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Pass-Through and Multinational Firms: Evidence from US Manufacturing Industries

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Abstract

In recent years, a greater portion of international trade is conducted by multinational firms. In this paper, I empirically analyze the relation between firms' multinational status and pricing behavior associating with foreign tax rate and exchange rate using data in US manufacturing industries. The results show that prices in industries with lower intrafirm share are more sensitive to foreign tax rate change. Also, this study concludes that industries with more intrafirm transaction show lower pass-through rate.

1. Introduction

In recent years, around 40% of all US international trade has occurred intrafirm.[1] Given this substantial existence of multinational firms in international trade, it is important to analyze how firms' organizational heterogeneity affects pass-through. The goal of this paper is examining firms' pricing behavior and discussing how it can be explained by the existence of multinational firms and other factors.

According to Engel (2003), firms' pricing leads to incomplete pass-through due to such factors that local nontraded costs, markup adjustment, and price adjusting costs.[2] If we take into account

[1] See introductions for Clausing (2003) and Neiman (2010), for example.

[2] There are several papers that explain incomplete pass-through using local cost although I do not refer them in the main part of this paper since they do not directly relate to what I do in my empirical research. Corsetti and Dedola (2005) theoretically explains that local cost in final good price results in incomplete pass-through by introducing local distribution service into the open-economy macroeconomic model. Goldberg and Verboven (2001) empirically supports this fact by finding that local costs play an important role in generating the local currency prices stability.

firms' multinationality, however, we also need to be concerned with specific factors for those multinational firms to determine their price. According to Bernard, Jensen and Schott (2006), multinational firms have both managerial and financial motives for setting prices in intrafirm transaction differently from arms-length transaction. Managerial motives include avoiding double marginalization in the presence of market power, whereas financial motivations encompass the minimization of corporate tax and tariff payments. In the empirical analysis of this paper, I will consider these multinational-firm specific motives in the empirical model.

The data I mainly reply on in the empirical study is the import price index data from the International Price Program (IPP) of the Bureau of Labor Statistics. IPP offers pricing data in US international trade for intrafirm transaction and arms-length transaction separately. Some papers such as Clausing (2003) and Neiman (2010) make use of this dataset to estimate exchange rate pass-through severally for intrafirm and arms-length transaction. Although utilizing this dataset is ideal, it is not available to this research. What I try to do instead in this paper is to estimate industry-level pricing behavior and pass-through, which I compare with the intrafirm transaction share of each industry as in Hellerstein and Villas-Boas (2010). This approach enables me to relate intra-firm transaction to pass-through, which partially overcomes the limitation of my dataset, i.e., inseparability of intrafirm transaction from arms-length transaction.

Also, this industry-wise estimation of pass-through is the largest distinction of this paper from other paper.[3] This attempt lets us find which industry with what characteristics has higher/lower pass-through, which is not approached by papers making use of intrafirm price data of IPP. I include Herfindahl Hirschman Index (HHI) as well as intrafirm transaction share in the industries characteristic in order to take competitiveness of industry into account, which is another distinction of this paper. This consideration takes multinational firms' managerial motives into account.

My empirical analysis has two objectives. The first one is testing multinational firms' financial motives. I will examine whether there is tax motivated income-shifting in transfer pricing by multinational firm, following Clausing (2003). As a result, my empirical analysis shows that there is no income-shifting pricing, which is the opposite to what Clausing (2003) finds. I also compare the result with HHI in each industry to find that tax-motivated income shifting is more likely to be performed when the industry is less competitive. The second one is estimating industry-level pass-through and compare it with intrafirm transaction share. Many papers show that pass-through in intrafirm transaction is higher than arms-length transaction. Hence the natural conjecture of the result is that industry with higher share of intrafirm transaction will express higher pass-through. In my empirical

[3] Hellerstein and Villas-Boas (2010) try the industry-level pass-through estimation. The difference between their paper and my paper comes from the specification of the empirical model and dataset.

analysis, however, we see the opposite relation between intrafirm share and pass-through: industry with higher intrafirm share shows lower pass-through. Although I also compare the pass-through with HHI, observed correlation between HHI and pass-through is subtle.

The remaining of this paper proceeds as follows. In the next section, I review Clausing (2003), Neiman (2010), and Hellerstein and Villas-Boas (2010) as the related literature. I will mainly overview their empirical strategy and results. In Section 3, I will show my empirical study and its result, and Section 4 concludes.

2. Literature Review

In this section, I review three papers which explain incomplete pass-through with considering firms' multinationality. As mentioned in the introduction, Bernard et al. (2006) conclude that multinationals have both managerial and financial motives for setting intrafirm trans-action prices differently from arms-length transaction. I first review Clausing (2003) which explains financial motives by finding multinational firms' price setting can be explained by tax-motivated income shifting. Then I review Hellerstein and Villas-Boas (2010) and Neiman (2010) both of which estimate pass-through associating with firms' multinationality using different strategies.

Clausing (2003) first theoretically hypothesize that multinational firms' tax-minimizing behavior leads to their shifting income to more lightly-taxed locations by manipulating transfer prices by constructing the following model.[4] The home-country based multinational firm's profit is written by $\pi(p) = (1-t_H)\pi_H(p) + (1-t_F)\pi_F(p)$ where t_x and π_x are tax rate and profit earned in country $x \in$ {Home; Foreign}, respectively, and p is transfer price. Profit from each country is written by $\pi_H(p) = \text{revenue}_H - \text{cost}_H + pm$ and $\pi_F(p) = \text{revenue}_F - \text{cost}_F - pm$, where m is the amount of material sent to Foreign. If we take derivative of $\pi(p)$ with respect to p, we have $\pi_p = (t_F - t_H)m$. So, if $t_H > t_F$, π_p is negative and the multinational firm has an incentive to underprice the transfer price whereas $t_F > t_H$ leads to overpriced transfer price for the same reason. This result shows that multinational firms tend to have higher transfer price when they export goods to higher tax rate country. In other words, by manipulating transfer pricing, they shift their income to low tax country.

