8-27-2017

Three Essays on International Macroeconomics

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University of Connecticut, 2017

My dissertation first studies the implication of household asset cross-holdings for consumption risk sharing of US and Japanese households. Given the previous evidence that finds income as a strong predictor of US households' foreign stock holdings, I use income level to divide households into groups with different probabilities to hold foreign stocks and compare the groups' consumption sensitivity to the deviation of their country's GDP growth from a global average, as a measure of consumption risk sharing. My result for the two countries does not suggest that higher income households have a higher level of international risk sharing.

Income is shown in the literature to be a positive predictor of US households' stock holdings, but there is no previous evidence that establishes the same relationship for Japanese households. In Chapter 2, I further investigate Japanese households' portfolio choice by performing a logit regression. I show that income is a weak predictor of asset cross-holdings, but total asset value, savings deposit, and business ownership are strong predictors of Japanese households' foreign stock market participation.

Chapter 3 focuses on a puzzle in previous studies on exporters' pricing-to-market behavior which have significant estimates that are out of the reasonable range. Based on the latest theoretical development in the exchange rate pass-through literature, I test if the estimates are improved when competition from exporters from competing countries is controlled for. With imperfect measure in the control for competition, many out-of-range estimates disappear. Exporters in different industries respond to competitor's exchange rate shocks differently, with those who produce more homogeneous goods more likely to have a negative estimate.

Three Essays on International Macroeconomics

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A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at the

University of Connecticut

2017

APPROVAL PAGE

Doctor of Philosophy Dissertation

Three Essays on International Macroeconomics

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2017

Acknowledgement

I thank Kanda Naknoi, Stephen Ross, and Kai Zhao for their valuable guidance and advice. I also thank Jungbin Hwang and Hyun Lee for the helpful comments on the earlier version of the manuscript. I am grateful for the Economics Department of the University of Connecticut for the financial support.

Contents

Chapter 1

Households' International Consumption Risk Sharing and Asset Cross-Holdings: Evidence from the US and Japan

Abstract

This chapter studies the implication of household asset cross-holdings for consumption risk sharing of US and Japanese households. Given the previous evidence that finds income as a strong predictor of US households' foreign stock holdings, we use income level to divide households into groups with different probabilities to hold foreign stocks and compare the groups' consumption sensitivity to the deviation of their country's GDP growth from a global average, as a measure of consumption risk sharing. Our result for the two countries does not suggest that higher income households have a higher level of international risk sharing.

1.1 Introduction

Consumption risk sharing is a natural implication of the Arrow-Debreu complete markets. Agents, even when they are from different countries, can pool idiosyncratic and country-specific risks by purchasing Arrow-Debreu securities and insure their consumption in the cross-section. Cochrane (1991) points out that full insurance is important because it implies the existence of a representative consumer used in many macroeconomic and financial models.

Although it is implied by the Arrow-Debreu model, the effectiveness of asset cross-holdings on international consumption risk sharing has not been fully studied in the literature. We attempt to answer this question by applying a modified version of the test commonly used in the risk sharing literature (Lewis (1999) and Sorensen, Wu, Yosha, and Zhu (2007)) to compare the consumption sensitivity to country-level shocks among different groups of households according to their likelihood of holding foreign stocks. More specifically, we regress different household groups' consumption growth deviation from the global mean on the shocks and compare the coefficients of the groups that are more likely to be asset holders to those of less likely asset holders.

Traditionally, the biggest obstacle of such a test is the absence of household level data with both asset holdings and consumption information. In the first part of this study, we address this issue by using income as an asset holdings predictor and comparing the degree of consumption risk sharing between households with different income levels. We choose income as the predictor because first, as Nechio (2014) points out, income has a significant and positive effect on both domestic and foreign asset holdings for US households, and secondly, we have data with both income and consumption dimensions for US and Japanese households. If asset cross-holdings can help households better insure their consumption internationally, we expect to see a higher level of international consumption risk sharing from households with higher income, as they hold more foreign and domestic assets, at least for the US households according to Nechio (2014).

The results from the regression with the US Consumption Expenditure Survey (CEX) do not support that high income leads to better risk sharing. On the contrary, we find that the top income quintile of the US households exhibits the biggest response to country-specific shocks, measured by the US GDP growth deviation from the G7 average. In addition, we find that their high sensitivity is clearly driven by the consumption of durable goods, once it is singled out from the total consumption. We perform the same analysis on the Japanese households with Family Income and Expenditure Survey (FIES) data. The estimated responses are more accurate than those of the US households but again we cannot find evidence of a positive relationship between income and consumption risk sharing.

