Global Effects of Local Subsidies*

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Abstract

How is the rest of the world affected when a country subsidizes some of its firms? A classic result is that the terms of trade of a country's trading partners improve when exported products are subsidized relative to domestic products. We show that there is an additional effect when subsidies vary across firms. Dispersion in subsidies among exported products worsens the terms of trade of the rest of the world whereas dispersion in subsidies among domestic products have the opposite effect. Finally, subsidies also affect the composition of trade via their differential effect across industries. The effect of subsidies on the terms of trade and on the composition of trade can be measured with firm-level data on revenues, inputs, and export shares, which we illustrate with Chinese firm-level data between 2007 and 2019. We find that China's subsidies lowered the terms of trade in the rest of the world by 1.6% in 2019, mostly due to their dispersion within exported products, whereas the gap in subsidies between exported and domestic products is negligible. We also find that subsidies had little effect on the composition of trade in 2007 but had a larger effect in 2019.

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1. Introduction

What are the effects of domestic subsidies on the country's trading partners? This is a central question in the ongoing debate about industrial policy. How is the rest of the world affected when China subsidizes Huawei, Shanghai Semiconductor, and BYD, or when the US subsidizes Intel and Taiwan Semiconductor? The same question can be asked of any domestic policy that effectively subsidizes some firms relative to others. Some examples are size-dependent labor laws in India and France or support for state-owned firms in many countries.

A well-known result, going back to Dixit and Norman (1985), is that export subsidies improve the terms of trade of the country's trading partners whereas subsidies on domestic products have the opposite effect. In this paper, we provide a modern treatment of this result in a multi-industry model of heterogeneous firms facing firm-specific subsidies.[1] Using this framework, we show that the standard terms of trade externality from subsidies can be measured from data on firm-level revenues, inputs, and export shares.

In addition to the effect of subsidies on exported vs. domestic products, the model features an additional channel via which a country's subsidies affect the terms of trade. Subsidies also affect the terms of trade via the *dispersion* of subsidies across products, where the distinction is between dispersion within exported products vs. dispersion within domestic products. When subsidies differ between exported products, the resulting misallocation of resources lowers real income in the rest of the world. In effect, the country "exports misallocation." In contrast, when subsidies differ primarily between domestic products, the only effect is to lower the subsidizing country's relative wage, which improves the terms of trade of the rest of the world.

Lastly, since our model features multiple industries, subsidies also affect the composition of trade, and by extension, the distribution of profits in the rest of the world. Here, the effect depends on the incidence of subsidies across

[1] Hereafter, when we refer to subsidies, we mean subsidies and taxes.

industries rather than their incidence on exported vs. domestic products. Firms in a given sector in the rest of the world are hurt when the country subsidizes firms in the same sector by more than in other sectors, or when dispersion in the sector is lower than in other sectors. When domestic policy affects the average subsidy and within-sector dispersion in all sectors equally, then domestic policy only affects the terms of trade and has no effect on the composition of trade or the distribution of profits.

In sum, the effect of a country's subsidies on the terms of trade of its trading partners is summarized their effect on exported vs. domestic products, whereas their effect on the composition of trade depends on the incidence of the subsidies across sectors. We show that the summary statistics that determine these two effects can be measured from estimates of firm-specific subsidies and export shares, where we impute firm-specific subsidies from the ratio of firm revenues to inputs.

We illustrate this procedure with Chinese firm level data from 2007 to 2019. We find that Chinese subsidies worsened the terms of trade in the rest of the world by 1.6% in 2019. Almost none of this effect is due to the classic mechanism of subsidies on exports vs. domestic products. Instead, the main channel via which Chinese subsidies adversely affect the rest of the world is via the dispersion of subsidies within exported products. We also find little evidence that subsidies affected the composition of trade in 2007. However, the differential impact of subsidies across industries grew between 2007 and 2019 so that by 2019, subsidies account for a larger share of the composition of trade.

This paper builds on three bodies of work. First, the mechanism via which a country's subsidies affect the rest of the world is a standard terms of trade externality as examined by Bagwell and Staiger (2001). Our contribution relative to this literature is to show how the terms of trade externality due to subsidies can be measured empirically from firm-level data. We also consider all forms of subsidies, and not just subsidies on exported products vs. domestic products.[2]

[2]We do not consider import tariffs, although Bagwell and Staiger (2006) show that a subsidy

We also build on the work that carefully measures specific subsidies. For example, Barwick et al. (2025) and Goldberg et al. (2024) measure subsidies to shipbuilding in China and semiconductors (around the world), respectively. Industrial policy are among the policies we have in mind, but are only a subset of policies that subsidize some firms relative to others. Moreover, this work does not attempt to assess the effect of industrial policy on the country's trading partners.

Finally, we build on the large body of work on resource misallocation. Most relevant to our paper is Bai et al. (2024) who analyze the effect of resource misallocation in an open-economy model. However, Bai et al. (2024) does not address our question, which is the effect of resource misallocation on the rest of the world.

The paper proceeds as follows: Section 2 presents the theoretical framework. Section 3 describes data and presents estimates of the effect of Chinese subsidies. Section 4 shows the effect of subsidizing specific groups of firms. Section 5 concludes.

2. Effect of Foreign Subsidies

In this section, we examine the effect of subsidies in the foreign country on the real wage in the home country and on bilateral trade at the sectoral level.