Based on the model, she estimates the following equation:

$$\begin{aligned}\ln p_{it} = {} & \alpha + \beta_1 \ln(1-\tau_{ky}) + \beta_2 \ln(1-\tau_{ky}) \times \text{Intra dummy}_{it} + \beta_3 \ln e_{kt} \\ & + \beta_4 \ln e_{kt} \times \text{Intra dummy}_{it} + \beta_5 \text{ Intra dummy}_{it} + \beta_6 \text{ Inpute dummy}_{it} \\ & + \beta_7 \text{ Link dummy}_{it} + \beta_9 \text{ No dollar}_{it} + \beta_z \text{ Industry dummies} + \varepsilon_{it}.\end{aligned}$$

[4] The model present here is different from her original model. I abstract the model but the result is qualitatively same.

i indicates products, k indicates countries, t indicates months, and y indicates years. p_{it} is the trade price reported by Bureau of Labor Statistic, τ_{ky} is tax rate of industry k in year y, which is either effective tax rate or statutory tax rate. Effective tax rate is calculated as the foreign income taxes paid by US affiliates in a given country divided by their pre-tax net income based on the data from teh Bureau of Economic Analysis surveys on US direct investment abroad. Statutory tax rate is obtained from Price Waterhouse. e_{kt} is exchange rate (per dollar). Inpute dummy and Link dummy are dummy variables for inputed price and link price, respectively. Bureau of Labor Statistics generates inputed prices when data are missing and also calculates a link price when survey items have changed in nature. No dollar is a dummy for goods where the price is not originally expressed in dollars.

Expected sign of coefficient based on the model and estimated coefficients are summarized in Table 1. The estimated coefficients are reported for the case of effective tax.

Table 1: Expected and estimated coefficient

	Expected sign	Estimated coefficient	
		Exports	Imports
$\ln(1-\tau_{ky})$	0^a	−0.7964	−1.814
$\ln(1-\tau_{ky}) \times$ Intra dummy$_{it}$	− for exports; + for imports^b	−1.997	1.354
$\ln e_{kt}$	—^{c}	−0.3543	−0.4228
$\ln e_{kt} \times$ Intra dummy$_{it}$	?^{d}	−0.6869	−0.1946

^{a} Prices for arms-length transaction should not be effected by tax rates
^{b} For low tax countries, intrafirm export prices should be lower and import prices should be higher.
^{c} As the dollar is stronger, prices should be lower.
^{d} If intrafirm trade is more sensitive to exchange rates, this should be negative.

The result basically follows expectation. By obtaining the positive positive coefficient of $\ln(1-\tau_{ky}) \times$ Intra dummy$_{it}$ for imports and negative coefficient for exports, Clausing (2003) finds the evidence of multinational firms' income shifting to lower tax countries. The coefficient of $\ln e_{kt} \times$ Intra dummy$_{it}$ is estimated to be negative, which means that intrafirm price reacts to change in exchange rate more sensitively, which supports the higher pass-through in intrafirm transaction compared with arms-length transaction. In the empirical study in this paper, I will also test the existence of tax-motivated transfer price manipulation following her empirical model.

Hellerstein and Villas-Boas (2010) analyze the impact of vertical relationships on firms' mark-up adjustment and the consequent incomplete pass-through in US auto industry. Their main analysis employs demand estimation approach (BLP) from IO literature using mi-crolevel data, which leads them to conclude the positive relation between degree of firms' vertical integration and pass-through. However, the most related part of their paper is their first look analysis of data. By performing industry level pass-though estimation, they find the positive relation between pass-through and in-

trafirm transaction share. The following equation is their pass-through equation.

$$\Delta \ln p_{it} = \alpha + \sum_{n=0}^{4} \beta_i^n \Delta \ln e_{it-n} \times \Delta \ln \omega_{it} + \delta_{it} \ln Y_t + \varepsilon_{it},$$

i stands for industry and t stands for quarter. $\Delta \ln x_{it} = \ln x_{it} - \ln x_{it-1}$ stands for percentage difference in variable x in industry i from period $t-1$ to t. p_{it} is the import price index from IPP of Bureau of Labor Statistics and ω_{it} is import weighted foreign CPI obtained from IMF's International Ginancial Statistics. Y_{it} is the US gross domestic purchase provided by Bureau of Economic Analysis. $\Delta \ln e_{it-n}$ is the percentage change in exchange rate over the period $t-n-1$ to $t-n$. As same in Burstein and Gopinath (2013) and Neiman (2010), the exchange rate pass-through is defined as $\sum_{n=0}^{4} \beta_i^n$ for each industry i.

They perform the estimation for sixteen manufacturing industries and find the pass-through greatly varies across industries from -0.02 to 0.56. By comparing the industry level pass-through with intrafirm share of each industry, they find the positive relation between them. Although their analysis does not utilize price data which separates intrafirm and arms-length transaction, their industry-level analysis enables them to relate the pass-though and intrafirm transaction. I follow their strategy in my empirical study in this paper. More specifically, I will take the same sixteen industry and estimate the pass-through equation for each industry to identify the relation between the pass-through and intrafirm transaction share. The difference of my research from theirs comes from the different dataset and different specification of pass-through equation. Also, in my analysis, I estimate the pass-through after one month, three month, and six months as well as twelve months whereas they estimate only pass-through after twelve months. This attempt provides us the transition of pass-though, which is another distinctive feature of my analysis from Hellerstein and Villas-Boas (2010).

Neiman (2010) makes use of the same pricing data as Clausing (2003) which separates intrafirm transaction from arms-length transaction to estimate pass-through. He focus on the US import market and estimate the following pass-through equation:

$$\Delta \ln p_{ict} = \alpha + \sum_{n=0}^{N} \beta^n \Delta \ln e_{ict-n} + \delta \Delta \ln \pi_{it}^{c} + \gamma \Delta \ln \pi_{it}^{US} + \varepsilon_{it},$$

i stands for industries, c stands for countries, and t stands for months. p_{ict} is the price of good i exported from country c at month t. $\Delta \ln e_{ict-n}$ is the percentage change in exchange rate between US and country c over the period $t-n-1$ to $t-n$. π_{it}^{c} and π_{it}^{US} are CPI in country c and US, respectively.

