# Master thesis - Appendix

*Paul-Emmanuel Chouc*[*]

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∗. Master in Economics at Institut Polytechnique de Paris (2020-2022). Contact: paul-emmanuel.chouc@ensae.fr.

# Contents

# Chapter 1

# Theoretical Framework

## 1.1 Proofs for Generalities

### 1.1.1 First stage of the utility maximisation program

In any country $i$, the first stage of the utility maximisation program of the consumer - which corresponds to the choice of varieties of the differentiated good - writes as:

$$\begin{aligned} \min_{[x_i(\omega)]_{\omega\in\Omega_i}} \quad & \int_{\Omega_i} p_i(\omega)x_i(\omega)d\omega \\ \text{s.t.} \quad & (\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} \geq X_i \end{aligned}$$

The Lagrangian is given by:

$$L([x_i(\omega)]_{\omega\in\Omega_i}, \lambda) = \int_{\Omega_i} p_i(\omega)x_i(\omega)d\omega - \lambda[(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} - X_i]$$

With $\lambda$ the Lagrange multiplier associated with the individual's constraint. The first-order condition with respect to the quantity of each variety (hence with respect to $x_i(\omega)$'s) can be written as:

$$\begin{aligned} & p_i(\omega) - \frac{\sigma}{\sigma-1}\frac{\sigma-1}{\sigma}[x_i(\omega)]^{\frac{\sigma-1}{\sigma}-1}(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}-1}\lambda = 0 \\ & \iff p_i(\omega) = [x_i(\omega)]^{-\frac{1}{\sigma}}(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{1}{\sigma-1}}\lambda \end{aligned} \tag{1.1}$$

And the complementary slackness condition gives:

$$\lambda[(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} - X_i] = 0$$

Knowing that for each variety $\omega$, $p_i(\omega)$ is positive, we deduce from 1.1 that $\lambda$ cannot be equal to 0. We then have from the complementary slackness condition:

$$(\int_{\Omega_i} [x_i(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} = X_i$$

Said otherwise, the constraint is binding. Plugging it in 1.1 yields:

$$
\begin{aligned}
& p_i(\omega) = [x_i(\omega)]^{-\frac{1}{\sigma}} X_i^{\frac{1}{\sigma}} \lambda \\
\iff & [x_i(\omega)]^{-\frac{1}{\sigma}} = \frac{p_i(\omega)}{\lambda} X_i^{-\frac{1}{\sigma}} \\
\iff & x_i(\omega) = [\frac{p_i(\omega)}{\lambda}]^{-\sigma} X_i \qquad (1.2)
\end{aligned}
$$

And we can plug this expression for $x_i(\omega)$ into equation 1.1.1:

$$
\begin{aligned}
& (\int_{\Omega_i} [\frac{p_i(\omega)}{\lambda}]^{1-\sigma} X_i^{\frac{\sigma-1}{\sigma}} d\omega)^{\frac{\sigma}{\sigma-1}} = X_i \\
\iff & (\int_{\Omega_i} [\frac{p_i(\omega)}{\lambda}]^{1-\sigma} d\omega)^{\frac{\sigma}{\sigma-1}} = 1 \\
\iff & \lambda^{-\sigma} = (\int_{\Omega_i} [p_i(\omega)]^{1-\sigma} d\omega)^{\frac{\sigma}{\sigma-1}} \\
\iff & \lambda = (\int_{\Omega_i} [p_i(\omega)]^{1-\sigma} d\omega)^{\frac{1}{1-\sigma}}
\end{aligned}
$$

$\lambda$ corresponds to the CES ideal price index, which we denote $P_i$ for each country $i$. From 1.2, demand for a variety $\omega$ is then given by:

$$
x_i(\omega) = [\frac{p_i(\omega)}{P_i}]^{-\sigma} X_i
$$

### 1.1.2 Second stage of the utility maximisation program

In country $i$, the second stage of the utility maximisation problem consists in:

$$
\begin{aligned}
\max_{q_i, X_i} \quad & \alpha \ln(X_i) + q_i + \frac{G_i}{L_i} \\
\text{s.t.} \quad & q_I + X_I P_i \leq R_i
\end{aligned}
$$

Denoting $\mu$ the Lagrange multiplier associated with the individual's budget constraint, the Lagrangian of this problem writes as:

$$
L(q_i, X_i, \mu) = \alpha \ln(X_i) + q_i + \frac{G_i}{L_i} + \mu(R_i - q_i - P_i X_i)
$$

The first-order conditions with respect to $q_i$ and $X_i$ write as:

$$
\begin{aligned}
& \begin{cases} \frac{\delta L}{\delta q_i} = 0 \\ \frac{\delta L}{\delta X_i} = 0 \end{cases} \\
\iff & \begin{cases} 1 - \mu = 0 \\ \frac{\alpha}{X_i} - \mu P_i = 0 \end{cases} \\
\iff & \begin{cases} \mu = 1 \\ X_i = \frac{\alpha}{P_i} \end{cases}
\end{aligned}
$$

Besides, the complementary slackness condition gives:

$$\begin{aligned} & \mu(R_i - q_i - X_i P_i) = 0 \\ \iff & (R_i - q_i - X_i P_i) = 0 \\ \iff & q_i = R_i - X_i P_i \\ \iff & q_i = R_i - \alpha \end{aligned}$$

So, the second stage of the individual's utility maximization problem gives:

$$X_i = \frac{\alpha}{P_i} \text{ and } q_i = R_i - \alpha$$

### 1.1.3 Pricing decision a firm exporting from country $j$ into country $k$

The problem of a firm with productivity $\varphi$ exporting its output from country $j$ into country $k$ writes as:

$$\begin{aligned} \max_{p_{j,k}(\varphi)} \quad & (1 - tax_j)(p_{j,k}(\varphi) x_k[p_{j,k}(\varphi)] - x_k[p_{j,k}(\varphi)] \frac{\tau_{j,k}}{\varphi}) \\ \text{s.t.} \quad & x_k[p_{j,k}(\varphi)] = [\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma} \frac{\alpha}{P_k} \end{aligned}$$

Plugging the individual demand schedule directly in the objective yields:

$$\max_{p_{j,k}(\varphi)} \quad (1 - tax_j)(p_{j,k}(\varphi)[\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma} \frac{\alpha}{P_k} - [\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma} \frac{\alpha \tau_{j,k}}{P_k \varphi})$$

We notice that corporate income taxes do not influence the firm's pricing decision. The problem simplifies into:

$$\max_{p_{j,k}(\varphi)} \quad \alpha[\frac{p_{j,k}(\varphi)}{P_k}]^{1-\sigma} - [\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma} \frac{\alpha \tau_{j,k}}{P_k \varphi} \tag{1.3}$$

The first-order condition with respect to $p_{j,k}(\varphi)$ is given by:

$$(1 - \sigma)\alpha[p_{j,k}(\varphi)]^{-\sigma}(\frac{1}{P_k})^{1-\sigma} + \sigma[p_{j,k}(\varphi)]^{-\sigma-1}(\frac{1}{P_k})^{1-\sigma} \frac{\alpha \tau_{j,k}}{\varphi} = 0$$

Which simplifies into:

$$(1 - \sigma)p_{j,k}(\varphi) + \sigma \frac{\tau_{j,k}}{\varphi} = 0$$

And eventually, we obtain:

$$p_{j,k}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{\tau_{j,k}}{\varphi} \tag{1.4}$$

Under monopolistic competition with CES preferences, the firm imposes a mark-up over its marginal costs. The mark-up is determined by consumers' elasticity of substitution between the differentiated varieties $\sigma$. The higher it is, the lower the mark-up: the more substitutable the varieties, the lower the market power of firms.

### 1.1.4 Firm-level sales from country $j$ into country $k$

From the pricing decision above, the firm's total sales from country $j$ in country $k$ are then given by:

$$\begin{aligned} r_{j,k}(\varphi) &= p_{j,k}(\varphi)[\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma}\frac{\alpha L_k}{P_k} \\ &= [\frac{p_{j,k}(\varphi)}{P_k}]^{1-\sigma}\alpha L_k \\ &= [\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{1-\sigma}\alpha L_k \end{aligned}$$

In Chaney (2005), Cobb-Douglas preferences are assumed over the two sectors and this requires to characterise individual income: a global fund is supposed to collect all firms' profits and all workers own a single share of that fund. With quasi-linear preferences, we can abstract from this characterisation and directly write:

$$r_{j,k}(\varphi) = [\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{1-\sigma}\alpha L_k$$

### 1.1.5 After-tax profits of a firm exporting from country $j$ into country $k$

The after-tax profits of the firm exporting from country $j$ in country $k$ write as:

$$\begin{aligned} \pi_{j,k}(\varphi) &= (1-tax_j)(r_{j,k}(\varphi) - [\frac{p_{j,k}(\varphi)}{P_k}]^{-\sigma}\frac{\alpha L_k\tau_{j,k}}{P_k\varphi}) \\ &= (1-tax_j)([\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{1-\sigma}\alpha L_k - [\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{-\sigma}\frac{\alpha L_k\tau_{j,k}}{P_k\varphi})) \\ &= (1-tax_j)(\frac{\sigma}{\sigma-1})^{-\sigma}(\frac{\tau_{j,k}}{\varphi P_k})^{1-\sigma}\alpha L_k(\frac{\sigma}{\sigma-1}-1) \\ &= \frac{1}{\sigma-1}(1-tax_j)(\frac{\sigma}{\sigma-1})^{-\sigma}(\frac{\tau_{j,k}}{\varphi P_k})^{1-\sigma}\alpha L_k \\ &= \frac{1}{\sigma}(1-tax_j)[\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{1-\sigma}\alpha L_k \\ &= \frac{1}{\sigma}(1-tax_j)r_{j,k}(\varphi) \end{aligned}$$

Which eventually yields:

$$\pi_{j,k}(\varphi) = \frac{1}{\sigma}(1-tax_j)[\frac{\sigma\tau_{j,k}}{(\sigma-1)\varphi P_k}]^{1-\sigma}\alpha L_k$$

## 1.2 Proofs for the Benchmark Case

### 1.2.1 Productivity cut-off $\varphi_{i,j}$

The unique cut-off productivity level, at which a firm from country $i$ is indifferent between entering country j and not entering it, is given by:

$$
\begin{aligned}
& \pi_j(\bar{\varphi}_{i,j}) - f_{i,j} = 0 \\
\iff & (1 - tax_j)\frac{1}{\sigma}[\frac{\sigma}{(\sigma-1)\bar{\varphi}_{i,j}P_j}]^{1-\sigma}\alpha L_j - f_{i,j} = 0 \\
\iff & \frac{1}{\sigma}[\frac{\sigma}{(\sigma-1)\bar{\varphi}_{i,j}P_j}]^{1-\sigma}\alpha L_j = \frac{f_{i,j}}{1 - tax_j} \\
\iff & (\frac{1}{\bar{\varphi}_{i,j}})^{1-\sigma} = \frac{f_{i,j}}{1 - tax_j}P_j^{1-\sigma}\frac{1}{\alpha L_j}(\frac{\sigma-1}{\sigma})^{1-\sigma}\sigma \\
\iff & \frac{1}{\bar{\varphi}_{i,j}} = (\frac{f_{i,j}}{1 - tax_j})^{\frac{1}{1-\sigma}}P_j(\frac{1}{\alpha L_j})^{\frac{1}{1-\sigma}}\frac{\sigma-1}{\sigma}\sigma^{\frac{1}{1-\sigma}} \\
\iff & \bar{\varphi}_{i,j} = (\frac{f_{i,j}}{1 - tax_j})^{\frac{1}{\sigma-1}}\frac{1}{P_j}(\alpha L_j)^{\frac{1}{1-\sigma}}\frac{\sigma}{\sigma-1}(\frac{1}{\sigma})^{\frac{1}{1-\sigma}} \\
\iff & \bar{\varphi}_{i,j} = (\frac{f_{i,j}}{1 - tax_j})^{\frac{1}{\sigma-1}}\frac{1}{P_j}L_j^{\frac{1}{1-\sigma}}\lambda_1
\end{aligned}
$$

Where $\lambda_1$ is a constant defined by:

$$\lambda_1 = \frac{\sigma}{\sigma-1}(\frac{\alpha}{\sigma})^{\frac{1}{1-\sigma}}$$

We can rewrite the productivity cut-off as in Chaney (2005):

$$\bar{\varphi}_{i,j} = (\frac{f_{i,j}}{1 - tax_j})^{\frac{1}{\sigma-1}}(P_j^{\sigma-1}L_j)^{-\frac{1}{\sigma-1}}\lambda_1$$

### 1.2.2 Determining the price index $P_j$

We compute the price index in country $j$, with $\Omega_j$ and $\Omega_{i,j}$ denoting respectively the set of varieties consumed in country $j$ and the set of varieties produced in country $j$ by firms headquartered in $i$. Because, there is a continuum of varieties produced in country $j$ by firms from country $i$, the law of large numbers applies.

$$
\begin{aligned}
P_j^{1-\sigma} &= \int_{\Omega_j} [p(\omega)]^{1-\sigma} d\omega \\
&= \sum_{i=1}^{N} \int_{\Omega_{i,j}} [p(\omega)]^{1-\sigma} d\omega \\
&= \sum_{i=1}^{N} L_i \int_{\bar{\varphi}_{i,j}}^{+\infty} [p_{i,j}(\varphi)]^{1-\sigma} dF(\varphi) \\
&= \sum_{i=1}^{N} L_i \int_{\bar{\varphi}_{i,j}}^{+\infty} [\frac{\sigma}{(\sigma-1)\varphi}]^{1-\sigma} dF(\varphi) \\
&= [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\int_{\bar{\varphi}_{i,j}}^{+\infty} \varphi^{\sigma-1} dF(\varphi)] \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\int_{\bar{\varphi}_{i,j}}^{+\infty} \varphi^{\sigma-\gamma-2} d\varphi] \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\frac{\varphi^{\sigma-\gamma-1}}{\sigma-\gamma-1}]_{\bar{\varphi}_{i,j}}^{+\infty} \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [0 - \frac{\bar{\varphi}_{i,j}^{\sigma-\gamma-1}}{\sigma-\gamma-1}]
\end{aligned}
$$

Because, by assumption, $\gamma > \sigma - 1$. We then have:

$$
P_j^{1-\sigma} = \gamma (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i \frac{\bar{\varphi}_{i,j}^{\sigma-\gamma-1}}{\gamma-(\sigma-1)}
$$

And plugging in the expression for the productivity threshold $\bar{\varphi}_{i,j}$, we obtain:

$$
\begin{aligned}
P_j^{1-\sigma} &= \frac{\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i \bar{\varphi}_{i,j}^{\sigma-\gamma-1} \\
&= \frac{\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i (\frac{f_{i,j}}{1-tax_j})^{\frac{\sigma-\gamma-1}{\sigma-1}} (P_j^{\sigma-1} L_j)^{\frac{\gamma+1-\sigma}{\sigma-1}} \lambda_1^{\sigma-\gamma-1} \\
&= \frac{\lambda_1^{\sigma-\gamma-1}\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} P_j^{\gamma+1-\sigma} [L_j(1-tax_j)]^{\frac{\gamma+1-\sigma}{\sigma-1}} \sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}}
\end{aligned}
$$

This simplifies into:

$$
\begin{aligned}
P_j^{-\gamma} &= \lambda_2^{-\gamma} [L_j(1-tax_j)]^{\frac{\gamma+1-\sigma}{\sigma-1}} \sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \\
\iff P_j &= \lambda_2 [L_j(1-tax_j)]^{\frac{\sigma-1-\gamma}{\gamma(\sigma-1)}} (\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}}
\end{aligned}
$$

And we can work further to retrieve Chaney (2005)'s notations:

$$\begin{aligned}
P_j &= \lambda_2[L_j(1-tax_j)]^{\frac{\sigma-1-\gamma}{\gamma(\sigma-1)}}(\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}} \\
&= \lambda_2[L_j(1-tax_j)]^{\frac{1}{\gamma}-\frac{1}{\sigma-1}}(\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}} \\
&= \lambda_2 L_j^{\frac{1}{\gamma}} L_j^{-\frac{1}{\sigma-1}}(1-tax_j)^{\frac{1}{\gamma}-\frac{1}{\sigma-1}}(\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}} \\
&= \lambda_2 (\frac{L_j}{L})^{\frac{1}{\gamma}} L_j^{-\frac{1}{\sigma-1}}(1-tax_j)^{\frac{1}{\gamma}-\frac{1}{\sigma-1}}(\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}} L^{\frac{1}{\gamma}}
\end{aligned}$$

Eventually:

$$P_j = \lambda_2 (\frac{L_j}{L})^{\frac{1}{\gamma}} L_j^{-\frac{1}{\sigma-1}}(1-tax_j)^{\frac{1}{\gamma}-\frac{1}{\sigma-1}}\theta_j$$

Where:

$$\begin{aligned}
\lambda_2^{-\gamma} &= \frac{\lambda_1^{\sigma-\gamma-1}\gamma}{\gamma-(\sigma-1)}(\frac{\sigma}{\sigma-1})^{1-\sigma} \\
\iff \lambda_2 &= \lambda_1^{\frac{\gamma-\sigma+1}{\gamma}}[\frac{\gamma}{\gamma-(\sigma-1)}]^{-\frac{1}{\gamma}}(\frac{\sigma}{\sigma-1})^{\frac{\sigma-1}{\gamma}}
\end{aligned}$$

And:

$$\begin{aligned}
\theta_j^{-\gamma} &= L^{-1}\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \\
&= \sum_{i=1}^{N}(\frac{L_i}{L}) f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \\
&= \sum_{i=1}^{N} s_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \\
&= \sum_{i=1}^{N} s_i f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)}
\end{aligned}$$

With $s_i$ denoting country $i$'s share of worldwide population.

### 1.2.3 Interpreting the expression for the price index

First, as in Chaney (2005), $\theta_j$ is a measure of the remoteness of country $j$. Indeed, let us consider a country $j$ very distant from all large economies (i.e., from countries with a large $s_i$). Note that such distance is not necessarily purely geographic but can also encompass cultural or legal barriers for instance. Indeed, this distance is characterized by a large fixed set-up cost for firms headquartered

in any large country $i$: $f_{i,j}$ being large, $f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)}$ is small.[1] Then, the sum is small and $\theta_j^{-\gamma}$ is small too. We eventually get that, for this remote country, $\theta_j$ is large.

Second, how does the price index depend on the corporate income tax rate? $(1-tax_j)$ is decreasing in the corporate income tax rate and from $\gamma > \sigma - 1$, we have that $\frac{\sigma-1-\gamma}{\gamma(\sigma-1)}$ is negative. From there, $P_j$ is increasing in the local corporate income tax rate. This may seem counter-intuitive as we found previously that corporate income taxation does not affect the pricing decision of firms, but the tax rate chosen by the government does influence the number of firms entering the corresponding market. A higher tax rate reduces the number of foreign firms setting up an affiliate in country $j$ and as these were firms with a relatively high productivity (they must have drawn $\varphi$'s above the productivity cut-off to set up an affiliate in country $j$), the average productivity of firms in country $j$ is reduced. The average price is then increased.

### 1.2.4 Equilibrium expression for the productivity cut-off

Plugging the expression found above for the price level, we can recompute the productivity cut-off $\bar{\varphi_{i,j}}$:

$$\begin{aligned}
\bar{\varphi_{i,j}} &= (\frac{f_{i,j}}{1-tax_j})^{\frac{1}{\sigma-1}} P_j^{-1} L_j^{-\frac{1}{\sigma-1}} \lambda_1 \\
&= (\frac{f_{i,j}}{1-tax_j})^{\frac{1}{\sigma-1}} \lambda_2^{-1} (\frac{L}{L_j})^{\frac{1}{\gamma}} L_j^{\frac{1}{\sigma-1}} (1-tax_j)^{\frac{1}{\sigma-1}-\frac{1}{\gamma}} \theta_j^{-1} L_j^{-\frac{1}{\sigma-1}} \lambda_1 \\
&= \frac{\lambda_1}{\lambda_2} f_{i,j}^{\frac{1}{\sigma-1}} (\frac{L}{L_j})^{\frac{1}{\gamma}} (1-tax_j)^{-\frac{1}{\gamma}} \theta_j^{-1}
\end{aligned}$$

Denoting $\lambda_3 = \frac{\lambda_1}{\lambda_2}$, we get:

$$\bar{\varphi_{i,j}} = \lambda_3 f_{i,j}^{\frac{1}{\sigma-1}} (\frac{L}{L_j})^{\frac{1}{\gamma}} \frac{1}{\theta_j} (1-tax_j)^{-\frac{1}{\gamma}} \tag{1.5}$$

### 1.2.5 Equilibrium sales, costs and profits

- Equilibrium sales. Adapting the general expression for sales without iceberg trade costs and a single index, for a firm entering country $j$, we get:

$$\begin{aligned}
r_j(\varphi) &= [\frac{\sigma}{(\sigma-1)\varphi P_j}]^{1-\sigma} \alpha L_j \\
&= [\frac{\sigma}{(\sigma-1)\varphi}]^{1-\sigma} P_j^{\sigma-1} \alpha L_j \\
&= [\frac{\sigma}{(\sigma-1)\varphi}]^{1-\sigma} \lambda_2^{\sigma-1} (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} L_j^{-1} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \theta_j^{\sigma-1} \alpha L_j \\
&= (\frac{\sigma}{\sigma-1})^{1-\sigma} \lambda_2^{\sigma-1} \alpha (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1} \\
&= \lambda_4 (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1}
\end{aligned}$$

  Where:

$$\lambda_4 = (\frac{\sigma}{\sigma-1})^{1-\sigma} \lambda_2^{\sigma-1} \alpha$$

1. Because, by assumption, $\gamma > \sigma - 1 \iff \frac{\gamma}{\sigma-1} > 1 \iff -(\frac{\gamma}{\sigma-1}-1) < 0$

Of course, this only stands for a firm that satisfies the productivity cut-off $\bar{\varphi_{i,j}}$ and therefore enters country $j$. The general formula writes as:

$$r_j(\varphi) = \begin{cases} \lambda_4 (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1}, \text{ if } \varphi \geq \bar{\varphi_{i,j}} \\ 0, \text{ otherwise} \end{cases}$$

- Equilibrium costs. In our simplified approach, the goods sold in country $j$ by a firm headquartered in $i$ are all produced locally. The variable costs incurred by the firm in country $j$, conditionally on entry, are given by:

$$\begin{aligned} c_j(\varphi) &= x_j(\varphi) L_j \frac{w_j}{\varphi} \\ &= x_j(\varphi) L_j \frac{1}{\varphi} \\ &= [\frac{p_j(\varphi)}{P_j}]^{-\sigma} \frac{\alpha}{P_j} L_j \frac{1}{\varphi} \\ &= [\frac{\sigma}{(\sigma-1) P_j \varphi}]^{-\sigma} \frac{\alpha}{\varphi P_j} L_j \\ &= (\frac{\sigma-1}{\sigma}) [\frac{\sigma}{(\sigma-1) P_j \varphi}]^{1-\sigma} \alpha L_j \\ &= r_j(\varphi) \frac{\sigma-1}{\sigma} \end{aligned}$$

  If the firm does not enter country $j$:

$$c_j(\varphi) = 0 = r_j(\varphi) \frac{\sigma-1}{\sigma}$$

  According to the above. Therefore, the following relation holds for any productivity level $\varphi$:

$$c_j(\varphi) = r_j(\varphi) \frac{\sigma-1}{\sigma}$$

- Equilibrium pre-tax profits. We deduce that for any productivity level $\varphi$, after-tax profits gross of the fixed entry cost are given by:

$$\pi_j(\varphi) = (1-tax_j)[r_j(\varphi) - c_j(\varphi)] = (\frac{1-tax_j}{\sigma}) r_j(\varphi)$$

### 1.2.6 Derivation of total sales

The total sales of firms headquartered in country $i$ in country $j$ are given by:

$$\begin{aligned} X_{i,j} &= L_i \int_{\bar{\varphi_{i,j}}}^{+\infty} r_j(\varphi) dF(\varphi) \\ &= L_i \int_{\bar{\varphi_{i,j}}}^{+\infty} \lambda_4 (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1} dF(\varphi) \\ &= \lambda_4 L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \theta_j^{\sigma-1} \int_{\bar{\varphi_{i,j}}}^{+\infty} \varphi^{\sigma-1} dF(\varphi) \end{aligned}$$

Where, as seen before when computing the price index $P_j$ at equilibrium:

$$\int_{\varphi_{i,j}^-}^{+\infty} \varphi^{\sigma-1} dF(\varphi) = \frac{\gamma}{\gamma-(\sigma-1)} {\varphi_{i,j}^-}^{\sigma-\gamma-1}$$

So:

$$\begin{aligned} X_{i,j} &= \lambda_4 L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1} \theta_j^{\sigma-1} \frac{\gamma}{\gamma-(\sigma-1)} {\varphi_{i,j}^-}^{\sigma-\gamma-1} \\ &= [\frac{\gamma\lambda_4\lambda_3^{\sigma-\gamma-1}}{\gamma-(\sigma-1)}] L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}-\frac{\sigma-1-\gamma}{\gamma}} (1-tax_j)^{\frac{\sigma-1}{\gamma}-1-\frac{\sigma-\gamma-1}{\gamma}} f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \theta_j^{\sigma-1-(\sigma-\gamma-1)} \\ &= \lambda L_i \frac{L_j}{L} (1-tax_j)^0 f_{i,j}^{1-\frac{\gamma}{\sigma-1}} \theta_j^{\gamma} \end{aligned}$$

Eventually, we obtain:

$$X_{i,j} = \lambda \frac{L_i L_j}{L} f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)} \theta_j^{\gamma}$$

Where:

$$\lambda = \frac{\gamma\lambda_4\lambda_3^{\sigma-\gamma-1}}{\gamma-(\sigma-1)}$$

## 1.3 Proofs with Tax Planning Margins

### 1.3.1 Profit maximization problem with profit shifting

Consider a multinational headquartered in country $j$ with productivity $\varphi$. The profit maximization problem of the multinational firm accounts for the profits booked and taxed in country $j$, but also for those shifted to jurisdiction $k$:

$$\begin{aligned} \max_{p_j^{PS}(\varphi),\, \Psi_j(\varphi)} \quad & (1-tax_j) * \pi_j^{PT,1}[p_j^{PS}(\varphi), \Psi_j(\varphi)] + \Psi_j(\varphi) \\ \text{s.t.} \quad & \pi_j^{PT,1} = \pi_j^{PT,0} - \Psi_j(\varphi) - \frac{a^{\frac{1}{\varepsilon_j}}}{2} \frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]} \end{aligned}$$

Plugging the definition of $\pi_j^{PT,1}$, the pre-tax profits ex post profit shifting, in the objective, we rewrite the problem as.

$$\max_{p_j^{PS}(\varphi),\, \Psi_j(\varphi)} \quad (1-tax_j)(\pi_j^{PT,0}[p_j^{PS}(\varphi)] - \Psi_j(\varphi) - \frac{a^{\frac{1}{\varepsilon_j}}}{2} \frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]}) + \Psi_j(\varphi)$$

This further simplifies into:

$$\max_{p_j^{PS}(\varphi),\, \Psi_j(\varphi)} \quad (1-tax_j)(\pi_j^{PT,0}[p_j^{PS}(\varphi)] - \frac{a^{\frac{1}{\varepsilon_j}}}{2} \frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]}) + tax_j \Psi_j(\varphi)$$

We first consider the first-order condition with respect to the amount of profits shifted to the low-tax jurisdiction, $\Psi_j(\varphi)$. It writes as:

$$\begin{aligned} & tax_j - (1 - tax_j) a^{\frac{1}{\varepsilon_j}} \frac{\Psi_j(\varphi)}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]} = 0 \\ \iff & \Psi_j(\varphi) = \frac{1}{a^{\frac{1}{\varepsilon_j}}} (\frac{tax_j}{1 - tax_j}) \pi_j^{PT,0}[p_j^{PS}(\varphi)] \end{aligned}$$

The first-order condition with respect to the price $p_j^{PS}(\varphi)$ is given by:

$$\begin{aligned} & (1 - tax_j)[\frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} + \frac{a^{\frac{1}{\varepsilon_j}}}{2} (\frac{\Psi_j(\varphi)}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]})^2 \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)}] = 0 \\ \iff & \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} + \frac{a^{\frac{1}{\varepsilon_j}}}{2} (\frac{\Psi_j(\varphi)}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]})^2 \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} = 0 \end{aligned}$$

From the first-order condition with respect to $\Psi_j(\varphi)$:

$$(\frac{\Psi_j(\varphi)}{\pi_j^{PT,0}[p_j^{PS}(\varphi)]})^2 = \frac{1}{a^{\frac{2}{\varepsilon_j}}} (\frac{tax_j}{1 - tax_j})^2$$

So, the first-order condition with respect to price can be rewritten as:

$$\begin{aligned} & \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} + \frac{1}{2a^{\frac{1}{\varepsilon_j}}} (\frac{tax_j}{1 - tax_j})^2 \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} = 0 \\ \iff & \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} [1 + \frac{1}{2a^{\frac{1}{\varepsilon_j}}} (\frac{tax_j}{1 - tax_j})^2] = 0 \\ \iff & \frac{\delta \pi_j^{PT,0}[p_j^{PS}(\varphi)]}{\delta p_j^{PS}(\varphi)} = 0 \\ \iff & (1 - \sigma)[p_j^{PS}(\varphi)]^{-\sigma} \frac{\alpha}{(P_j^{PS})^{1-\sigma}} + \sigma [p_j^{PS}(\varphi)]^{-\sigma-1} \frac{\alpha}{\varphi (P_j^{PS})^{1-\sigma}} = 0 \\ \iff & (1 - \sigma) p_j^{PS}(\varphi) + \frac{\sigma}{\varphi} = 0 \\ \iff & p_j^{PS}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{1}{\varphi} \end{aligned}$$