Two possible hypotheses can explain the puzzling discovery from the data: first, income as a predictor for foreign asset holdings is not good enough, or secondly, income is a good predictor, but foreign asset holdings are either inadequate or ineffective to completely insure against country-level shocks.

Nechio (2014) has established a positive relationship between income and foreign asset holdings for the US households, therefore eliminating the first hypothesis for the US. Our evidence shows that Hypothesis 2 is a strong possibility for the US households. It is worth noting that Nechio (2014) only studies participation but not share of foreign equity in the household portfolio. It is possible that they might be more likely to invest in foreign assets, but their shares are not enough to insure against their higher exposure to country-level shocks.

As far as we know, this chapter is the first to empirically investigate the effectiveness of asset cross-holdings on international consumption risk sharing on a household level. Existing studies that look at the impact of stock holdings on risk sharing are either limited to a single-country world or purely on an aggregate country level. Mankiw and Zeldes (1991) first argue that distinguishing between stockholders and non-holders is necessary to answer the equity premium puzzle, as the two groups demonstrate very different consumption patterns. Attanasio, Banks, and Tanner (2002) further endogenize the stock holding decision and confirm the difference in consumption. Guvenen (2007) compares the level of risk sharing between stockholders and non-holders and concludes that entrepreneurial income shocks cannot be easily hedged with stockholding. In a multi-country world, Sorensen, Wu, Yosha, and Zhu (2007) discover that, from country-level data, over time as equity home bias declines, consumption risk sharing increases. But no direct connection has been made between foreign asset holdings and international risk sharing. This chapter aims to contribute to the closing of the gap.

The rest of the chapter is organized as follows: Section 1.2 reviews the literature and introduces the methodology. Section 1.3 describes the data used in the regression. Section 1.4 exhibits and interprets the regression results. Section 1.5 concludes.

1.2 Literature and Methodology

In general, households in open economies are exposed to global shocks, country-level shocks, and idiosyncratic shocks. In Arrow-Debreu complete markets, they can insure against the last two types of shocks by investing in foreign and domestic securities. When all households only face the same global shocks, their consumption growth is equalized and the households are said to have perfect consumption insurance[1].

But in reality, consumption grows at different rates across households, and their deviation from the global average consumption growth might be attributed to country-level and idiosyncratic shocks. Two fields of literature address the discrepancy between the international implication of this theory and the data. International consumption risk sharing literature documents the lack of consumption insurance between households from different countries. Equity home bias literature investigates households' preference for domestic assets over foreign ones and implies that it might be the reason for the lack of

[1] See Obstfeld, Rogoff, and Wren-lewis (1996) for a textbook treatment.

consumption insurance.

Consumption risk sharing literature focuses on whether households can effectively insure against non-aggregate risks and can be broadly divided into domestic and foreign branches. Many domestic consumption risk sharing studies focus on the US market, such as Cochrane (1991), Mace (1991), and Nelson (1994). These studies all concentrate on testing whether US household consumption responds to idiosyncratic shocks. Under an international setting, consumption risk sharing is examined by Backus, Kehoe, and Kydland (1992, 1993), who discover that contrary to what the theory suggests, correlations of consumption among developed countries are actually lower than correlations of output and productivity. Many explanations for this puzzle have been suggested, such as leisure (Backus et al., 1992) and nontradable goods (Stockman and Tesar, 1995).

One thing of the most importance that needs our special attention is that, in all of the domestic consumption risk sharing studies, country level shocks are regarded as the aggregate shock that cannot be hedged away; if a household's consumption only responds to country-level shocks, it is considered perfect risk sharing in the single-country setting. But in an international setting, country-level shocks are themselves non-aggregate that can be insured against through international asset cross-holdings; the fully insured households in the domestic studies are not fully insured in a multi-country world.

The low level of international consumption risk sharing might be due to the lack of international diversification in households' portfolios; after all, if households do not trade the contingent claims, risks will not be easily shared among them. In the equity home bias literature, French and Poterba (1990, 1991) show that households tend to invest very little in foreign stocks, therefore forgoing significant potential diversification benefit. Shiller, Kon-Ya, and Tsutsui (1991) discover that the lack of cross-border diversification is common even for institutional investors. Various reasons have been suggested, such as inflation risk and dead-weight loss[2].

[2]See Lewis (1999) for an inclusive review.

