Barbados, Cayman Islands, and United Kingdom Islands.

Table 5. Effects of the TCJA

Charges for the use of intellectual property	(1)	(2)	(3)	(4)	(5)
GDP_{it}	1.535***	0.788***	0.783***	0.783***	0.187***
	(0.035)	(0.040)	(0.040)	(0.040)	(0.079)
$Weighted\ distance_i$	-0.207	-0.389***	-0.384***	-0.384***	-0.433***
	(0.173)	(0.133)	(0.133)	(0.134)	(0.139)
$TaxHaven_i$	6.744***	3.915***	2.567***	2.597	0.885
	(0.163)	(0.192)	(0.831)	(0.832)	(1.130)
IMP_{it}		0.594***	0.595***	0.595***	0.565***
		(0.023)	(0.023)	(0.023)	(0.024)
$TH_i * IMP_{it}$			0.185*	0.175*	0.230*
			(0.098)	(0.099)	(0.134)
$TH_i * IMP_{it} * AfterTCJA$				0.027	0.034
				(0.044)	(0.134)
$FDI\ Inflows_{it}$					0.709***
					(0.073)
Year FE	YES	YES	YES	YES	YES
N	2483	2483	2483	2483	2329
R-sq	0.403	0.552	0.552	0.552	0.562

Note: Standard errors are clustered at country level in parentheses
*(*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)*

inappropriate for our purpose.

There are additional arguments against using PPML in the context of this paper. Our data is more dense than typical bilateral trade data. In the data we use, the fraction of zeros is around 10%. Yotov et al. (2016) point out that Monte Carlo simulations show that the PPML estimators perform very well when the proportion of zeros is large. For example, in their simulations Santos Silva and Tenreyro (2011) set a typical share of zeros between 62% to 83% to explore the probability of observing the zero trade values to advocate the PPML specifications. Head and Mayer (2014) also argue that PPML is superior to OLS in the case that there are more than 50% zeros in the data, which is not the case in our data. While we acknowledge that dropping zero trade flows is not an ideal method, the density of our data along with the simple OLS interpretation of our interaction coefficient strongly favors our central regression estimators.

5.6 The Treatment of Zeros–Version 2

In the results thus far we use a typical log-linearized OLS specification of the gravity model. This means that we have to drop observations with zero trade flows. If the fraction of zeros is large, the linear-in-logs form can generate a bias. **?** report that the proportion of trading partners that do not trade with each other accounts for approximately half the observations at the country level. For example, in their simulations Santos Silva and Tenreyro (2011) set a typical share of zeros between 62% to 83% to explore the probability of observing the zero trade values to doubt the effectiveness of log-linearized OLS specifications, which is not the case in our data. Head and Mayer (2014) point out that one commonly used method to handle the presence of zeros is to assign a very small value to replace the zero trade flows. We check the robustness by replacing zeros with half of the minimized value of the intellectual property export from country i to China. Our results are robust with inclusions of the remaining part of the observations.

One other method adopted recently (starting with Santos Silva and Tenreyro, 2006) is the Poisson Pseudo-maximum Likelihood (PPML) estimators of the non-linear gravity equation, which accommodates the zero observed trade flows.[15] We estimate the equation 3 using PPML specification, the coefficient on the interaction is still positive and significant for pure tax havens, which are countries with lower local production abilities, such as Bermuda, Barbados, Cayman Islands, and United Kingdom Islands. While we acknowledge that dropping zero trade flows is not an ideal method, the density of our data along with the simple OLS interpretation of our interaction coefficient strongly favors our central regression

[15] In addition to the problem of zeros the PPML estimator is advocated because it solves a general problem of heteroskedasticity in gravity regressions. Heteroskedasticity indicates a problem with the measured errors on the estimated coefficients not the location of the point estimates. In our central specifications, we adjust for heteroscedasticity by calculating the robust standard errors.

estimators.

6. Conclusion

This paper undertakes an empirical analysis of BaTis data on export and import volumes with the aim of understanding how tax havens bias the value of intellectual property transactions. Despite our results confirming the anecdotal evidence that intangible assets exports to tax havens play a role in corporate tax evasion, we find that the value of intellectual property exports recorded to tax havens is disproportionately smaller than to non-tax havens for MNEs in the United States, roughly 65 percent. The results are consistent with Ruhl et al.(2021), which found that if we re-attribute the value of service trade between the United States and tax havens, the services trade balance of the US will increase while that of tax havens will decrease. In addition, the underreporting pattern is stronger for intellectual property exports than for the total services trade.