Then, the pre-tax profits ex-ante the intra-group transaction, which we now directly write as a function of the productivity level $\varphi$, are given by:

$$\begin{aligned}\pi_j^{PT,0}(\varphi) &= [\frac{p_j^{PS}(\varphi)}{P_j^{PS}}]^{1-\sigma}\alpha L_j - \frac{\alpha}{\varphi(P_j^{PS})^{1-\sigma}}[p_j^{PS}(\varphi)]^{-\sigma}L_j \\ &= \frac{\alpha L_j}{(P_j^{PS})^{1-\sigma}}[(\frac{\sigma}{\sigma-1}\frac{1}{\varphi})^{1-\sigma} - \frac{1}{\varphi}(\frac{\sigma}{\sigma-1}\frac{1}{\varphi})^{-\sigma}] \\ &= \frac{\alpha L_j}{(P_j^{PS})^{1-\sigma}}(\frac{\sigma}{\sigma-1}\frac{1}{\varphi})^{-\sigma}\frac{1}{\varphi}(\frac{\sigma}{\sigma-1}-1) \\ &= \alpha L_j(P_j^{PS}\varphi)^{\sigma-1}(\frac{\sigma}{\sigma-1})^{-\sigma}\frac{1}{\sigma-1}\end{aligned}$$

Plugging this expression into the first-order condition with respect to $\Psi_j(\varphi)$ yields the optimal intra-group transaction:

$$\Psi_j(\varphi) = \frac{\alpha L_j}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})(P_j^{PS}\varphi)^{\sigma-1}(\frac{\sigma}{\sigma-1})^{-\sigma}\frac{1}{\sigma-1}$$

Which can be expressed as a share of pre-tax profits ex ante the transaction:

$$\frac{\Psi_j(\varphi)}{\pi_j^{PT,0}(\varphi)} = \frac{1}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})$$

We deduce the cost of profit shifting, which is incurred in country $j$:

$$\begin{aligned}\frac{a^{\frac{1}{\varepsilon_j}}}{2}\frac{[\Psi_j(\varphi)]^2}{\pi_j^{PT,0}(\varphi)} &= \frac{a^{\frac{1}{\varepsilon_j}}}{2}[\frac{\Psi_j(\varphi)}{\pi_j^{PT,0}(\varphi)}]\Psi_j(\varphi) \\ &= \frac{a^{\frac{1}{\varepsilon_j}}}{2}\frac{1}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})\frac{\alpha}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})(P_j^{PS}\varphi)^{\sigma-1}(\frac{\sigma}{\sigma-1})^{-\sigma}\frac{1}{\sigma-1} \\ &= \frac{\alpha}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2(P_j^{PS}\varphi)^{\sigma-1}(\frac{\sigma}{\sigma-1})^{-\sigma}\frac{1}{\sigma-1} \\ &= \frac{1}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2\pi_j^{PT,0}(\varphi)\end{aligned}$$

We subtract the amount of shifted profits and the costs of the operation from the pre-tax profits ex ante the internal transaction. This yields the pre-tax profits actually booked in country $j$:

$$\begin{aligned}\pi_j^{PT,1}(\varphi) &= \pi_j^{PT,0}(\varphi) - \Psi_j(\varphi) - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2\pi_j^{PT,0}(\varphi) \\ &= \pi_j^{PT,0}(\varphi)[1 - \frac{\Psi_j(\varphi)}{\pi_j^{PT,0}(\varphi)} - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2] \\ &= \pi_j^{PT,0}(\varphi)[1 - \frac{1}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j}) - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2]\end{aligned}$$

### 1.3.2 After-tax profits conditional on entering country $j$

Conditional on entering country $j$, the total after-tax profits $\pi_j^{PS}(\varphi)$ of the firm are given by:

$$\begin{aligned}
\pi_j^{PS}(\varphi) &= (1-tax_j)\pi_j^{PT,1}(\varphi) + \Psi_j(\varphi) \\
&= (1-tax_j)\pi_j^{PT,0}(\varphi)[1 - \frac{1}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j}) - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})^2] + \Psi_j(\varphi) \\
&= \pi_j^{PT,0}(\varphi)[1 - tax_j - \frac{1}{a^{\frac{1}{\varepsilon_j}}}tax_j - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}tax_j^2(\frac{1}{1-tax_j})] + \Psi_j(\varphi) \\
&= \pi_j^{PT,0}(\varphi)[1 - tax_j - \frac{1}{a^{\frac{1}{\varepsilon_j}}}tax_j - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}tax_j^2(\frac{1}{1-tax_j}) + \frac{\Psi_j(\varphi)}{\pi_j^{PT,0}(\varphi)}] \\
&= \pi_j^{PT,0}(\varphi)[1 - tax_j - \frac{1}{a^{\frac{1}{\varepsilon_j}}}tax_j - \frac{1}{2a^{\frac{1}{\varepsilon_j}}}tax_j^2(\frac{1}{1-tax_j}) + \frac{1}{a^{\frac{1}{\varepsilon_j}}}(\frac{tax_j}{1-tax_j})] \\
&= \pi_j^{PT,0}(\varphi)[1 - tax_j + \frac{2tax_j - 2tax_j(1-tax_j) - tax_j^2}{2a^{\frac{1}{\varepsilon_j}}(1-tax_j)}] \\
&= \pi_j^{PT,0}(\varphi)[1 - tax_j + \frac{tax_j^2}{2a^{\frac{1}{\varepsilon_j}}(1-tax_j)}]
\end{aligned}$$

### 1.3.3 Productivity cut-off with profit shifting

Consider a firm headquartered in country $i$. It enters country $j$ if and only if:

$$\begin{aligned}
& \pi_j^{PS}(\varphi) > f_{i,j} \\
\iff & \pi_j^{PT,0}(\varphi)(1-ETR_j) > f_{i,j} \\
\iff & \pi_j^{PT,0}(\varphi) > \frac{f_{i,j}}{1-ETR_j} \\
\iff & \frac{\alpha L_j}{\sigma}[\frac{\sigma}{(\sigma-1)\varphi P_j^{PS}}]^{1-\sigma} > \frac{f_{i,j}}{1-ETR_j} \\
\iff & \varphi^{\sigma-1} > [\frac{\sigma f_{i,j}}{\alpha L_j(1-ETR_j)}](\frac{\sigma}{\sigma-1})^{\sigma-1}(\frac{1}{P_j^{PS}})^{\sigma-1} \\
\iff & \varphi > \frac{1}{P_j^{PS}}(\frac{\sigma}{\sigma-1})[\frac{\sigma f_{i,j}}{\alpha L_j(1-ETR_j)}]^{\frac{1}{\sigma-1}}
\end{aligned}$$

This defines the new productivity cut-off, with profit shifting:

$$\bar{\varphi_{i,j}}^{PS} = \frac{1}{P_j^{PS}}(\frac{\sigma}{\sigma-1})[\frac{\sigma f_{i,j}}{\alpha L_j(1-ETR_j)}]^{\frac{1}{\sigma-1}}$$

Which can be rewritten following Chaney (2005)'s notations as:

$$\bar{\varphi_{i,j}}^{PS} = \lambda_1[(P_j^{PS})^{\sigma-1}L_j]^{-\frac{1}{\sigma-1}}(\frac{f_{i,j}}{1-ETR_j})^{\frac{1}{\sigma-1}}$$

We conclude that the firm enters market $j$ if and only if satisfies:

$$\varphi > \bar{\varphi_{i,j}}^{PS}$$

### 1.3.4 Equilibrium price index with profit shifting

The following computations are very similar to the ones presented above for the benchmark case. We compute the price index in country $j$, with $\Omega_j$ and $\Omega_{i,j}$ denoting respectively the set of varieties consumed in country $j$ and the set of varieties produced in country $j$ by firms headquartered in $i$. Because, there is a continuum of varieties produced in country $j$ by firms from country $i$, the law of large numbers applies.

$$\begin{aligned}
(P_j^{PS})^{1-\sigma} &= \int_{\Omega_j} [p(\omega)]^{1-\sigma} d\omega \\
&= \sum_{i=1}^{N} \int_{\Omega_{i,j}} [p(\omega)]^{1-\sigma} d\omega \\
&= \sum_{i=1}^{N} L_i \int_{\bar{\varphi}_{i,j}^{PS}}^{+\infty} [p_{i,j}(\varphi)]^{1-\sigma} dF(\varphi) \\
&= \sum_{i=1}^{N} L_i \int_{\bar{\varphi}_{i,j}^{PS}}^{+\infty} [\frac{\sigma}{(\sigma-1)\varphi}]^{1-\sigma} dF(\varphi) \\
&= [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\int_{\bar{\varphi}_{i,j}^{PS}}^{+\infty} \varphi^{\sigma-1} dF(\varphi)] \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\int_{\bar{\varphi}_{i,j}^{PS}}^{+\infty} \varphi^{\sigma-\gamma-2} d\varphi] \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [\frac{\varphi^{\sigma-\gamma-1}}{\sigma-\gamma-1}]_{\bar{\varphi}_{i,j}^{PS}}^{+\infty} \\
&= \gamma [\frac{\sigma}{(\sigma-1)}]^{1-\sigma} \sum_{i=1}^{N} L_i [0 - \frac{(\bar{\varphi}_{i,j}^{PS})^{\sigma-\gamma-1}}{\sigma-\gamma-1}]
\end{aligned}$$

Because, by assumption, $\gamma > \sigma - 1$. We then have:

$$(P_j^{PS})^{1-\sigma} = \gamma (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i \frac{(\bar{\varphi}_{i,j}^{PS})^{\sigma-\gamma-1}}{\gamma-(\sigma-1)}$$

And plugging in the expression for the productivity threshold $\bar{\varphi}_{i,j}^{PS}$, we get:

$$\begin{aligned}
(P_j^{PS})^{1-\sigma} &= \frac{\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i \bar{\varphi}_{i,j}^{\sigma-\gamma-1} \\
&= \frac{\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} \sum_{i=1}^{N} L_i (\frac{f_{i,j}}{1-ETR_j})^{\frac{\sigma-\gamma-1}{\sigma-1}} [(P_j^{PS})^{\sigma-1} L_j]^{\frac{\gamma+1-\sigma}{\sigma-1}} \lambda_1^{\sigma-\gamma-1} \\
&= \frac{\lambda_1^{\sigma-\gamma-1}\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma} (P_j^{PS})^{\gamma+1-\sigma} [L_j(1-ETR_j)]^{\frac{\gamma+1-\sigma}{\sigma-1}} \sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}}
\end{aligned}$$

This simplifies into:

$$(P_j^{PS})^{-\gamma} = \lambda_2^{-\gamma}[L_j(1-ETR_j)]^{\frac{\gamma+1-\sigma}{\sigma-1}} \sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}}$$

$$\iff P_j^{PS} = \lambda_2[L_j(1-ETR_j)]^{\frac{\sigma-1-\gamma}{\gamma(\sigma-1)}} (\sum_{i=1}^{N} L_i f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}})^{-\frac{1}{\gamma}}$$

And we can retrieve Chaney (2005)'s notations, which yield:

$$P_j^{PS} = \lambda_2 (\frac{L_j}{L})^{\frac{1}{\gamma}} L_j^{-\frac{1}{\sigma-1}} (1-ETR_j)^{\frac{1}{\gamma}-\frac{1}{\sigma-1}} \theta_j$$

Where:

$$\lambda_2^{-\gamma} = \frac{\lambda_1^{\sigma-\gamma-1}\gamma}{\gamma-(\sigma-1)} (\frac{\sigma}{\sigma-1})^{1-\sigma}$$

$$\iff \lambda_2 = \lambda_1^{\frac{\gamma-\sigma+1}{\gamma}} [\frac{\gamma}{\gamma-(\sigma-1)}]^{-\frac{1}{\gamma}} (\frac{\sigma}{\sigma-1})^{\frac{\sigma-1}{\gamma}}$$

And $\theta_j^{-\gamma} = \sum_{i=1}^{N} s_i f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)}$.

### 1.3.5 Derivation of total sales with profit shifting

The total sales of firms headquartered in country $i$ in country $j$ are given by:

$$\begin{aligned} X_{i,j} &= L_i \int_{\bar{\varphi_{i,j}}^{PS}}^{+\infty} r_j^{PS}(\varphi) dF(\varphi) \\ &= L_i \int_{\bar{\varphi_{i,j}}^{PS}}^{+\infty} \lambda_4 (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-ETR_j)^{\frac{\sigma-1}{\gamma}-1} \varphi^{\sigma-1} \theta_j^{\sigma-1} dF(\varphi) \\ &= \lambda_4 L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-ETR_j)^{\frac{\sigma-1}{\gamma}-1} \theta_j^{\sigma-1} \int_{\bar{\varphi_{i,j}}^{PS}}^{+\infty} \varphi^{\sigma-1} dF(\varphi) \end{aligned}$$

Where, as seen before when computing the price index $P_j$ at equilibrium:

$$\int_{\bar{\varphi_{i,j}}^{PS}}^{+\infty} \varphi^{\sigma-1} dF(\varphi) = \frac{\gamma}{\gamma-(\sigma-1)} (\bar{\varphi_{i,j}}^{PS})^{\sigma-\gamma-1}$$

So:

$$\begin{aligned} X_{i,j} &= \lambda_4 L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}} (1-ETR_j)^{\frac{\sigma-1}{\gamma}-1} \theta_j^{\sigma-1} \frac{\gamma}{\gamma-(\sigma-1)} (\bar{\varphi_{i,j}}^{PS})^{\sigma-\gamma-1} \\ &= [\frac{\gamma \lambda_3^{\sigma-\gamma-1}\lambda_4}{\gamma-(\sigma-1)}] L_i (\frac{L_j}{L})^{\frac{\sigma-1}{\gamma}-\frac{\sigma-1-\gamma}{\gamma}} (1-ETR_j)^{\frac{\sigma-1}{\gamma}-1-\frac{\sigma-\gamma-1}{\gamma}} f_{i,j}^{\frac{\sigma-\gamma-1}{\sigma-1}} \theta_j^{\sigma-1-(\sigma-\gamma-1)} \\ &= \lambda L_i \frac{L_j}{L} (1-ETR_j)^0 f_{i,j}^{1-\frac{\gamma}{\sigma-1}} \theta_j^{\gamma} \end{aligned}$$

Eventually, we obtain:

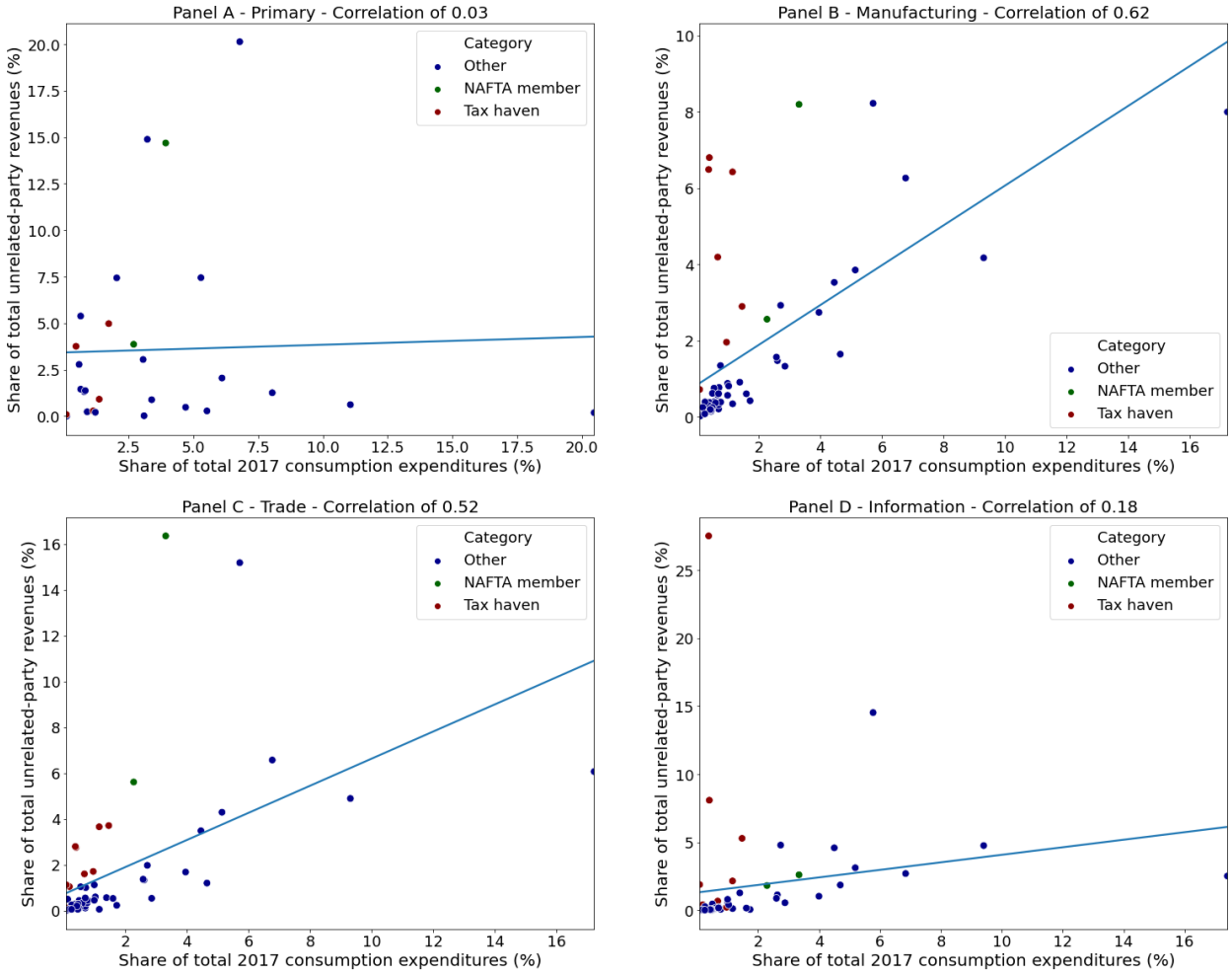
$$X_{i,j} = \lambda \frac{L_i L_j}{L} f_{i,j}^{-(\frac{\gamma}{\sigma-1}-1)} \theta_j^{\gamma} \text{ , where } \lambda = \frac{\gamma}{\gamma-(\sigma-1)} \lambda_3^{\sigma-\gamma-1} \lambda_4$$

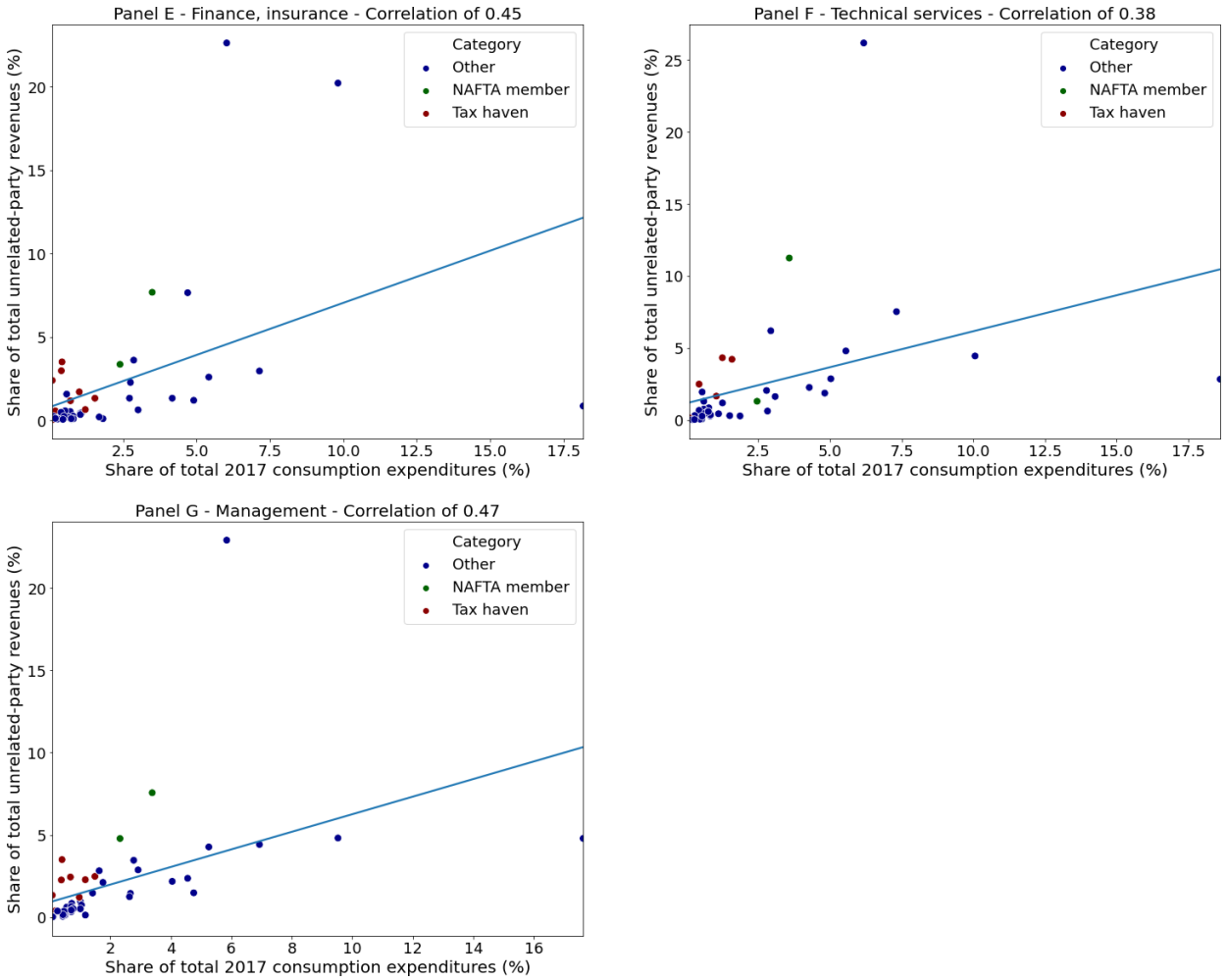
# Chapter 2

# Empirical Analysis

## 2.1 Graphs per Industry Group

Figure 2.1: Relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures, broken down by industry group






Note: This figure presents, for each industry group, the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to final consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv et al. (2019) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of final consumption expenditures. The correlation between partner jurisdictions' share of foreign unrelated-party revenues and their share of final consumption expenditures is also indicated. Revenue figures come from the aggregated and anonymized country-by-country data of the IRS; final consumption expenditures are sourced from the UNCTAD's data portal.

## 2.2 Econometric Modelling

### 2.2.1 Non-linear response to taxation

Table 2.1: Non-linear relationship between corporate income tax rates and unrelated-party revenues

| | (1) ln(UPR) | (2) ln(UPR) |
|---|---|---|
| Statutory tax rate | -0.0769*** | |
| | (0.000) | |
| Squared statutory tax rate | 0.00138*** | |
| | (0.004) | |
| EATR | | -0.0514*** |
| | | (0.007) |
| Squared EATR | | 0.000846** |
| | | (0.048) |
| ln(GDP) - WOE | 1.204*** | 1.202*** |
| | (0.000) | (0.000) |
| ln(Foreign Market Access) | 0.357*** | 0.359*** |
| | (0.000) | (0.000) |
| ln(Distance) | -0.495*** | -0.512*** |
| | (0.000) | (0.000) |
| Constant | -2.330* | -2.386* |
| | (0.082) | (0.081) |
| Gravity control variables | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 508 | 504 |
| R-squared | 0.839 | 0.823 |
| Adj. R-squared | 0.834 | 0.818 |

*p*-values in parentheses

Using robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: In this table, we add the squared tax variable (either the statutory corporate income tax rate or the effective average tax rate) to the benchmark specification. These results rely on the IRS' aggregate country-by-country report statistics from 2016 to 2019. Estimation is done via Ordinary Least Squares (OLS); time fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues, "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook and "EATR" for the Effective Average Tax Rate.

### 2.2.2 Alternative samples

Table 2.2: Determinants of unrelated-party revenues in the IRS' sectoral country-by-country data

| | (1) ln(UPR) | (2) ln(UPR) | (3) ln(UPR) |
|---|---|---|---|
| Statutory tax rate | -0.00967* | | -0.0797*** |
| | (0.087) | | (0.000) |
| EATR | | -0.00846 | |
| | | (0.138) | |
| Squared statutory tax rate | | | 0.00154*** |
| | | | (0.000) |
| ln(GDP) - WOE | 0.952*** | 0.947*** | 0.948*** |
| | (0.000) | (0.000) | (0.000) |
| ln(Foreign Market Access) | 0.246*** | 0.247*** | 0.267*** |
| | (0.000) | (0.000) | (0.000) |
| ln(Distance) | -0.174** | -0.159** | -0.135* |
| | (0.031) | (0.046) | (0.090) |
| Constant | -3.202*** | -3.268*** | -2.646** |
| | (0.006) | (0.005) | (0.022) |
| Gravity control variables | Yes | Yes | Yes |
| Sector x Year fixed effects | Yes | Yes | Yes |
| Observations | 1269 | 1269 | 1269 |
| R-squared | 0.756 | 0.756 | 0.760 |
| Adj. R-squared | 0.749 | 0.749 | 0.752 |

$p$-values in parentheses

Using robust standard errors.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Note: In this table, we re-estimate the benchmark specification and the non-linear relationship. These results rely on the IRS' sectoral country-by-country report statistics from 2016 to 2019. Estimation is done via Ordinary Least Squares (OLS); Sector x Year interacted fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues, "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook and "EATR" for the Effective Average Tax Rate.

Table 2.3: Linear effect of the statutory tax rate on unrelated-party revenues by industry group

| | (1) ln(UPR) | (2) ln(UPR) | (3) ln(UPR) | (4) ln(UPR) | (5) ln(UPR) | (6) ln(UPR) | (7) ln(UPR) |
|---|---|---|---|---|---|---|---|
| Statutory tax rate | -0.0540 | -0.0152** | 0.000512 | -0.0268* | 0.00935 | -0.0185 | 0.00243 |
| | (0.107) | (0.041) | (0.967) | (0.093) | (0.694) | (0.111) | (0.803) |
| ln(GDP) - WOE | 0.0672 | 0.944*** | 1.064*** | 1.187*** | 0.771*** | 1.126*** | 0.918*** |
| | (0.754) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ln(Foreign Market Access) | -0.575*** | 0.377*** | 0.429*** | 0.181 | 0.279** | 0.180** | 0.264*** |
| | (0.003) | (0.000) | (0.000) | (0.123) | (0.024) | (0.026) | (0.001) |
| ln(Distance) | -0.655** | -0.0976 | -0.0413 | -0.352 | 0.0762 | -0.484** | -0.0940 |
| | (0.024) | (0.550) | (0.813) | (0.178) | (0.717) | (0.010) | (0.584) |
| Constant | 22.71*** | 0.690 | -4.684* | -7.488** | 0.0925 | -5.055** | -2.073 |
| | (0.001) | (0.691) | (0.064) | (0.011) | (0.976) | (0.044) | (0.328) |
| Gravity control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Primary | Manufacturing | Trade | Information | Finance | Technical services | Management |
| Observations | 92 | 219 | 217 | 217 | 162 | 172 | 190 |
| R-squared | 0.633 | 0.814 | 0.776 | 0.708 | 0.655 | 0.794 | 0.784 |
| Adj. R-squared | 0.572 | 0.801 | 0.760 | 0.687 | 0.622 | 0.776 | 0.766 |

$p$-values in parentheses

Using robust standard errors.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Note: In this table, we consider the benchmark specification with the statutory corporate income tax rate and again use the IRS' sectoral country-by-country report statistics from 2016 to 2019, but we distinguish one sub-sample per industry group. Estimation is done via Ordinary Least Squares (OLS); year fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues and "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook.

Table 2.4: Non-linear effect of the statutory tax rate on unrelated-party revenues by industry group

| | (1) ln(UPR) | (2) ln(UPR) | (3) ln(UPR) | (4) ln(UPR) | (5) ln(UPR) | (6) ln(UPR) | (7) ln(UPR) |
|---|---|---|---|---|---|---|---|
| Statutory tax rate | -0.261 | -0.0688*** | -0.0220 | -0.171*** | -0.159** | -0.106*** | -0.0139 |
| | (0.231) | (0.000) | (0.495) | (0.000) | (0.042) | (0.000) | (0.454) |
| Squared statutory tax rate | 0.00360 | 0.00122*** | 0.000506 | 0.00326*** | 0.00368** | 0.00193*** | 0.000380 |
| | (0.304) | (0.004) | (0.460) | (0.000) | (0.018) | (0.002) | (0.399) |
| ln(GDP) - WOE | 0.0830 | 0.937*** | 1.062*** | 1.170*** | 0.753*** | 1.124*** | 0.916*** |
| | (0.697) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ln(Foreign Market Access) | -0.596*** | 0.395*** | 0.436*** | 0.231** | 0.326*** | 0.209*** | 0.270*** |
| | (0.003) | (0.000) | (0.000) | (0.047) | (0.006) | (0.009) | (0.001) |
| ln(Distance) | -0.649** | -0.0634 | -0.0272 | -0.262 | 0.176 | -0.436** | -0.0812 |
| | (0.027) | (0.694) | (0.876) | (0.291) | (0.374) | (0.018) | (0.639) |
| Constant | 24.99*** | 1.180 | -4.469* | -6.183** | 1.657 | -4.367* | -1.946 |
| | (0.001) | (0.489) | (0.081) | (0.030) | (0.579) | (0.073) | (0.354) |
| Gravity control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Primary | Manufacturing | Trade | Information | Finance | Technical services | Management |
| Observations | 88 | 215 | 213 | 213 | 158 | 168 | 186 |
| R-squared | 0.434 | 0.771 | 0.713 | 0.659 | 0.560 | 0.742 | 0.704 |
| Adj. R-squared | 0.334 | 0.755 | 0.693 | 0.635 | 0.517 | 0.719 | 0.680 |

$p$-values in parentheses

Using robust standard errors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: In this table, we consider the non-linear specification with the statutory corporate income tax rate and again use the IRS' sectoral country-by-country report statistics from 2016 to 2019, but we distinguish one sub-sample per industry group. Estimation is done via Ordinary Least Squares (OLS); year fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues and "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook.