International consumption risk sharing and equity home bias are two of the six major puzzles in international macroeconomics in Obstfeld and Rogoff (2001) and are inherently linked. Lewis (1999), in her review of the two subjects, renames the former "consumption home bias" to suggest its close relationship with the latter. Sorensen et al. (2007), using country-level data, measure both international consumption risk sharing and equity home bias over time, and suggest the former increases as the latter declines.

This study is related to both fields of literature. Our goal is to investigate, on the household level, whether holding foreign stocks can effectively improve international consumption risk sharing.

If one aims to compare the level of international consumption risk sharing among different household groups, the group's sensitivity to the country-level shocks can be captured with the following specification:

$$\Delta c_{i,j,t} - \Delta c_{A,t} = \theta_i + \beta_i(\Delta y_{j,t} - \Delta y_{A,t}) + \gamma_i w_{i,t} + u_{i,t} \tag{1.1}$$

where c and y stand for the log of consumption and GDP respectively, i stands for a specific household group in country j, and A stands for the global average. Of the two independent variables, $\Delta y_{j,t} - \Delta y_{A,t}$ is country j's output growth deviation from the global average, a measure of its country-specific shock. $w_{i,t}$ is the cyclical component of each group's income that controls for group-specific shocks. The dependent variable $\Delta c_{i,j,t} - \Delta c_{A,t}$ is group i's consumption growth deviation from the global average. θ_i is interpreted as the group-specific long-run average of its consumption growth deviation from global average. β_i represents how much the group's consumption growth deviates from the global average when their country's output growth leads or lags behind the global GDP average. γ_i is group i's consumption sensitivity towards group-specific shocks. $u_{i,t}$ is the error term.

β_i is of primary interest for our study as it represents the group's consumption sensitivity to country-level shocks. International consumption risk sharing is rejected if it is significantly greater than 0 as it means that the household is responsive to country-level shocks.

Lewis (1999) and Sorensen et al. (2007) both have tests similar to (1.1). But there are two key differences between our specification and theirs. First, their primary interest is in comparing the consumption's sensitivity to country shocks over time. As a result, they pool all countries together and run a cross section regression each year to compare β_t for each t. They implicitly assume that at any point in time, every country has the same sensitivity to country-specific shocks, but the sensitivity might change over time. The second difference is that they do not control for the group-specific shocks represented by the cyclical component of income and therefore the third term on the right hand side does not appear in their specification. But for our purpose of comparing the level of risk sharing between groups, Equation (1.1) implies that each group has the same response to the shocks over the test period and β_i's are compared for different i's.

Besides the total consumption, we further single out the consumption of durable goods and compare it to the consumption of everything else. This first facilitates the comparison with Mace (1991) in the domestic consumption risk sharing literature. In addition, due to the special roles played by durable goods, there is a growing literature that investigates its properties and effect on non-durables and portfolio choice both theoretically and empirically. Fernandez-Villaverde and Krueger (2011) have a very extensive review on durable goods consumption in the life cycle. Examples of recent empirical study such as Browning and Crossley (2009) and Parker, Souleles, Johnson, and McClelland (2013) focus on how households change their consumption of durable goods differently than that of other goods in respond to shocks.

In the Arrow-Debreu model, households share risks by purchasing contingent claims. It would be natural to assume that households that participate in foreign equity markets can better insure against country-specific shocks. If one seeks to measure the impact of asset cross-holdings on international consumption risk sharing, the ideal approach is to randomly assign asset holding status to a sample of households and compare the β_i between the foreign asset holders and non-holders.

The difficulty of adopting such a straightforward method arises from the lack of household level data with both asset holding and consumption dimensions. For the US, the CEX has detailed consumption information but does not distinguish between either stock and bond holdings or domestic and foreign holdings. The Panel Study of Income Dynamics (PSID) has detailed financial accounts for households and has a panel structure but only includes food consumption. The Survey of Consumer Finances (SCF) has a 3-year frequency which renders statistical inferences powerless. Japan can be another example: Japan's FIES does not publish financial assets at all and Nikkei Radar survey only asks questions on financial holdings.

With the SCF data from 1998, 2001, 2004, and 2007, Nechio (2014) shows that income level is a good predictor of both foreign and domestic equity holding. Therefore, if indeed holding foreign assets helps household insure against country-level risks effectively, higher income households should demonstrate a smaller response to such risks. And since both CEX and FIES have consumption and income information, the finding in Nechio (2014) suggests that income can be used to distinguish households with a higher probability to hold foreign stocks from those with a lower probability. When households are divided into groups according to their income, the higher income group is expected to have a higher level of international consumption risk sharing than the lower income group, since they are more likely to invest in foreign assets.