There are two countries, home and foreign. Utility of the representative consumer in the home country $U^{\prime}$ and foreign country U are given by:

$$U^{\prime} = \prod_i C_i^{\prime\,\alpha_i} \quad \text{and} \quad U = \prod_i C_i^{\alpha_i}$$

where $C_i^{\prime}$ and C_i are CES aggregates of varieties of product i produced in the two

on domestic products (which we do consider) is isomorphic to an import tariff.

countries:[3]

$$C_i^{\prime} = \left(\sum_{j \in I_i^{d\,\prime}} C_{ij}^{\prime\, \frac{\sigma-1}{\sigma}} + \sum_{j \in I_i^x} C_{ij}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \text{and} \quad C_i = \left(\sum_{j \in I_i^d} C_{ij}^{\frac{\sigma-1}{\sigma}} + \sum_{j \in I_i^{x\,\prime}} C_{ij}^{\prime\, \frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

Here $I_i^{d\prime}$ and $I_i^{x\prime}$ denote varieties of product i made by the home country sold in the domestic and export market, respectively. Likewise, I_i^d and I_i^x denote varieties made in the foreign country sold in the domestic and in the export markets.

The production function of each variety is the product of firm TFP A_{ij} and labor. Producers in the foreign country face a firm-specific subsidy on their sales where $\tau_{ij} > 1$ denotes a tax and $\tau_{ij} < 1$ denotes a subsidy, where net tax revenues are zero. We assume no subsidies in the home country and no trade costs. The profit-maximizing price of variety j of product i is $\frac{\sigma}{\sigma-1}\frac{\tau_{ij}}{A_{ij}}$ for a variety produced by the foreign country and $\frac{\sigma}{\sigma-1}\frac{w^{\prime}}{A_{ij}^{\prime}}$ for the variety produced in the home country, where $w^{\prime}$ is the wage in the home country.[4]

Holding constant firm TFP in both countries, the change in the home country's real wage is:

$$d\log\frac{w^{\prime}}{P^{\prime}} = \sum_i \alpha_i (1 - s_i^{\prime})\, d\log\left(\frac{w^{\prime}\,\gamma_i^x}{\tau_i^x}\right)$$

The key drivers of the home country's real wage are the home country's relative wage $w^{\prime}$ (we normalize the foreign wage to 1), the average tax on exported varieties τ_i^x, and an index of dispersion in τ_{ij} within the foreign country's exported

[3]The Cobb-Douglas shares α_i sum to 1

[4]We normalize the foreign wage to one.

varieties defined as:[5]

$$\frac{1}{\tau_i^x} \equiv \left(\sum_{j \in I_i^x} \left(\frac{A_{ij}}{A_i^x} \right)^{\sigma-1} \tau_{ij}^{-\sigma} \right)^{\frac{1}{\sigma}} \quad \text{and} \quad \gamma_i^x \equiv \left(\sum_{j \in I_i^x} \left(\frac{A_{ij}}{A_i^x} \frac{\tau_i^x}{\tau_{ij}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

Note that $\gamma_i^x = 1$ when τ_{ij} are the same for all exported varieties. The elasticity of the home real wage to these endogenous variables are the product of the Cobb-Douglas shares of each industry α_i and the import share in each sector $1 - s_i^{\prime}$.[6]

In turn, we solve for the change in the relative wage by imposing balanced trade:

$$d \log w^{\prime} = \kappa \sum_i \alpha_i \left[\frac{1 - s_i^{\prime}}{m^{\prime}} s_i^{\prime} \, d \log \left(\tau_i^x / \gamma_i^x \right) + \frac{1 - s_i}{m} s_i \, d \log \left(\tau_i^d / \gamma_i^d \right) \right]$$

The key forcing variables are the change in the average tax on exported varieties and domestic varieties, τ_i^x and τ_i^d, and misallocation between exported varieties and domestic varieties, γ_i^x and γ_i^d, where the average tax and misallocation among domestic varieties are defined analogously to the average tax and misallocation on exported varieties:[7]

$$\frac{1}{\tau_i^d} \equiv \left(\sum_{j \in I_i^d} \left(\frac{A_{ij}}{A_i^d} \right)^{\sigma-1} \tau_{ij}^{-\sigma} \right)^{\frac{1}{\sigma}} \text{and} \quad \gamma_i^d \equiv \left(\sum_{i \in I_i^d} \left(\frac{A_{ij}}{A_i^d} \frac{\tau_i^d}{\tau_{ij}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

As with the misallocation index for exported varieties, $\gamma_i^d = 1$ when τ_{ij} are the same for all domestic varieties in the foreign country. The elasticity of the relative wage to these forcing variables are also functions of the Sato-Vartia expenditure shares of local varieties s_i and $s_i^{\prime}$.[8]

[5] The weights in τ^x and γ^x are firm TFP A_{ij} relative to aggregate TFP of exported products $A_i^x \equiv \left(\sum_{j \in I_i^x} A_{ij}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$.

[6] To be precise $s_i^{\prime}$ is the Sato-Vartia expenditure share of local varieties in sector i in the home country

[7] $A_i^d \equiv \left(\sum_{j \in I_i^d} A_{ij}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$.