Table 2.5: Determinants of unrelated-party revenues in the OECD's country-by-country data

| | (1) ln(UPR) | (2) ln(UPR) | (3) ln(UPR) |
|---|---|---|---|
| Statutory tax rate | -0.00399 | | -0.0284 |
| | (0.457) | | (0.109) |
| EATR | | 0.00216 | |
| | | (0.673) | |
| Squared statutory tax rate | | | 0.000559 |
| | | | (0.144) |
| ln(GDP) - WOE | 1.021*** | 1.014*** | 1.019*** |
| | (0.000) | (0.000) | (0.000) |
| ln(Foreign Market Access) | -0.0459 | -0.0332 | -0.0445 |
| | (0.295) | (0.448) | (0.310) |
| ln(Distance) | -0.500*** | -0.508*** | -0.499*** |
| | (0.000) | (0.000) | (0.000) |
| Constant | -3.242*** | -3.065*** | -2.971*** |
| | (0.000) | (0.000) | (0.000) |
| Gravity control variables | Yes | Yes | Yes |
| Parent country x Year FE | Yes | Yes | Yes |
| Observations | 2486 | 2486 | 2486 |
| R-squared | 0.655 | 0.655 | 0.656 |
| Adj. R-squared | 0.650 | 0.650 | 0.650 |

$p$-values in parentheses

Using robust standard errors.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Note: In this table, we re-estimate the benchmark specification and the non-linear relationship. These results rely on the OECD's aggregated country-by-country report statistics for 2016 and 2017, including 14 non-US headquarter countries. Estimation is done via Ordinary Least Squares (OLS); Parent country x Year interacted fixed effects and gravity control variables are systematically included. "UPR" stands for unrelated-party revenues, "ln(GDP) - WOE" for the logarithm of the Gross Domestic Product sourced from the IMF's World Economic Outlook and "EATR" for the Effective Average Tax Rate.

# Chapter 3

# Policy Implications

## 3.1 Data on the Activities of Multinational Enterprises

### 3.1.1 Definitions of the revenue variables

In country-by-country report statistics, the three revenue variables are defined as follows:

- Unrelated-party revenues: "The sum of revenues of all the constituent entities of the MNE group in the relevant tax jurisdiction generated from transactions with independent parties."
- Related-party revenues: "The sum of revenues of all the constituent entities of the MNE group in the relevant tax jurisdiction generated from transactions with associated enterprises."
- Total revenues: "Revenues should include revenues from sales of inventory and properties, services, royalties, interest, premiums and any other amounts. Revenues should exclude payments received from other constituent entities that are treated as dividends in the payer's tax jurisdiction. Total revenues should equal the sum of unrelated and related party revenues."

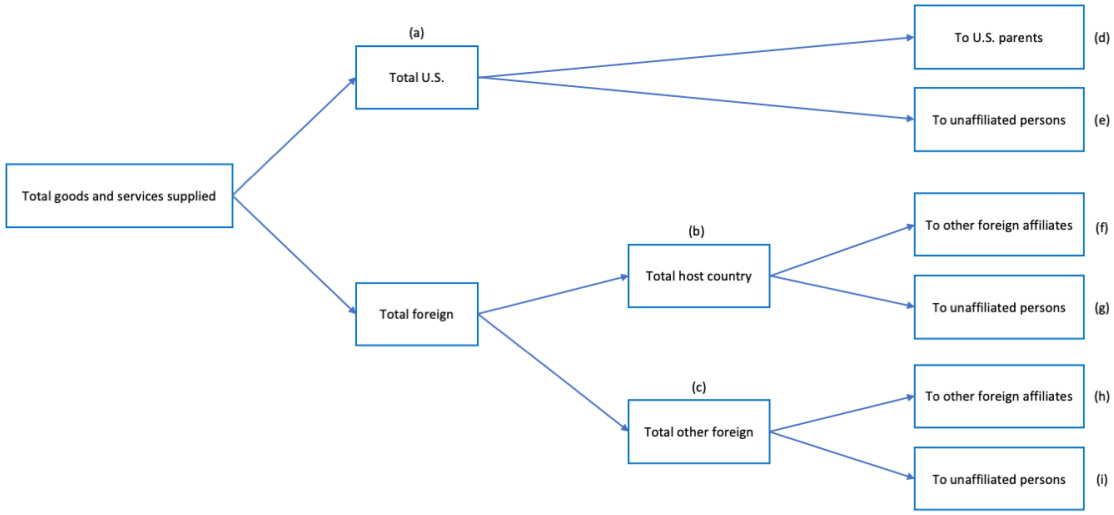
In the BEA's data on the activities of US multinational enterprises, the sales of goods and services are defined as follows:

- Goods supplied: "Goods supplied are generally defined as sales of economic outputs that are tangible. For sales in wholesale and retail trade, goods supplied include only the value of goods resold; they consist of reported sales of goods less BEA's estimate of the value of the distributive services provided by selling, or arranging for the sale of, goods (this estimate is added to reported sales of services to calculate services supplied)."
- Services supplied: "Services supplied are generally defined as sales of economic outputs that are intangible. For sales in insurance, services supplied consist of reported premiums less BEA's estimates of the premiums set aside for expected or 'normal' losses plus a measure of premium supplements, which represent income earned on funds that insurers hold on policyholders' behalf. For sales in banking, services supplied include not only the explicit fees and commissions reported as sales but also BEA's estimate of the value of implicit services provided by banks. (The values subtracted from and added to sales of services in insurance and banking are added to and subtracted from, respectively, reported values of other income.) For sales in wholesale and retail trade, services supplied include BEA's estimate of the value of the distributive services provided by selling, or arranging for the sales of, goods (this estimate is subtracted from reported sales of goods to calculate goods supplied). For industries other

than insurance, banking, and wholesale and retail trade, services supplied consist of reported sales of services."

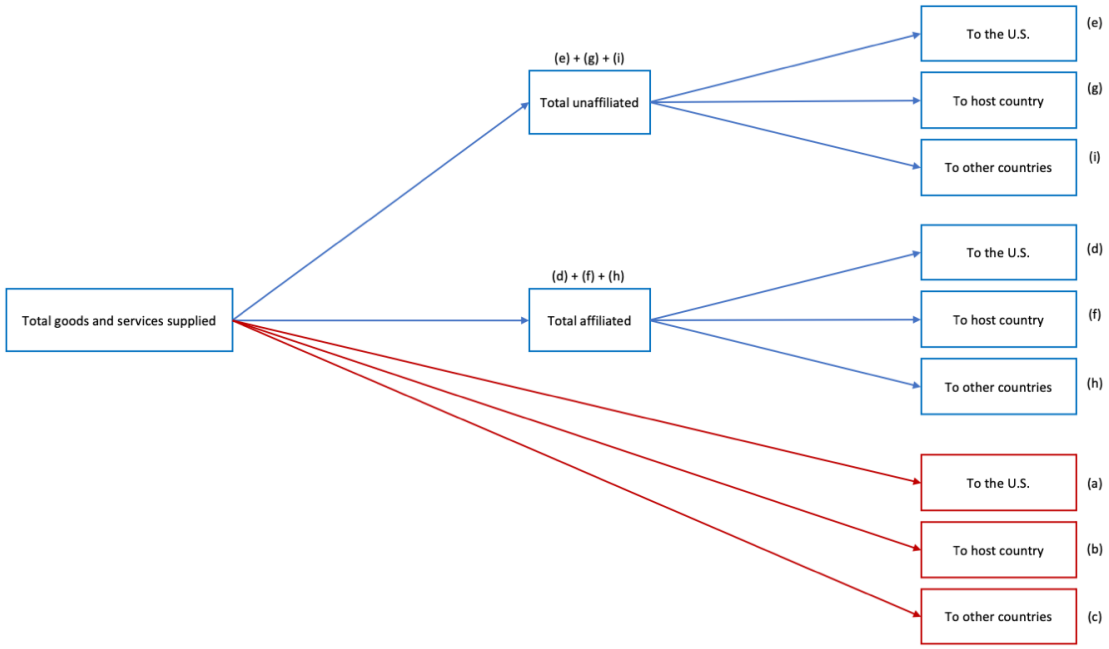
### 3.1.2 Organization of Table II.E2 in the BEA's data

Figure 3.1: Disaggregation of the goods and services supplied in Table II.E2 of the BEA's data on the activities of US multinational enterprises



### 3.1.3 Re-organization of Table II.E2 for the destination-based adjustment

Figure 3.2: Disaggregation of the goods and services supplied after the re-organization operated in the destination-based adjustment of revenue variables




### 3.1.4 Illustrating the combination of IRS and BEA data

To illustrate the computations that combine the country-by-country revenue variables and the BEA's statistics, let us take the example of France.

*Step 1*

In the IRS' 2017 country-by-country data, this partner jurisdiction is associated with the following values for revenue variables:

- Unrelated-party revenues: 146.5 billion USD;
- Related-party revenues: 58.1 billion USD;
- Total revenues: 204.6 billion USD.

*Step 2*

From the Table II.E2 of the BEA's 2017 data on the activities of US multinationals, we find that:

- Goods and services supplied to unaffiliated parties amount to 155.3 billion USD. These are distributed as follows:

  - 84% (131.0 billion USD) are directed to France;
  - 1% (1.8 billion USD) are directed to the US;
  - 14% (22.5 billion USD) are directed to other countries.

- Goods and services supplied to affiliated parties amount to 41.5 billion USD. These are distributed as follows:
  - 21% (8.7 billion USD) are directed to France;
  - 13% (5.3 billion USD) are directed to the US;
  - 66% (27.5 billion USD) are directed to other countries.

- Total goods and services supplied amount to 196.7 billion USD. These are distributed as follows among ultimate destination types:
  - 71% (139.8 billion USD) are directed to France;
  - 4% (7.0 billion USD) are directed to the US;
  - 25% (49.9 billion USD) are directed to other countries.

*Step 3*

From there, we deduce the following split for the three revenue variables in the IRS' country-by-country data:

- Unrelated-party revenues:
  - $84\% * 146.5 = 123.7$ billion USD are directed to France;
  - $1\% * 146.5 = 1.7$ billion USD are directed to the US;
  - $14\% * 146.5 = 21.2$ billion USD are directed to other countries.

- Related-party revenues:
  - $21\% * 58.1 = 12.2$ billion USD are directed to France;
  - $13\% * 58.1 = 7.4$ billion USD are directed to the US;
  - $66\% * 58.1 = 38.5$ billion USD are directed to other countries.

- Total revenues:
  - $71\% * 204.6 = 145.4$ billion USD are directed to France;
  - $4\% * 204.6 = 7.3$ billion USD are directed to the US;
  - $25\% * 204.6 = 51.9$ billion USD are directed to other countries.

*Other cases*

Should France be absent from BEA data, in Step 2, we would instead compute the amounts of goods and services supplied to affiliated, unaffiliated and any party at the European level. We would have similarly computed the destination-based distribution of these three amounts at the continental level. From there, the resulting percentages would have been applied similarly as in the Step 3 above, so as to split the revenue variables of country-by-country data.

## 3.2 Trade Statistics

A key purpose of our research on the revenue variables of country-by-country report statistics is to propose an adjusted geographical breakdown of unrelated-party, related-party and total revenues that reflects the ultimate destination of the sales, rather than the location of the subsidiaries that register the transactions in their financial accounts. The current methodology developed works in two steps: (i) at the country-pair level, revenue variables are split between revenues directed to the affiliate country, to the headquarter country or to any other destination and (ii) the latter sales are distributed to their (approximative) final destination based on the distribution of the affiliate country's exports of goods and services.

Because of their important role in the adjustment methodology, trade statistics must be selected carefully. The following describes the different databases that were considered, the criteria used to assess them and the combination of sources used for benchmark computations. Section 3.2.1 highlights the main criteria that may differentiate the databases and their influence over the selection process. The sections 3.2.2 and 3.2.3 present the sources considered respectively for trade in goods and for trade in services. Section 3.2.4 details the retained combination of data used in the main computations. Eventually, Section 3.2.5 describes the preparation of the retained data.

### 3.2.1 General considerations

Our use case for trade statistics first requires bilateral data, that show a detailed breakdown of partner jurisdictions for each exporting country. Besides, since country-by-country revenue variables cover (among other elements) the sales of both goods and services, we are looking for either a unique source combining merchandise and service flows or different but compatible sources. Eventually, while trade statistics may often differ based on the sectoral disaggregation that they allow, we only use the total exports of goods and services for now.[1]

From there, Laffitte and Toubal (2022) point at an additional dichotomy in merchandise trade statistics: while data sources based on customs registries define transactions by considering the physical cross-border movement of goods, the statistics on the exports of goods from countries' balances of payments measure trade according to changes in ownership. Laffitte and Toubal (2022) further underline the impact of this distinction in the case of Apple's contract manufacturing processes. Put in a very schematic manner, let us consider a French consumer buying an iPad in a French store. The good was produced by Apple's manufacturing partner in China but remained, throughout the whole value chain, the property of Apple's Irish subsidiary (as defined in the contract binding Apple and the manufacturing partner). Once assembled, the device was shipped directly from China to France. The good is then treated differently depending on the database considered: customs registries reflect an export from China to France based on the movement of the product, whereas the Irish balance of payments records an export of merchandise from Ireland to France as the ownership is transferred from Apple Sales International (incorporated in Ireland) to the French consumer.

In the US country-by-country data, this sale by Apple would be recorded based on the tax residence of the affiliate that owns the product until it is bought in France and registers the transaction in its income statement, Apple Sales International. Due to the corporate structure set up by Apple for tax planning purposes, which Laffitte and Toubal (2022) describe based on declarations to the US Senate, the activities of the Irish subsidiary may appear under "Stateless

1. An industry-by-industry adjustment of US country-by-country reports statistics might be considered. Indeed, the IRS proposes these data for 7 broad groups of sectors and the BEA data on the activities of US multinational enterprises also provide sectoral breakdowns.

entities". But assuming that it instead accrues to the unrelated-party revenues of US multinational companies in Ireland, our aim is to re-attribute an approximately equivalent amount to France. This can only be achieved if the trade statistics used in our adjustment include a corresponding transaction from Ireland to France. More generally, we are looking to approximate a distribution of multinational companies' sales that would be based on the ultimate location of customers. We should ideally favor data sources that measure trade according to changes in ownership, like the exports of goods and services shown in balances of payments.

Eventually, in merchandise trade statistics based on customs registries, imports and exports are not accounted for in the same way, which may lead (among other factors) to bilateral inconsistencies. In the United Nations (2011) framework, that provides the statistical standard for most data sources on trade in merchandise, it is recommended that imports be accounted for on the basis of the country of origin of the goods and that exports be reported on the basis of the country of last known destination at the time of the export. These notions are respectively defined by the following:

- Rules of origin generally include two criteria: "the criterion of goods *wholly produced* (obtained) in a given country, where only one country enters into consideration in attributing origin; the criterion of *substantial transformation*, where two or more countries have taken part in the production of the goods";

- "The country of last known destination is the last country - as far as it is known at the time of exportation - to which goods are to be delivered, irrespective of where they have been initially dispatched to and whether or not, on their way to that last country, they are subject to any commercial transactions or other operations that change their legal status".

In practice, both of these notions present difficulties:

- For imports, the country of origin may be difficult to identify for several reasons. First, and very simply, documentary requirements regarding the origin of the goods vary from a country to another and therefore, the quality of the available information is uneven. Besides, according to United Nations (2011), statistics on trade between the member-States of a customs union often record imports based on the country of consignment (to which the goods are dispatched from the exporting country), instead of the country of origin;

- For exports, when the good leaves the country where it was produced initially, its ultimate destination is not always known. As such, the country of last known destination reported to customs may not correspond to the place where the good will be consumed or used. This is especially true with the increasing complexity of globalized value chains (e.g., the good may have to follow a series of secondary transformations and the location of the final steps may not be known long in advance) and the optimization of logistic chains (e.g., the last known destination at the time of the export can be a warehouse in Belgium, from which the good will finally be sent to France, Germany or the Netherlands).

Despite these difficulties, the notion of "country of origin" attached to imports is closer to our objective of building a distribution of sales that reflects the final destination of the transactions. Therefore, in the preprocessing of merchandise trade statistics based on customs data, we systematically focus on imports.

### 3.2.2 Statistical sources on trade in goods

#### Merchandise trade statistics based on customs registries

As illustrated by Laffitte and Toubal (2022) with the case of Apple, trade in goods statistics based on customs registries define transactions according to the cross-border movement of goods. They generally follow the methodology of the United Nations (2011) under which "as a general guideline, it is recommended that international merchandise trade statistics record all goods which add to or subtract from the stock of material resources of a country **by entering (imports) or leaving (exports) its economic territory**" (page 13). Change of ownership may also be used but "only in exceptional cases when the general guideline is not applicable or not sufficient" (page 13).

Two sources of such merchandise trade statistics are considered for our adjustment of country-by-country revenue variables. First, UN Comtrade data constitute the reference statistical source for customs-based merchandise trade flows (see United Nations (2016-2019)). As such, these data follow the United Nations (2011) standard and reflect the physical cross-border movement of goods. They feature additional information and allow for instance to isolate re-exports or re-imports.[2] We download the relevant data from the UN Comtrade online portal.[3] For the year 2017, focusing on imports, the resulting dataset involves 234 unique partners and 169 unique reporters while, on average, each reporter is associated with 167 partners.

Second, we consider the Balanced International Merchandise Trade Statistics (BIMTS) of the OECD (see OECD (2016-2019) to access the data and Fortanier and Sarrazin (2016) for the corresponding methodology). Readily accessible on the data portal of the OECD, BIMTS cover more than 160 reporting countries. For each of these, the dataset provides its "Balanced Trade Value", i.e. its exports corrected for bilateral asymmetries, to a variety of partner countries in current USD. Data are available for 12 years, from 2007 to 2018, and for a broad variety of commodity categories. In 2017, focusing only on the total of all commodities, the dataset covers 162 unique partners and on average, each reporting country is associated with 135 destinations.

#### Merchandise trade statistics as per the balance of payments

On the other hand, balances of payments use ownership changes as the primary criterion to define trade flows. The latest and most broadly applied standard for such reporting is the Sixth Edition of the Balance of Payments and International Investment Position Manual (BPM6, International Monetary Fund (2010)). In particular, in the goods and services account, balances of payments include a "general merchandise" field defined as follows: "general merchandise on a balance of payments basis covers **goods whose economic ownership is changed between a resident and a nonresident** and that are not included in the following specific categories: goods under merchanting, nonmonetary gold, and parts of travel, construction, and government goods and services not included elsewhere" (page 151).

The BEA maintains the US International Transactions Accounts (ITAs). In particular, the current account in these quarterly statistics theoretically records the exports of goods and services from US residents to non-residents based on changes in ownership. On the data portal of the BEA, we focus on Table 1.5 "U.S. International Trade in Goods and Services by Area and Country" (see

2. Re-exports occur when a country imports foreign goods and then re-exports them to their country of origin; they are included in the country's exports, but United Nations (2011) recommends they be also recorded as a standalone item. Re-imports occur when a country exports goods to a foreign partner and then re-imports them; they are included in the country's imports, but United Nations (2011) recommends they be also recorded as a standalone item.

3. The process followed to collect these data is described in details in this online repository: https://github.com/pechouc/comtrade_data_selection.

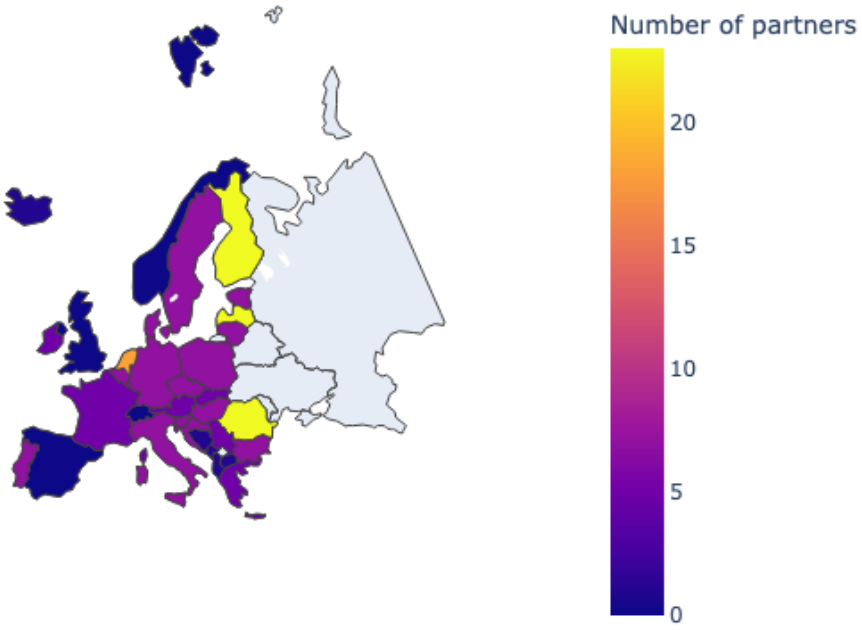
BEA (2016-2019)). From 1999 to 2020, it provides several indicators that break down by sector and nature of transactions the US exports and imports of goods and services to and from 90 partners. The latter include 18 continental aggregates or regional organizations and 72 destination countries (UK Caribbean Islands being aggregated as a single partner jurisdiction). The bilateral breakdown of US transactions in these data is thus less granular than in the UN Comtrade database or the BIMTS, but the way trade is defined in principle corresponds more closely to our use case.

In practice, as explained in Bureau of Economic Analysis (2021), the US ITAs are not fully consistent with the BPM6 standards, due in particular to the treatment of "manufacturing services on physical inputs owned by others" (which corresponds to the contract manufacturing operations described by Laffitte and Toubal (2022)). For instance, when US-owned goods leave the US for processing, they are counted as part of exports based on the physical movement of the merchandise; when they are sent back to the US, they appear as imports despite the absence of a change in their ownership. Articles 11.3 to 11.6 describe the issue in more details. Therefore, the ITAs do not yet allow to treat the goods exchanged via contract manufacturing relationships in a way that would be closer to our definition of destination-based sales than what can be achieved with customs-based sources.

Bilateral data on the exports of goods as per the balance of payments, that define transactions based on changes in ownership, are limited outside of the US. In its balance of payments annual data, Eurostat provides a limited breakdown of the exports of goods by partner country. Granularity varies depending on the field (e.g., "goods" or "general merchandise on a balance of payments basis") and on the reporting country considered.

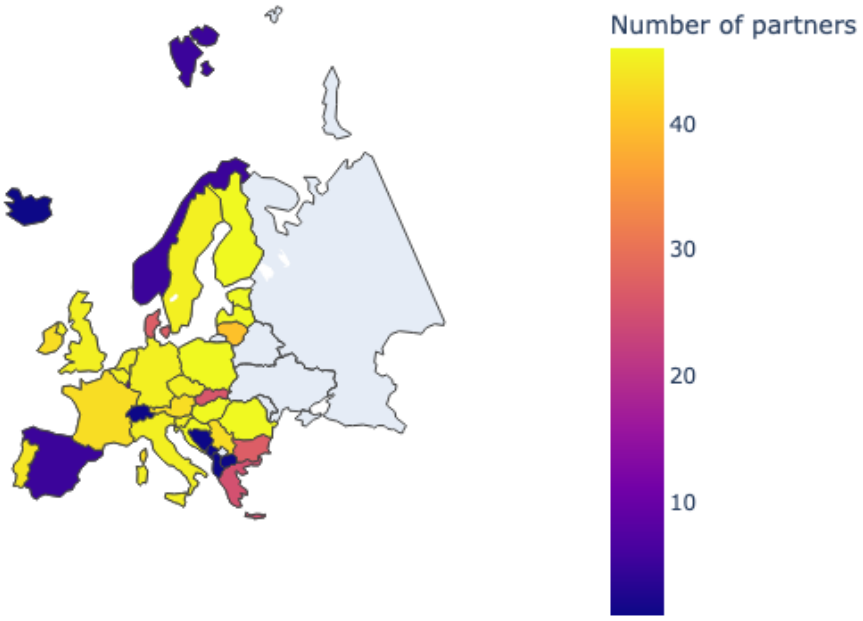
- For general merchandise in particular (on which we focus when dealing with US ITAs), only 4 reporting countries display more than 20 partner entities: Cyprus, Finland, Latvia and Romania. The Netherlands is associated with 18 partners and the 33 other reporting countries display 7 partners or less. In most cases, only a distinction between intra-EU and extra-EU exports (or exports to and outside the Euro area) is given. In the above, the number of partner countries is systematically assessed after eliminating missing values. The map in Figure 3.3 shows the number of partner entities associated to each reporting country, taking 2016 as reference.

Figure 3.3: Granularity of the bilateral breakdowns of the "general merchandise on a balance of payments basis" item in Eurostat data per parent country




- Considering the total exports of goods allows for higher granularity. Most EU Member-States display 40 partner countries or more as can be seen in Figure 3.4 (excluding missing values and again taking 2016 as reference). However, one must keep in mind that the total exports of goods include not only the general merchandise as defined above but also the undesired "net exports of goods under merchanting" (which may lead to negative values in rare cases) and "non-monetary gold". The coverage for these two sub-fields is similar to that of general merchandise and thus, they cannot be isolated from the total exports of goods.

Figure 3.4: Granularity of the bilateral breakdowns of the "goods" item in Eurostat data per parent country




To assess whether total exports of goods as per the balance of payments could be used as the trade statistics required by our methodology, we further examine the consistency between general merchandise and total exports of goods data. Indeed, if the two values are close, we could defend the assumption that the distribution of total exports of goods can be used as a proxy for the distribution of the exports of general merchandise, on which we would ideally focus. We do so by comparing the 262 reporting country / partner entity pairs for which they are both available:

- For 30 of them, the numbers are the same, meaning that there are no net exports of goods under merchanting nor exports of non-monetary gold or that both cancel out (as the former can be negative);
- 41 pairs display a strictly larger amount for general merchandise, which may happen if the net exports of goods under merchanting are negative. Total exports of good are then 1.3% smaller than exports of general merchandise on average;
- Eventually, in most cases (191 observations or 73% of the sample), the value for general merchandise is strictly lower than the total exports of goods. For these observations, on average, total exports of goods are 2.9% higher than the exports of general merchandise.

But the weight of the different categories of merchandise exports in the total varies substantially

from a reporting country to another. We compute the ratio of total exports of goods to exports of general merchandise for each reporting country (restricting partners to "EU28" and "EXT_EU28" and summing each variable over the two). Total exports of goods can be larger than general merchandise exports by up to 29.7% in the case of Luxembourg. Sweden, Denmark and Cyprus also display substantial discrepancies of respectively 9.0%, 6.8% and 6.5%. Eventually, 4 other countries (Ireland, Austria, Germany and Belgium) display a discrepancy of more than 3% between the two totals. From these observations, we conclude that although total exports of goods are closely comparable with the exports of general merchandise in most cases, this approximation cannot reasonably apply to several reporting countries.

### 3.2.3 Statistical sources on trade in services

Contrarily to the exports of goods, the main statistical standards for trade in services are consistent with the definition of trade as per the balance of payments and with the BPM6 standard. More precisely, the 1994 General Agreement on Trade in Services (GATS) defines trade in services as the delivery of a service through one of the following modes of supply:

- Cross-border supply, whenever a service is produced in a country and consumed in another;
- Consumption abroad, which takes place when a service is consumed in the country where it is produced but the consumer or his/her property is abroad at the moment of consumption;
- Commercial presence, which covers cases when the service supplier establishes a foreign presence to deliver the services;
- And presence of natural persons, when an individual is present abroad to deliver the commercial services on behalf of a foreign firm.

The exports of services as they are presented in countries' balance of payments reflect all these modes of supply but the third one. In the second and fourth cases, the service is consumed and produced in the same country but either of the parties involved in the transaction is located abroad. Commercial presence, in which case the legal persons trading are both found in the same country, is instead covered by the Foreign Affiliate Trade Statistics (FATS).

Furthermore, most statistical sources break down the exports of services according to the Extended Balance of Payments Services (EBOPS 2010) classification as defined in BPM6 (see International Monetary Fund (2010)). This classification distinguishes the following 12 categories:

Table 3.1: Extended Balance of Payments Services (EBOPS 2010) classification

| |
|---|
| Manufacturing services on physical inputs owned by others |
| Maintenance and repair services n.i.e. |
| Transport |
| Travel |
| Construction |
| Insurance and pension services |
| Financial services |
| Charges for the use of intellectual property n.i.e. |
| Telecommunications, computer, and information services |
| Other business services |
| Personal, cultural, and recreational services |
| Government goods and services n.i.e. |

Note: "n.i.e." stands for "not included elsewhere".

Our main source of trade in services data is the Balanced Trade in Services (BaTIS) database of the OECD and the WTO (see OECD-WTO (2016-2019) to access the data and Liberatore and Wettstein (2021) for the methodology). The database was first released in 2017 under the BPM5 standard and importantly, it was updated to BPM6 in early 2021. It provides annual data on the exports of services of 202 reporting economies from 2005 to 2019. Exports are broken down according to the 12 main EBOPS categories and the database therefore allows to distinguish commercial services from governmental services. Taking the example of the year 2017, considering exports, final balanced values and commercial services, each reporting country is associated with 200 destinations on average.

In the work of Liberatore and Wettstein (2021), the most extreme differences between reported trade values and final balanced values are observed for Bermuda. The authors explain that "the United States, the Netherlands, Ireland and the United Kingdom report sizeable transactions with Bermuda, most notably in insurance and financial services, which appear to go completely undetected in Bermuda's own data. These issues are most probably linked to the presence of foreign-controlled MNEs and also occur, although at a smaller scale, in countries such as the Cayman Islands and Barbados". The balanced exports of services of Bermuda are 41 times larger than its reported exports, meaning that other countries register much larger imports of services from Bermuda than Bermuda does in its exports. Similarly, the balanced imports of services of Bermuda are 18 times larger than its reported imports, meaning that other countries register much larger exports of services to Bermuda that Bermuda does in its imports. To some extent, the same appears for the Cayman Islands and Barbados.

As a potential alternative for the US, the ITAs prepared and released by the BEA also provide bilateral information on trade in services. However, as the corresponding merchandise trade statistics, they are not entirely consistent with the BPM6 standard, due again to the treatment of contract manufacturing relationships. For instance, when Apple goods are produced abroad by a contract manufacturer, no exchange of merchandise should be recorded based on the change in ownership criterion but a manufacturing service is imported from abroad by Apple. In the Article

12.5 of Bureau of Economic Analysis (2021), the authors explain that "the coverage and presentation of services differ in some ways from BPM6 recommendations. One major gap stems from not yet providing estimates of *manufacturing services on physical inputs owned by others*, a specific form of contract manufacturing. At present, BEA's statistics show 'n.a.' (not available) for this major services component".