1.3 Data and Summary Statistics

We use FIES database for Japan and CEX for the US in our study. The FIES is administered by Statistics Bureau of Japan, and the bureau collects detailed household income and expenditure information, along with demographics. Every six months, a sample of roughly 9,000 households is surveyed monthly to represent all but one-person student households in Japan. Households are asked to keep records of daily income and expenditures in a special-purpose account book. Unfortunately, micro-data is not available due to privacy concerns. However, the bureau releases a tabulated dataset that reports the average of income and consumption expenditures for each income quintiles. The quintiles are divided based on each household's annual income summarized at the end of each households' survey period. The aggregation of durables, nondurables, services, and total consumption is readily tabulated by the data publisher, and is directly adopted in this study. Currently, we have quarterly data from 2002Q1 to 2014Q2.

On the other hand, the US data is much more detailed. The CEX is conducted by the US Bureau of Labor Statistics and contains information about income and the complete range of expenditures of roughly 5,000 households that represent the entire US population. The interview component of the CEX adopts a staggered rotating panel structure: 20% of the sample is replaced by new households every quarter and quarterly interviews are distributed among each month. Each household is given five interviews. The first interview is for baseline only and is not included in the data. In all of the four interviews that follow, households are asked to provide all the expenditures in the three previous months. But income information is only collected in the second and the fifth interviews. The procedure might result in an out-of-sync income ranking and we need to take this into account when we interpret the results. Each sample household in the CEX has a weight ω that corresponds to the number of households in the US population the sample household represents. The weighted average consumption can be calculated as $\sum_{i=1}^{n} \omega_i C_i / \sum_{i=1}^{n} \omega_i$ for n households in the quintile at any point in time. The US data is available from 2001Q1 to 2014Q4.

To conform with the FIES income-consumption structure, households in the CEX are divided into income quintiles and the quintile consumption is the weighted average consumption of all households in each quintile. Consumption levels from both countries are adjusted for inflation with consumer price index (CPI) series from the International Financial Statistics database provided by the International Monetary Fund (IMF). Consumption growth is calculated as the first difference of the log of consumption levels.

For the global average output and consumption, we use the GDP and total consumption series for G7 countries published by the Organization for Economic Co-operation and Development (OECD), as this is a group of large advanced economies with developed financial markets. Country-level GDP and consumption series for the US and Japan are obtained from the same database. As the OECD only publishes seasonally adjusted series, our group growth rates are also calculated after the consumption levels are stripped off the seasonal component using STL decomposition by Cleveland, Cleveland, and Terpenning (1990).

Table 1.1: Summary Statistics of US Household Consumption Growth Rates (%)

		Min	**Max**	**Median**	**Mean**	**St. Dv.**
Total	**Average**	-3.94	5.13	-0.08	0.00	1.73
	Quint 1	-10.60	39.20	0.31	0.90	7.53
	Quint 2	-9.62	7.71	0.05	-0.31	3.84
	Quint 3	-6.68	5.12	-0.20	-0.16	2.88
	Quint 4	-4.54	6.13	-0.25	-0.13	2.37
	Quint 5	-7.10	5.38	0.43	-0.05	2.30
Durables	**Average**	-26.41	15.87	-0.16	-0.65	8.09
	Quint 1	-76.33	92.30	-2.37	0.39	39.50
	Quint 2	-44.86	59.03	-1.57	-1.09	23.87
	Quint 3	-49.99	39.11	0.82	-0.63	20.64
	Quint 4	-40.34	31.40	0.96	-0.66	14.51
	Quint 5	-28.60	23.45	-0.53	-0.85	13.19
Others	**Average**	-2.30	6.00	-0.22	0.08	1.62
	Quint 1	-8.04	36.69	-0.30	0.96	6.45
	Quint 2	-6.58	6.41	-0.42	-0.23	2.84
	Quint 3	-6.58	4.28	-0.25	-0.10	2.24
	Quint 4	-4.35	5.16	0.29	-0.06	2.08
	Quint 5	-4.61	5.36	-0.17	0.05	2.07

Note: Each series contains 55 quarterly growth rates from 2001Q2 to 2014Q4

Several observations can be made from the summary statistics in Table 1.1. There is a huge jump in consumption growth of the lowest quintile (Quintile 1). Their consumption has a maximum quarterly growth of 39%, 92%, and 37% in "total", "durables", and "others" categories, all of which are reached simultaneously in 2014Q1, when a large number of high-spending households entered the lowest income quintile.