He runs this regression for intrafirm transaction and arms-length transaction. Also, he tries several level of N from 0 to 30 month to have the pass-through transition. As same in Burstein and Gopinath (2013) and Hellerstein and Villas-Boas (2010), the exchange rate pass-through is defined as

$\sum_{n=0}^{N} \beta^n$. The results are summarized in the Table 2 where “long run” corresponds to 3 years. The reported coefficients are from regression using data after dropping large changes.

Table 2: Long-run and after 1 year exchange rate pass-through

	Including non-dollar prices		Excluding non-dollar prices	
	Long run	After 1 year	Long run	After 1 year
Intrafirm	0.30	0.19	0.25	0.13
Arms-length	0.22	0.16	0.16	0.10

As can be seen from the Table 2, intrafirm transaction shows higher pass-through com-pared with the arms-length transaction. From the estimated pass-transition, we observe that the pass-through from intrafirm and arms-length transaction is almost same until five months passes and then get away so that intrafirm pass-through grows faster. In my analysis, I will try one month, three months, six months, and twelve months for N and examine the transition of pass-through. From my analysis, we will see which industry shows higher grow rate of pass-through. I will relate this result to the intrafirm transition share and conclude whether industries with higher intrafirm share show higher growth rate of pass-through.

In this section, I reviewed three papers which explain how firms' multinationality leads to different pass-through from arms-length transaction. Three of them support the common result that intrafirm transaction leads to higher exchange rate pass-through. Also, Clausing (2003) shows that pricing by intrafirm transaction is distorted by the tax-motivated income shifting behavior. Following their analysis, in the next section, I will construct a dataset and examine how price is affected by the foreign tax rate and how pass-through varies across industries with different level of intrafirm transaction share.

3. Empirical Study

My empirical analysis has two objectives. First is testing whether foreign firms' pricing shows tax-motivated income shifting or not. The second is estimating pass-through transition to relate it with the existence of multinational firms. Since my dataset cannot separate intra-firm transaction from arms-length transaction, my empirical analysis employs Hellerstein and Villas-Boas (2010)'s strategy: I will perform estimation for each of several industries with different level of intrafirm transaction shares and then, compare the results with intrafirm share and another factor such as HHI.

There are several distinction in my empirical study from other papers. First, I estimate pass-through transition for each industry. This industry-wise attempt is not accessed by papers utilizing Bu-

reau of Labor Statistics data. Second, I consider market competitiveness by introducing HHI in the analysis. Although firms' price setting behavior should be affected by competitive environment, none of three papers take this into account. Last, the dataset I construct employs different countries and time range.

In my empirical study, I pick up sixteen manufacturing industries in US import market with seven countries from December 2005 to December 2011. The seven countries are China, Canada, Mexico, Japan, Germany, United Kingdom, and France, who account for 60% of US import on average from 2009 to 2013.[5] The sixteen industries are determined based on 3-digit NAICS and summarized in Table 3 with their intrafirm import share and Herfindahl Hirschman Index (HHI). I employ the result of intrafirm import share in Bernard, Jensen, Redding and Schott (2008) and the HHI come from US Census Bureau.[6] These industries are the same as in Hellerstein and Villas-Boas (2010) except that I use 314 for Textiles whereas Hellerstein and Villas-Boas (2010) use 313. As can be seen in Figure 1, there is little relation between HHI and intrafirm transaction share.

Focusing on US import market enables me to make use of the monthly Import Price Index data from IPP of Bureau of Labor Statistics (December 2005＝100). I use monthly exchange rate (per US dollar) data from University of British Columbia web site[7] and calculate industry-level exchange rate by taking import-weighted sum where the import share is obtained based on trade data from US International Trade Commission.

Since multinational firms have an incentive to adjust transfer prices due to tax rate of countries they operate, I collect two types of tax data, both of which are adopted by Clausing (2003): effective tax rate and statutory tax rate. According to Clausing (2003), the effective tax rate is defined as the foreign income taxes paid by US affiliates in a given country divided by their pre-tax net income. I use data from surveys on US direct investment abroad by Bureau of Economic Analysis in order to calculate the effective tax.[8] As for statutory tax rate, I adopt annual tax rate (% of commercial profit) reported by the World Bank. Industry-level tax rate is obtained in the same way as having industry-level exchange rate by having import-weighted sum of them.

Table 4 shows the mean and variance of the effective tax rate and statutory tax rate for each industry. For every industry, effective tax rate is smaller than statutory tax rate. This tendency is

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5 This is according to calculation based on the data from US International Trade Commission.

6 HHI from US Census Bureau is calculated for top 50 firms in each industry based on value of shipment.

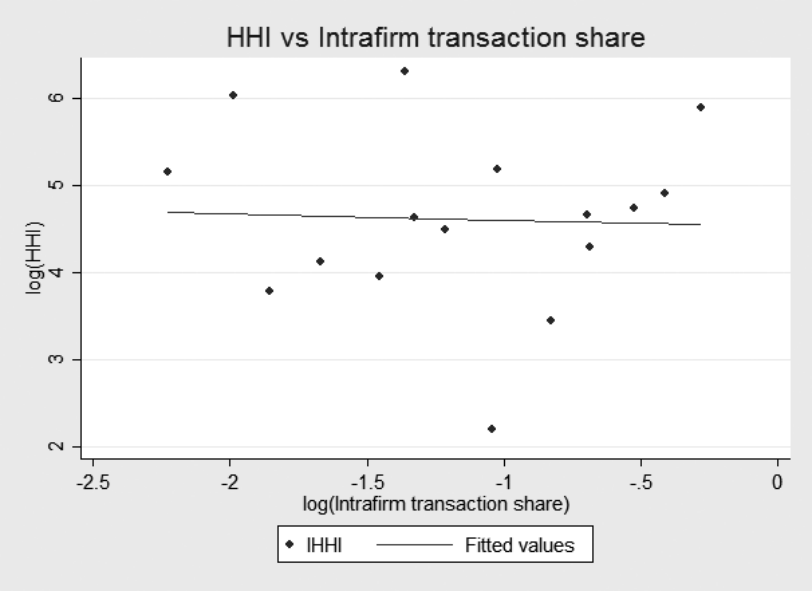
7 http://pacific.commerce.ubc.ca/xr/data.html.