### 3.2.4 Retained benchmark

We retain the following trade statistics for the benchmark destination-based adjustment:

- For merchandise trade statistics, we rely on the UN Comtrade database. We primarily focus on imports, as the associated criterion of the country of origin relates more closely to our purpose of identifying the final destination of the transactions, and we subtract re-imports whenever they are reported. With this selection, we leave aside from the benchmark:
  - Balance of payments statistics. While the bilateral breakdown provided by Eurostat data is too narrow for our computations, the US ITAs could be a reasonable alternative. However, its departures from BPM6 (and thus, from the change in ownership criterion) in the case of contract manufacturing relationships reduces the interest of using these data for our purpose. Because they are based on customs registries, UN Comtrade data share these issues, but their bilateral breakdown is more granular;[4]
  - BIMTS data, which only provide balanced values of trade (that aim at reconciling the gaps between the exports and the imports). Imports indeed correspond more closely to the goal of our adjustment. We illustrate this issue with the specific case of Hong Kong below.
- For trade in services statistics, we use BaTIS data. We focus on balanced values of trade and on commercial services. According to Liberatore and Wettstein (2021), in the case of manufacturing services on physical inputs owned by others, the balanced value is close to the reported exports of services as many importing countries do not yet record this item. Besides, in the specific case of Bermuda, the Cayman Islands and Barbados, we rely on the values reported by their partners.

In the benchmark computations, the same data sources are used for the US and for other countries. The code however allows to distinguish the two as the US ITAs may provide a satisfying alternative to the main estimates. In the case of services, the code also allows to exclude certain types of flows based on the EBOPS classification of Figure 3.1 (which we do not do in the benchmark). For instance, as the "charges for the use of intellectual property" are often used by multinational companies to shift their profits to low-tax jurisdictions, we may want to abstract from them.

#### Treatment of China - Hong Kong - US trade flows in BIMTS

The treatment of Hong Kong in Fortanier and Sarrazin (2016) illustrates well the reason why the BIMTS balanced value of trade may not correspond to the purpose of our destination-based adjustment. Mainly due its role of interface between China and the rest of the world, 96% of the

4. That being said, if the ITAs are updated to match the BPM6 standards in the future or if another statistical source ultimately provides trade in merchandise data that are compatible with the change in ownership criterion, this choice may very well be reconsidered.

exports reported by Hong Kong in UN Comtrade data are in fact re-exports. When the ultimate destination country instead registers the country of origin of the goods (most often China) in its imports, substantial asymmetries arise. By combining detailed statistics on these re-exports from the Hong Kong Census Office with UN Comtrade data, Fortanier and Sarrazin (2016) provide the following example:

Figure 3.5: Extract from the methodological paper associated with BIMTS data

**Table 4. Two examples of trade asymmetries between China and the US where re-exports from Hong Kong are important, before and after re-export adjustment ('000 USD, 2011)**

| | HS 851762* | HS851762 *adjusted* | HS 950490** | HS 950490 *adjusted* |
|---|---|---|---|---|
| (1) Exports of China to the US | 4,975,623 | 4,975,623 | 1,627,651 | 1,627,651 |
| (2) Exports of Hong Kong to the US | 2,097,909 | 2,097,909 | 715,711 | 715,711 |
| *(3) Of which re-exports originating from China* | *1,920,029* | *1,920,029* | *715,467* | *715,467* |
| (4) Imports of the US from China | 9,482,884 | 7,562,855 | 2,352,516 | 1,637,049 |
| (5) Imports of the US from HK | 138,023 | 2,058,052 | 5,602 | 721,069 |
| China-US asymmetry (abs) | 4,507,261 | 2,587,232 | 724,865 | 9,398 |
| Hong Kong- US asymmetry (abs) | 1,959,886 | 39,857 | 710,109 | 5,358 |

** HS 851762: Machines for the reception, conversion & transmission/regeneration of voice, images/other data*
*** HS 950490: Articles for funfair/table/parlour games (excl. playing cards), incl. pintables*

In the HS 851762 category, Hong Kong registers 2.1 billion USD of exports to the US in 2011 but the vast majority of these correspond to re-exports of goods initially produced in China (Column 1). The US records very small imports of Hong Kong which would indicate that the country of origin (China) was correctly identified. The authors correct for this trade asymmetry by adjusting the US imports, which then reflect much larger imports from Hong Kong on the one hand and much lower imports from China on the other hand (Column 2). They justify this approach as "preserving the role of entrepôts in the value chain, recognizing their important role as a distribution and logistics hubs, whilst also minimizing the need for extra estimations" (indeed, other methods consist in estimating a Hong Kong mark-up on re-exports and re-attributing all remaining trade to the country of origin).

As our purpose is to proxy the final destination of transactions, we would instead consider the opposite adjustment, netting out the intermediary role of Hong Kong. This example illustrates why the balanced value of BIMTS data may not match our objective and highlights the importance of focusing on imports in UN Comtrade data.

### 3.2.5 Preparation of benchmark trade statistics

We collect UN Comtrade data from the dedicated online portal.[5] We restrict the set of partner entities to individual countries. We then complement the dataset with continent codes ("Africa", "Americas", "Asia-Pacific" and "Europe"). We primarily focus on imports net of re-imports, but we also make use of the available information about exports in some cases. Indeed, there are two main cases in which a pair of origin and destination country may appear in the exports but not in the imports:

- In the first case, the imports do not appear in the data because the destination country does not record any trade statistics in the UN Comtrade database. Let us consider the example

5. More details on the collection and compilation process are provided in this GitHub repository: https://github.com/pechouc/comtrade_data_selection.

of Gabon, which is absent from the database for the years considered. As such, if we focused exclusively on imports to build our mapping of merchandise flows, Gabon would never appear as a destination of exports. For instance, it would be associated with 0 exports of goods from France, while France records exports of merchandise worth 487.7 million USD to Gabon in 2017. To deal with such cases, for countries that do not report any trade data via the UN Comtrade database in the year considered, flows to these destinations are taken based on the exports reported by other countries. With exports too, we net out re-exports.

- In the second case, the destination country does report data via the UN Comtrade database. For instance, Aruba does not record any import from Uruguay in 2017, while Uruguay records non-zero exports to Aruba (2.8 million USD). We cannot determine whether this apparent inconsistency is due to an omission on the Aruba side or Uruguay was not identified as the country of origin of the transaction and thus netted out from imports as per the statistical standard for trade in merchandise. In such cases, we exclusively rely on imports.

For BaTIS data, we also restrict the set of reporters and partners to individual countries. In most cases, we focus on the balanced value of trade (i.e., the value that reconciles exports and imports) and on commercial services. In the specific case of Bermuda, the Cayman Islands and Barbados, we rely on the trade values reported by their partners: for their exports, we take partner countries' reported imports from Bermuda, the Cayman Islands and Barbados and their imports correspond to partner countries' reported exports. We add continent codes as for UN Comtrade data. Eventually, specifically in the BaTIS data, for certain reporting countries, some service exports are not broken down at the destination country level but are presented as directed to the "Rest of the world". We redistribute these amounts to the "Other Europe", "Other Africa", etc. aggregate partners based on the relative importance of the corresponding continents for each reporting country concerned.

In another module, we load the two datasets and restrict the set of destinations to the set of partner jurisdictions in either the IRS' or the OECD's country-by-country report statistics, depending on the use case. Countries that appear among destinations in the trade statistics but are absent from the set of affiliate jurisdictions in country-by-country data are aggregated at the continental level. We then merge the two datasets on each pair of reporting and partner countries. We retain all the country pairs for which we have either merchandise- or service-related information and we replace the resulting missing values with zeros. This process has two main implications, which we illustrate with 2017 as reference year:

- First, it comes down to assuming that the coverage of the two datasets is complete for all the reporting countries that they involve. Let us take the example of France, which is present as a reporting country in both UN Comtrade and BaTIS datasets. Among the partner jurisdictions associated with France in the preprocessed UN Comtrade dataset, French exports of merchandise to Gibraltar are of 202.0 million USD. But Gibraltar does not appear among France's partners in the pre-treated BaTIS data. When merging the two datasets, we keep the France-Gibraltar row and replace the service exports by zero, considering that the partner being absent from BaTIS simply means that there are no exports of services from France to Gibraltar.

- Second, several exporting countries are only present in the UN Comtrade extract (35 countries) or in the BaTIS data (2 countries). It is not likely for these countries to exclusively export merchandise or services. Hence, if we were interested in the absolute amounts of

exports of these countries, we should find a way to estimate the missing data. In our computations, we solely look for a distribution of these countries' exports, e.g. what percentage of Andorran exports (only in UN Comtrade data) France, the US or Germany represent. In this case, replacing missing values by zeros comes down to assuming that the distribution of observed exports is the same as that of unobserved transactions and thus, as the distribution of these countries' overall exports.

From there, after having restricted the set of partner countries to that observed in the IRS' country-by-country report statistics and combined the two datasets, we obtain data on the exports of merchandise and / or services from 236 unique reporting countries to 138 partner jurisdictions. We sum merchandise and service exports into a single variable covering all kinds of exports.

There remain a few affiliate countries in the preprocessed country-by-country report statistics for which we lack a distribution of exports. In the specific case of the UK Caribbean Islands, which we aggregate as a single partner in country-by-country data to match the BEA statistics on the activities of US multinational enterprises, the distribution of exports is obtained from the trade statistics available for the different jurisdictions that compose this group. In all the other cases, we impute the missing exports distribution based on the one observed at the continental level. By doing so, we obtain a distribution of exports or, at least, a proxy for it for all the affiliate jurisdictions in country-by-country report statistics.

Eventually, all the export distributions are winsorized at the 0.5% level to eliminate the less significant destinations.

## 3.3 Remarks on the Extension to Non-US Multinationals

In this document, we analyze a few possibly critical issues with the methodology behind the extension of our destination-based adjustment to non-US multinationals. In Section 3.3.1, we first assess the existence of a "headquarter country bias" that would not be accounted for with this simplified methodology. Beside this issue, in Section 3.3.2, we underline another assumption on which our simplified adjustment implicitly relies. However, we only have limited ways of testing or discussing this hypothesis.

### 3.3.1 Headquarter country bias

In our proposed extension of the destination-based adjustment to non-US multinationals, we extrapolate the BEA's data on the activities of multinational companies to non-US headquarters. We use them to split the revenue variables between local and foreign sales, the latter being obtained by summing the share of sales that are directed to the US and the share of transactions involving any other country. For instance, in 2017, French multinationals are estimated to record 14.5 billion USD of unrelated-party revenues associated with foreign transactions in Singapore. While local sales are associated with their final destination, the revenues generated abroad are allocated based on the distribution of exports of the affiliate jurisdiction considered. In particular, because France accounts for 1.4% of the exports of goods and services from Singapore, it is allocated 1.4% of the 14.5 billion USD identified above. A potential issue with this procedure could be that it does not account for the fact that France is the headquarter country of the multinationals considered: it is treated exactly like the US, China or Germany based on the distribution of Singaporean exports.

We use the BEA's data on the activities of US multinational enterprises to assess this issue. The adjustment may be questioned if a strong "headquarter country bias" is observed in the sales percentages of US multinational companies. For each partner jurisdiction, we want to know whether

sales to the US represent a disproportionate share of foreign sales (sales to the US plus sales to any third country), compared with the weight of the US in the exports of this partner. Said otherwise, do the Singaporean affiliates of US multinational companies sell more in the US than Singapore exports to the US in general? We compare the sales percentages drawn from BEA data and the distribution of each partner country's exports from non-winsorized, benchmark trade statistics (UN Comtrade for merchandise and BaTIS for services). We obtain Table 3.2 for the 20 largest exporters to the US in 2017.

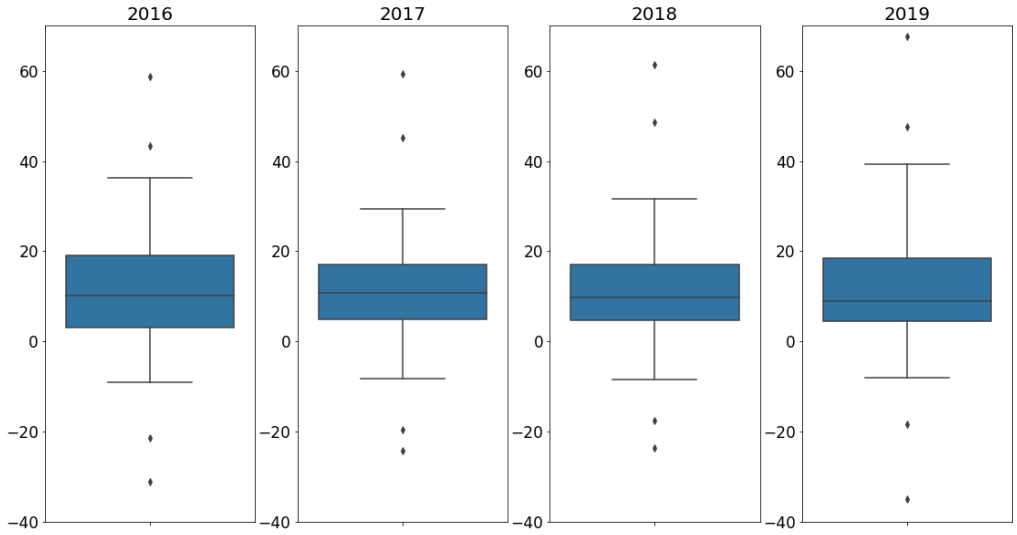
Table 3.2: Top 20 largest exporters to the US in 2017, with the share of the US in the total foreign sales booked by US multinational companies and in exports

| Affiliate country | US share in foreign sales (%) | US share in exports (%) |
|---|---|---|
| China | 36.3 | 19.9 |
| Canada | 83.2 | 68.0 |
| Mexico | 82.4 | 70.9 |
| Japan | 19.9 | 18.3 |
| Germany | 17.6 | 9.7 |
| United Kingdom | 25.1 | 16.3 |
| Korea, Republic of | 27.3 | 11.7 |
| India | 64.3 | 19.1 |
| France | 12.3 | 9.7 |
| Ireland | 18.7 | 21.4 |
| Switzerland | 13.8 | 13.7 |
| Italy | 30.0 | 9.8 |
| Taiwan | 22.3 | 10.6 |
| Brazil | 22.5 | 15.9 |
| Malaysia | 38.9 | 12.5 |
| Thailand | 31.7 | 11.6 |
| Singapore | 15.4 | 8.5 |
| Netherlands | 16.4 | 4.9 |
| Israel | 60.8 | 32.2 |
| Belgium | 22.8 | 5.6 |

Note: This table presents two percentage shares for each of the 20 largest exporters to the US in 2017. The "US share in foreign sales (%)" column is based on BEA data and is obtained as the ratio of total sales to the US to the sum of total sales to the US and to any third country. The "US share in exports (%)" column stands for the weight of the US in each country's total exports (including both merchandise and services). Export percentages are obtained by combining UN Comtrade statistics on trade in goods and BaTIS data for trade in services.

Except for Switzerland and Japan, the share of US sales in the BEA's data is consistently larger than the weight of the US in the country's exports. An extreme case is India: 64% of the foreign sales of goods and services of US multinational companies' affiliates in India are directed to the US, but the US only represents 19% of Indian exports. In Figure 3.6, we show the distribution of the gaps between both percentage series for the four income years available.

Figure 3.6: Distribution of the difference between the US share in foreign sales and the US share in exports




Note: For each available income year, this figure presents the distribution of the difference between the share of the US in the total foreign sales booked by US multinational companies in a given partner jurisdiction and the weight of the US in the exports of this partner. The share of the US in foreign sales is based on BEA data and is obtained as the ratio of total sales to the US to the sum of total sales to the US and to any third country. Export percentages are obtained by combining UN Comtrade statistics on trade in goods and BaTIS data for trade in services.

Consistently in the four years, the majority of observations display a positive gap, meaning that the share of sales to the US in the BEA's data is higher than the share of the US in the total exports of the country considered. This gap is generally comprised, roughly speaking, between 0 and 20 percentage points.

Coming back to the specific case of India, interestingly, we see that the discrepancy (64% vs. 19%) is mostly driven by sales to US parents: it is likely that many US multinational companies have offshored their manufacturing or internal service activities in India. What if we focus on sales of goods and services to unaffiliated entities in the BEA-based percentage? Table 3.3 follows the structure of the table above, focusing on extra-group transactions in the "US share of foreign sales (%)" column.

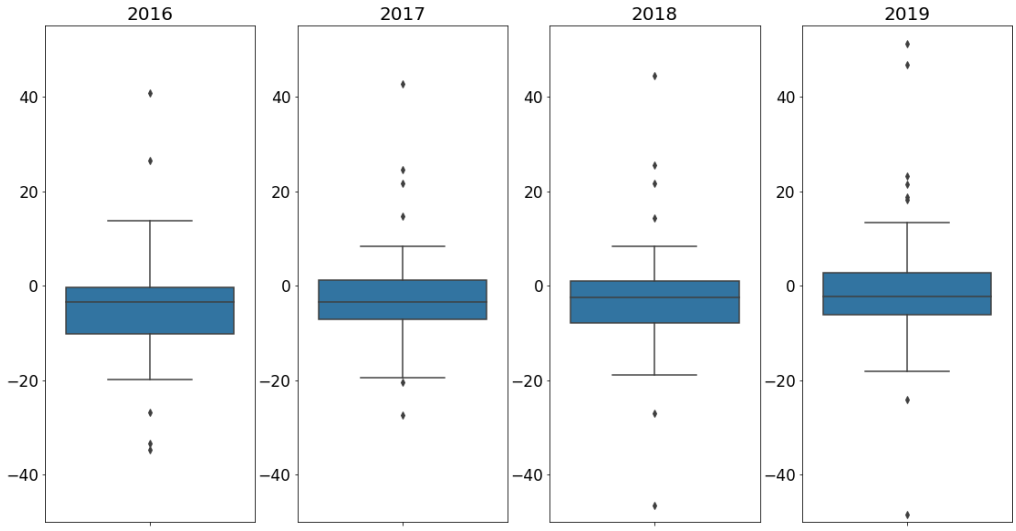
Table 3.3: Top 20 largest exporters to the US in 2017, with the share of the US in the sales to foreign unaffiliated entities of US multinational companies and in exports

| Affiliate country | US share in foreign sales (%) | US share in exports (%) |
|---|---|---|
| China | 13.3 | 19.9 |
| Canada | 63.4 | 68.0 |
| Mexico | 50.5 | 70.9 |
| Japan | 5.4 | 18.3 |
| Germany | 12.3 | 9.7 |
| United Kingdom | 14.6 | 16.3 |
| Korea, Republic of | 4.5 | 11.7 |
| India | 40.8 | 19.1 |
| France | 7.3 | 9.7 |
| Ireland | 2.0 | 21.4 |
| Switzerland | 7.2 | 13.7 |
| Italy | 16.0 | 9.8 |
| Taiwan | 25.4 | 10.6 |
| Brazil | 8.9 | 15.9 |
| Malaysia | 12.3 | 12.5 |
| Thailand | 5.6 | 11.6 |
| Singapore | 5.2 | 8.5 |
| Netherlands | 6.7 | 4.9 |
| Israel | 26.0 | 32.2 |
| Belgium | 1.5 | 5.6 |

Note: This table presents two percentage shares for each of the 20 largest exporters to the US in 2017. The "US share in foreign sales (%)" column is still based on BEA data, but it is now obtained as unrelated-party sales to the US divided by the sum of unrelated-party sales to the US and to any third country. The "US share in exports (%)" column stands for the weight of the US in each country's total exports (including both merchandise and services). Export percentages are obtained by combining UN Comtrade statistics on trade in goods and BaTIS data for trade in services.

The existence of a headquarter country bias is now much less obvious and on the contrary, the weight of the US in each country's exports is most often larger than the share of the US in the foreign unrelated-party sales of local affiliates of US multinational companies. Interestingly, Ireland displays a very large gap (2% vs. 21%) while it used to show balanced figures (19% vs. 21%). This would a priori underline the importance of US multinational companies' intra-group transactions in the exports of this jurisdictions. Figure 3.7 confirms this observation.

Figure 3.7: Distribution of the difference between the US share in sales to foreign unaffiliated entities and the US share in exports




Note: For each available income year, this figure presents the distribution of the share of the US in the sales directed to foreign unaffiliated entities and booked by US multinational companies in a given partner jurisdiction, minus the weight of the US in the exports of this partner. The share of the US in foreign sales is based on BEA data and is obtained as unrelated-party sales to the US divided by the sum of unrelated-party sales to the US and to any third country. Export percentages are obtained by combining UN Comtrade statistics on trade in goods and BaTIS data for trade in services.

The gaps are now centered closer to 0 percentage point and they are generally negative, down to circa -10 percentage points. Although there exists a headquarter country bias for total sales and there remains substantial heterogeneity even when we focus on third-party transactions, we conclude that **our adjustment for unrelated-party revenues should be more robust to a possible headquarter country bias than that for total or related-party revenues**.

### 3.3.2 Applicability of US multinational companies' domestic sales percentages

With our extended adjustment, when splitting the revenues booked by non-US multinational companies in the US between local and foreign sales, we apply the domestic split between local sales and sales from exports observed for US multinational companies in the US. In 2017, Table I. O1 gives that the 13,439 billion USD sales booked by US parents in the US are split as follows: 88% are directed to the US (or equivalently to the affiliate country) and 12% are directed to any foreign country. This split is stable over the years: for 2016, Table I. O1 also yields 88% vs. 12%; for 2018, we obtain 87% vs. 13%; for 2019, we obtain 88% vs. 12%. In the 2017 adjustment, we therefore assume that 88% of the revenues booked by non-US multinational companies in the US are directed to the US and that the rest corresponds to exports. One may question the applicability of this ratio that is computed for the domestic activities of US multinational companies and applied to foreign activities of non-US multinational companies.

The Analytical AMNE database of the OECD allows to challenge this figure (see OECD (2016) and Cadestin et al. (2018)). We use the "Analytical AMNE.xlsx" file downloaded from the OECD's

website. The first tab ("GO bilateral"), once restricted to 2016 and the US, indicates that the gross output of foreign-owned firms in the US amounts to 2,590 billion current USD across all industries. The second tab, restricted to 2016, the US and foreign-owned firms, indicates that foreign multinational companies register 436 billion current USD of exports in the US. Taking the ratio of exports to gross output, we get 17%. This ratio is **to be compared with the 12-13% found above based on BEA data and both seem broadly consistent**. However, Analytical AMNE data are not available after 2016 and we cannot pursue this comparison for the other years in our sample.

## 3.4 Assessment of the Adjustment

### 3.4.1 Revision of preliminary remarks

In this section, we replicate the results of our benchmark descriptive study, based on the adjusted country-by-country revenue variables. We thereby underline the effect of our destination-based adjustment, that comforts our interpretation of the decorrelation between the distribution of un-adjusted revenue variables and the location of US multinational enterprises' final markets.

Before digging deeper in country-level analyses, Table 3.4 allows to compare domestic and foreign sales after the destination-based adjustment. It also displays the relative weight of each of the 4 continental aggregates in foreign sales.

Table 3.4: Evolution of the continental distribution of US multinationals' unrelated-party revenues, based on adjusted revenue variables

| | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|
| Sales to the US (billion USD) | 6,943.7 | 9,413.8 | 10,013.7 | 10,435.0 |
| Sales abroad (billion USD) | 3,882.0 | 5,188.3 | 5,707.2 | 5,614.7 |
| *Of which Europe (%)* | 39.8 | 39.1 | 39.2 | 39.6 |
| *Of which Asia-Pacific (%)* | 36.2 | 37.3 | 38.4 | 38.0 |
| *Of which America (%)* | 22.6 | 22.5 | 21.3 | 21.4 |
| *Of which Africa (%)* | 1.3 | 1.1 | 1.0 | 1.0 |

Note: This table presents the absolute amounts of US multinational companies' unrelated-party revenues in the US and in foreign jurisdictions. The latter total is obtained by summing unrelated-party revenues over all non-US partner countries but "Stateless entities" and continental totals. These figures are presented in current billion USD. The distribution of foreign unrelated-party revenues among 4 regional aggregates (Europe, Asia-Pacific, America, Africa) is also presented, continents' respective weights being expressed in percentage. All figures are based on country-by-country data adjusted via the computations presented above.

These results are relatively stable from a year to another, with a substantial increase in the absolute amounts of unrelated-party revenues from 2016 to 2017, explained by country-by-country reporting becoming mandatory for large multinational companies. However, we observe substantial differences with the same table built upon non-adjusted data.

First, in all four years, sales to the US are reduced by slightly more than 10%. This means that the exports now excluded from the unrelated-party revenues registered domestically by US multinational enterprises are not fully compensated for by the foreign sales that are re-attributed to the headquarter country. Mechanically, foreign sales have increased substantially. This represents a jump by roughly 30%.

Second, we observe that the continental distribution of foreign unrelated-party revenues has been recomposed. European countries still display the largest concentration of US multinational companies' sales but they have lost 6 to 7 percentage points through the destination-based adjustments. On the contrary, the weights of Asia-Pacific and America have both increased, the former being closer and closer to Europe over time. This discrepancy underlines the importance of European platform jurisdictions in the global sales network organized by US multinational firms.

### 3.4.2 New relationship between sales and consumption expenditures

Furthermore, with Table 3.5, we investigate the effect of our destination-based adjustment at the partner country level. Focusing on 2017 adjusted data, we show the 20 largest destinations for US multinational companies' foreign unrelated-party sales. For each of these countries, we display the adjusted revenues in billion USD, the corresponding share of total foreign unrelated-party revenues and the country's share of the final consumption expenditures observed in the sample.

Table 3.5: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, based on adjusted revenue variables

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| Canada | 542.9 | 10.5 | 3.1 |
| United Kingdom | 528.8 | 10.2 | 5.3 |
| China | 460.7 | 8.9 | 15.9 |
| Germany | 334.0 | 6.5 | 6.2 |
| Japan | 320.2 | 6.2 | 8.6 |
| Mexico | 269.5 | 5.2 | 2.1 |
| France | 217.0 | 4.2 | 4.7 |
| Brazil | 178.8 | 3.5 | 4.1 |
| Singapore | 164.5 | 3.2 | 0.4 |
| Netherlands | 160.3 | 3.1 | 1.3 |
| Australia | 149.6 | 2.9 | 2.5 |
| Switzerland | 135.6 | 2.6 | 1.1 |
| Hong Kong | 135.5 | 2.6 | 0.6 |
| Ireland | 134.8 | 2.6 | 0.3 |
| Italy | 122.5 | 2.4 | 3.6 |
| Korea | 116.0 | 2.2 | 2.4 |
| India | 109.2 | 2.1 | 4.3 |
| Belgium | 86.3 | 1.7 | 0.9 |
| Spain | 80.9 | 1.6 | 2.4 |
| Russia | 67.2 | 1.3 | 2.6 |

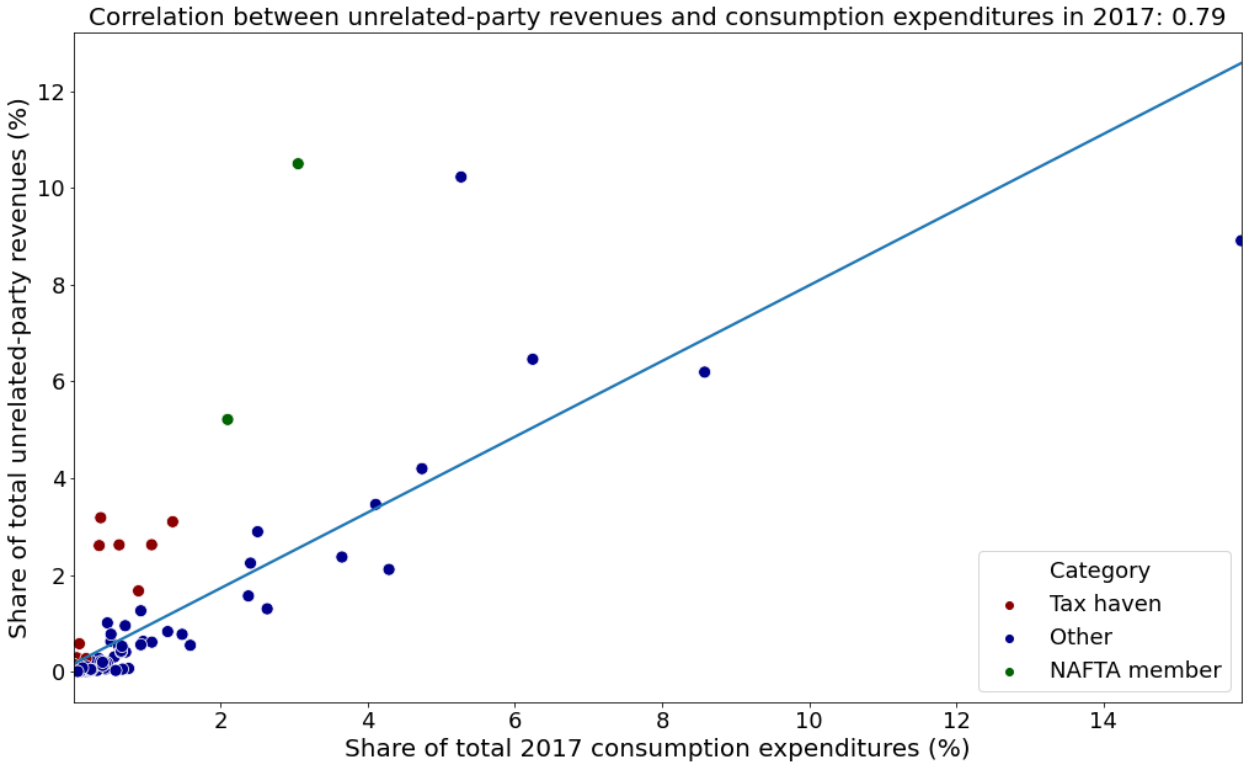
Note: This table presents the 20 main partner jurisdictions for the US multinational companies, based on the unrelated-party revenues booked by the latter. It displays each country's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the US-US observation) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 10.2% of US multinational companies' adjusted foreign unrelated-party revenues and 5.3% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

The highest-ranking countries have been recomposed, especially in favor of NAFTA members

(Canada moving from second to first, Mexico from eleventh to sixth), the largest economy of the sample (China moving from fourth to third) or France (from tenth to seventh). Oppositely, the most well-known sales platform of US technology multinational companies, Ireland, has tumbled from third to fourteenth: before the adjustment, it represented 6.2% of foreign unrelated-party revenues and it only accounts for 2.6% after the destination-based adjustment. In a similar manner, Switzerland has moved from eighth to thirteenth (4.5% of foreign unrelated-party revenues before the adjustment vs. 2.6% after) and Singapore from seventh to ninth (5.2% vs. 3.2%). Importantly, the weight of these three countries in the foreign unaffiliated sales of US multinational enterprises is now more in line with the size of these economies, as indicated by their share of final consumption expenditures.