In Table 1.1, for total consumption, the highest earning households (Quintile 5) demonstrate the lowest growth volatility. Also, from the negative and small positive means and medians, the cumulative growth over the 14-year period for US households is very small, if not negative. The growth for durable consumption is much more volatile, with the steepest drop reaches -76% in a quarter for the lowest-earning households. Again, the volatility monotonically decreases as household's income increases. The consumption category "others" includes mainly nondurables and services, which are mostly recurring purchases. So, it is unsurprising to see a lower volatility and a narrower range than the total consumption. The volatility, once again, decreases as we move to higher income quintiles.

Table 1.2 describes the consumption growth of Japanese households. First, we see the same volatility rankings among different consumption categories; durables consumption is the most volatile, others the least, with the total in between. And again, the highest earning households have the lowest volatility in durables consumption. But now both the "others" and "total" categories have median households (Quintile 3) as the steadiest grower. What is also notable is that every single mean is now negative.

There is no clear pattern in comparing Tables 1.1 and 1.2 in general. Compared with their US counterparts, Japanese households have more volatility in total (2.01% vs 1.76%) and durables (11.52% vs 8.24%), but have a slightly smoother growth (1.63% vs 1.64%) in consuming everything else.

Table 1.3 summarizes the aggregate series. Immediately noteworthy is how low the standard deviations are. The US and Japanese GDP growths are less volatile (standard deviation 0.64% and 1.16% respectively) than any household group (including the total

Table 1.2: Summary Statistics of Japanese Household Consumption Growth Rates (%)

		Min	Max	Median	Mean	St. Dv.
Total	**Average**	-8.74	4.64	0.21	-0.24	2.01
	Quint 1	-10.32	6.94	0.30	-0.19	3.89
	Quint 2	-6.94	6.88	0.06	-0.27	3.03
	Quint 3	-7.12	4.35	-0.45	-0.21	2.30
	Quint 4	-9.02	6.31	-0.21	-0.31	2.82
	Quint 5	-10.46	5.19	0.14	-0.20	2.76
Durables	**Average**	-43.37	21.40	-1.27	-0.38	11.52
	Quint 1	-68.99	60.15	5.55	-0.54	32.59
	Quint 2	-47.82	46.06	0.92	-0.78	20.19
	Quint 3	-40.41	50.76	-3.09	-0.62	20.19
	Quint 4	-55.52	43.96	2.92	-0.29	18.58
	Quint 5	-47.45	34.20	-3.47	-0.13	17.38
Others	**Average**	-6.44	3.62	-0.12	-0.23	1.63
	Quint 1	-8.08	4.67	0.15	-0.18	3.22
	Quint 2	-5.88	5.57	-0.26	-0.24	2.65
	Quint 3	-4.90	3.93	0.08	-0.18	2.04
	Quint 4	-7.92	6.09	-0.07	-0.31	2.33
	Quint 5	-7.31	4.16	0.00	-0.21	2.30

Note: Each series contains 49 quarterly growth rates from 2002Q2 to 2014Q2

Table 1.3: Summary Statistics of Aggregate Growth Series (%)

	Min	Max	Median	Mean	St. Dv.
G7 GDP	-2.27	1.09	0.49	0.34	0.60
G7 Consumption	-1.07	0.94	0.42	0.39	0.37
US GDP	-2.11	1.68	0.56	0.44	0.64
JP GDP	-4.09	2.66	0.30	0.17	1.16