[8] $m \equiv \sum_i \alpha_i (1 - s_i)$ and $m^{\prime} \equiv \sum_i \alpha_i (1 - s_i^{\prime})$ are the aggregate share of imports in the foreign

The change in the home real wage is then:

$$\begin{aligned} d\log\frac{w^{\prime}}{P^{\prime}} \approx & -\sum_{i}\alpha_{i}(1-s_{i}^{\prime})(1-\kappa\, s_{i}^{\prime})\, d\log\left(\tau_{i}^{x}/\gamma_{i}^{x}\right) \\ & +\frac{m^{\prime}\kappa}{m}\sum_{i}\alpha_{i}\, s_{i}\,(1-s_{i})\, d\log\left(\tau_{i}^{d}/\gamma_{i}^{d}\right) \end{aligned} \tag{1}$$

This equation delivers two messages. First, as is well known, export subsidies in the foreign country (τ_i^x falls) benefit the home country, and subsidies to domestic products (τ_i^d falls) hurt the home country. Second, holding constant the average export subsidy, subsidies that affect exported products differentially also affect the home country's real wage. More misallocation within exported products (γ_i^x falls) lowers the home country's real wage. Similarly, misallocation within domestic varieties also affect the home country, with an opposite sign: more misallocation within domestic varieties (γ_i^d falls) raise the home country's real wage.

The upshot is that it is not enough to measure average subsidies on exported vs. domestic varieties. It is also important to measure the dispersion in subsidies within the two types of varieties. In the next section, we will calculate the average and the dispersion of the subsidy for exported vs. domestic varieties to quantify the effect of effect of subsidies in China on the real wage in the rest of the world.

We end by showing the effect of subsidies on trade imbalances at the product level. Foreign exports of a product, X_i, relative to the home country's exports of the same product, $X_i^{\prime}$, is:

$$\frac{X_{i}}{X_{i}^{\prime}}=\left(\frac{A_{i}^{x}\,\gamma_{i}^{x}\,w^{\prime}P_{i}^{\prime}}{A_{i}^{x\,\prime}\,\tau_{i}^{x}\,P_{i}}\right)^{\sigma-1}\frac{w^{\prime}L^{\prime}}{L}$$

Holding constant firm TFP and the overall tax rate, the change in the product-level trade imbalance is:

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country and at home and $\kappa\equiv\left[\frac{1}{\sigma-1}+\sum_{k}\alpha_{k}\left(\frac{1-s_{k}^{\prime}}{m^{\prime}}s_{k}^{\prime}+\frac{1-s_{k}}{m}s_{k}\right)\right]^{-1}$

$$
\begin{aligned}
d\log\left(\frac{X_i}{X_i^{\prime}}\right)^{\frac{1}{\sigma-1}} = & -s_i^{\prime}\, d\log\left(\tau_i^x/\gamma_i^x\right) \;+\; z_i \sum_k \alpha_k \,\frac{1-s_k^{\prime}}{m^{\prime}} s_k^{\prime} d\log\left(\tau_k^x/\gamma_k^x\right) \\
& -\; s_i\, d\log\left(\tau_i^d/\gamma_i^d\right) \;+\; z_i \sum_k \alpha_k \,\frac{1-s_k}{m} s_k\, d\log\left(\tau_k^d/\gamma_k^d\right)
\end{aligned}
\tag{2}
$$

where $z_i \equiv \frac{1+(\sigma-1)(s_i+s_i^{\prime})}{1+(\sigma-1)\sum_k \alpha_k\left(\frac{1-s_k^{\prime}}{m^{\prime}} s_k^{\prime}+\frac{1-s_k}{m} s_k\right)}$.

We take four messages from this result.

First, the effect of product specific subsidies on the product level trade imbalance depends on the product specific subsidy *relative* to subsidies on *all* products. If subsidies and misallocation among exported products are the same for all products, then the first term in (2) is zero. Likewise, when the average subsidy or the extent of misallocation between domestic varieties is the same for all products, the second term in (2) is zero.

Second, subsidies that only affect domestic products can distort trade flows in the same way that subsidies on exported products do. This effect is given by the second term in (2).

Third, product level trade imbalances can also be driven by *dispersion* in subsidies. This effect is captured by γ_i^x and γ_i^d. Here, more misallocation in a product (relative to all product) lowers the country's bilateral product level surplus.

Fourth, whether the foreign country exports too much or too little for a given product does not necessarily indicate whether the home country gains or loses from the distortion to trade flows. For example, when the foreign country's trade surplus in a product is excessively large because of export subsidies, the real wage in the home country rises. In contrast, when the foreign country subsidizes domestic sales of a product, its trade surplus in the product is also "too large." However, in this case the home country real wage falls.

In the next section, we will also use equation (2) to measure the effect of

subsidies on trade imbalances at the product level.

3. Quantifying Global Effect of Local Subsidies

In the previous section, we showed that the aggregate and distributional effects of a country's subsidies on the rest of the world is captured by four summary statistics: the average tax on exported products τ^x, average tax on domestic products τ^d, the misallocation index within exported products γ^x, and the misallocation index within domestic products γ^d. In this section we show how to measure these statistics from firm level data. We then illustrate the procedure with Chinese firm level data from 2007 to 2019.