This paper provides evidence of mispriced intellectual property trade through bilateral trade data at the country level. Transferring intellectual property to tax havens at a lower value may however require the use of strategies that are complex and difficult to capture in the bilateral dataset. The new evidence on transfer mispricing has several implications for policy and future research. First, our observation shows that mispriced transfer is concentrated in the transaction of intellectual property compared to the other categories of services trade. Second, given our findings, tax authorities should pay attention to transfer pricing in intangible services transactions as a source of revenue leakage. Limited by the information of our data, we just examine if intellectual property is under-reported when it moves from the US to tax havens at the country level. In future work, we plan to analyze the channels of tax-motivated profit shifting, such as transfer pricing, and strategic location of intangibles with firm-level data.

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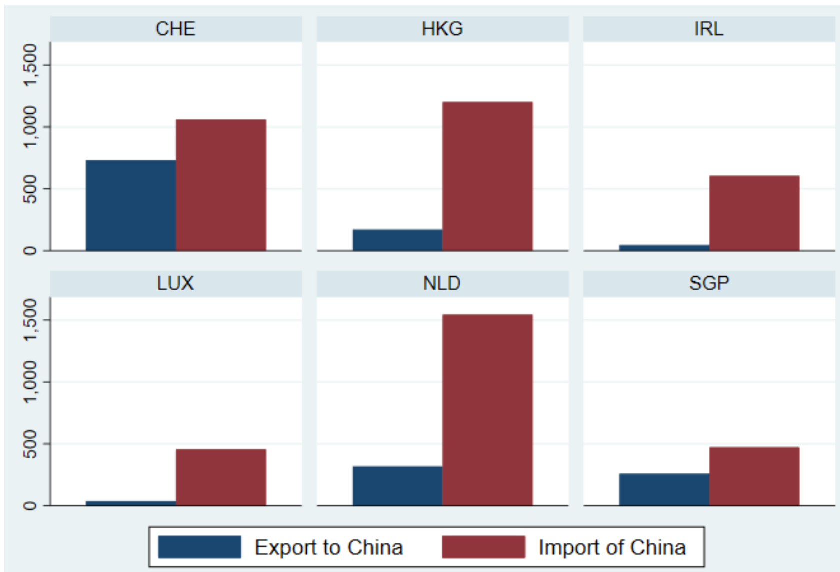
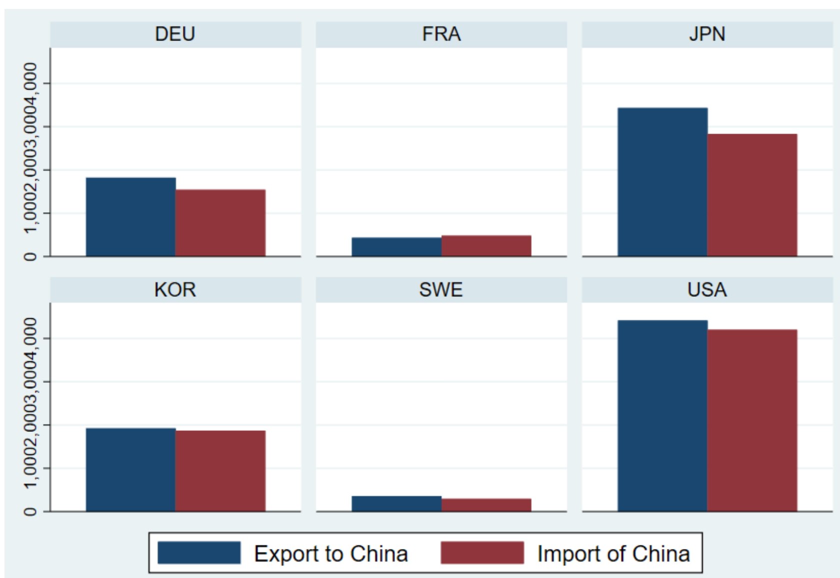


(a) Tax Havens



(b) Non Tax Havens

Figure 3. Differences between Tax Havens' and Non Tax Havens' exports versus China's imports