Figure 3.8 further highlights the new relationship between destination countries' share of US multinational enterprises' foreign unrelated-party revenues and of final consumption expenditures. The correlation between the two has increased substantially: before the adjustment, it was of 0.66 and now reaches 0.79 after the destination-based adjustment.

Figure 3.8: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

Although a number of tax havens still display a disproportionately high share of unrelated-

party revenues compared with their weight in final consumption expenditures, the corresponding dots are now grouped closer to the indicative regression line. On the contrary, both NAFTA members (Canada and Mexico) have seen their share of unrelated-party revenues increase through the adjustment. We therefore observe a more robust relationship between adjusted unaffiliated sales and our proxy for market size. The United Kingdom, along with major commercial partners of the US, now shows the largest discrepancy between unrelated-party revenues and final consumption expenditures. Said otherwise, the destination-based adjustment seems to correct for a substantial part of US multinational companies' relocation of sales to low-tax, platform jurisdictions.

### 3.4.3 "Winners" and "losers" from the adjustment

To better understand the impact of the adjustment on the distribution of US multinational companies' unrelated-party revenues, Tables 3.6 and 3.7 respectively show the largest losers and winners from the operation (i.e., the partner countries whose unrelated-party revenues decrease or increase the most).

Table 3.6: 10 largest "losers" from the adjustment of unrelated-party revenues

| Partner country | Change in UPR (billion USD) | Change in UPR (%) |
|---|---|---|
| Ireland | -110.2 | -45.0 |
| Switzerland | -44.9 | -24.9 |
| Singapore | -42.8 | -20.6 |
| Luxembourg | -9.2 | -23.5 |
| UK Islands, Caribbean | -9.1 | -55.6 |
| Peru | -2.9 | -30.3 |
| Jersey | -2.3 | -31.8 |
| Macau | -2.2 | -12.9 |
| Bermuda | -1.9 | -16.7 |
| Puerto Rico | -1.8 | -11.3 |

Note: This table is obtained by comparing the unrelated-party revenues attributed to each partner country respectively in the IRS' country-by-country report statistics and in the adjusted country-by-country data. The change in revenues is defined as the adjusted revenues minus the non-adjusted revenues. We retain the 10 countries with the lowest change in absolute amounts and the difference is also expressed as a percentage of non-adjusted revenues. "UPR" stands for unrelated-party revenues.

Except for Peru, all of the 10 largest losers from the adjustment are listed as tax havens by Tørsløv, Wier, and Zucman (2018).[6] In particular, the largest loser from the adjustment of country-by-country revenue variables is Ireland, at which some anecdotal evidence hints as the archetypal example of a low-tax sales platform used by US multinational companies.[7] This 45% decrease might even be an underestimation. On the one hand, based on the BEA's data, only 26% of the unrelated-party revenues booked by US multinationals in Ireland are considered as local sales: extra-group sales are thus slashed by 74%. On the other hand, Ireland is attributed additional unrelated-party revenues from other jurisdictions that partly offset this cut. Typically, because Ireland represents 4.4% of the total US exports of goods and services in our data, it is allocated 57 billion USD of the

6. UK Caribbean Islands are not classified as such but all the tax jurisdictions that compose this group are considered as tax havens in Tørsløv, Wier, and Zucman (2018).

7. See for instance Laffitte and Toubal (2022) for the analysis of a few multinational companies' tax planning practices.

unrelated-party revenues registered domestically by US multinational companies. Because of the inclusion of intra-group flows in trade statistics, the disproportionate weight of Ireland in the US exports of goods and services may itself be related to the use of this jurisdiction as a sales platform.

Among the "winners" from the adjustment, we find mostly large developed or emerging economies. NAFTA members along the US, Canada and Mexico, respectively rank 2$^{nd}$ and 3$^{rd}$. This group also gathers rather high-tax jurisdictions: Korea and Mexico, that display the largest relative increases (+112% and +108%), for instance impose corporate income tax rates of 27.5% and 30% respectively. Overall these two rankings comfort the idea that our proposed destination-based adjustment operates a re-balancing from the low-tax sales platforms used by US multinational companies to large, higher-tax economies.

Table 3.7: 10 largest "winners" from the adjustment of unrelated-party revenues

| Partner country | Change in UPR (billion USD) | Change in UPR (%) |
|---|---|---|
| China | 221.2 | 92.4 |
| Canada | 170.0 | 45.6 |
| Mexico | 140.0 | 108.1 |
| Germany | 116.5 | 53.6 |
| Japan | 111.1 | 53.1 |
| France | 70.5 | 48.1 |
| Korea | 61.3 | 112.0 |
| India | 51.1 | 87.9 |
| UK | 42.1 | 8.7 |
| Netherlands | 38.8 | 31.9 |

Note: This table is obtained by comparing the unrelated-party revenues attributed to each partner country respectively in the IRS' country-by-country report statistics and in the adjusted country-by-country data. The change in revenues is defined as the adjusted revenues minus the non-adjusted revenues. We retain the 10 countries with the highest change in absolute amounts and the difference is also expressed as a percentage of non-adjusted revenues. "UPR" stands for unrelated-party revenues.

The specific case of the Netherlands, that appears among the largest winners from the adjustment (with a 38.8 billion USD or 31.9% increase) and that is classified as a tax haven by Tørsløv, Wier, and Zucman (2018), is particularly interesting to perceive some potential limitations of the adjustment. On the one hand, the BEA's data attribute 65% of the sales of goods and services registered by US multinationals in the Netherlands to local transactions. Although unrelated-party revenues are thus cut by almost one third, this reduction is much more limited than the one applied to Ireland for instance (-74% after splitting revenues based on BEA data and -45% eventually). On the other hand, the unrelated-party revenues attributed from other affiliate jurisdictions to the Netherlands more than offset this reduction, as shown in Table 3.8.

Table 3.8: Mapping of unrelated-party revenues attributed to the Netherlands following our destination-based adjustment, per affiliate jurisdiction of origin

| Affiliate country | UPR (million USD) | Share of the Netherlands in exports (%) |
|---|---|---|
| Netherlands | 78,916.3 | .. |
| United States | 37,761.8 | 2.9 |
| Ireland | 10,855.2 | 4.7 |
| United Kingdom | 7,431.6 | 7.0 |
| Belgium | 4,598.6 | 16.3 |
| Switzerland | 3,508.4 | 3.0 |
| Germany | 3,117.5 | 7.0 |
| UK Islands, Caribbean | 2,650.0 | 31.6 |
| Singapore | 2,001.7 | 1.8 |
| Bermuda | 1,474.2 | 35.9 |

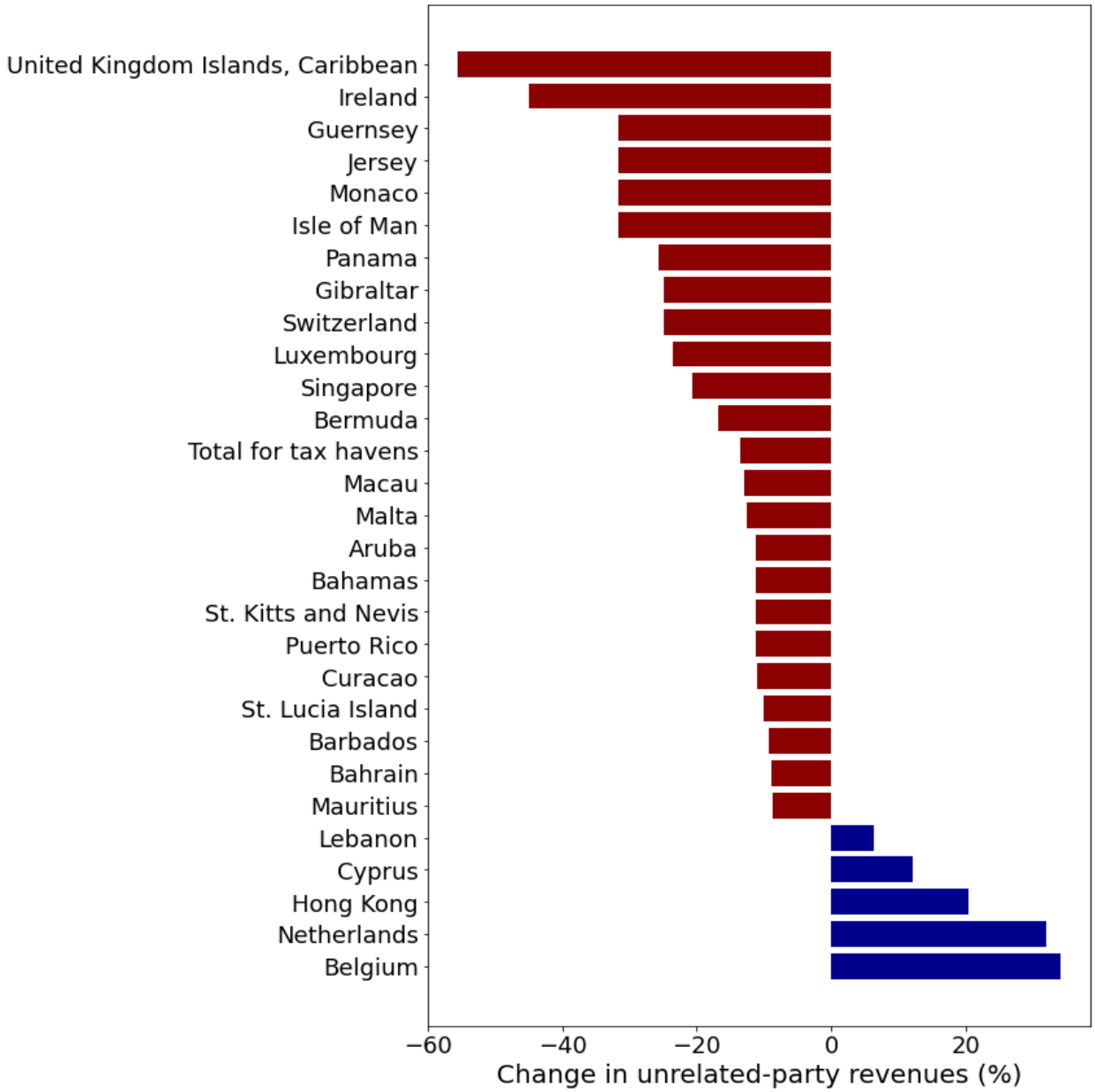
Note: This table indicates the 10 main affiliate jurisdictions from which the post-adjustment unrelated-party revenues of US multinational companies in the Netherlands are sourced. The "Share of the Neth. in exports" column indicates the weight of the Netherlands in the affiliate country's exports based on our retained set of trade statistics. Note that the export percentages actually used in the computations (that exclude the US from the set of destinations) are higher by, say, a few percentage points except for the US itself. It is used to determine the unrelated-party revenues eventually allocated to the Netherlands following the methodology of our destination-based adjustment. The latter are expressed in 2017 billion USD. "UPR" stands for unrelated-party revenues.

First, the decrease due to the initial split is almost entirely compensated for by the re-direction of US-US sales to the Netherlands. Indeed, according to trade statistics in 2017, the Netherlands accounts for 2.9% of the US exports of merchandise and services and this partner jurisdiction therefore captures 37.8 billion USD from the unrelated-party revenues booked domestically by US multinational companies. Second, because of its weight in their exports of goods and services, the Netherlands is attributed large amounts of unrelated-party revenues from some of the other tax havens identified by Tørsløv, Wier, and Zucman (2018) (e.g., Ireland, Belgium or Switzerland). Typically, based on our trade statistics, the Netherlands accounts for more than 30% of the total exports of the UK Caribbean Islands or Bermuda. These results may suggest that the second step of our adjustment (i.e., the attribution of sales directed to any third country) may itself be distorted by the sales platform status of some jurisdictions.

### 3.4.4 Focus on tax havens

Table 3.6 spurs us to focus more specifically on the evolution of tax havens. Their aggregate weight moves from 27% of the foreign unrelated-party revenues of US multinationals in the IRS' country-by-country report statistics to 18% in the adjusted mapping of sales. Figure 3.9 shows that most of the tax havens listed by Tørsløv, Wier, and Zucman (2018) in our sample (24 out of 29) see their unrelated-party revenues decrease.

Figure 3.9: Change in tax havens' unrelated-party revenues




Note: This figure presents the percentage change in unrelated-party revenues implied by our destination-based adjustment for the tax havens listed by Tørsløv, Wier, and Zucman (2018). For each tax haven, it is computed as the ratio of the difference between adjusted and non-adjusted unrelated-party revenues to non-adjusted unrelated-party revenues. The aggregated evolution of all tax haven unrelated-party revenues is also presented as the "Total for tax havens". Red bars indicate a decrease in unrelated-party revenues, while blue bars indicate an increase.

Notable exceptions are Belgium, the Netherlands and Hong Kong, as well as Cyprus and Luxembourg to a lesser extent. The first three are important hubs for international trade and the sales that they are attributed from other partner countries more than offset the split based on the BEA's data. Typically, Belgium is mainly attributed sales from the US (it accounts for 1.2% of its exports of merchandise and services) or from Ireland (5.8% of exports), while Hong Kong heavily

benefits from the US (2.1% of exports) and Singapore (11.9% of exports). We already made a similar observation for the Netherlands.

### 3.4.5 Including non-US multinationals

We further assess the extension of our destination-based adjustment beyond US multinational companies. Table 3.9 ranks the 20 largest partner jurisdictions based on adjusted extra-group sales, showing their share of the total foreign unrelated-party revenues and their share of final consumption expenditures.

Table 3.9: Post-adjustment relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| United States | 2,572.7 | 14.8 | 26.9 |
| United Kingdom | 1,473.2 | 8.5 | 3.8 |
| China | 1,406.5 | 8.1 | 11.3 |
| Germany | 917.3 | 5.3 | 4.5 |
| Canada | 784.7 | 4.5 | 2.2 |
| France | 624.0 | 3.6 | 3.4 |
| Hong Kong | 610.9 | 3.5 | 0.4 |
| Japan | 551.1 | 3.2 | 6.1 |
| Singapore | 514.8 | 3.0 | 0.3 |
| Brazil | 486.1 | 2.8 | 2.9 |
| Italy | 476.3 | 2.7 | 2.6 |
| Mexico | 473.1 | 2.7 | 1.5 |
| Netherlands | 462.5 | 2.7 | 1.0 |
| Switzerland | 422.1 | 2.4 | 0.8 |
| Australia | 395.3 | 2.3 | 1.8 |
| Korea | 361.4 | 2.1 | 1.7 |
| Spain | 348.4 | 2.0 | 1.7 |
| India | 309.7 | 1.8 | 3.1 |
| Belgium | 282.2 | 1.6 | 0.6 |
| Russia | 255.2 | 1.5 | 1.9 |

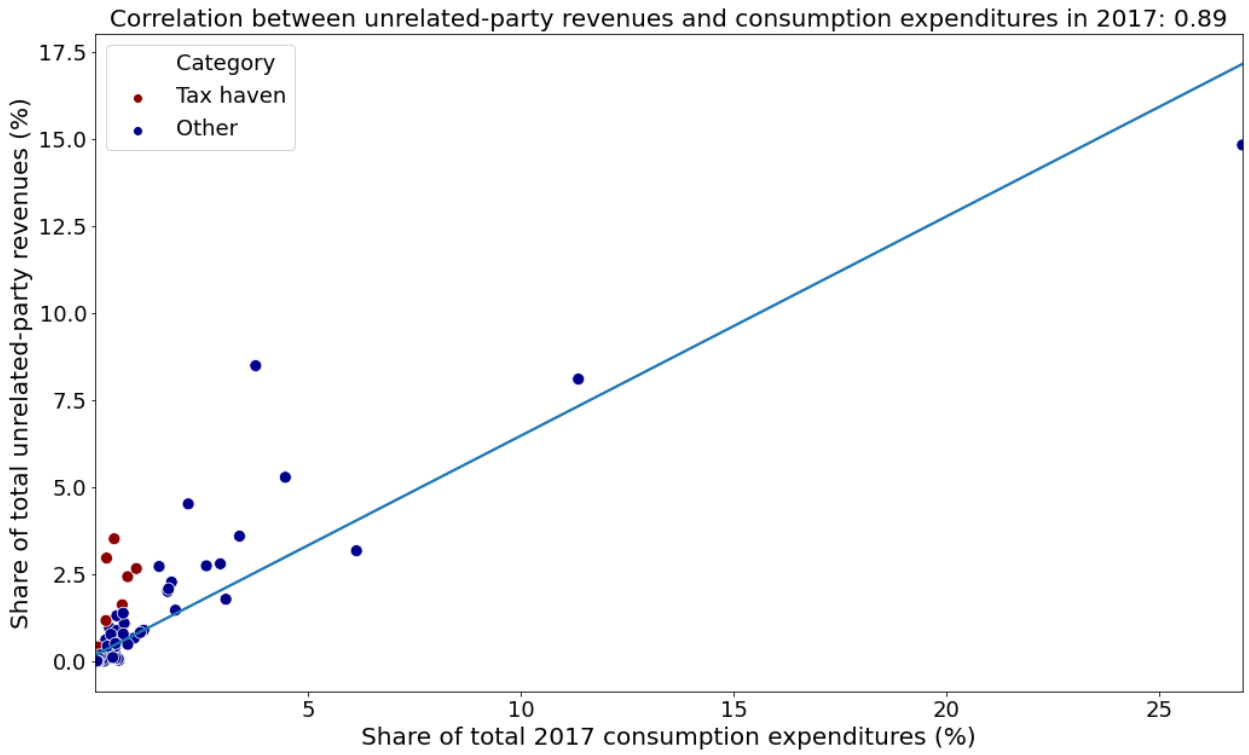
Note: This table presents the 20 main partner jurisdictions for multinational companies headquartered in the 15 parent countries considered, based on the unrelated-party revenues booked by the latter. It displays each partner's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the domestic observations) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 8.5% of multinational companies' adjusted foreign unrelated-party revenues and 3.8% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

The three main partner jurisdictions (the US, the UK and China) have maintained their positions, but their respective weights have moved in different directions. The shares of foreign unrelated-party revenues attributed to the US and the UK have decreased (from 15.7% to 14.8% and from 10.2% to 8.5% respectively), whereas China now comes closer to the UK. It concentrates 8.1% of the transactions with foreign unaffiliated parties (vs. 5.6% before the adjustment). Large developed economies seem to benefit from the extended adjustment, with the striking examples of

Japan and France (from 14th with 2.3% to 8th with 3.2% and from 10th with 3.0% to 6th with 3.6% respectively). The weights of Germany and Canada also increase, as these partners replace Singapore and Switzerland in the top five. Oppositely and similarly to the outcome of the adjustment for US multinational companies, most of the smaller economies that displayed a disproportionate share of foreign unrelated-party revenues lose from the adjustment. While Ireland drops out of the ranking (from the 15th position initially), Singapore moves from 4th to 9th (5.2% vs. 3.0%) and Switzerland from 5th to 14th (4.5% vs. 2.4%). Hong Kong, whose importance remains roughly stable, is a notable exception to this dynamic.

Figure 3.10 confirms the improved consistency between the distribution of foreign unrelated-party revenues and a macroeconomic proxy for market size like the final consumption expenditures. As in the specific case of US multinational companies, the correlation between the two has increased (from 0.84 to 0.89) and tax havens have moved closer to the "normal" relationship, indicated by the regression line.

Figure 3.10: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals

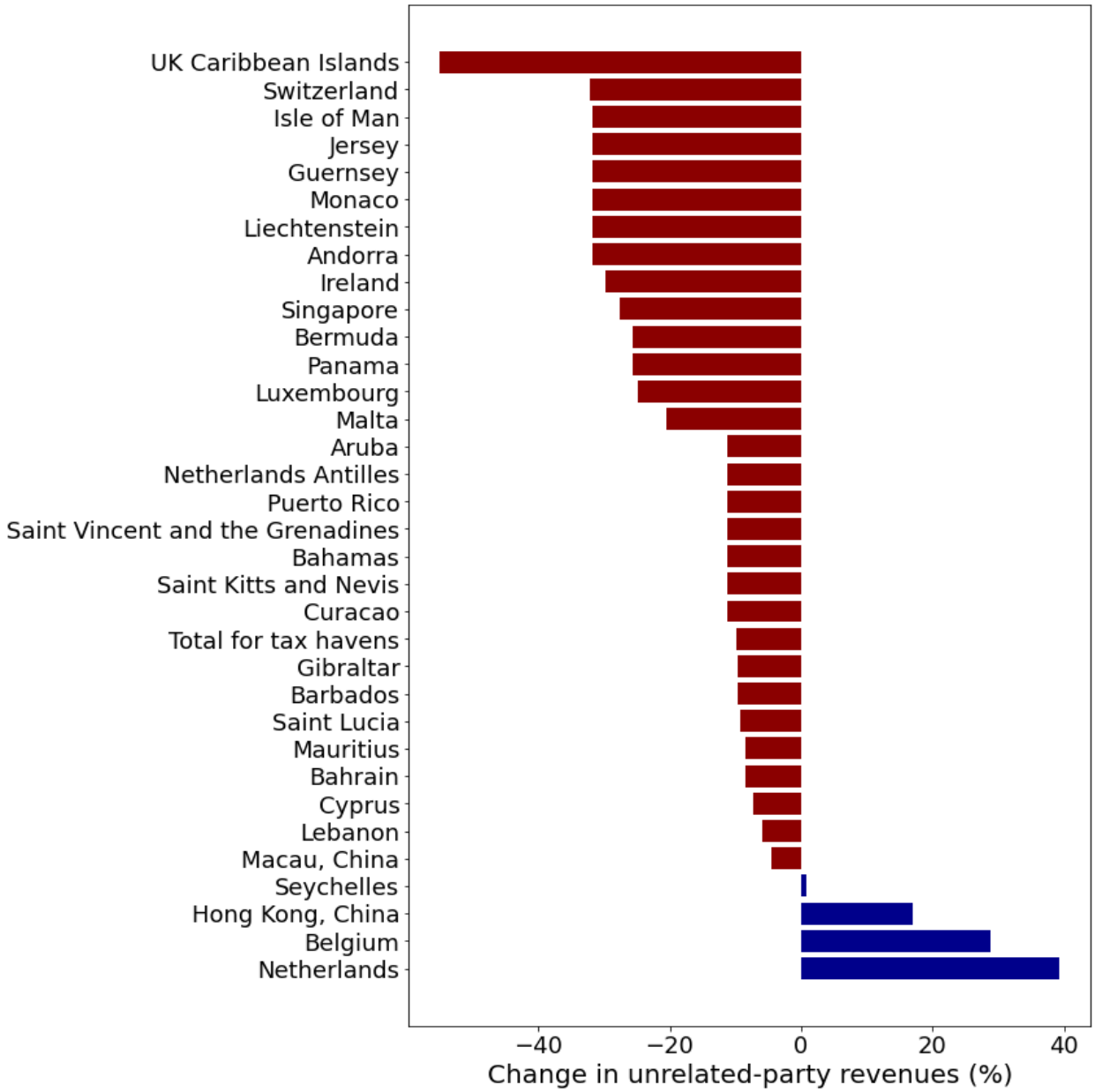



Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

Eventually, as in the assessment of our adjustment for US multinationals, we can focus more specifically on the evolution of the revenues booked in tax havens. Their aggregate weight moves

from 21% of the foreign unrelated-party revenues of in-sample multinationals based on non-adjusted country-by-country report statistics to 16% in the adjusted mapping of extra-group sales. Figure 3.9 shows that most of the tax havens listed by Tørsløv, Wier, and Zucman (2018) in our sample (29 out of 36, including the three jurisdictions not shown) see their unrelated-party revenues decrease.

Figure 3.11: Change in tax havens' unrelated-party revenues, including non-US multinationals




Note: This figure presents the percentage change in unrelated-party revenues implied by our destination-based adjustment for the tax havens listed by Tørsløv, Wier, and Zucman (2018). For each tax haven, it is computed as the ratio of the difference between adjusted and non-adjusted unrelated-party revenues to non-adjusted unrelated-party revenues. The aggregated evolution of all tax haven unrelated-party revenues is also presented as the "Total for tax havens". Red bars indicate a decrease in unrelated-party revenues, while blue bars indicate an increase. The Marshall Islands and Belize are not shown as they respectively display +800% and +192% increases; Antigua and Barbuda is not shown either as it moves from zero to non-zero unrelated-party revenues.

This result again corroborates the idea that the adjustment operates a re-balancing of extra-group sales from potentially low-tax sales platforms to other, larger economies where ultimate consumers and users are more likely to be found. Excluding smaller jurisdictions, the increase in the unrelated-party revenues observed for Hong Kong, the Netherlands and Belgium (both in the case of US multinationals only and with the extended adjustment) may also hint at the limitations of our methodology.

### 3.4.6 Potential limitations

While most tax havens are indeed penalized by the destination-based adjustment, some others display an increase in unaffiliated sales from US multinational companies. Importantly, investigating these results highlights some of the potential limitations of our methodology.

First, despite efforts to select the most appropriate data sources, trade statistics might not necessarily reflect the ultimate destination of the merchandise and services supplied. Because they do not distinguish intra-group and extra-group transactions, they might be somewhat distorted by the aggressive tax planning practices of multinational companies, the sales platforms chosen by US multinational enterprises accounting for an inflated share of exports. Besides, typically in the case of the Netherlands or Hong Kong, the importance of local ports (e.g., Rotterdam, Amsterdam, etc.) and airports (e.g. Schiphol) may also affect trade statistics to some extent.

Second, and more fundamentally, the eloquent concentration of tax havens in Table 3.8 questions the capacity of our methodology to capture the multi-layer sales platform networks organized by US multinational enterprises. If the latter simply used Ireland as a unique intermediary stage before the delivery of the goods and services to the final customer, Irish trade statistics would give more weight to large economies rather than to low-tax jurisdictions and our methodology could efficiently correct for the implied distortion. But in practice, the transactions of large multinationals are organized as complex cross-border schemes that we can only partly unravel via our adjustment.

## 3.5 Robustness Checks

In this section, we present various robustness checks or alternatives to the benchmark computations that highlight some strengths and limitations of our proposed adjustment of country-by-country revenue variables. In Section 3.5.1, we assess the impact of excluding certain flows of services, known to be manipulated by multinational firms for tax planning purposes, from the trade statistics used in the adjustment. Then, Section 3.5.2 underlines the sensitivity of the results for a few partner jurisdictions to the winsorizing threshold, set arbitrarily at 0.5% in the benchmark computations. In Section 3.5.3, we show that the adjustment is robust to the choice of another macroeconomic indicator than final consumption expenditures in its assessment. Eventually, Section 3.5.4 answers a possible concern that the results obtained for the extended sample of parent countries be mainly driven by US multinational companies.

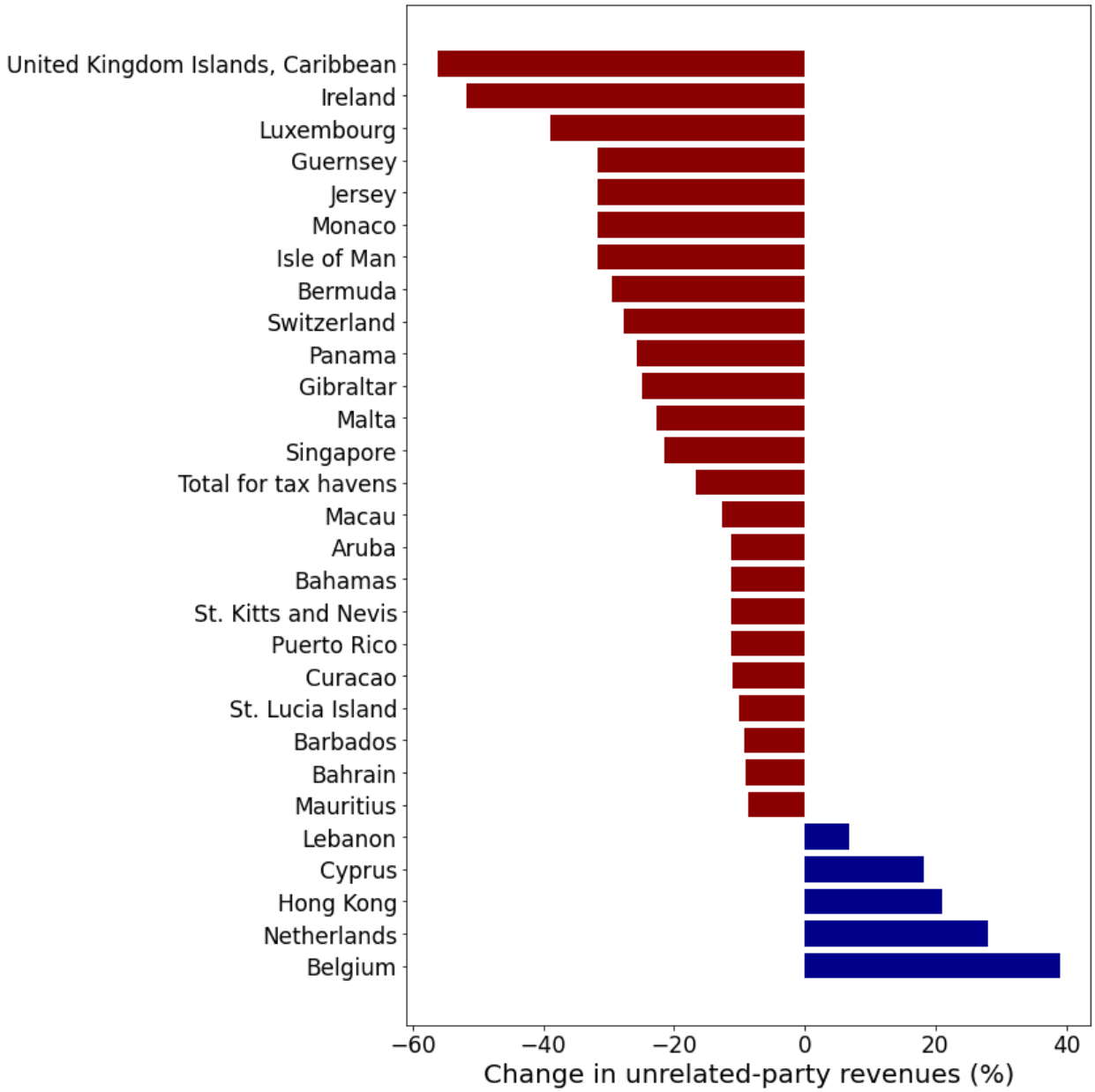
### 3.5.1 Excluding certain flows of services

In our methodology, trade statistics are used to distribute the sales that are directed from a given partner jurisdiction to any third country (excluding the headquarter country for US multinationals). As these data do not allow to distinguish intra-group and extra-group transactions, they may be endogenous to the profit shifting operations of multinational companies. In particular, certain flows of services involving tax havens might reflect tax planning strategies rather than the location of the actual beneficiaries or users of the services. To mitigate this possibility, we propose to exclude

certain flows of services from the trade statistics used in our adjustment. Based on the EBOPS 2010 classification covered by BaTIS data, we net out "insurance and pension services", "financial services" and "charges for the use of intellectual property".