8 Manufacturing industries we can observe from Bureau of Economic Analysis data are: food, chemicals, primary and fabricated metals, machinery, computers and electronic products," electrical equipment, appliances, and components, transportation equipment, and manufacturing total. When I merge data, I categorize 311 and 312 as food, 314, 315, 316, 325, 326, and 327 as chemicals, 331 and 332 as primary and fabricated metals, 333 as machinery, 334 as computers and electronic products, 335 as electrical equipment, appliances, and components, 336 as transportation equipment, and 337 and 339 as manufacturing total. When industries are categorized in the same class, the variation of tax rate between those industries only come form the variation of import share.

Table 3: Intrafirm transaction share and HHI for each industry

Industry	NAICS	Intrafirm import share	HHI（permillage）
Food	311	0.266	102.1
Beverages and tobacco	312	0.256	555.4
Textiles	314	0.137	418.6
Apparel	315	0.156	44
Leather goods	316	0.108	174.8
Chemicals	325	0.593	114
Rubber and plastics	326	0.438	31.3
Nonmetallic metals	327	0.297	89.6
Primary Metals	331	0.359	180.6
Fabricated metals	332	0.353	9
Industrial Machinery	333	0.503	72.7
Computers	334	0.663	136.6
Electrical equipment	335	0.500	105.3
Autos	336	0.756	365
Furniture	337	0.188	61.5
Miscellaneous	339	0.234	52.4

Figure 1: Plotting Intrafirm transaction share and HHI



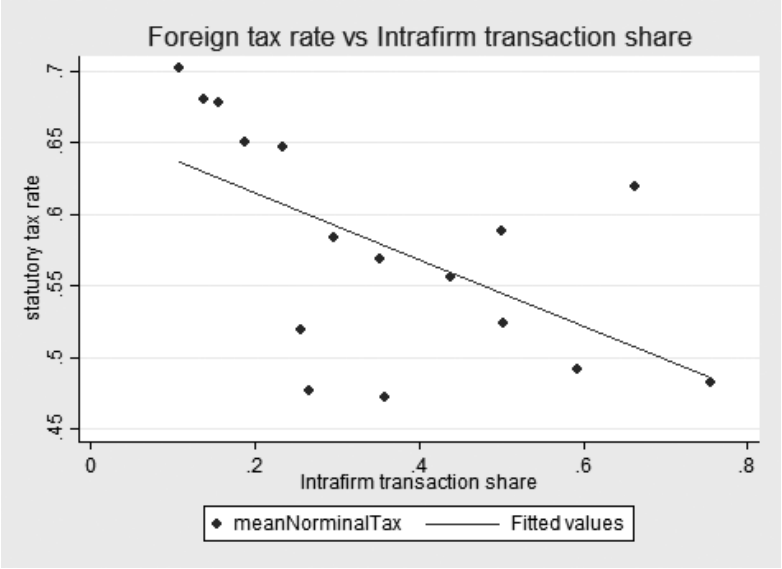
different from Clausing（2003）whose data has almost same level of effective tax rate and statutory tax rate although the level of effective tax rate is similar to hers. This difference seems to come from the difference of data source.[9] Figure 2 demonstrates the negative relation between foreign tax rate

[9] Clausing（2003）relies on data from Water House, which is not available to this research. Instead, I use the tax rate data（% out of commercial income）from the World Bank.

Table 4: Effective tax and Statutory tax

Industry	NAICS	Effective Tax		Statutory Tax	
		mean	variance	mean	variance
Food	311	0.353	0.002	0.476	0.003
Beverages and tobacco	312	0.301	0.002	0.519	0.0001
Textiles	314	0.229	0.0009	0.679	0.004
Apparel	315	0.232	0.001	0.677	0.004
Leather goods	316	0.225	0.0009	0.701	0.005
Chemicals	325	0.420	0.009	0.491	0.001
Rubber and plastics	326	0.318	0.0025	0.555	0.002
Nonmetallic metals	327	0.317	0.002	0.583	0.001
Primary Metals	331	0.316	0.021	0.471	0.002
Fabricated metals	332	0.479	0.162	0.568	0.002
Industrial Machinery	333	0.319	0.011	0.523	0.001
Computers	334	0.094	0.128	0.618	0.002
Electrical equipment	335	0.110	0.037	0.588	0.001
Autos	336	0.302	0.318	0.482	0.0009
Furniture	337	0.254	0.014	0.650	0.004
Miscellaneous	339	0.288	0.022	0.647	0.004

Figure 2: Plotting Intrafirm transaction share and Statutory Tax Rate



and intrafirm import share. This tendency can be interpreted as follows. When the foreign tax rate is increased, FDI in foreign country becomes more costly relative to importing via arms-length transaction since the affiliate need to pay more tax in foreign countries whereas cost of buying materials in arms-length transaction is not changed.

3.1. Foreign tax rate and price sensitivity

In this subsection, I construct an empirical model which tests the relation between foreign tax rate and import price change discussed by Clausing (2003). In her model, Clausing (2003) argues that price set in intrafirm transition should become higher due to lower tax in foreign country whereas price set in arms-length transaction should not be affected by foreign tax rate. She tested this statement in her empirical analysis and shows that her conjecture of higher intrafirm import price due to lower foreign tax rate is true. In this study, I will check her conjecture using my dataset. In my analysis, I cannot follow her specification of empirical model because of inseparability between intrafirm and arms-length transaction of my dataset. Instead, I estimate tax rate coefficients on price change for each industry and compare them with intrafirm share. If her statement is true, I will have higher coefficient of tax rate in industries with higher share of intrafirm trade.

There are other differences in our datasets. First, although she adopts monthly data from January 1997 to December 1999, my monthly data covers from December 2005 to December 2011. Second, as for statutory tax data, my data source is different from hers as I mention in the previous section.

The equation to be estimated is

$$\ln p_{it} = \alpha_i + \beta_i \ln e_{it} \ln \omega_{it} + \gamma_i \ln(1 - \tau_{it}) + \delta_i \ln Y_t + \varepsilon_{it},$$

where p_{it} is the import price index of industry i at time t, τ_{it} is either effective or statutory tax level of industry i at time t, e_{it} is the import-weighted exchanger rate in industry i at time t. Following Hellerstein and Villas-Boas (2010), I let each exchange rate term be a cross term with import-weighted foreign CPI in each industry i at time t, ω_{it}, which is the proxy for foreign production cost. I also include gross domestic purchase in the US, Y_t as a demand shifter. The CPI data comes from IMF's International Financial Statistics while the US gross domestic purchase is provided by Bureau of Economics Analysis. This specification of equation is basically a modification of Hellerstein and Villas-Boas (2010) by adding tax term.