The main empirical challenge is to measure τ at the product level. There are two challenges. First, we need to measure τ. One option is to directly measure specific subsidies, but it is nearly impossible to directly measure all relevant subsidies. A second option is to impute the effective subsidy rate from a firm's profit maximization conditions. Specifically, if the firm production function is linear in firm TFP and labor, revenue per worker $\frac{P_{ij}Y_{ij}}{L_{ij}}$ is equal to $\frac{\sigma-1}{\sigma}\frac{1}{\tau_{ij}}$.[9] If the production function is linear in labor and capital, profit maximization implies that the ratio of revenues to inputs $\frac{P_{ij}Y_{ij}}{K_{ij}^{\theta_i}L_{ij}^{1-\theta_i}}$ is equal to $\frac{\sigma-1}{\sigma}\frac{r^{\theta_i}}{\tau_{ij}}$.

The advantage of τ imputed from data on firm revenues and inputs is that it captures the net effect of *all* subsidies. Furthermore, we only need data on firm revenues and inputs (and the share of capital θ_i); we do not need to directly measure all relevant subsidies. The disadvantage is that what we impute as τ could be something else, such as adjustment costs or heterogeneity in markups.

A second issue is that even when we have a measure of τ, our unit of observation is a *firm*, whereas we need τ at the *product* level. For firms that only sell in the domestic market, we assume that the τ we impute for the firm applies to all their products. For firms that export, we need data on their exports vs. their sales in the domestic markets to impute the τ on exported and domestic

[9] Remember we normalize the foreign wage to 1.

products.

We now implement this method using Chinese firm level data. We use micro-data from China's National Bureau of Statistics Annual Industrial Survey between 2007 and 2013 and the National Tax Office's firm survey between 2007 and 2019. The NBS data is a census of industrial firms with revenues exceeding 5 million RMB and all state-owned firms. The tax data is a survey of all firms (including firms outside of manufacturing). We restrict the sample of the tax data to firms in the industrial sector. We further impute sampling weights in the tax data to match the size distribution and the aggregates of the NBS data in 2013. In both datasets, the variables we use are firm value-added, employment, capital, sector, and the share of exports in total sales.

Table 1 show summary statistics of the data. For the sake of brevity, we only show the data for 2007, 2013, and 2019, where the 2007 data is from the NBS and the 2013 and 2019 data are from the Tax Survey. The first row shows the gap in the average subsidy $(1/\tau)$ between exporting and non-exporting firms. The data shows that, on average, exporting firms were *taxed* relative to non-exporters in 2007 and 2013. This changed by 2019, when exporting firms were subsidized (by 36%) relative to non-exporting firms.

Recall that the effect of subsidies on exporting firms (relative to non-exporting firms) on the average subsidy of exported *products* relative to that of non-exported products depends critically on the share of sales of exporting firms that are exported vs. sold in the domestic market. The second row in Table 1 shows this number. It shows that the share of export markets in total sales of exporting firms fell from 21% to only 9% between 2007 and 2019.

The next two rows show the gap in average subsidies and export shares for state vs. non-state firms. State firms were massively subsidized relative to non-state firms in 2007 (on the order of 37%). However, by 2019, the average subsidy of state owned firms declined to only 4% compared to that of non-state firms. The last row shows that, on average, state firms export less compared to non-state firms. This implies that any subsidy favoring state firms will tend to in-

Table 1: Data Moments

	2007	2013	2019
Exporters vs. Non-exporters			
Subsidy gap (%)	-9	-10	36
Export share gap (%)	21	12	9
State vs. Non-State			
Subsidy gap (%)	37	7	4
Export share gap (%)	-28	-12	-8

crease the subsidy of domestic products relative to that of exported products. However, by 2019, the gap in exporting behavior of state owned relative to non-state firms had also diminished.

Table 2 shows the average subsidy for exported vs. domestic products implied by the moments for exporting vs. non-exporting firms in Table 1. The first two rows show the average subsidy for exported products (row 1) and domestic products (row 2) (we assume the revenue-weighted average of taxes and subsidies across all products is zero). In 2007, our estimates indicate that the average exported product was taxed (by 7%) whereas the average domestic product was subsidized (at 2%). By 2019, this had been reversed: the average exported product was subsidized (by 34%) whereas the average domestic product was taxed (by 1%).

Recall that subsidies effect the rest of the world not only through their effect on average subsidies on exported vs. domestic products, but also via their effect on the dispersion of subsidies. The last two rows in Table 2 shows the effect of Chinese subsidies on the dispersion of subsidies within exported products (row 3) and domestic products (row 4). Specifically the table shows γ^x and γ^d, where the index is decreasing in the dispersion in subsidies (the index is 1 when there is no dispersion). This evidence indicates that there is more dispersion in subsidies within exported products compared to domestic products.

Table 2: Inferred Moments: Exports vs. Domestic Products

	2007	2013	2019
Average subsidy (%)			
Exports	-8	-9	34
Domestic	2	1	-1
Subsidy dispersion index			
Within exports	0.70	0.61	0.69
Within domestic	0.65	0.50	0.59

Table 3 shows the effect of Chinese subsidies on real income in the rest of the world. We use the moments shown in Table 2 in the equation for the real wage in the rest of the world in equation (1). The elasticities of the moments in Table 2 on the real wage depends on the Sato-Vartia expenditure shares on imported products (in China and the rest of the world); we infer these shares the two-digit level from the World Input-Output tables.