First, looking at the effect of the adjustment on 2017 country-by-country report statistics, we find that the exclusion of these flows of services marginally raises the correlation between partners' share of foreign unrelated-party revenues and their share of final consumption expenditures. Ex ante any adjustment, this correlation is of 0.66; after the benchmark adjustment, we get to 0.79; with the adjustment excluding certain flows of services, we obtain a correlation of 0.80. Second, the exclusion reduces slightly the weight of tax havens in the adjusted mapping of US multinational companies' unrelated-party revenues. Before any adjustment, in the IRS' country-by-country data, the havens listed by Tørsløv, Wier, and Zucman (2018) account for 27% of the unrelated-party revenues booked outside of the US. After the adjustment, this share is reduced to 18% without the exclusion of some flows of services and to 17% with this restriction of trade statistics. Third, as shown in Figure 3.12, the exclusion does not affect the sign of the adjustment for any tax haven, but it accentuates the increase of the unrelated-party revenues attributed to Belgium.

Figure 3.12: Change in tax havens' unrelated-party revenues, excluding certain flows of services




Note: This figure presents the percentage change in unrelated-party revenues implied by our destination-based adjustment for the tax havens listed by Tørsløv, Wier, and Zucman (2018). For each tax haven, it is computed as the ratio of the difference between adjusted and non-adjusted unrelated-party revenues to non-adjusted unrelated-party revenues. The aggregated evolution of all tax haven unrelated-party revenues is also presented as the "Total for tax havens". Red bars indicate a decrease in unrelated-party revenues, while blue bars indicate an increase. The following flows of services are excluded from trade statistics: "insurance and pension services", "financial services" and "charges for the use of intellectual property".

Overall, for the income year 2017, the exclusion of the most sensitive flows of services from trade statistics only has a marginal effect on the outcome of the adjustment. However, this departure from the benchmark computations proves more significant for the 2016 income year, with the specific evolution of Bermuda. Initially, in the IRS' 2016 country-by-country report statistics, US

multinational companies record 10.3 billion USD of unrelated-party revenues in Bermuda. Based on the BEA's statistics, 64% are indeed attributed to Bermuda as local sales and the rest is split between the US and other foreign countries. However, as Bermuda accounts for 0.6% of total US exports in the unrestricted trade statistics, it is attributed a portion of the US-US sales. This 5.8 billion USD addition explains why sales to Bermuda eventually increase by 20% through the adjustment. With the exclusion of the most sensitive flows of services, the weight of Bermuda in US exports decreases substantially. Bermuda then accounts for less than 0.5% of US exports and it is winsorized. Eventually, sales to Bermuda are reduced by 36% through the adjustment.

### 3.5.2 Sensitivity to the winsorizing threshold

The preprocessing of trade statistics for our adjustment of country-by-country revenue variables also involves winsorizing the smallest destinations from each country's distribution of exports. In the benchmark computations, we exclude the destinations that account for less than 0.5% of the total exports, as we do not expect foreign multinationals to operate such niche operations. However, the choice of this winsorizing threshold is rather arbitrary and for a few small partner jurisdictions, results are quite sensitive to its choice.

Typically, appplying a 0.1% winsorizing threshold in the adjustment of US multinational companies' unrelated-party revenues generates a dramatic increase in the sales attributed to Lebanon (+623% after the adjustment). In the IRS' 2017 country-by-country report statistics, unrelated-party revenues of 249 million USD are recorded in Lebanon and in the trade statistics that we obtain, Lebanon stands for 0.12% of the total US exports of goods and services. With a 0.5% winsorizing threshold, none of the domestic sales of US multinational companies are attributed to Lebanon. With a 0.1% winsorizing threshold, 1,537 million USD of additional unrelated-party revenues are allocated, which heavily drives the adjusted sales upwards.

Table 3.10: Mapping of unrelated-party revenues attributed to Lebanon following our destination-based adjustment, per affiliate jurisdiction of origin and with a 0.1% winsorizing threshold

| Affiliate country | UPR (million USD) | Share of Lebanon in exports (%) |
|---|---|---|
| United States | 1537.3 | 0.12 |
| Lebanon | 205.0 | .. |
| Greece | 35.8 | 2.65 |
| Egypt | 9.3 | 1.76 |
| Ukraine | 8.2 | 0.88 |
| Jordania | 2.7 | 1.92 |
| Cyprus | 2.5 | 1.19 |
| Kuwait | 1.3 | 0.62 |
| Georgia | 0.4 | 0.91 |
| Senegal | 0.1 | 0.66 |

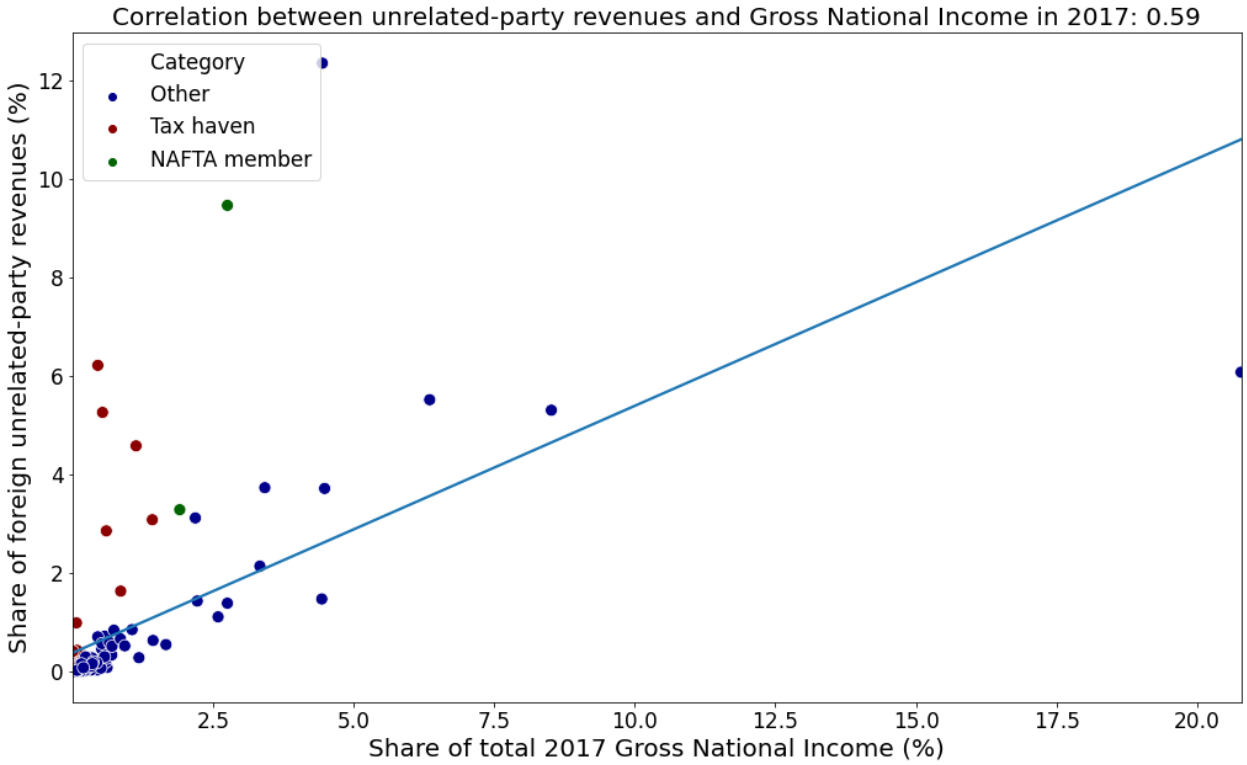
Note: This table indicates the 10 main affiliate jurisdictions from which the post-adjustment unrelated-party revenues of US multinational companies in Lebanon are sourced. The "Share of Lebanon in exports" column indicates the weight of Lebanon in the affiliate country's exports based on our retained set of trade statistics. Note that the export percentages actually used in the computations (that exclude the US from the set of destinations) are higher by, say, a few percentage points except for the US itself. It is used to determine the unrelated-party revenues eventually allocated to Lebanon following the methodology of our destination-based adjustment. The latter are expressed in 2017 billion USD. "UPR" stands for unrelated-party revenues.

### 3.5.3 Robustness to the choice of macro-indicator

To assess the relevance of the adjustment of country-by-country revenue variables, one criterion consists in comparing the distribution of unrelated-party revenues to that of a proxy for market size. In the benchmark evaluation of the adjustment, consistently with the draft nexus and revenue sourcing rules for the Pillar One Amount A released by the OECD in February 2022, we use final consumption expenditures (UNCTAD (2016-2019)). Considering the IRS' 2017 country-by-country report statistics, the correlation between partners' share of foreign unrelated-party revenues and their share of consumption expenditures is initially of 0.66 and increases up to 0.79 with the destination-based adjustment.

Similarly, now considering Gross National Income (GNI), we initially have a low correlation (0.59) between partners' share of foreign unrelated-party revenues and their share of the market size proxy. In Figure 3.13, we observe that essentially two types of partner jurisdictions locate very significantly above the line of best fit (i.e., their share of foreign unrelated-party revenues is disproportionately large compared with their share of GNI): close commercial partners of the US (the UK in blue and Canada in green) on the one hand and tax havens on the other hand. This is very close to what we could observe with final consumption expenditures.

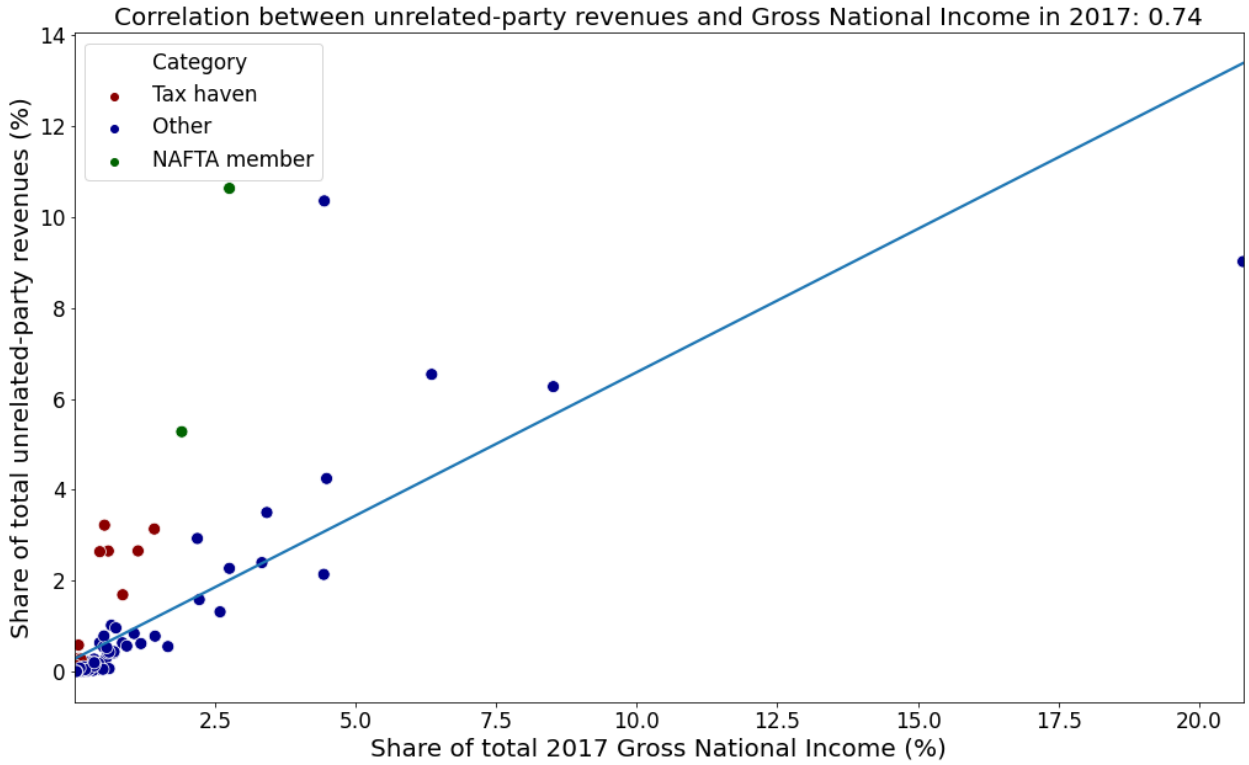
Figure 3.13: Relationship between all partners' share of foreign unrelated-party revenues and their share of GNI




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the total GNI observed in the sample. The x-axis corresponds to GNI and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of GNI. Revenue shares come from the IRS' country-by-country data; GNI data from from the World Bank's and the OECD's National Accounts Statistics.

After the adjustment of country-by-country revenue variables, the correlation between partners' share of foreign unrelated-party revenues and their share of GNI is susbtantially higher (0.74). The dots associated with tax havens in Figure 3.14 are now grouped closer to the line of best fit, meaning that the weight of these partners in the distribution of US multinationals' extra-group sales is now more in line with the size of their economies. On the other hand, Mexico has moved away from the regression line, coming closer to other large commercial partners of the US that still display disproportionate shares of foreign unrelated-party revenues (the UK in blue and Canada in green).

Figure 3.14: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of GNI




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the total GNI observed in the sample. The x-axis corresponds to GNI and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of GNI. Revenue shares come from the adjusted country-by-country data; GNI data from from the World Bank's and the OECD's National Accounts Statistics.

### 3.5.4 Exclusion of the US in the extended adjustment

When evaluating the extended destination-based adjustment, beyond US multinational companies only, we find that the correlation between partner countries' share of foreign unrelated-party revenues and their share of final consumption expenditures is increased: from 0.84 based on the OECD's non-adjusted country-by-country report statistics to 0.89 using the adjusted sales mapping. The importance of tax havens is reduced as the weight of the jurisdictions listed by Tørsløv, Wier, and Zucman (2018) moves from 21% of foreign unrelated-party revenues to 16%. However, one may be concerned about the extent to which these results are driven by the sole adjustment of

US multinational companies' revenues. We therefore review the key points of this assessment while excluding the US from our extended sample of 15 parent jurisdictions.

First, we consider the ranking of the 20 largest partner jurisdictions based on unaffiliated transactions, as per the non-adjusted country-by-country report statistics of the OECD. Table 3.11 relates their share of foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample.

Table 3.11: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, for non-US multinationals only

| Partner jurisdiction | Share of foreign UPR (%) | Share of cons. exp. (%) |
|---|---|---|
| United States | 22.2 | 26.9 |
| United Kingdom | 9.4 | 3.8 |
| China (People's Republic of) | 5.4 | 11.3 |
| Singapore | 5.2 | 0.3 |
| Switzerland | 4.5 | 0.8 |
| Hong Kong, China | 4.3 | 0.4 |
| Germany | 4.0 | 4.5 |
| Brazil | 3.0 | 2.9 |
| France | 2.8 | 3.4 |
| Italy | 2.7 | 2.6 |
| Spain | 2.2 | 1.7 |
| Netherlands | 2.2 | 1.0 |
| Australia | 2.1 | 1.8 |
| Belgium | 1.6 | 0.6 |
| Canada | 1.6 | 2.2 |
| Mexico | 1.4 | 1.5 |
| Thailand | 1.4 | 0.5 |
| Russia | 1.3 | 1.9 |
| Poland | 1.2 | 0.7 |
| Korea | 1.2 | 1.7 |

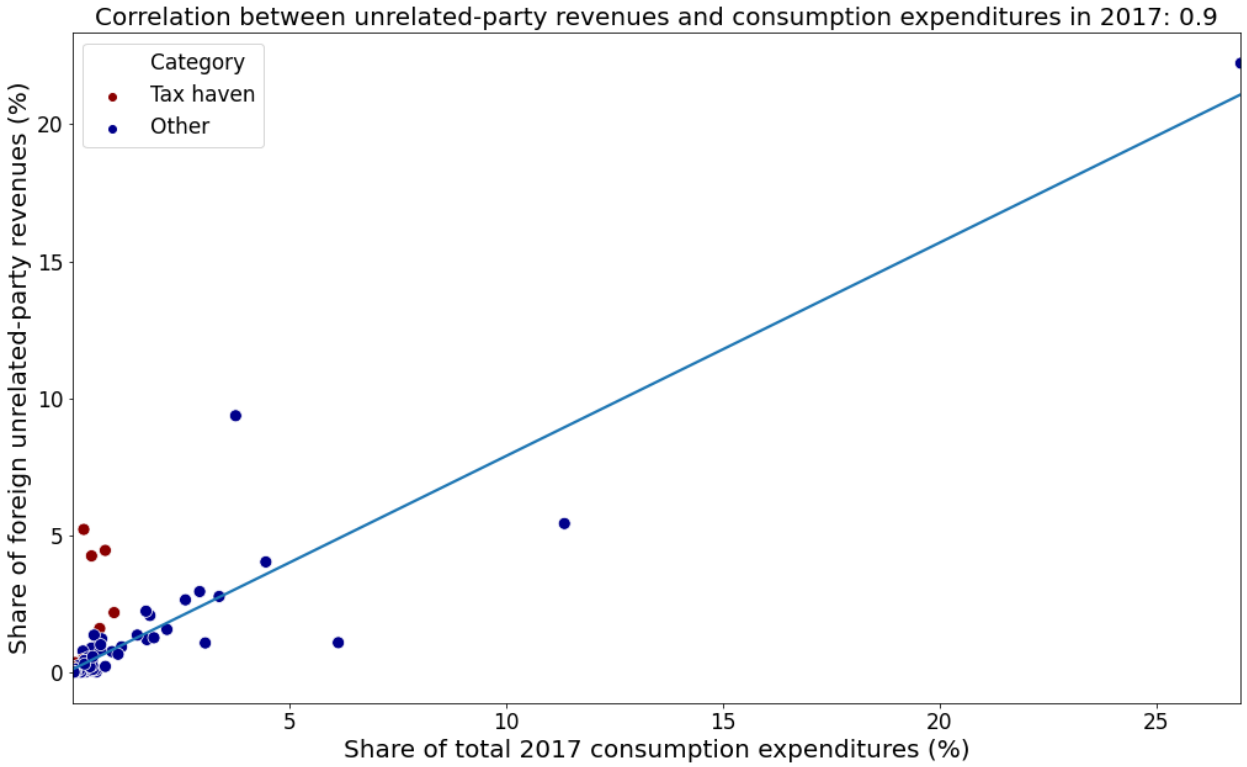
Note: This table presents the 20 main partner jurisdictions for the multinational companies headquartered in 15 parent countries, based on the unrelated-party revenues booked by the latter. It displays each country's share of the total foreign unrelated-party revenues (i.e., excluding domestic observations) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 9.4% of multinational companies' unrelated-party revenues outside their headquarter countries and 3.8% of the total consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the IRS' country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Comparing this table with our benchmark descriptive statistics, we first observe that the ranking of the largest partner jurisdictions is rather robust to the exclusion of the US from the set of headquarter countries. Except for Ireland and Japan, that drop out from the ranking and are replaced by Thailand and Poland, the list of partner jurisdictions stays almost the same. The US, the UK, China, Singapore and Switzerland still make up the top 5 in that order, while the most notable change comes from Canada (from $7^{\text{th}}$ with 3.9% to $15^{\text{th}}$ with 1.6% of foreign unrelated-party revenues). The latter observation may not be surprising as Canada is a close commercial partner of the US. Finally, the share of the foreign unrelated-party revenues of the US increases substantially (from 15.7% to 22.2%), which is a mechanical outcome of the exclusion of US multinational

companies' non-US sales.

In addition to the consistency of the ranking, after excluding the US from the set of headquarter countries, we still observe substantial heterogeneity in the relationship between partner jurisdictions' share of foreign unrelated-party revenues and their share of final consumption expenditures. In particular, the disproportionate weight of Singapore, Switzerland and Hong Kong that rank from $4^{th}$ to $6^{th}$ and cumulatively account for around 1.5% of final consumption expenditures remains striking. We therefore illustrate this relationship for all partner jurisdictions in Figure 3.15.

Figure 3.15: Relationship between all partners' shares of foreign unrelated-party revenues and final consumption expenditures, for non-US multinationals only

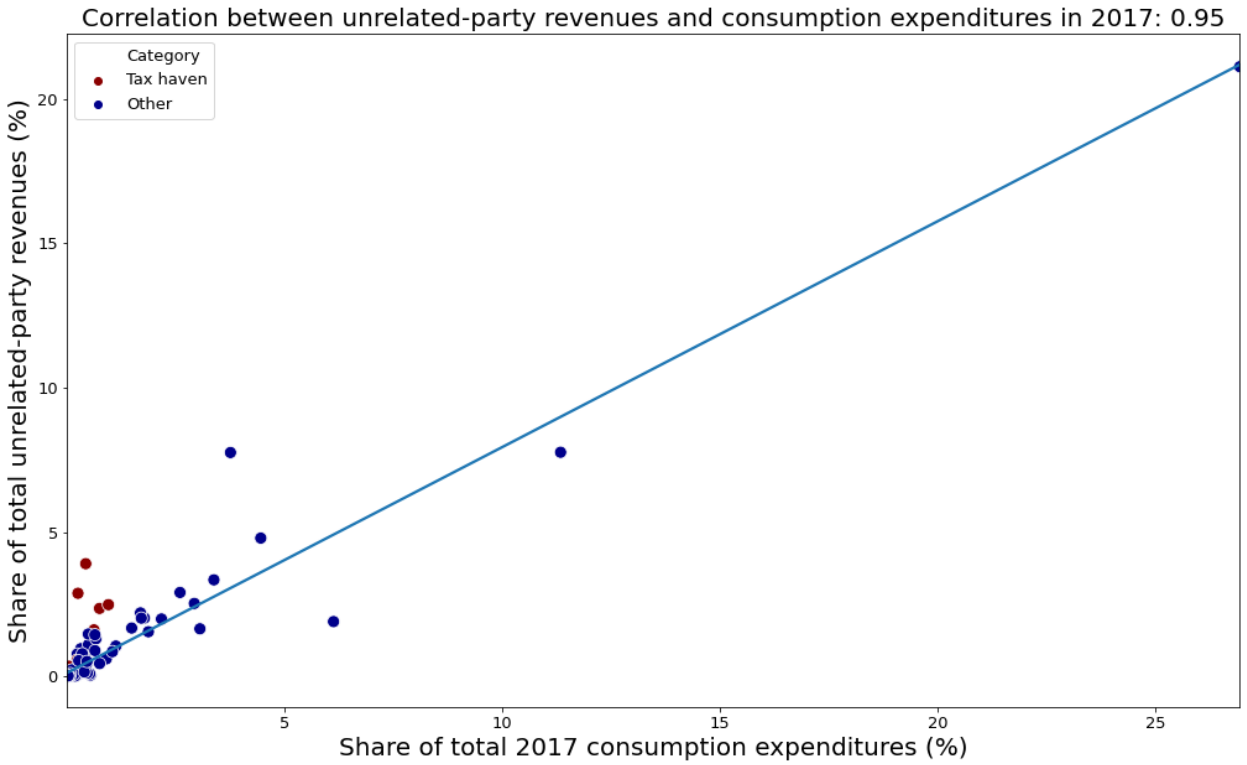



Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

While we found a correlation of 0.84 in the benchmark descriptive study, we now observe a correlation of 0.90 between partner jurisdictions' share of foreign unrelated-party revenues and their share of final consumption expenditures. While this change may hint at a lower intensity in the use of sales platforms by non-US multinational companies, it is also driven (at least partly) by the mechanical increase in the US share of foreign unrelated-party revenues, making the comparison of these correlations difficult. That being said, two points can be mentioned regarding the relationship between the concentration of extra-group sales and market size. First, we still observe

the disproportionate weight of some tax havens, which stand well above the line of best fit on the left-hand part of the graph. Second, after our destination-based adjustment, the weight of these jurisdictions in the distribution of extra-group sales is reduced and the correlation between partner countries' share of foreign unrelated-party revenues and their share of final consumption expenditures increases (0.90 to 0.95). Figure 3.16 reproduces the above based on the adjusted mapping of sales.

Figure 3.16: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, for non-US multinationals only




Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

Eventually, as a last indicator, when excluding the US from the set of headquarter countries, the adjustment still reduces the weight of tax havens in the distribution of multinationals' extra-group sales. The share of the jurisdictions listed by Tørsløv, Wier, and Zucman (2018) indeed moves from 19% of foreign unrelated-party revenues in the OECD's country-by-country report statistics to 15% in the adjusted mapping. Overall, we conclude that the results presented in our benchmark descriptive study and in the assessment of the proposed adjustment for the extended sample of headquarter countries are not driven solely by the US.

## 3.6 International Tax Reform Simulations

In this section, we illustrate how the adjusted mapping of multinationals' sales can be used to simulate proposed reforms of the international corporate income tax system. Indeed, several proposals involve an apportionment of multinationals' income or of their so-called "tax deficit" based on the distribution of their extra-group sales.[8] For instance, in the two-pillar proposal fostered by the OECD, Pillar One allocates a part of in-scope multinationals' tax base to their "market jurisdictions" (i.e., to the tax jurisdictions where their customers are located or where value creation occurs). Full formulary apportionment proposals go further and distribute the entire taxing rights, generally based on a combination of payroll costs, tangible assets and destination-based extra-group sales. We can also mention the Minimum Effective Tax Rate (METR) proposal of Kadet et al. (2021) who propose to first determine multinational companies' undertaxed profits and then, to allocate these additional tax bases across countries based on the distribution of their destination-based sales.

We first explain some of the issues that are likely to arise when using non-adjusted and adjusted mappings of the country-by-country revenue variables to simulate such reforms. We then turn to the "unilateral scenario" of Baraké et al. (2021a), before giving additional insights on the impact of the sales mapping adjustment for simulations of sales apportionment formulas.

### 3.6.1 Preliminary remarks

The main difficulty for the following computations lies in that they rely on several, distinct computations that may not be available for the same sets of countries. To ensure the comparability of the revenue gain estimates across countries, these methodologies often require additional assumptions that may hinder the accuracy of the results.

From Baraké et al. (2021a) and Baraké et al. (2021b), tax deficit estimates are available for around 80 countries. They either report aggregated country-by-country statistics via the OECD for 2017 or they are included in the results of Tørsløv, Wier, and Zucman (2018), who provide estimates of profits booked in tax havens by the multinational companies headquartered in a broad set of jurisdictions. Both of the proposals simulated below involve distributing a part or the entirety of these tax deficits based on the distribution of multinationals' unrelated-party revenues. But the non-adjusted and adjusted sales mappings are based on country-by-country report statistics and as such, they are only available for a limited set of countries. Using these mappings of sales, we can only distribute the tax deficits of at most 34 jurisdictions (while over 80 estimates are available). We do cover the most important headquarter countries and thus most of the total tax deficit, but assumptions are required to impute the tax deficits of countries for which we lack a sales mapping.

Furthermore, among the 34 jurisdictions for which we can deduce a destination-based mapping of multinationals' sales, many countries only provide a limited country-by-country breakdown. Some even only report a continental split of the revenue variables. Not only does this make the adjusted sales mapping less precise, but this also limits the usability of the non-adjusted statistics. Having determined an estimate for the tax deficit of the Isle of Man, if we only know how its multinationals' sales are distributed across continents, how can we allocate the corresponding revenues to the right taxing jurisdictions? The main objective of Baraké et al. (2021a) was to provide revenue gain estimates for EU Member-States, so that they can deal with this issue with rough but simple imputations. We use the same approach for the results presented in Section 3.6.2. In Section 3.6.3,

8. Introduced by Clausing, Saez, and Zucman (2020), the "tax deficit" of a multinational company is defined as the difference between the amount of corporate income taxes that the group would pay under a global minimum tax rate and the amount that it actually pays.

we instead (i) distribute only the tax deficits of countries that report a sufficiently detailed bilateral breakdown in their country-by-country statistics and (ii) focus on the outcome for the partners that are explicitly included in the reports of all these parent countries.

Eventually, in the latter approach, we only have tax deficit estimates for some of the countries on which we focus in our revenue gain estimates. Because domestic sales generally represent a substantial share of multinationals' total revenues, taxing jurisdictions are expected to collect a large portion of their own tax deficit. The revenue gains of countries for which we lack a tax deficit estimate are therefore likely to be underestimated relatively to countries for which we have such an estimate. To compare all jurisdictions on an equal footing, we discuss the revenues that are estimated to be collected from foreign multinational companies.

### 3.6.2 Unilateral scenario of tax deficit collection

We first revise the estimated corporate income tax revenue gains from the "unilateral scenario" defined by Baraké et al. (2021a). In their report, the authors estimate the effect of a global minimum tax on corporate profits. They envision three scenarios: a multilateral implementation of the reform, similar to the agreements reached by more than 130 members of the Inclusive Framework in July and October 2021; a partial cooperation case involving only EU Member States; the unilateral scenario, with one headquarter country independently applying the minimum tax and drawing revenues from the taxation of foreign multinational companies' undertaxed profits. Indeed, the taxing country is assumed to collect a share of foreign firms' tax deficit, based on its weight in their unrelated-party sales.