Note: Each series contains 56 quarterly growth rates from 2001Q1 to 2014Q4

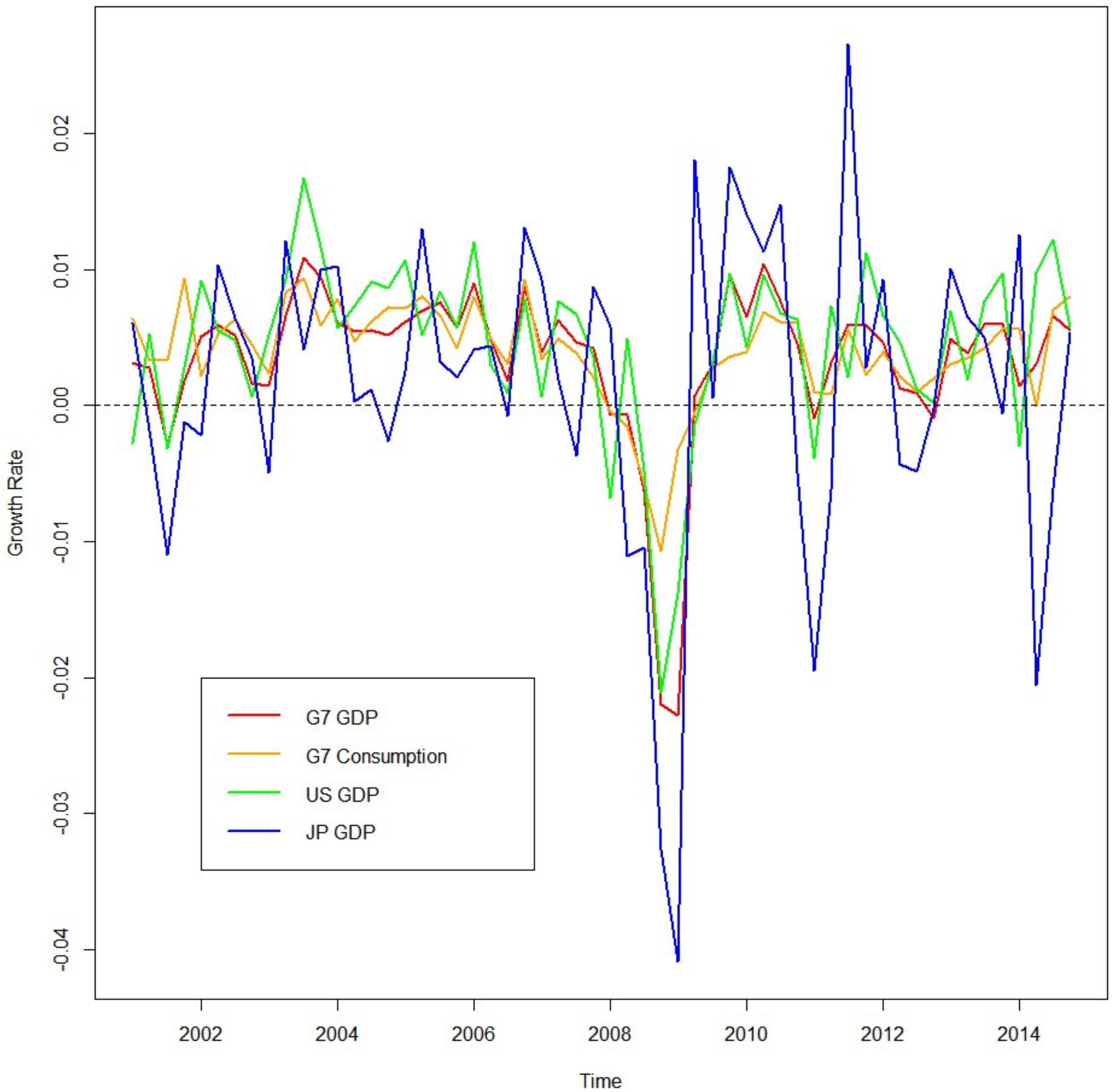

Figure 1.1: Aggregate Growth Rates

average) in any consumption category. And yet the G7 GDP and consumption are even smoother. It is not difficult to imagine the deviations around the aggregate consumption growth for the household quintiles. Also, all the means and medians of the aggregate series are positive, compared to a generally negative pattern in Tables 1.1 and 1.2. The difference in volatility can be seen in Figure 1.1. Japanese GDP fluctuates the most among the four aggregate series whereas G7 consumption is the smoothest. The three GDP series are strongly correlated, more so after the Great Recession than before.

1.4 Regression Results

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test is applied to every series on both the left- and right-hand side of Equation (1.1) and and stationarity cannot be rejected for any series[3]. We apply a GLS regression with AR(1) residuals to account for serial correlation. Regression coefficients are recorded in Tables 1.4 and 1.5. Also recorded are each regression's number of observation, Akaike information criterion (AIC), and the log likelihood.

1.4.1 US households

Table 1.4 suggests some intriguing patterns of the US households. First, the appearance of negative β's is puzzling. Households in Quintiles 1, 2, 3, and 4 have negative responses to US-specific shocks in at least one of the three consumption categories. Because of the negative coefficients and for the sake of consistency, every significance in this section, including that of the positive values, is based on two-tailed tests[4]. Due to the high standard error of these estimates, the null hypothesis of a zero coefficient cannot be rejected in any

[3]Some series fail to pass the Augmented Dickey-Fuller test, but their highest AR(1) coefficient is less than 0.25. Therefore, in our case, the KPSS seems more appropriate.