Table 3: Aggregate Effect of Subsidies on ROW

	2007	2013	2019
% Change in Real Wage			
Total	-0.6	-2.8	-1.4
From $\tau^x \neq \tau^d$	-0.02	-0.2	0.4
From $\gamma^x \neq 1$	-1.1	-3.9	-3.4
From $\gamma^d \neq 1$	0.5	1.3	1.1

The first row in Table 3 shows that Chinese subsidies hurts the rest of the world. Chinese subsidies lowers the real wage in the rest of the world by 0.6% in 2007 and by 1.4% in 2019. The next rows shows the effect of individual components in equation 1. Row 2 shows the effect of the gap in average subsidies of exported vs. domestic products only. This shows that in 2007, the gap in average subsidies between exported vs. domestic products hurts the rest of

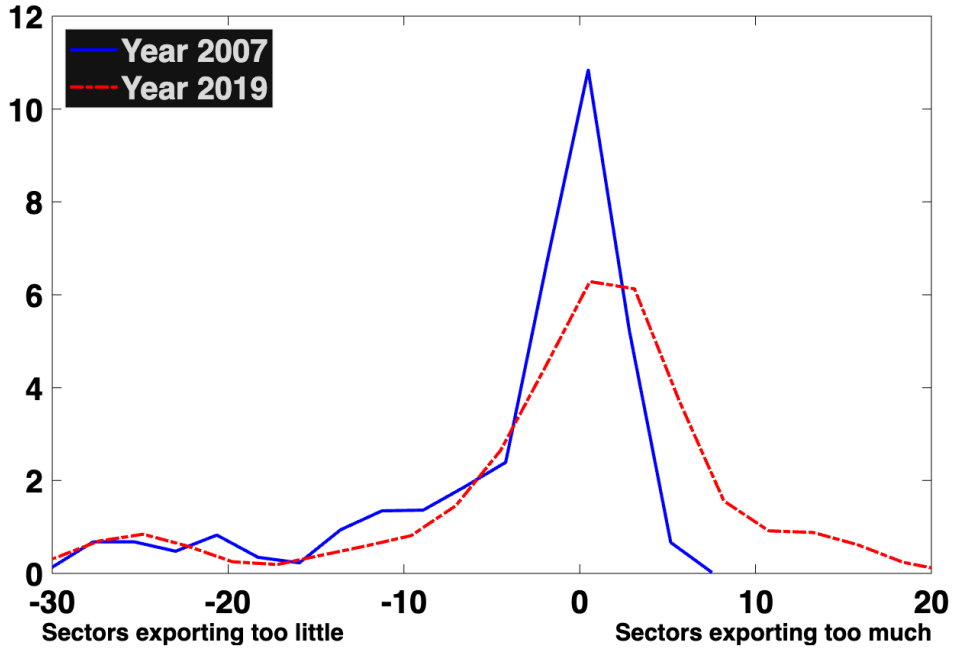
the world, albeit by very little (0.02%). By 2019, the gap in average subsidies between exported and domestic products swing in the other direction, which benefits the rest of the world. The table shows that this gap raises the real wage in the rest of the world by 0.4% in 2019.

The next two rows in Table 3 shows the effect of *dispersion* in subsidies within exported products (row 3) and domestic products (row 4). Remember that dispersion within exported products hurts China's trading partners, whereas dispersion within domestic benefits benefits them. This is exactly what Table 3 shows. Furthermore, in this case, the dispersion within exported products is larger than within domestic products, so the negative effect of subsidy dispersion within exported products exceeds the positive effect of dispersion within domestic products. The upshot then is that the main driver behind the negative effect of Chinese subsidies on the rest of the world is not the classic effect of subsidies on domestic vs. exported products, but rather the inequality within exported products in the effect of subsidies.

We now turn to the effect of subsidies on the composition of trade. What matters for the composition of trade is not the effect of subsidies on exported vs. domestic products but rather their differential effect across sectors. As shown in equation 2, higher subsidies in the sector (in exported and dometic products) relative to other sectors increase bilateral exports of the sector. And it is not just the average subsidy in the sector but also the dispersion in subsidies within products in the sector, where more dispersion in the sector relative to other sectors *lower* the trade balance of China in the sector.

Figure 1 shows the effect of these two forces on the composition of exports using equation 2. Specifically it shows the distribution of the gap between the actual bilateral trade surplus (as a percent of total bilateral trade in the sector) and the hypothetical trade surplus in a sector when subsidies are completely eliminated. The observations to the right are industries where subsidies result in China exporting "too much," whereas the observations to the left are those where China exports "too little." It is evident that the effect of subsidies is more

Figure 1: Gap between Exports and Counterfactual Exports



unequal across sectors in 2019 compared to 2007. This suggests that the effect of subsidies on sectoral trade imbalances is larger in 2019 compared to the earlier period.

Figures 2 compares the actual trade surplus (on the y-axis) in 2007 with our estimate of the trade surplus due to subsidies (on the x-axis) in the same year. Each circle represents a two-digit industry. All observations above the horizontal dashed line represents industries with a trade surplus. Likewise all industries to the right of the vertical dashed line represents those where our estimates indicate that subsidies increased the trade surplus in the sector.

What stands out in Figure 2 is that the majority of industries with a bilateral trade surplus lie to the left of the vertical dashed line. This indicates that in the absence of subsidies, the sectoral trade surplus in these sectors would have been even higher. Put differently, subsidies lower the trade surplus in these sectors.