Said otherwise, if France were to unilaterally implement a minimum tax at an effective rate of 15%, it would not only collect a top-up tax on the profits of French multinational companies that are taxed below the minimum rate. But it would also determine the worldwide tax deficit of, say, Apple and collect part of it, based on the weight of France in the sales of the company. If French customers and users account for 2% of Apple's global unrelated-party revenues, France collects 2% of Apple's tax deficit. In practice however, in the absence of sufficient micro-data, Baraké et al. (2021a) compute tax deficits at the headquarter country level and these are allocated based on aggregated revenue variables: if France represents 2% of US multinational companies' unrelated-party revenues in country-by-country data, it collects 2% of the total US tax deficit.

We use the latest tax deficit estimates for the fiscal year 2017 and modify the allocation key. We follow the same methodology to deal with aggregate partners and the missing sales mappings. We compare each headquarter country's revenue gains based, on the one hand, on the unrelated-party revenues of the OECD's country-by-country data and on adjusted revenues on the other hand. Table 3.12 presents the outcome of the unilateral scenario for EU Member States and parent countries included in country-by-country data.

Table 3.12: Revision of the estimated revenue gains from the unilateral scenario of Baraké et al. (2021a), based on the destination-based adjustment of country-by-country revenue variables

| Taxing country | Using unadj. UPR (bn. USD) | Using adj. UPR (bn. USD) | Change in % |
|---|---|---|---|
| Austria | 3.7 | 4.0 | 6.5 |
| Belgium | 4.8 | 5.2 | 8.0 |
| Cyprus | 0.2 | 0.2 | 2.2 |
| Czech Republic | 0.5 | 0.6 | 29.9 |
| Denmark | 2.0 | 2.2 | 8.1 |
| Estonia | 0.1 | 0.1 | 0.6 |
| Finland | 1.7 | 1.8 | 4.4 |
| France | 6.4 | 7.6 | 18.6 |
| Germany | 16.3 | 18.3 | 12.0 |
| Greece | 2.3 | 2.3 | -0.2 |
| Hungary | 0.8 | 0.9 | 8.1 |
| Ireland | 13.9 | 13.7 | -1.4 |
| Italy | 4.7 | 5.4 | 16.5 |
| Latvia | 0.2 | 0.2 | 1.6 |
| Luxembourg | 6.4 | 6.4 | -0.3 |
| Malta | 0.2 | 0.2 | -4.0 |
| Netherlands | 3.8 | 4.6 | 21.1 |
| Poland | 4.5 | 4.7 | 5.0 |
| Portugal | 0.3 | 0.4 | 26.1 |
| Romania | 0.3 | 0.3 | 16.6 |
| Slovakia | 0.1 | 0.2 | 25.0 |
| Slovenia | 0.0 | 0.1 | 7.5 |
| Spain | 6.5 | 6.9 | 6.0 |
| Sweden | 3.2 | 3.4 | 8.1 |
| EU | 83.0 | 89.6 | 8.0 |

| Taxing country | Using unadj. UPR (bn. USD) | Using adj. UPR (bn. USD) | Change in % |
|---|---|---|---|
| Argentina | 0.6 | 0.7 | 8.2 |
| Australia | 3.3 | 3.6 | 7.6 |
| Bermuda | 1.4 | 1.4 | -1.5 |
| Brazil | 3.5 | 3.7 | 6.6 |
| Canada | 11.4 | 12.4 | 9.1 |
| Chile | 0.5 | 0.4 | -7.3 |
| China | 9.1 | 11.6 | 27.7 |
| India | 1.2 | 1.8 | 57.0 |
| Indonesia | 0.5 | 0.6 | 21.4 |
| Isle of Man | 0.1 | 0.1 | -3.3 |
| Japan | 7.3 | 8.4 | 14.9 |
| Malaysia | 0.8 | 1.0 | 24.0 |
| Mexico | 1.9 | 2.7 | 44.2 |
| Norway | 0.6 | 0.7 | 20.9 |
| Peru | 0.3 | 0.3 | -19.4 |
| Singapore | 3.4 | 2.7 | -21.5 |
| South Africa | 3.3 | 3.4 | 0.3 |
| Switzerland | 7.2 | 5.9 | -18.8 |
| United Kingdom | 13.5 | 13.9 | 2.9 |
| United States | 70.4 | 71.8 | 1.9 |
| OECD | 201.7 | 213.9 | 6.1 |
| Full sample | 238.6 | 252.8 | 6.0 |

Note: This table presents the revision of the revenue gain estimates proposed by Baraké et al. (2021a) for their unilateral scenario. The first column, "Using unadj. UPR (bn. USD)", is obtained by using the non-adjusted country-by-country statistics of the OECD and the second column, "Using adj. UPR (bn. USD)", is obtained by using our adjusted sales mapping for the unrestricted set of headquarter countries (34 parent jurisdictions). Revenue gain estimates are presented in current billion USD for the income year 2017 and the change due to our destination-based adjustment of country-by-country revenue variables is expressed in percentage. The sample comprises 24 EU Member States and 20 non-EU countries having reported country-by-country data in 2017. "UPR" stands for unrelated-party revenues.

Overall, these results are consistent with our expectations. First, the revenue gains of most tax havens are decreasing. For instance, the revenues attributed to Ireland are slightly smaller using the adjusted mapping of unrelated-party revenues (-1.4%), those estimated for Switzerland are reduced more significantly by 18.8% and the decrease is even deeper for Singapore (-21.5%). Second, the effect is generally positive for non-haven jurisdictions. That being said, the evolution of the revenue gains for Belgium or the Netherlands (increasing by 8.0% and 21.1% respectively), for Luxembourg (roughly stable) and for Chile or Peru (decreasing by 7.3% and 19.4% respectively) are more surprising. To make the effect of the adjustment more visible and more comparable from a taxing country to another (a jurisdiction with a higher initial tax deficit will mechanically display a percentage change closer to zero), we can focus on revenues collected from foreign multinationals. In Table 3.13, we show by how much these change when running the computations with unadjusted or adjusted sales.

Table 3.13: Change in the revenues drawn from foreign multinational companies implied by the destination-based adjustment

| Taxing country | Using unadj. UPR (m. USD) | Using adj. UPR (m. USD) | Change in % |
|---|---|---|---|
| Austria | 580 | 823 | 42 |
| Belgium | 810 | 1,195 | 48 |
| Cyprus | 20 | 25 | 26 |
| Czech Republic | 396 | 533 | 35 |
| Denmark | 174 | 337 | 94 |
| Estonia | 16 | 17 | 4 |
| Finland | 184 | 261 | 42 |
| France | 2,401 | 3,593 | 50 |
| Germany | 2,894 | 4,852 | 68 |
| Greece | 95 | 89 | -6 |
| Hungary | 223 | 288 | 29 |
| Ireland | 1,186 | 991 | -16 |
| Italy | 1,527 | 2,298 | 51 |
| Latvia | 9 | 11 | 28 |
| Luxembourg | 416 | 397 | -5 |
| Malta | 39 | 33 | -17 |
| Netherlands | 1,454 | 2,264 | 56 |
| Poland | 695 | 917 | 32 |
| Portugal | 240 | 318 | 32 |
| Romania | 231 | 280 | 21 |
| Slovakia | 133 | 169 | 27 |
| Slovenia | 31 | 35 | 12 |
| Spain | 1,167 | 1,559 | 34 |
| Sweden | 458 | 716 | 56 |
| EU | 15,379 | 22,001 | 43 |

| Taxing country | Using unadj. UPR (m. USD) | Using adj. UPR (m. USD) | Change in % |
|---|---|---|---|
| Argentina | 508 | 558 | 10 |
| Australia | 1,459 | 1,709 | 17 |
| Bermuda | 94 | 73 | -22 |
| Brazil | 1,944 | 2,175 | 12 |
| Canada | 2,191 | 3,231 | 47 |
| Chile | 446 | 412 | -7 |
| China | 2,848 | 5,372 | 89 |
| India | 599 | 1,258 | 110 |
| Indonesia | 422 | 535 | 27 |
| Isle of Man | 10 | 7 | -32 |
| Japan | 1,296 | 2,391 | 84 |
| Malaysia | 286 | 474 | 65 |
| Mexico | 1,426 | 2,250 | 58 |
| Norway | 278 | 404 | 45 |
| Peru | 204 | 142 | -30 |
| Singapore | 2,716 | 1,979 | -27 |
| South Africa | 356 | 365 | 3 |
| Switzerland | 3,671 | 2,311 | -37 |
| United Kingdom | 6,407 | 6,798 | 6 |
| United States | 11,960 | 13,303 | 11 |
| OECD | 50,607 | 62,850 | 24 |
| Full sample | 58,228 | 72,517 | 25 |

Note: This table presents the revenues that are estimated to be drawn from foreign multinationals in the unilateral scenario proposed by Baraké et al. (2021a). The first column, "Using unadj. UPR (bn. USD)", is obtained by using the non-adjusted country-by-country statistics of the OECD and the second column, "Using adj. UPR (bn. USD)", is obtained by using our adjusted sales mapping for the unrestricted set of headquarter countries (34 parent jurisdictions). Revenue gain estimates are presented in current million USD for the income year 2017 and the change due to our destination-based adjustment of country-by-country revenue variables is expressed in percentage. The sample comprises 24 EU Member States and 20 non-EU countries having reported country-by-country data in 2017. "UPR" stands for unrelated-party revenues.

Interestingly, two forces seem to drive the above results. There is not only a form of re-balancing in favour of non-haven jurisdictions but also an increase in the total amounts collected from foreign multinationals (+25% over the full sample). Indeed, the adjusted revenue variables give less weight to domestic sales than the OECD's country-by-country report statistics.

### 3.6.3 Full sales apportionment

As an alternative, to account for the limitations highlighted in Section 3.6.1 and further illustrate the possibilities offered by the adjustment of country-by-country revenue variables, we simulate the revenues from a full apportionment of multinationals' tax deficits based on extra-group sales. Contrarily to the above, each country is not assumed to collect the entirety of its own tax deficit. If France only accounts for, say, 60% of the unrelated-party revenues of French multinational companies, then France only collects 60% of its tax deficit and the rest is shared across the other market jurisdictions served by these firms.

**Methodological considerations**

First, we only distribute the tax deficits of the countries for which we have both satisfying non-adjusted and adjusted sales mappings. As in the benchmark extension of our destination-based adjustment to non-US multinationals, we restrict the set of parent countries to the 15 jurisdictions that report at least 60 unique partners in their aggregated country-by-country reports. Table 3.14 lists these countries and shows their respective tax deficits. They gather a total tax deficit of 115.2 billion USD, versus a full sample total of 180.3 billion USD based on the estimates of Baraké et al. (2021b), hence a 64% "coverage rate".

Table 3.14: Restricted set of headquarter countries and associated 2017 tax deficit estimates as per Baraké et al. (2021b)

| Headquarter country | Tax deficit to be allocated (billion USD) |
|---|---|
| Australia | 1.8 |
| Bermuda | 1.3 |
| China (People's Republic of) | 6.3 |
| Denmark | 1.8 |
| France | 4.0 |
| Germany | 13.4 |
| India | 0.6 |
| Italy | 3.1 |
| Japan | 6.0 |
| Luxembourg | 6.0 |
| Mexico | 0.4 |
| South Africa | 3.0 |
| Spain | 5.4 |
| Switzerland | 3.6 |
| United States | 58.5 |

Note: This table presents the 15 headquarter countries retained based on the granularity of the bilateral breakdown of their aggregated country-by-country report statistics, as well as their tax deficits as per the latest estimates of Baraké et al. (2021b). Those are presented for the income year 2017 and a 15% minimum rate, in current billion USD.

Second, we also focus on a restricted set of countries when estimating the revenue effects of the full sales apportionment reform. We focus on the countries that are reported as partner jurisdictions in all of the 15 aggregated country-by-country reports. Indeed, we know that these countries are never integrated to regional aggregates and we have, for each parent, their exact amount of unrelated-party revenues: we do not need to make assumptions about how sales attributed to aggregate partners are distributed, which may reduce the accuracy of the estimates and limit comparability across taxing jurisdictions. We obtain a set of 46 countries, out of which 6 are classified as tax havens by Tørsløv, Wier, and Zucman (2018).

Third, in the resulting table, we show the revenues collected specifically from foreign multinational companies. These two columns allow to compare the revenue gains of the different taxing jurisdictions. Otherwise, because of the importance of domestic sales for most multinational companies, the countries whose tax deficits are being distributed would be expected to collect a substantial share of their own tax deficit and their revenue gains would mechanically be increased relatively to the other countries.

**Results**

Table 3.15 presents the results from these computations.

Table 3.15: Revenue gains collected from foreign multinational companies under a full apportionment of headquarter countries' tax deficit

| Taxing country | Using unadj. UPR (m. USD) | Using adj. UPR (m. USD) | Discrepancy (%) |
|---|---|---|---|
| Argentina | 427.0 | 459.7 | 7.7 |
| Australia | 1,086.6 | 1,250.0 | 15.0 |
| Austria | 459.2 | 594.6 | 29.5 |
| Brazil | 1,541.4 | 1,699.6 | 10.3 |
| Bulgaria | 38.9 | 32.6 | -16.3 |
| Canada | 1,978.0 | 2,847.1 | 43.9 |
| Chile | 349.8 | 324.1 | -7.3 |
| China | 2,296.0 | 4,024.9 | 75.3 |
| Colombia | 268.3 | 284.7 | 6.1 |
| Czech Rep. | 324.9 | 351.6 | 8.2 |
| Denmark | 148.6 | 200.8 | 35.1 |
| Egypt | 73.0 | 79.9 | 9.5 |
| Finland | 153.1 | 171.5 | 12.0 |
| France | 1,816.8 | 2,456.3 | 35.2 |
| Germany | 2,252.7 | 3,200.6 | 42.1 |
| Hungary | 179.3 | 181.0 | 0.9 |

| Taxing country | Using unadj. UPR (m. USD) | Using adj. UPR (m. USD) | Discrepancy (%) |
|---|---|---|---|
| India | 511.5 | 961.6 | 88.0 |
| Indonesia | 304.9 | 378.7 | 24.2 |
| Italy | 1,272.5 | 1,670.1 | 31.2 |
| Japan | 1,203.0 | 1,967.8 | 63.6 |
| Korea | 444.0 | 870.2 | 96.0 |
| Malaysia | 219.1 | 357.5 | 63.1 |
| Mexico | 1,028.0 | 1,705.6 | 65.9 |
| Morocco | 40.7 | 56.8 | 39.6 |
| Norway | 238.7 | 279.2 | 17.0 |
| Philippines | 112.8 | 190.0 | 68.5 |
| Poland | 560.1 | 663.1 | 18.4 |
| Portugal | 197.7 | 233.1 | 17.9 |
| Romania | 183.3 | 182.0 | -0.7 |
| Russia | 586.3 | 819.4 | 39.7 |
| Slovakia | 110.4 | 109.5 | -0.8 |
| South Africa | 306.7 | 304.1 | -0.8 |
| Spain | 947.7 | 1,127.6 | 19.0 |
| Sweden | 383.2 | 497.3 | 29.8 |
| Taiwan | 274.9 | 498.6 | 81.3 |
| Thailand | 326.2 | 459.3 | 40.8 |
| Turkey | 321.5 | 471.8 | 46.8 |
| UAE | 261.2 | 474.9 | 81.8 |
| UK | 4,958.7 | 5,080.6 | 2.5 |
| United States | 6,410.2 | 6,847.6 | 6.8 |
| Non-havens | 34,596.8 | 44,365.3 | 28.2 |
| Belgium | 699.1 | 873.8 | 25.0 |
| Hong Kong | 1,161.5 | 1,349.0 | 16.1 |
| Ireland | 1,145.2 | 761.3 | -33.5 |
| Luxembourg | 277.4 | 244.7 | -11.8 |
| Singapore | 2,305.7 | 1,587.2 | -31.2 |
| Switzerland | 3,028.1 | 1,743.1 | -42.4 |
| Tax havens | 8,617.1 | 6,559.1 | -23.9 |
| Full sample | 43,213.9 | 50,924.4 | 17.8 |

Note: This table presents the revenues collecting by each taxing country from foreign multinationals under a full sales apportionment of tax deficits. The first column, "Using unadj. UPR (bn. USD)", is obtained by using the non-adjusted country-by-country statistics of the OECD and the second column, "Using adj. UPR (bn. USD)", is obtained by using our adjusted sales mapping for the restricted set of headquarter countries (15 parent jurisdictions). Revenue gain estimates are presented in current million USD for the income year 2017 and the change due to our destination-based adjustment of country-by-country revenue variables is expressed in percentage. "UPR" stands for unrelated-party revenues.

As explained above, for comparability purposes, we show the detailed estimates per taxing country only for the revenues collected from foreign multinational companies. Including countries' collection of their own multinationals' tax deficits, the full sample of jurisdictions on which we focus in Table 3.15 gathers revenue gains of 111.3 billion USD and 110.9 billion USD, using respectively

the non-adjusted country-by-country report statistics and the adjusted revenue variables. Said otherwise, our restricted set of taxing jurisdictions covers most of the total tax deficit (115.2 billion USD) being allocated. Revenues collected from foreign multinationals represent between 39% and 46% of the total depending on the sales mapping considered.

Before the adjustment of unrelated-party revenues, the total tax revenues collected from foreign multinationals amount to 43.2 billion USD. With 8.6 billion USD accruing to these jurisdictions, the 6 tax havens in the set of interest capture 20% of the total. After the adjustment, the total tax revenues collected from foreign multinationals are of 50.9 billion USD. This increase (+18%) is explained by the lower importance that the adjusted mapping of extra-group sales gives to domestic transactions. With 6.6 billion USD now accruing to these jurisdictions, tax havens in the set of interest capture 13% of the total tax revenues. Their share has thus gone down significantly with our proposed adjustment of country-by-country revenue variables. This shift in favor of the non-havens in the sample could be expected as tax havens were already identified as the biggest "losers" from our adjustment.

## 3.7 Main Results for Other Income Years

In the following section, we reproduce the main tables and figures that allow to assess the benchmark destination-based adjustment of country-by-country revenue variables for different income years. Section 3.7.1 presents the results for the 2016 income year, considering the adjustment for US multinational companies and the extension to other headquarter countries. In Sections 3.7.2 and 3.7.3, we apply our methodology respectively to the IRS' 2018 and 2019 country-by-country report statistics.

### 3.7.1 Results for 2016

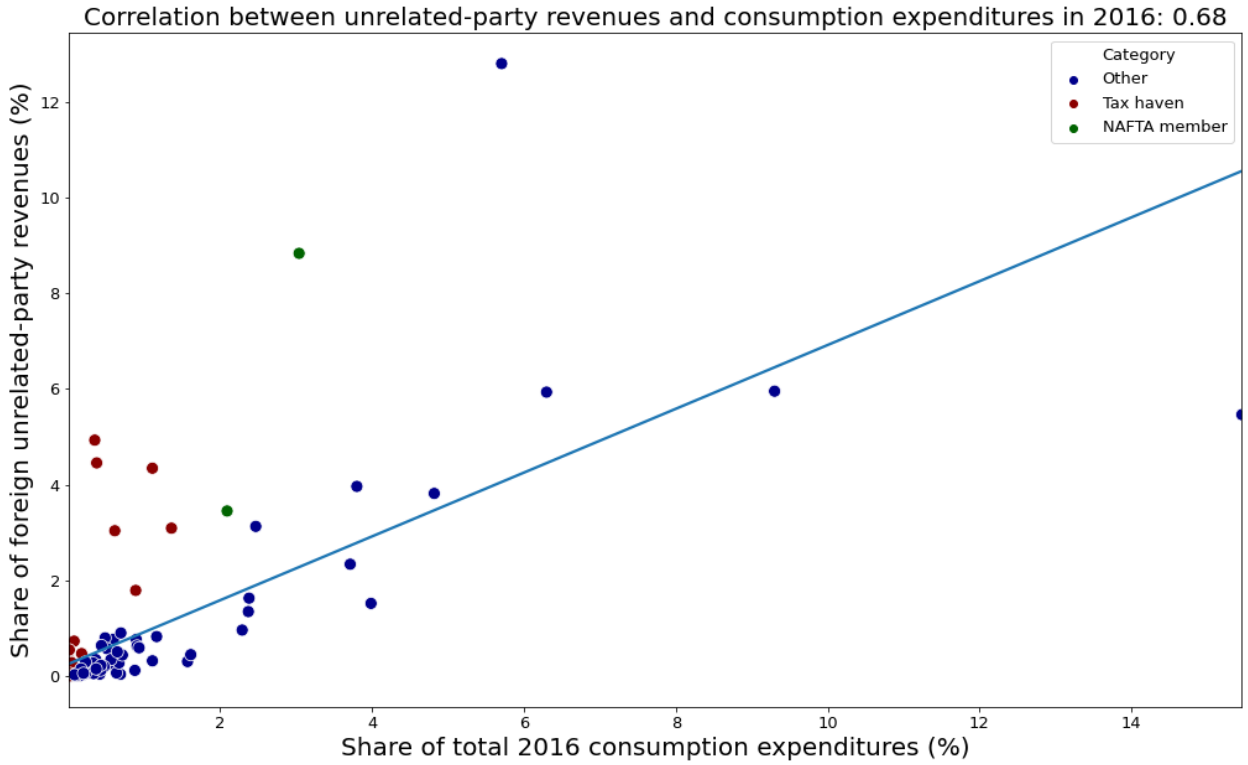
**Focusing on US multinational companies**

Table 3.16: Top 20 largest partner jurisdictions [2016]

| Partner country | UPR (USD billion) | Share of foreign UPR (%) |
|---|---|---|
| United Kingdom | 386.3 | 12.8 |
| Canada | 266.6 | 8.8 |
| Japan | 179.7 | 5.9 |
| Germany | 179.1 | 5.9 |
| China | 164.9 | 5.5 |
| Ireland | 148.8 | 4.9 |
| Singapore | 134.5 | 4.4 |
| Switzerland | 131.1 | 4.3 |
| Brazil | 119.7 | 4.0 |
| France | 115.2 | 3.8 |
| Mexico | 104.2 | 3.4 |
| Australia | 94.4 | 3.1 |
| Netherlands | 93.3 | 3.1 |
| Hong Kong | 91.7 | 3.0 |
| Italy | 70.6 | 2.3 |
| Belgium | 54.1 | 1.8 |
| Spain | 49.2 | 1.6 |
| India | 45.9 | 1.5 |
| Korea | 40.7 | 1.3 |
| Russia | 29.1 | 1.0 |

Note: This table presents the 20 most important partner countries for US multinational companies. This ranking is based on the unrelated-party revenues booked by US multinational enterprises in each of these jurisdictions. Revenues are presented in absolute amounts (expressed in 2017 billion USD) and as a share of US multinational companies' total foreign unrelated-party revenues (expressed in percentage). All figures are based on the IRS' 2017 country-by-country data. "UPR" stands for unrelated-party revenues.

Figure 3.17: Relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2016]



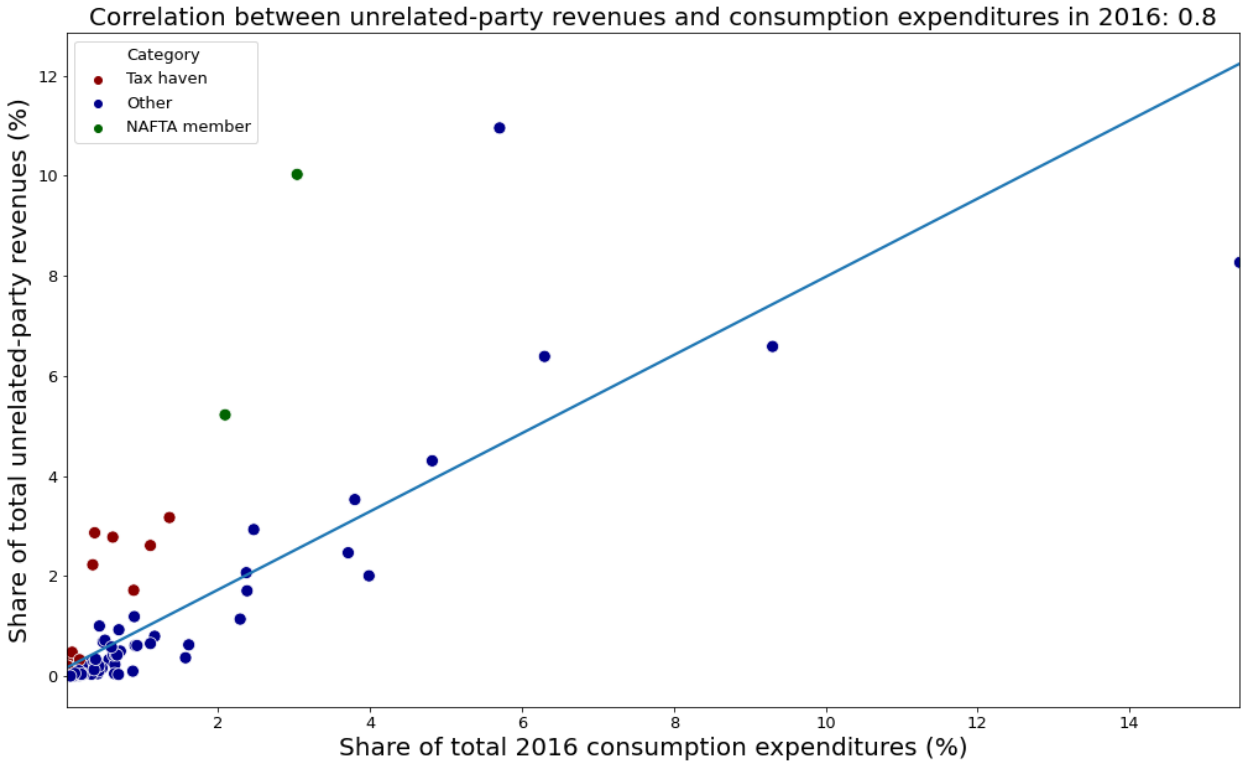

Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

Table 3.17: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, based on adjusted revenue variables [2016]

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| United Kingdom | 423.9 | 11.0 | 5.7 |
| Canada | 388.0 | 10.0 | 3.0 |
| China | 320.0 | 8.3 | 15.5 |
| Japan | 255.0 | 6.6 | 9.3 |
| Germany | 247.2 | 6.4 | 6.3 |
| Mexico | 202.1 | 5.2 | 2.1 |
| France | 166.5 | 4.3 | 4.8 |
| Brazil | 136.6 | 3.5 | 3.8 |
| Netherlands | 122.7 | 3.2 | 1.4 |
| Australia | 113.4 | 2.9 | 2.5 |
| Singapore | 110.9 | 2.9 | 0.4 |
| Hong Kong | 107.5 | 2.8 | 0.6 |
| Switzerland | 101.0 | 2.6 | 1.1 |
| Italy | 95.4 | 2.5 | 3.7 |
| Ireland | 86.1 | 2.2 | 0.3 |
| Korea | 80.0 | 2.1 | 2.4 |
| India | 77.6 | 2.0 | 4.0 |
| Belgium | 66.4 | 1.7 | 0.9 |
| Spain | 66.0 | 1.7 | 2.4 |
| Taiwan | 46.0 | 1.2 | 0.9 |

Note: This table presents the 20 main partner jurisdictions for the US multinational companies, based on the unrelated-party revenues booked by the latter. It displays each country's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the US-US observation) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 11.0% of US multinational companies' adjusted foreign unrelated-party revenues and 5.3% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Figure 3.18: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2016]




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

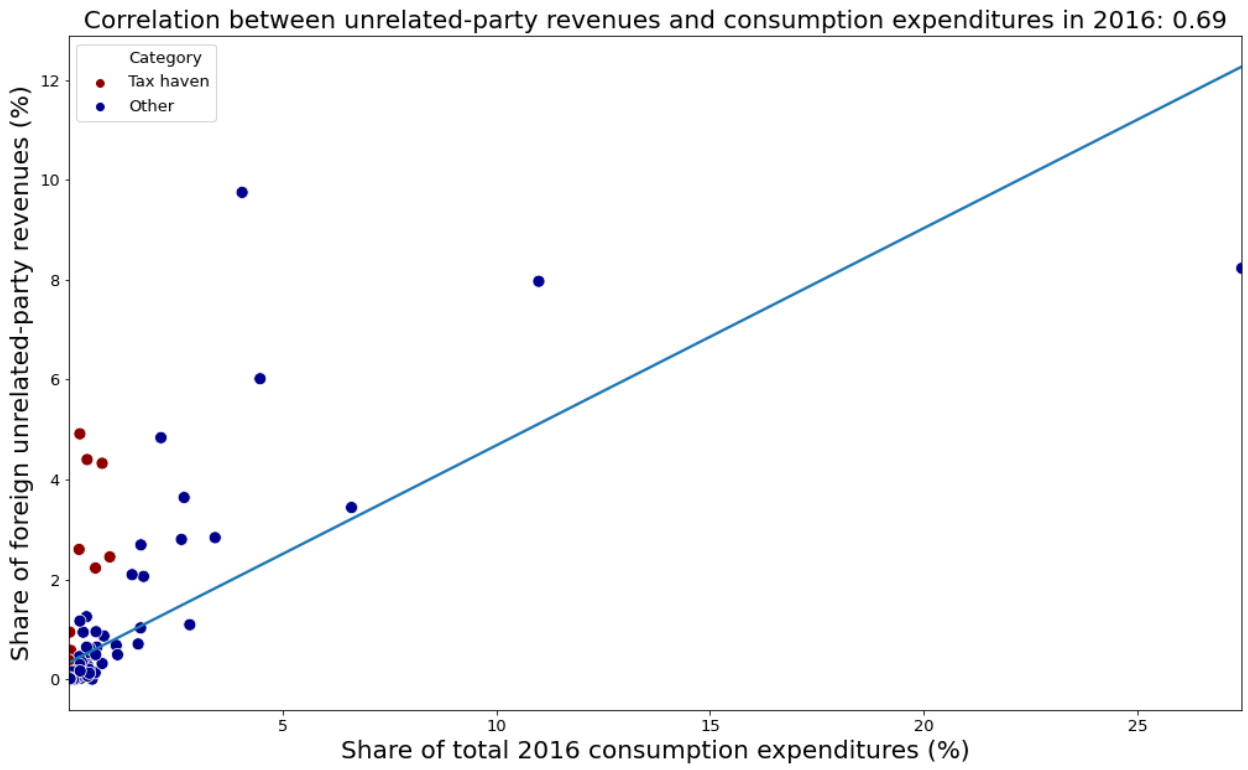
**Extension to other headquarter countries**