The estimation is performed for each industry as well as for aggregate import market. Also, I consider two kinds of tax following Clausing (2003): effective tax and statutory tax. The result is shown from Table 5 to Table 8.

Although we have negative coefficient on tax rate in some cases in effective tax case, we have positive coefficient on tax rate in most of statutory tax case and many of effective tax case. Having positive coefficient on tax rate is consistent with the optimal transfer price manipulation by multinational firms in her model. In Clausing (2003), she has negative tax coefficient in arms-length transaction though she expects this to be 0. Since my data set is aggregate in transaction arrangement, the negative coeffi-

Table 5: Tax=Effective tax, total and first 8 industries

	(1) Total	(2) 311	(3) 312	(4) 314	(5) 315	(6) 316	(7) 325	(8) 326	(9) 327
$\ln e_{it} \ln \omega_{it}$	−0.00659*	0.0299	0.0215***	−0.0907***	−0.0480***	−0.184***	−0.0128	−0.0872***	−0.102***
	(0.00386)	(0.0372)	(0.00363)	(0.0260)	(0.0169)	(0.0155)	(0.0102)	(0.0107)	(0.0233)
$\ln(1-\tau_{it})$	0.0678***	−0.222	0.0262	0.422***	0.0184	0.234***	0.237***	0.188***	0.544***
	(0.00950)	(0.135)	(0.0375)	(0.113)	(0.0648)	(0.0631)	(0.0420)	(0.0528)	(0.0732)
$\ln Y_{it}$	1.215***	3.544***	0.637***	0.540***	0.344***	0.100	1.314***	0.376***	0.862***
	(0.0605)	(0.290)	(0.0842)	(0.176)	(0.114)	(0.0892)	(0.196)	(0.131)	(0.175)
Constant	−6.904***	−29.69***	−1.623*	0.424	1.783	5.479***	−7.600***	2.272*	−2.176
	(0.601)	(2.868)	(0.819)	(1.886)	(1.217)	(0.966)	(1.932)	(1.339)	(1.760)
Observations	1,118	73	73	73	73	73	73	73	73
R-squared	0.356	0.696	0.651	0.588	0.471	0.801	0.754	0.828	0.692
Number of NAIC	16								

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p < 0.1

Table 6: Tax=effective tax, latter 8 industries

	(1) 331	(2) 332	(3) 333	(4) 334	(5) 335	(6) 336	(7) 337	(8) 339
$\ln e_{it} \ln \omega_{it}$	−0.00813	−0.0857***	−0.0478***	0.0643***	−0.0708***	−0.0167***	−0.115***	−0.00637
	(0.0137)	(0.0153)	(0.00305)	(0.00270)	(0.0112)	(0.00326)	(0.0324)	(0.00509)
$\ln(1-\tau_{it})$	0.0326	−0.0456	0.0437***	−0.00345	0.0911***	0.0246*	−0.0998***	−0.0769***
	(0.0324)	(0.0557)	(0.0131)	(0.00361)	(0.0165)	(0.0128)	(0.0194)	(0.00979)
$\ln Y_{it}$	4.462***	0.852***	0.488***	−0.311***	0.261*	0.344***	0.562***	1.431***
	(0.289)	(0.219)	(0.0833)	(0.0583)	(0.132)	(0.0567)	(0.127)	(0.0954)
Constant	−37.87***	−2.383	0.751	6.620***	3.103**	1.609***	0.240	−9.035***
	(2.796)	(2.269)	(0.828)	(0.582)	(1.380)	(0.554)	(1.420)	(0.959)
Observations	73	61	61	73	73	49	73	71
R-squared	0.811	0.775	0.915	0.945	0.678	0.784	0.587	0.861

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Tax=statutory tax, first 8 industries

	(1) Total	(2) 311	(3) 312	(4) 314	(5) 315	(6) 316	(7) 325	(8) 326	(9) 327
$\ln e_{it} \ln \omega_{it}$	−0.00159	−0.0627**	0.00845**	−0.0396	−0.0249	−0.0997***	−0.0343***	−0.0797***	−0.0739***
	(0.00372)	(0.0309)	(0.00381)	(0.0349)	(0.0189)	(0.0161)	(0.0112)	(0.0101)	(0.0172)
$\ln(1-\tau_{it})$	0.125***	0.677***	0.610***	0.0418	0.0341**	0.0634***	0.255**	0.180***	0.499***
	(0.0135)	(0.0902)	(0.108)	(0.0275)	(0.0145)	(0.0102)	(0.126)	(0.0356)	(0.0401)
$\ln Y_{it}$	1.069***	1.891***	0.494***	0.826***	0.390***	0.261***	1.271***	0.328***	0.749***
	(0.0595)	(0.286)	(0.0666)	(0.178)	(0.102)	(0.0701)	(0.252)	(0.122)	(0.130)
Constant	−5.462***	−12.44***	0.286	−2.885	1.151	3.165***	−6.891***	2.712**	−1.181
	(0.591)	(2.918)	(0.692)	(1.931)	(1.113)	(0.756)	(2.501)	(1.244)	(1.297)
Observations	1,166	73	73	73	73	73	73	73	73
R-squared	0.374	0.826	0.759	0.521	0.509	0.847	0.661	0.852	0.829
Number of NAIC	16								

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Tax＝statutory tax, latter 8 industries

	(1) 331	(2) 332	(3) 333	(4) 334	(5) 335	(6) 336	(7) 337	(8) 339
$\ln e_{it} \ln \omega_{it}$	−0.0111	−0.0741***	−0.0435***	0.0460***	−0.0346***	−0.0177***	−0.213***	−0.0183***
	(0.0145)	(0.0110)	(0.00487)	(0.00445)	(0.0124)	(0.00271)	(0.0242)	(0.00417)
$\ln (1-\tau_{it})$	0.0328	0.140***	0.160***	−0.112***	0.183***	0.0917**	0.132***	0.112***
	(0.121)	(0.0456)	(0.0456)	(0.0248)	(0.0393)	(0.0445)	(0.0146)	(0.0116)
$\ln Y_{it}$	4.513***	0.664***	0.339***	−0.387***	0.368***	0.394***	−0.145	0.820***
	(0.349)	(0.149)	(0.0729)	(0.0543)	(0.136)	(0.0620)	(0.0966)	(0.0752)
Constant	−38.32***	−0.582	2.229***	7.497***	1.758	1.191*	8.090***	−2.870***
	(3.455)	(1.507)	(0.735)	(0.549)	(1.419)	(0.606)	(1.065)	(0.752)
Observations	73	73	73	73	73	73	73	71
R-squared	0.808	0.769	0.900	0.957	0.647	0.784	0.738	0.888

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

cient might be due to negative relation between price and (1-tax rate) in arms-length transaction.