Figure 3 shows the relationship between the trade surplus and the effect

Figure 2: Sectoral Trade Surplus, 2007

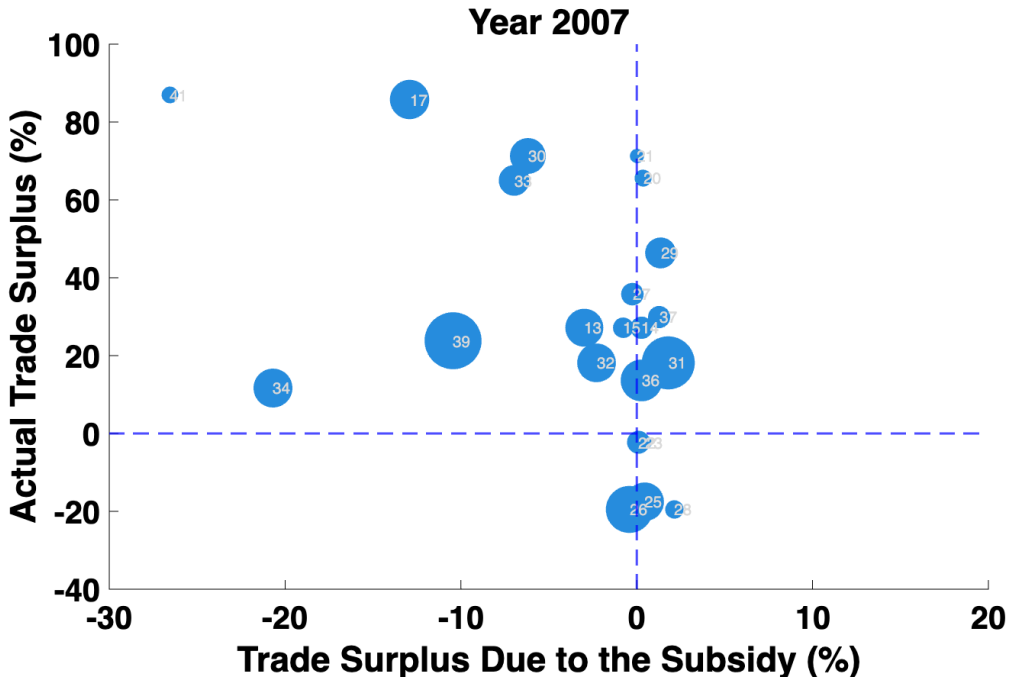
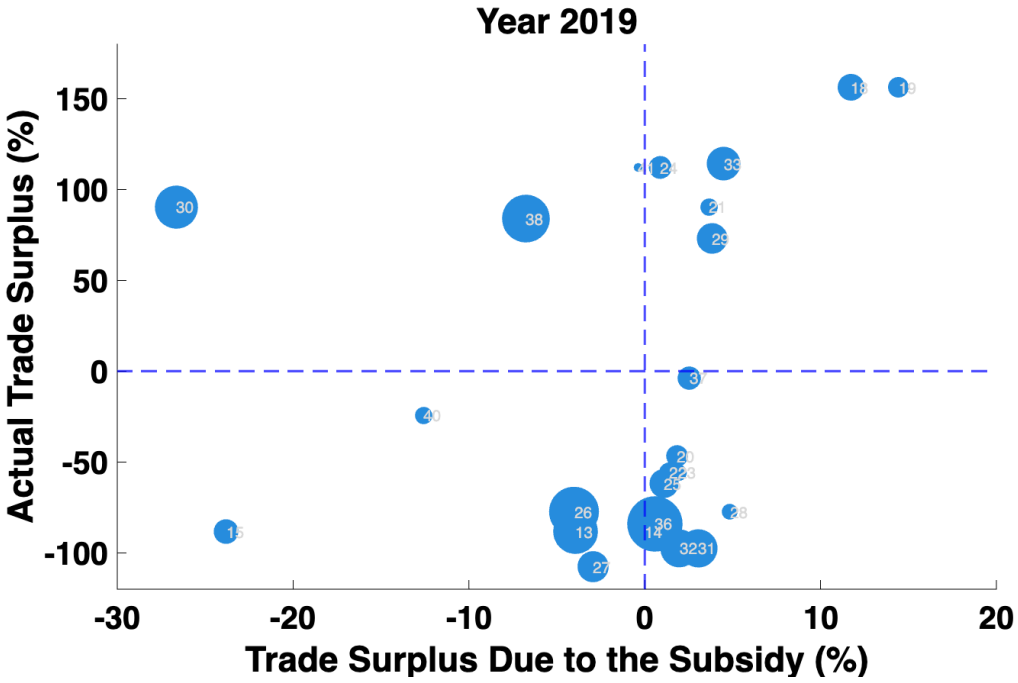


Figure 3: Sectoral Trade Surplus, 2019



of subsidies on the trade surplus in 2019. Compared to 2007, the northeast quadrant is more populated in 2019. Put differently, there are more industries in 2019 with bilateral surpluses and where a share of these surpluses were due to subsidies.

4. Effect of Specific Subsidies

In this previous section, we imputed subsidies on specific firms and estimated their effect on aggregate welfare and the composition of trade. We can also use the model to we examine the hypothetical effect of a specific subsidy. Specifically, suppose that a group of firms are subsidized, where $s \equiv d \log \frac{1}{\tau}$ denotes the subsidy. Holding constant subsidies on the other firms, the effect of the subsidy on the home country's real wage is:

$$s \sum_i \alpha_i \left((1 - s_i^{\prime})(1 - \kappa\, s_i^{\prime})\, \omega_i^x \; - \; \frac{m^{\prime} \kappa}{m}\, s_i\, (1 - s_i)\, \omega_i^d \right)$$

where ω_i^x is the share of the subsidized firms in total exports in product i, and ω_i^d is the share of the subsidized firms in total domestic sales in product i.