[4]It is straightforward to convert the significance between one-tailed and two-tailed tests; the p-value in a one-tailed test is simply one half of the p-value of the two-tailed test. Coefficients with one asterisk have significance at 10% in a two-tailed test and 5% in a one-tailed test.

Table 1.4: US Consumption Risk Sharing Regression Coefficients

		Coeficients			Goodness-of-fit			
		Total	Durables	Others		Total	Durables	Others
Average	**Intercept**	-0.006*** (0.002)	-0.018** (0.009)	-0.004*** (0.002)	**n**	55	55	55
	β	1.737** (0.659)	7.850** (3.473)	1.365** (0.659)	**AIC**	-302.910	-122.100	-304.589
	γ	0.099 (0.064)	0.131 (0.348)	0.105 (0.065)	**LogLik**	156.455	66.050	157.294
Quint1	**Intercept**	0.003 (0.011)	-0.006 (0.035)	0.002 (0.011)	**n**	55	55	55
	β	-0.986 (2.980)	-0.457 (15.258)	-0.780 (2.317)	**AIC**	-135.161	44.462	-156.130
	γ	0.145*** (0.035)	0.327** (0.128)	0.142*** (0.033)	**LogLik**	72.581	-17.231	83.065
Quint2	**Intercept**	-0.006* (0.003)	-0.013 (0.018)	-0.005 (0.003)	**n**	55	55	55
	β	-0.090 (1.484)	1.725 (8.381)	-0.136 (1.252)	**AIC**	-214.767	-20.393	-237.637
	γ	0.184*** (0.055)	0.502 (0.305)	0.158*** (0.052)	**LogLik**	112.384	15.197	123.819
Quint3	**Intercept**	-0.006* (0.003)	-0.004 (0.017)	-0.006** (0.003)	**n**	55	55	55
	β	0.593 (1.208)	-5.480 (7.729)	1.353 (0.969)	**AIC**	-238.116	-28.763	-264.610
	γ	0.157** (0.065)	0.349 (0.395)	0.154** (0.059)	**LogLik**	124.058	19.382	137.305
Quint4	**Intercept**	-0.006** (0.003)	-0.019 (0.017)	-0.004** (0.002)	**n**	55	55	55
	β	0.640 (1.066)	9.580 (6.559)	-0.202 (0.825)	**AIC**	-253.334	-53.580	-277.453
	γ	0.088 (0.105)	0.448 (0.648)	0.059 (0.075)	**LogLik**	131.667	31.790	143.726
Quint5	**Intercept**	-0.007*** (0.002)	-0.024** (0.011)	-0.005** (0.002)	**n**	55	55	55
	β	2.229** (0.842)	12.882** (4.870)	1.303 (0.909)	**AIC**	-275.464	-82.236	-272.187
	γ	0.082 (0.093)	0.348 (0.540)	0.060 (0.104)	**LogLik**	142.732	46.118	141.094

Notes: Standard errors are in the parentheses
, **, and * stand for two-tailed significance at 10%, 5%, and 1% levels*

of the negative cases.

A striking revelation is that our evidence does not agree with the expectation of "more income, more foreign asset, therefore more risk sharing". US households demonstrate the opposite pattern, with risk sharing rejected only for the highest earning households at 5% level. Their total consumption's high sensitivity is largely driven by the durables consumption, which exceeds G7 average by almost 13% when US GDP leads G7 GDP by 1%. Recall from the last section that the highest earning US households have the lowest volatility in both total and durables consumption. The regression coefficients show that even though the highest quintile households' total and durables consumption growths do not fluctuate as much as those of other households, the fluctuation synchronizes with US-specific shocks to a very high degree. The overall rejection of risk sharing for an average US household's total consumption (1.737 with significance at 1%) is largely attributed to the high sensitivity of the highest quintile, which in turn is driven by its tremendously high sensitivity in durables consumption.