Table 3.18: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals [2016]

| Partner country | Share of foreign UPR (%) | Share of cons. exp. (%) |
|---|---|---|
| United Kingdom | 9.7 | 4.1 |
| United States | 8.2 | 27.4 |
| China | 8.0 | 11.0 |
| Germany | 6.0 | 4.5 |
| Singapore | 4.9 | 0.3 |
| Canada | 4.8 | 2.2 |
| Hong Kong | 4.4 | 0.4 |
| Switzerland | 4.3 | 0.8 |
| Brazil | 3.6 | 2.7 |
| Japan | 3.4 | 6.6 |
| France | 2.8 | 3.4 |
| Italy | 2.8 | 2.6 |
| Spain | 2.7 | 1.7 |
| Ireland | 2.6 | 0.2 |
| Netherlands | 2.4 | 1.0 |
| Belgium | 2.2 | 0.6 |
| Mexico | 2.1 | 1.5 |
| Australia | 2.1 | 1.8 |
| Colombia | 1.3 | 0.4 |
| Peru | 1.2 | 0.3 |

Note: This table presents the 20 main partner jurisdictions for the multinational companies headquartered in retained parent countries, based on the unrelated-party revenues booked by the latter. It displays each country's share of the total foreign unrelated-party revenues (i.e., excluding domestic observations) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 9.7% of multinational companies' unrelated-party revenues outside their headquarter countries and 4.1% of the total consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the IRS' country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Figure 3.19: Relationship between all partners' shares of foreign unrelated-party revenues and final consumption expenditures, including non-US multinationals [2016]



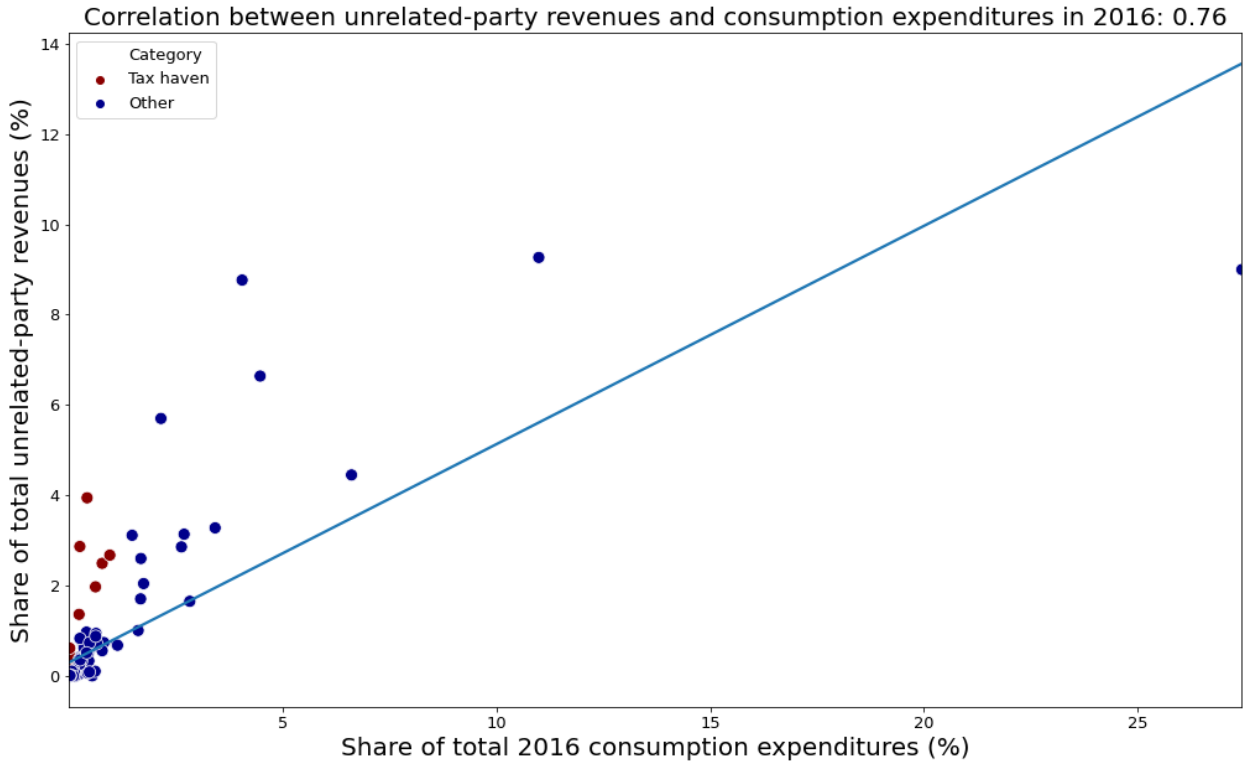

Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

Table 3.19: Post-adjustment relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals [2016]

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| China | 752.8 | 9.3 | 11.0 |
| United States | 731.0 | 9.0 | 27.4 |
| United Kingdom | 712.1 | 8.8 | 4.1 |
| Germany | 539.6 | 6.6 | 4.5 |
| Canada | 463.3 | 5.7 | 2.2 |
| Japan | 361.8 | 4.5 | 6.6 |
| Hong Kong | 320.6 | 3.9 | 0.4 |
| France | 266.6 | 3.3 | 3.4 |
| Brazil | 255.2 | 3.1 | 2.7 |
| Mexico | 253.2 | 3.1 | 1.5 |
| Singapore | 233.1 | 2.9 | 0.3 |
| Italy | 232.4 | 2.9 | 2.6 |
| Netherlands | 217.6 | 2.7 | 1.0 |
| Spain | 211.5 | 2.6 | 1.7 |
| Switzerland | 202.8 | 2.5 | 0.8 |
| Australia | 166.4 | 2.0 | 1.8 |
| Belgium | 160.6 | 2.0 | 0.6 |
| Korea | 138.9 | 1.7 | 1.7 |
| India | 134.6 | 1.7 | 2.8 |
| Ireland | 111.1 | 1.4 | 0.2 |

Note: This table presents the 20 main partner jurisdictions for multinational companies headquartered in the retained parent countries, based on the unrelated-party revenues booked by the latter. It displays each partner's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the domestic observations) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 8.8% of multinational companies' adjusted foreign unrelated-party revenues and 4.1% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Figure 3.20: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, including non-US multinationals [2016]




Note: This figure presents the relationship between partner jurisdictions' share of multinational companies' foreign unrelated-party revenues (i.e., excluding domestic observations) and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into two groups: tax havens as listed by Tørsløv, Wier, and Zucman (2018) and non-haven jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

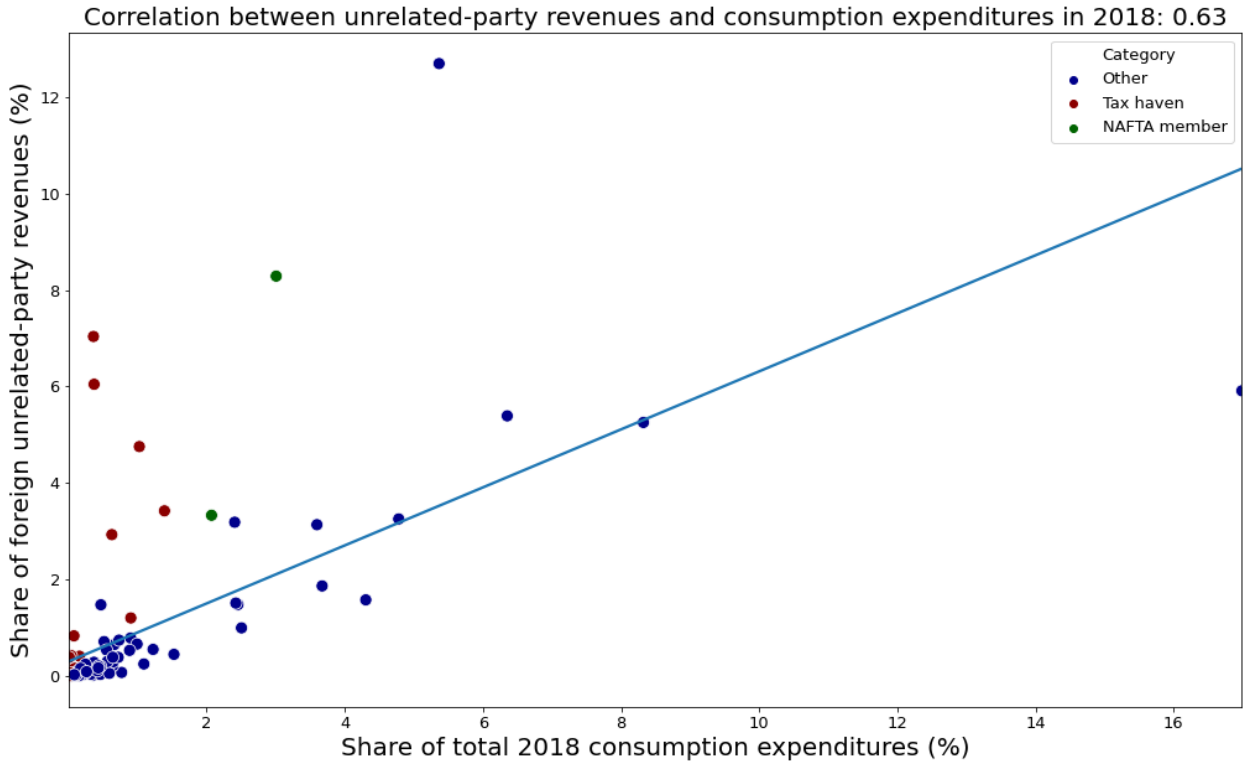
### 3.7.2 Results for 2018

Table 3.20: Top 20 largest partner jurisdictions [2018]

| Partner country | UPR (USD billion) | Share of foreign UPR (%) |
|---|---|---|
| United Kingdom | 556.6 | 12.7 |
| Canada | 363.4 | 8.3 |
| Ireland | 308.6 | 7.0 |
| Singapore | 265.1 | 6.0 |
| China | 259.2 | 5.9 |
| Germany | 236.4 | 5.4 |
| Japan | 230.4 | 5.2 |
| Switzerland | 208.5 | 4.7 |
| Netherlands | 150.0 | 3.4 |
| Mexico | 146.0 | 3.3 |
| France | 142.7 | 3.2 |
| Australia | 139.7 | 3.2 |
| Brazil | 137.5 | 3.1 |
| Hong Kong | 128.4 | 2.9 |
| Italy | 81.8 | 1.9 |
| India | 69.1 | 1.6 |
| Spain | 66.2 | 1.5 |
| Korea | 64.9 | 1.5 |
| UAE | 64.7 | 1.5 |
| Belgium | 52.7 | 1.2 |

Note: This table presents the 20 most important partner countries for US multinational companies. This ranking is based on the unrelated-party revenues booked by US multinational enterprises in each of these jurisdictions. Revenues are presented in absolute amounts (expressed in 2017 billion USD) and as a share of US multinational companies' total foreign unrelated-party revenues (expressed in percentage). All figures are based on the IRS' 2017 country-by-country data. "UPR" stands for unrelated-party revenues.

Figure 3.21: Relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2018]



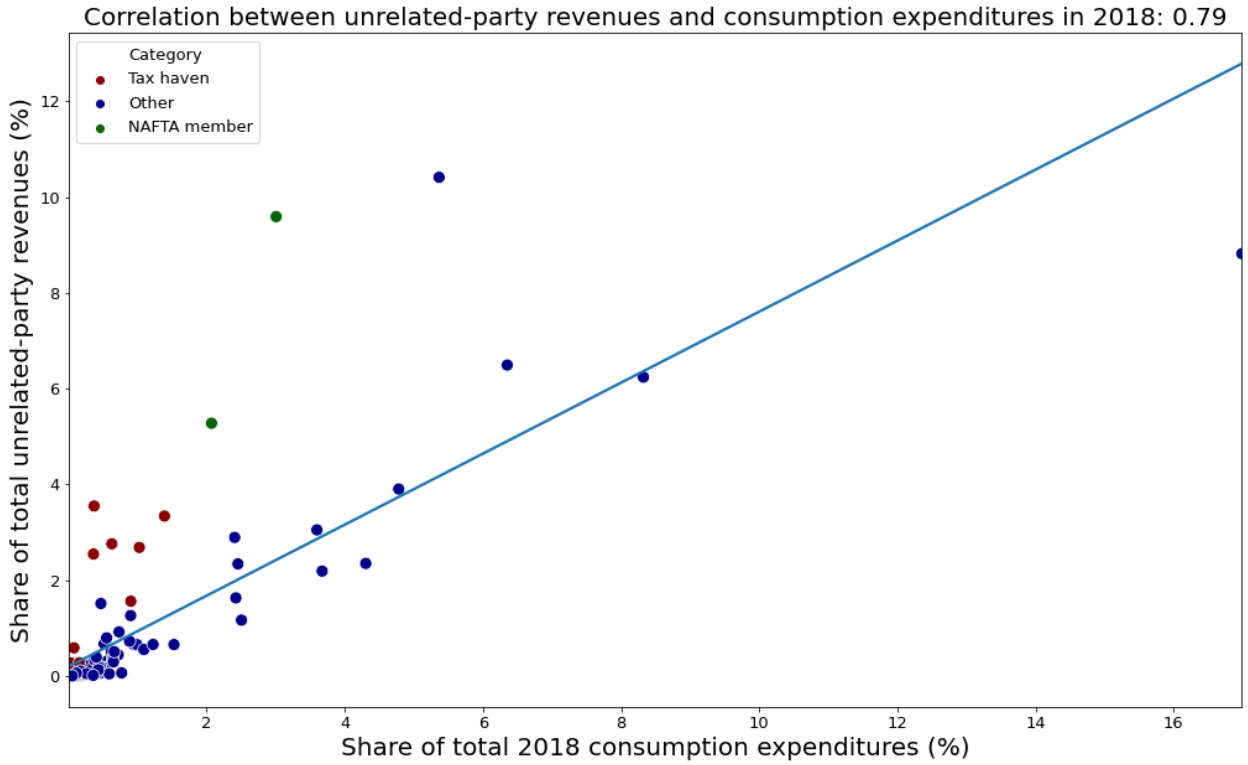

Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

Table 3.21: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, based on adjusted revenue variables [2018]

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| United Kingdom | 592.4 | 10.4 | 5.4 |
| Canada | 545.7 | 9.6 | 3.0 |
| China | 501.7 | 8.8 | 17.0 |
| Germany | 369.4 | 6.5 | 6.4 |
| Japan | 355.0 | 6.2 | 8.3 |
| Mexico | 300.3 | 5.3 | 2.1 |
| France | 222.1 | 3.9 | 4.8 |
| Singapore | 201.9 | 3.5 | 0.4 |
| Netherlands | 190.0 | 3.3 | 1.4 |
| Brazil | 173.6 | 3.1 | 3.6 |
| Australia | 164.6 | 2.9 | 2.4 |
| Hong Kong | 157.1 | 2.8 | 0.6 |
| Switzerland | 152.7 | 2.7 | 1.0 |
| Ireland | 144.9 | 2.5 | 0.4 |
| India | 133.7 | 2.4 | 4.3 |
| Korea | 133.2 | 2.3 | 2.5 |
| Italy | 124.6 | 2.2 | 3.7 |
| Spain | 92.8 | 1.6 | 2.4 |
| Belgium | 88.9 | 1.6 | 0.9 |
| UAE | 86.1 | 1.5 | 0.5 |

Note: This table presents the 20 main partner jurisdictions for the US multinational companies, based on the unrelated-party revenues booked by the latter. It displays each country's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the US-US observation) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 10.4% of US multinational companies' adjusted foreign unrelated-party revenues and 5.4% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Figure 3.22: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2018]




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

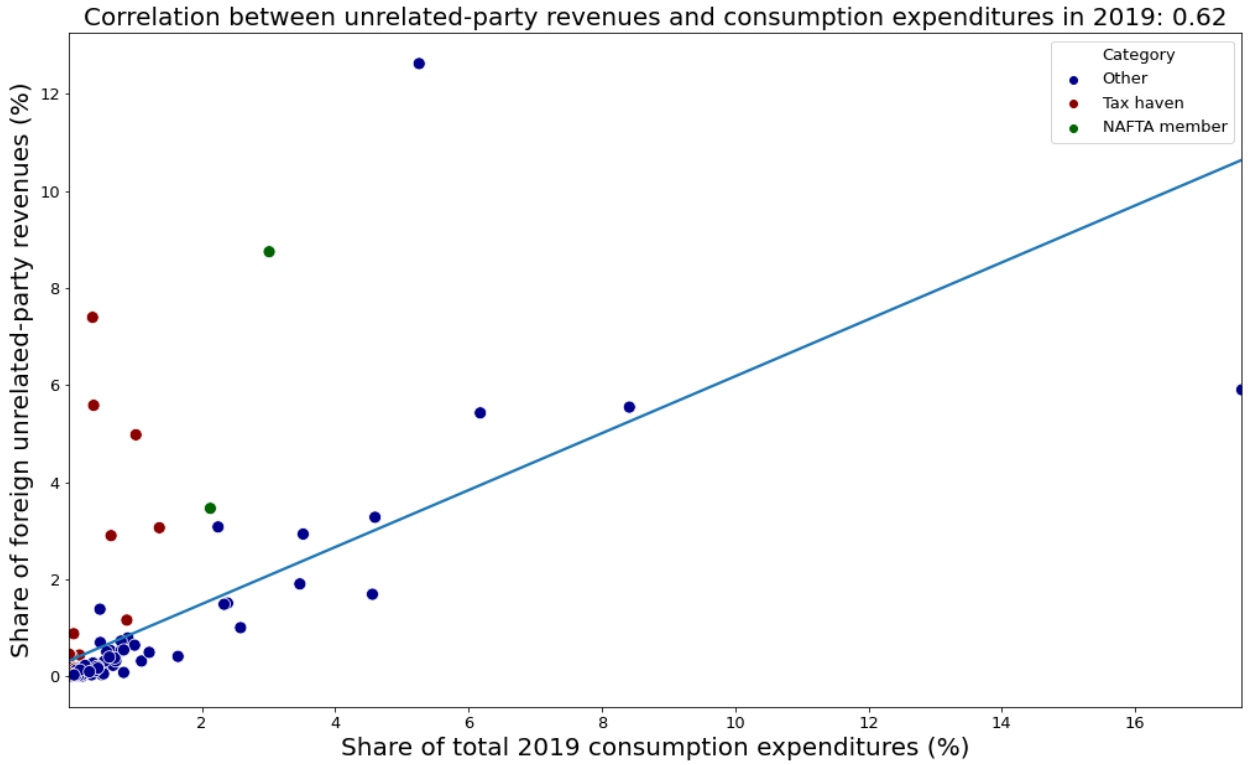
### 3.7.3 Results for 2019

Table 3.22: Top 20 largest partner jurisdictions [2019]

| Partner country | UPR (USD billion) | Share of foreign UPR (%) |
|---|---|---|
| United Kingdom | 549.5 | 12.6 |
| Canada | 380.8 | 8.7 |
| Ireland | 321.9 | 7.4 |
| China | 256.9 | 5.9 |
| Singapore | 243.0 | 5.6 |
| Japan | 241.3 | 5.5 |
| Germany | 236.2 | 5.4 |
| Switzerland | 216.6 | 5.0 |
| Mexico | 150.5 | 3.4 |
| France | 142.6 | 3.3 |
| Australia | 133.9 | 3.1 |
| Netherlands | 133.2 | 3.0 |
| Brazil | 127.5 | 2.9 |
| Hong Kong | 126.1 | 2.9 |
| Italy | 82.8 | 1.9 |
| India | 73.5 | 1.7 |
| Korea | 65.6 | 1.5 |
| Spain | 64.5 | 1.5 |
| UAE | 60.1 | 1.4 |
| Belgium | 50.3 | 1.2 |

Note: This table presents the 20 most important partner countries for US multinational companies. This ranking is based on the unrelated-party revenues booked by US multinational enterprises in each of these jurisdictions. Revenues are presented in absolute amounts (expressed in 2017 billion USD) and as a share of US multinational companies' total foreign unrelated-party revenues (expressed in percentage). All figures are based on the IRS' 2017 country-by-country data. "UPR" stands for unrelated-party revenues.

Figure 3.23: Relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2019]



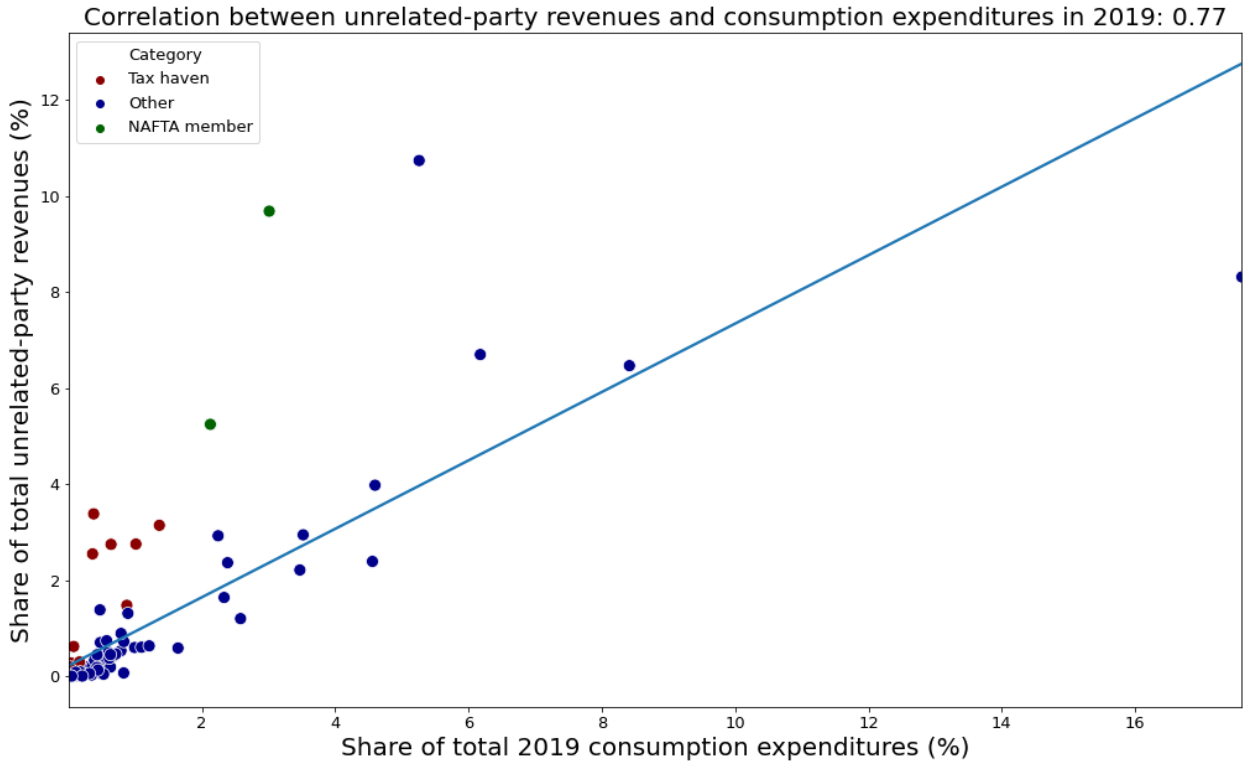

Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of the final consumption expenditures observed in the sample. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the IRS' country-by-country data; final consumption expenditures from the UNCTAD data portal.

Table 3.23: Relationship between the 20 largest partners' share of foreign unrelated-party revenues and their share of final consumption expenditures, based on adjusted revenue variables [2019]

| Partner country | UPR (USD billion) | Share of UPR (%) | Share of cons. exp. (%) |
|---|---|---|---|
| United Kingdom | 600.0 | 10.7 | 5.3 |
| Canada | 541.1 | 9.7 | 3.0 |
| China | 464.5 | 8.3 | 17.6 |
| Germany | 374.3 | 6.7 | 6.2 |
| Japan | 361.3 | 6.5 | 8.4 |
| Mexico | 293.1 | 5.2 | 2.1 |
| France | 222.2 | 4.0 | 4.6 |
| Singapore | 188.9 | 3.4 | 0.4 |
| Netherlands | 175.6 | 3.1 | 1.4 |
| Brazil | 164.5 | 2.9 | 3.5 |
| Australia | 163.4 | 2.9 | 2.2 |
| Switzerland | 153.7 | 2.8 | 1.0 |
| Hong Kong | 153.4 | 2.7 | 0.6 |
| Ireland | 142.3 | 2.5 | 0.4 |
| India | 133.5 | 2.4 | 4.6 |
| Korea | 132.0 | 2.4 | 2.4 |
| Italy | 123.5 | 2.2 | 3.5 |
| Spain | 91.6 | 1.6 | 2.3 |
| Belgium | 82.5 | 1.5 | 0.9 |
| UAE | 77.2 | 1.4 | 0.5 |

Note: This table presents the 20 main partner jurisdictions for the US multinational companies, based on the unrelated-party revenues booked by the latter. It displays each country's amount of unrelated-party revenues, its share of the total foreign unrelated-party revenues (i.e., excluding the US-US observation) and its share of the final consumption expenditures observed in the sample. For instance, the United Kingdom is found to account for 10.7% of US multinational companies' adjusted foreign unrelated-party revenues and 5.3% of the total final consumption expenditures of in-sample partner jurisdictions. Revenue shares are based on the adjusted country-by-country data; final consumption expenditures are sourced from the UNCTAD data portal. "UPR" stands for unrelated-party revenues.

Figure 3.24: Post-adjustment relationship between all partners' share of foreign unrelated-party revenues and their share of final consumption expenditures [2019]




Note: This figure presents the relationship between partner jurisdictions' share of US multinational companies' foreign unrelated-party revenues and their share of final consumption expenditures. The x-axis corresponds to consumption expenditures and the y-axis to revenues. Dots, that all stand for a given partner country, are distinguished into three groups: NAFTA members (Canada and Mexico), tax havens as listed by Tørsløv, Wier, and Zucman (2018) and other jurisdictions. The indicative trend line is obtained via the ordinary least-squares estimation of a model regressing the share of unrelated-party revenues over the share of consumption expenditures. Revenue shares come from the adjusted country-by-country data; final consumption expenditures from the UNCTAD data portal.

# Chapter 4

# References

## 4.1 Bibliography


Baraké, Mona, Theresa Neef, Paul-Emmanuel Chouc, and Gabriel Zucman. 2021a. *Collecting the Tax Deficit of Multinational Companies: Simulations for the European Union.* Research Report. EU Tax Observatory, July. https://halshs.archives-ouvertes.fr/halshs-03323095.

———. 2021b. *Revenue Effects of the Global Minimum Tax: Country-by-Country Estimates.* Publication parue dans Note n°2 EU Tax Observatory, October. https://www.taxobservatory.eu/publication/2938/.

Chaney, Thomas. 2005. "Liquidity Constrained Exporters." *Journal of Economic Dynamics and Control* (August). https://doi.org/10.1016/j.jedc.2016.03.010.

Clausing, Kimberly, Emmanuel Saez, and Gabriel Zucman. 2020. "Ending Corporate Tax Avoidance and Tax Competition: A Plan to Collect the Tax Deficit of Multinationals." *SSRN Electronic Journal* (January). https://doi.org/10.2139/ssrn.3655850.

Kadet, Jeffery, Alex Cobham, Tommaso Faccio, Javier Garcia-Bernardo, Petr Janský, and Sol Picciotto. 2021. "For a Better GLOBE: A Minimum Effective Tax Rate for Multinationals." *SSRN Electronic Journal* (January). https://doi.org/10.2139/ssrn.3798887.

Laffitte, Sebastien, and Farid Toubal. 2022. "Multinationals' Sales and Profit Shifting in Tax Havens." *American Economic Journal: Economic Policy,* https://www.aeaweb.org/articles?id=10.1257/pol.20200203.

Tørsløv, Thomas R, Ludvig S Wier, and Gabriel Zucman. 2018. "The Missing Profits of Nations," Working Paper Series, no. 24701 (June). https://doi.org/10.3386/w24701. http://www.nber.org/papers/w24701.


## 4.2 Data Sources


BEA. 2016-2019. *Table 1.5. U.S. International Trade in Goods and Services by Area and Country.* https://apps.bea.gov/iTable/iTable.cfm?reqid=62&step=6&isuri=1&tablelist=30164&product=1. International Transactions, International Services, and International Investment Position Tables.

Bureau of Economic Analysis. 2021. *U.S. International Economic Accounts: Concepts and Methods* [in eng]. BEA, July.

Cadestin, Charles, Koen De Backer, Isabelle Desnoyers-James, Sébastien Miroudot, Davide Rigo, and Ming Ye. 2018. "Multinational enterprises and global value chains: the OECD analytical AMNE database," no. 211, https://doi.org/https://doi.org/https://doi.org/10.1787/d9de288d-en. https://www.oecd-ilibrary.org/content/paper/d9de288d-en.

Fortanier, Fabienne, and Katia Sarrazin. 2016. *Balanced International Merchandise Trade Data: Version 1.* Working Party on International Trade in Goods and Trade in Services Statistics. Link: https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=STD/CSSP/WPTGS%282016)18&docLanguage=En. OECD, March.

International Monetary Fund. 2010. *Balance of Payments Manual, Sixth Edition.* Manuals & Guides. DOI: https://doi.org/10.5089/9781589068124.069. International Monetary Fund, January.

Liberatore, Antonella, and Steen Wettstein. 2021. "The OECD-WTO Balanced Trade in Services Database (BPM6 edition)" (January).

OECD. 2016. *The Analytical AMNE database - Multinational enterprises and global value chains.* https://www.oecd.org/sti/ind/analytical-amne-database.htm.

———. 2016-2019. *Balanced International Merchandise Trade dataset (BIMTS).* https://stats.oecd.org/Index.aspx?DataSetCode=BIMTS_HS2017.

OECD-WTO. 2016-2019. *Balanced Trade in Services dataset (BaTIS).* https://stats.oecd.org/Index.aspx?DataSetCode=BATIS_EBOPS2010.

UNCTAD. 2016-2019. *Gross Domestic Product (GDP) - Final consumption expenditure.* https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx.

United Nations. 2011. *International merchandise trade statistics : concepts and definitions 2010* [in eng]. Statistical papers. Series M ; no. 52, rev. 3. New York: United Nations. ISBN: 9789211615418.

———. 2016-2019. *United Nations Comtrade Database - International Trade Statistics Database.* https://comtrade.un.org/data/.