The sign of the effect of the subsidy on the home country's real wage is ambiguous, as it depends on the sales share of the subsidized firms in the export market ω_i^x relative to the share of the same firms in the domestic market ω_i^d. When the subsidized firms only sell in the domestic market ($\omega_i^x = 0$) then the subsidy unambiguously lowers the real wage of the home country. On the other hand, when the subsidized firms only sell in the export market ($\omega_i^d = 0$), then the subsidy unambiguously raises the real wage of the home country.

This effect is only partial, as taxes have to be raised on the other firms to pay the subsidy. Assuming that taxes rise uniformly for all non-subsidized firms, taxes rise by $s\,\beta$ where β denotes the ratio of the revenue share of subsidized firms to the revenue share of the non-subsidized firms. The effect of higher taxes on the home country's real wage is then given by:

$$- s\,\beta \sum_i \alpha_i \left((1 - s_i^{\prime})(1 - \kappa\, s_i^{\prime})\,(1 - \omega_i^x) \;-\; \frac{m^{\prime}\kappa}{m}\, s_i\,(1 - s_i)\,(1 - \omega_i^d) \right)$$

Note the effect of higher taxes paid by other firms is small if the share of the subsidized firms (in total revenues) is small (β is small).

Putting together these two effects, the net effect of the subsidy is:

$$\begin{aligned} d\log \frac{w^{\prime}}{P^{\prime}} \approx\; & s \sum_i \alpha_i (1 - s_i^{\prime})(1 - \kappa\, s_i^{\prime})\; (\omega_i^x (1 + \beta) - \beta) \\ & - s \sum_i \alpha_i \,\frac{m^{\prime}\kappa}{m}\, s_i\,(1 - s_i)\; \left(\omega_i^d (1 + \beta) - \beta\right) \end{aligned} \tag{3}$$

When there is only one product, the subsidy raises the home country's real wage when

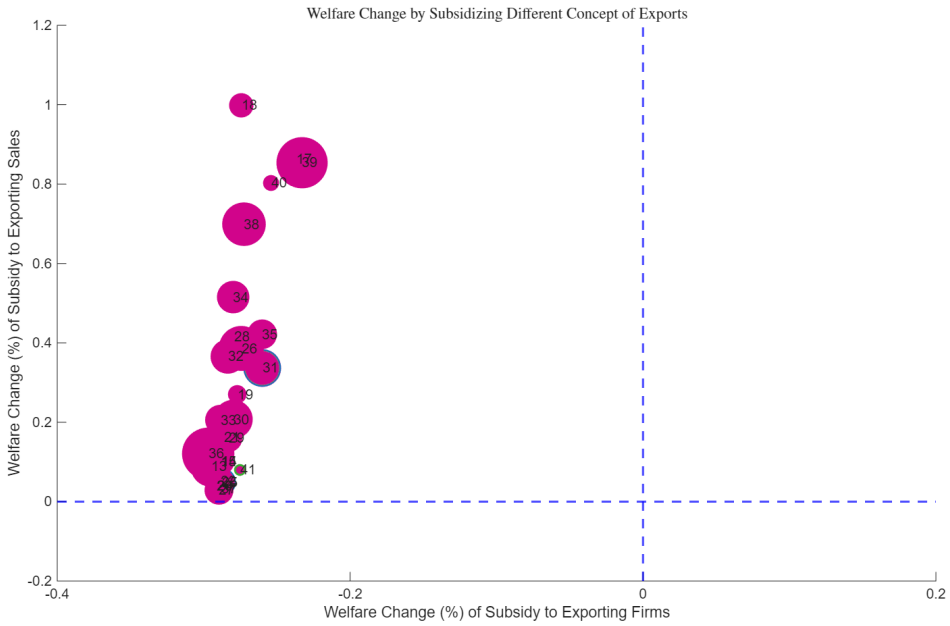
$$\frac{\omega^x (1 + \beta) - \beta}{\omega^d (1 + \beta) - \beta} > \frac{s}{(\sigma - 1)^{-1} + s}$$

More generally, the effect of the subsidy depends on the extent to which the subsidized firms are oriented towards exports or towards the domestic market. In the next section, we will use equation 3 to measure the effect of subsidies to specific groups of firms in China.

To illustrate this point, we contrast the effect of subsidizing only exported products vs. subsidizing exporting firms. Specifically, in each industry, we calculate the effect on the real wage in the rest of the world if we only subsidize exported products by 10%. We then calculate the effect of implementing the same subsidy but on all the products of exporting firms by 10%. The result is shown in Figure 4, which shows the effect on the real wage in the rest of the world when we subsidize only exports (y-axis) or all exporting firms (x-axis) in an industry in 2019.

As can be seen, subsidizing exports only raises the real wage in the rest of the world. This is not surprising, given the logic that subsidies on exported goods improves the terms of trade of the rest of the world. What is perhaps more surprising is that subsidizing exporting *firms* by the same amount *lowers* the

Figure 4: Subsidizing Exports: Products vs. Firms, China 2019



real wage in the rest of the world in every single industry in 2019. The reason is because by 2019, the export share of exporting firms is typically very low, averaging only 9% (see Table 1). The implication of the low export share in 2019 of exporting firms is that when we subsidize these firms, the subsidy on domestic products increases by more than the subsidy on exported products. The result then is a decline in the terms of trade in the rest of the world.