Figure 3 and 4 show the plotting of tax coefficients and intrafirm transaction in effective tax case and statutory tax case, respectively. If the result in Clausing (2003) holds, we should have the positive relation between intrafirm transaction share and tax coefficient since her estimation shows higher tax coefficient in intrafirm transaction in import market.

However, as can be seen in Figure 3 and 4, we have slightly negative relation between intrafirm transaction share and tax coefficient, which is opposite to the result in Clausing (2003).

Figure 3: Intrafirm share vs sensitivity to effective tax change

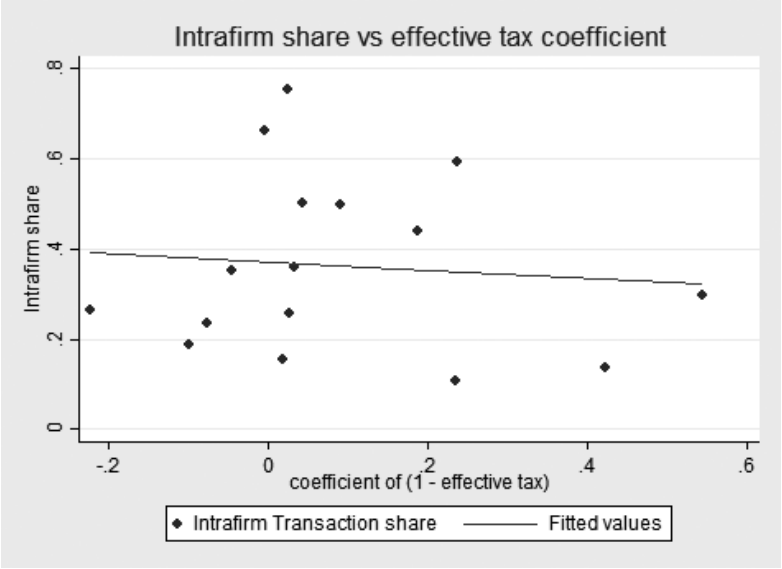
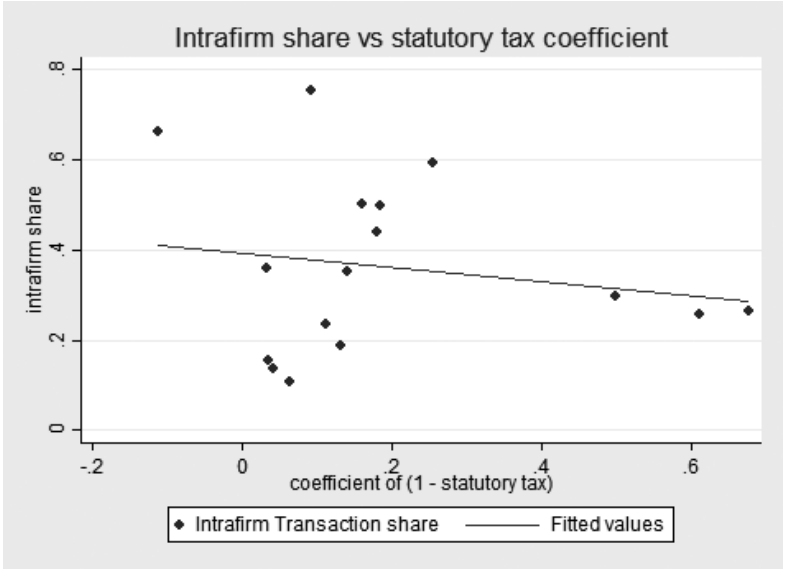


Figure 4: Intrafirm share vs sensitivity to statutory tax change



In Figure 5 and 6, I plot the relation between tax coefficient and HHI. We observe the positive relation between them, which shows that when the market is less competitive, taxmotivated income-shifting pricing is observed more often.