5. Conclusion

When a country subsidizes some firms and taxes other firms, what are the effects on the rest of the world? This paper tackles this question in the framework of a canonical model of heterogeneous firms facing firm-specific taxes or subsidies. We report two main results.

First, aggregate welfare in the rest of the world depends on the effect of subsidies on exported vs. domestic products. Aggregate welfare increases when

on average exported products are subsidized and when domestic products are taxed. Aggregate welfare also increases when subsidies are unequal among domestic products, and falls when subsidies differs among exported products.

Second, subsidies also affect the composition of trade, but via their differential effect across sectors instead of their effect on exported vs. domestic products. Here, more subsidies in a sector relative to other sectors increases the country's trade surplus in the sector. Likewise, less dispersion of subsidies within a sector relative to other sectors also increases the country's trade surplus in the sector.

These two forces can be measured with firm-level data on revenues, inputs, and export shares, which we implement with Chinese firm-level data from 2007-2019. We find that China's subsidies lowered welfare in the rest of the world by 1.6% in 2019, mostly due to dispersion in subsidies within exported products, whereas the gap in average subsidies between exported and domestic products is quantitatively unimportant. We also find that subsidies had little effect on the composition of trade in 2007 but had a larger effect in 2019.

Finally, we make note of several simplications that can be relaxed in future work. First are the simplications in the model. We do not model entry/exit, either into production or into exporting. This can obviously be relaxed. The model is also entirely static: we do not model the effect of subsidies on firm TFP, largely because we don't have any estimates of this relationship. We also assume constant markups – relaxing this assumption is an obvious next step.

Second is that we impute firm-specific subsidies from the firm's profit maximization conditions. This has the advantage of capturing the net effect of all subsidies and taxes, but likely captures other forces such as adjustment costs and differences in markups across firms. An alternative is to use direct measures of taxes and subsidies. The disadvantage is that this necessarily misses other policies that also affect the firm's effective subsidy rate. Nonetheless, this is something we will attempt in future work.

Appendix

A Calibration Details of the Model

- The home country is the rest of the world, and foreign country is China.
- We observe the market share $s_i^{\prime}$ and s_i in the home country and foreign country from the world input-output table.
- We get the relative industrial distortion by $\tau_i \propto \frac{P_i Y_i}{K_i^{\theta_i} L_i^{1-\theta_i}}$, where $P_i Y_i$ is the industrial valued-added, K_i is the industrial capital, L_i is the industrial employment, and θ_i is the capital share of the industrial Cobb-Douglas production function.
- By normalizing the average distortion in China to be 1, we can pin down the sectoral distortion: $\sum_i \frac{\alpha_i}{\tau_i} = 1$.
- In the foreign coutry, the relative firm-level τ_{ij} and A_{ij} are obtained following Hsieh and Klenow (2009)[10].
  - Assume the CES elasticity parameter $\sigma = 5$.
  - The misallocation parameters γ_i^d and γ_i^x can be measured directly from τ_{ij} and A_{ij}.
  - We can also measure the relative ratio of $\frac{\tau_i^d}{\tau_i^x}$ from τ_{ij} and A_{ij}.
  - Using the definition of the industrial subsidy τ_i to pin down τ_i^d and τ_i^x:

$$\frac{1}{\tau_i} = \frac{\sum_i \alpha_i (1 - s_i)}{\sum_i \alpha_i (1 - s_i^{\prime})} \frac{1 - s_i^{\prime}}{(\gamma_i^x)^{\sigma-1} \tau_i^x} + \frac{s_i}{(\gamma_i^d)^{\sigma-1} \tau_i^d}$$

  - Firm-level distortion τ_{ij} will be adjusted propotionally within each sector.

[10] τ_{ij} and A_{ij} are only comparable within the industry i following Hsieh and Klenow (2009).We need the following steps to make them comparable across industries.

- Then we can pin down the productivity.
  - We normalize the productivity of the home country's exporting productivity $A_i^{x/}$ to be 1 for all the industries.
  - We use the balanced trade equation to pin down the nominal wage:

$$\sum \alpha_i(1-s_i) = w^{/} \sum_i \alpha_i(1-s_i^{/})$$

  - We can use the following equations to determine the productivity of the domestic aggregate productivity of the foreign country A_i^d:

$$\frac{1-s_i}{s_i} = \left(\frac{A_i^{x/}/w^{/}}{A_i^d\gamma_i^d/\tau_i^d}\right)^{\sigma-1}$$

  - Using the definition of A_i^d, we can pin down the level of A_{ij} that is comparable across industires.

$$A_i^d \equiv \left(\sum_{j\in I_i^d} A_{ij}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}.$$

  - With the level of A_{ij} which is comparable across industires in hand, we can pin down A_i^x:

$$A_i^x \equiv \left(\sum_{j\in I_i^x} A_{ij}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}.$$

  - Finally, using the following equation, we can pin down the productivity of the domestic sector of the home country $A_i^{d/}$:

$$\frac{1-s_i^{/}}{s_i^{/}} = \left(\frac{A_i^x\gamma_i^x/\tau_i^x}{A_i^{d/}/w^{/}}\right)^{\sigma-1}.$$

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