Figure 5: Intrafirm share vs sensitivity to effective tax change

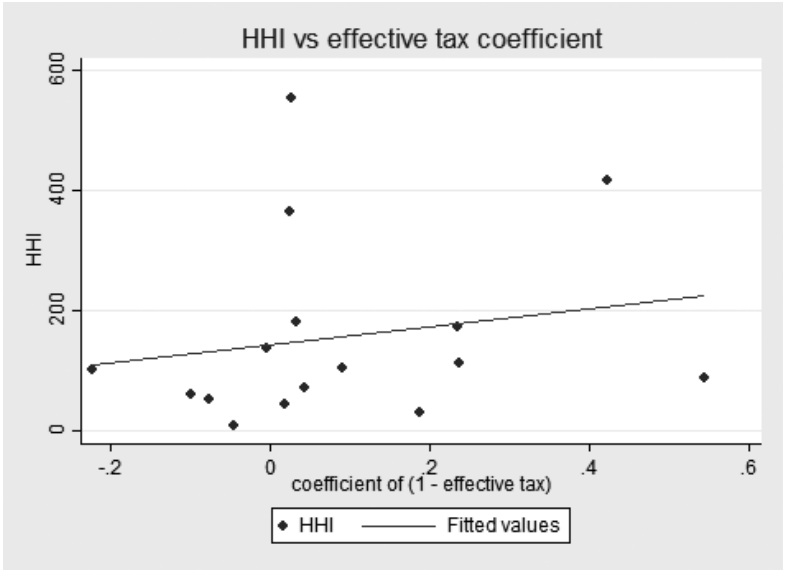
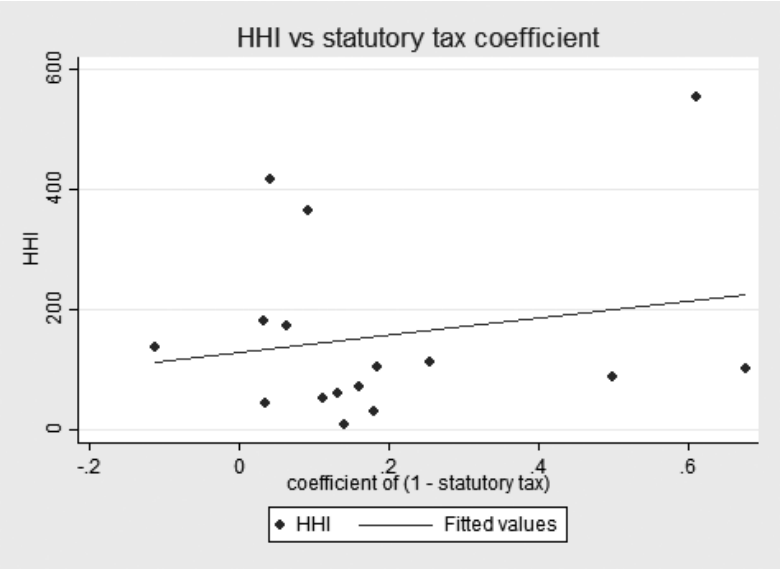


Figure 6: Intrafirm share vs sensitivity to statutory tax change



3.2. Pass-through estimation

In this subsection, I estimate exchange rate pass-through following Neiman (2010). In his empirical study, he shows the intrafirm transition has higher pass-through compared with arms-length transaction by providing pass-through transition over 3 years for intrafirm tran-sition and arms-length transition separately. In my analysis, I estimate the pass-through equation for several industries with different level of intrafirm transition share and compare the pass-through with intrafirm share and test the result in Neiman (2010) by concluding whether there is positive relation between intrafirm share and pass-through or not.

Following Burstein and Gopinath (2013) and Hellerstein and Villas-Boas (2010), I specify the pass-through equation as follows:

$$\Delta \ln p_{it} = \alpha + \sum_{n=0}^{N} \beta_i^n \Delta \ln e_{it-n} + \delta_i^1 \Delta \ln \omega_{it} + \delta^2 \ln Y_t + \varepsilon_{it},$$

where $\Delta \ln x_{it} = \ln x_{it} - \ln x_{it-1}$ stands for percentage difference in variable x in industry i from period $t-1$ to t and $\Delta \ln e_{it-n}$ is the percentage change in exchange rate over the period $t-n-1$ to $t-n$. According to Burstein and Gopinath (2013) and Neiman (2010), the exchange rate pass-through is

defined as $\sum_{n=0}^{N} \beta_i^n$ for each industry i. I set N as 1, 3, 6, or 12 and estimate pass-through in each time range. Table 9 shows the results.[10]

As can be seen from Table 9, exchange rate pass-through greatly varies across industries and some industries even show negative pass-through. Figure 7 shows the plotting of transition of exchange rate pass-through for each industry as well as aggregate import market. Compared with the estimated transition in Neiman (2010), the growth rate of pass-through from my estimation is quite high: after 1 year, the it reaches 0.33 in total manufacturing industry while it is 0.19 from Neiman (2010).

Figure 8 shows the relation between the pass-through and intrafirm share. Expected result from Neiman (2010) is that intrafirm share and exchange rate pass-through should have a positive relation. However, the plotting shows the negative relation between intrafirm share and pass-through, which is opposite to previous literature's conclusion.

Figure 9 shows the relation between the pass-through and HHI. Although we observe slightly negative relation, degree of competitiveness seems not to explain the pass-through well.

Table 9: Estimated exchange rate pass-through

Industry	NAICS	Pass-through			
		1 month	3 months	6 months	12 months
Total		0.00608	0.0653	0.1554	0.33148
Food	311	0.0306	0.2013	0.2662	0.52475
Beverages and tobacco	312	0.00195	0.003747	0.0208	0.02984
Textiles	314	−0.0591	0.0011	0.23817	0.417215
Apparel	315	0.022	0.0114	−0.051173	0.14125
Leather goods	316	0.139	0.142	0.148	0.375
Chemicals	325	−0.012	−0.0309	−0.07892	0.24942
Rubber and plastics	326	0.0176	0.04046	0.09291	0.34726
Nonmetallic metals	327	0.013	0.0775	0.0237	0.031111
Primary Metals	331	0.00307	0.2863	0.5109	0.944
Fabricated metals	332	0.00372	0.03264	0.085089	−0.004021
Industrial Machinery	333	0.0105	0.003808	−0.028	−0.08439
Computers	334	−0.00284	−0.02403	−0.091165	−0.107505
Electrical equipment	335	0.00502	0.01698	0.00304	0.00571
Autos	336	0.00213	−0.0009892	0.01333	0.03799
Furniture	337	0.069	0.3292	0.435	1.1207
Miscellaneous	339	0.00736	0.00557	0.01395	−0.01925

[10] Since exchange rate is per US dollar, pass-through is negative. In Table 9, I report $-\sum_{n=0}^{N} \beta_i^n$

Figure 7: Pass-through transition over 12 months

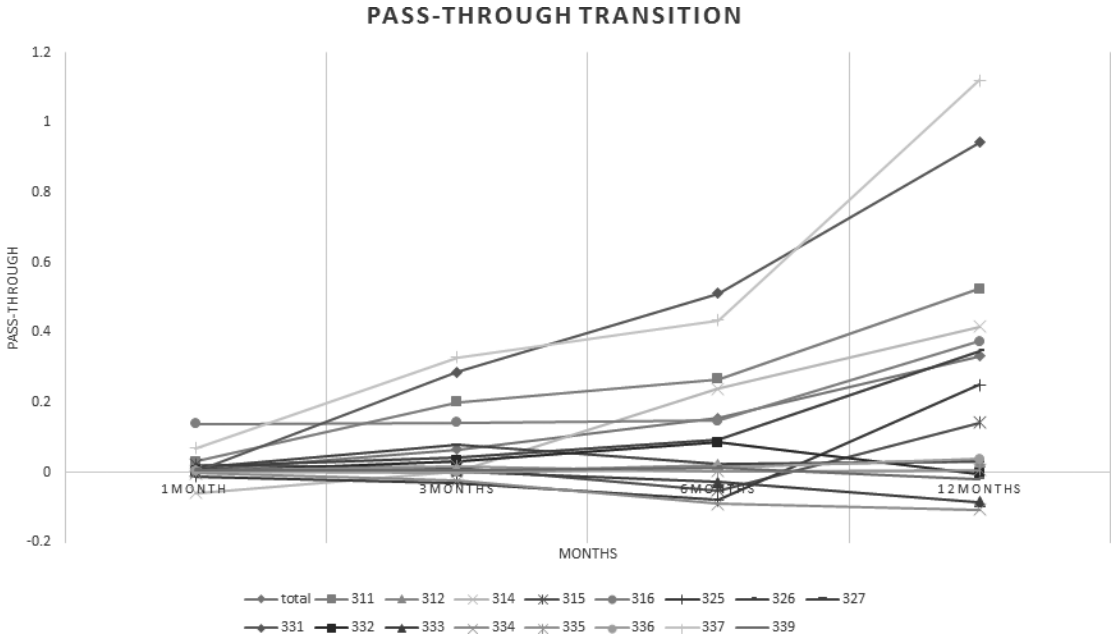
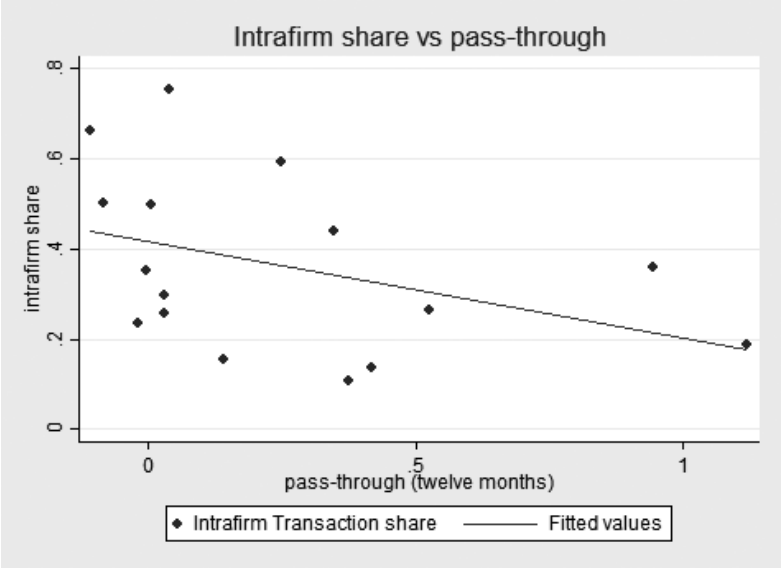


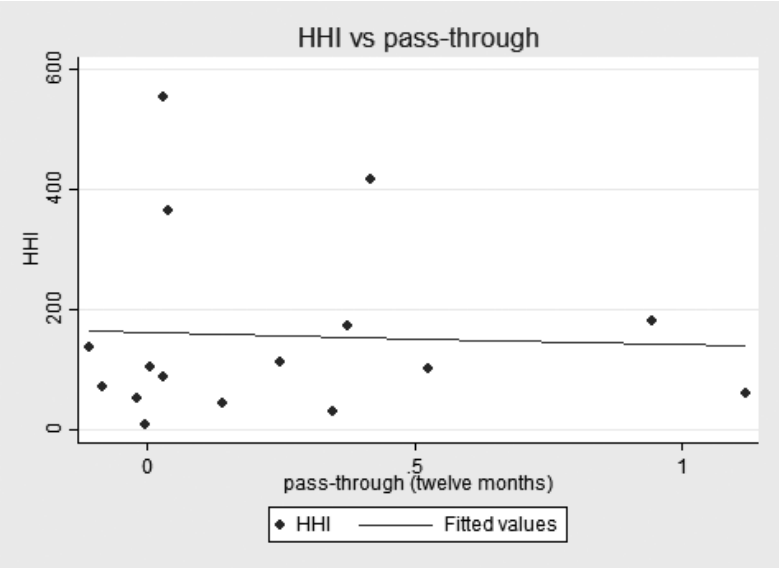
Figure 8: Pass-through and Intrafirm Share



4. Conclusion

In this paper, I tested the following two evidences from previous literature which analyzes multinational firm's pricing associating with foreign tax rate and exchange rate. First is that multina-

Figure 9: Pass-through and HHI



tional firms manipulate the transfer price to be higher for the goods exporting to low tax countries according to profit maximization. Second is that multinational firms' intrafirm transaction shows the higher exchange rate pass-through compared to arms-length transaction. In addition, I examined both evidences with market competitiveness by asking market competitiveness have positive relation with tax-rate sensitivity or level of pass-through.

The results are opposite to the evidence from previous literature. First, I found slightly negative relation between tax coefficient and intrafirm share. This means that industry price becomes more sensitive when the industry has lower intrafirm share. According to the model in Clausing (2003), intrafirm pricing of goods exporting to is affected by the change of foreign tax rate whereas arms-length transaction is not. The expected result supporting her evidence in my study is that industry price is more sensitive to foreign tax rate change when the industry has higher intrafirm share. However, the result shows the opposite relation.

As for exchange rate pass-through, the result from my estimation was also contrary to the evidence from previous literature. The expected result according to the previous works was that industry with higher intrafirm transaction share will show higher pass-through. As Figure 8 shows, however, the result revealed negative relation between pass-through and intrafirm transaction share. I also estimated the transition of pass-through, which shows rapid growth rate compared to the result in Neiman (2010).

In addition to test the evidence from previous literature, I examined the estimated tax coefficient and pass-through with HHI. Although HHI did not explain pass-thorough well, positive relation

was observed between tax coefficient and HHI. This means that when the market is less competitive, price becomes more sensitive to the change in foreign tax rate. This suggestive result might help us understand multinationals' pricing behavior from view point of market environment.

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