Also, an average US households' sensitivity to US-specific shocks is higher in durables consumption than in other consumption (7.850 vs 1.737, both at two-tailed 5%). This is in drastic contrast with Mace (1991) who rejects risk sharing for nondurables but not for durables. But this contrast does not necessarily mean contradiction, as the definition of "aggregate shock" is different under different settings. Mace (1991) implicitly views the US as the only economy and investigates if US households can insure against idiosyncratic shocks (i.e. job loss, injury, etc.). In that universe, synchronizing one's consumption with country-level shocks is considered effective risk sharing, as those shocks are the top-level aggregate shocks. The evidence that US durables consumption highly correlates with US country-level shocks is interpreted as in favor of effective risk sharing in the US-only universe. But in a global context, country level shocks are now one of the "non-aggregate" shocks one seeks to hedge against whereas the global shocks (shocks to G7 average GDP in our particular case) is the new "aggregate". The high correlation is now proof against effective international risk sharing among households from different countries.

We can interpret durables' high sensitivity towards country-level shocks as one of households' mechanisms of achieving smoother consumption in other goods. Households only buy cars and home appliances when the country's economy is doing well and stick to their older existing ones otherwise, so that their consumption of everyday goods and services can be relatively smoother. The difference of standard deviations of durables and others in Table 1.1 may be the result of this consumption behavior.

The income coefficients γ, on the other hand, do not raise contradiction to our expectations as the β's. For the total consumption, the lower four quintiles significantly respond to their respective income shocks at the 0.27 to 0.46 range, while we cannot reject the hypothesis that the highest earning households are relatively immune to change in income.

Note that the intercepts for all the regressions are consistently negative, though of various significance. This suggests that in the long run, the US consumption grows at a slower pace than the global average.

Nechio (2014) has established the positive predictive power of income level on foreign asset holdings for US households. But the evidence raises the question why more foreign asset participation cannot improve international consumption insurance. It might be that asset cross-holdings are not effective risk sharing mechanisms, contrary to what the theory suggests. Another possible explanation is that the highest income households have the highest exposure to country-level shocks to begin with. Parker and Vissing-Jørgensen (2009) show that higher earning households disproportionately bear more of the country risks. In addition, the results of Nechio (2014) also suggest that the highest earning households have the highest probability of owning domestic stocks, so they might be more exposed to US-specific risks through owning either more US stocks or US businesses. Future studies on international consumption risk sharing need to consider measuring the various levels of exposure, as it may require a smaller or larger share of foreign stock holdings to insure.

1.4.2 Japanese Households

In Table 1.5, the 3rd quintile exhibits the lowest sensitivity to Japanese country shocks for total consumption. Again, recall from the last section that the median Japanese households have the lowest volatility in total consumption. Now they are shown to have the lowest sensitivity to country-level shocks. This suggests that even though they all fail to insure consumption effectively, the median households respond to country shocks to the smallest degree. Meanwhile, Quintile 2 has the highest sensitivity to country-level shocks in all consumption categories. Similar to the highest earning US households, Quintile 5 here is also has a very high response to country-level shocks in durables consumption. The driving force of durables consumption is even more produced in Quintile 2.

The Japanese households can overall hedge against group-specific shocks relatively well except for the lowest two quintiles. And for the lower earning households, their sensitivity mainly come from their consumption other than durable goods; it is possible that they cannot afford to use durables as a way to smooth out nondurable consumption due to their low income.

Again, the evidence suggests that the highest earning households are not doing any better in insuring against country-level risks. Like in the US case, it is possibly due to their higher exposure to the Japanese country shocks, but on the other hand, unlike in the US case where Nechio (2014) confirms the predictive power of income on asset holdings, income's effect on Japanese households' asset holding is open to question, which is answered in Chapter 2.

1.4.3 Alternative specification without income component

As mentioned in Section 1.2, a commonly used specification (Lewis, 1999; Sorensen et al., 2007) does not account for the group-specific income component in Equation (1.1).

Table 1.5: Japanese Consumption Risk Sharing Regression Coefficients

		Coeficients				Goodness-of-fit		
		Total	**Durables**	**Others**		**Total**	**Durables**	**Others**
Average	**Intercept**	-0.004*** (0.001)	0.003 (0.009)	-0.005*** (0.001)	**n**	49	49	49
	β	0.876*** (0.221)	6.254*** (1.537)	0.617*** (0.205)	**AIC**	-272.341	-88.698	-283.629
	γ	0.238* (0.133)	0.582 (0.980)	0.211 (0.127)	**LogLik**	141.170	49.349	146.815
Quint1	**Intercept**	-0.004 (0.003)	0.003 (0.027)	-0.005 (0.003)	**n**	49	49	49
	β	1.008* (0.555)	7.778* (4.620)	0.729 (0.476)	**AIC**	-188.649	20.087	-204.484
	γ	0.450* (0.245)	0.965 (2.020)	0.436** (0.212)	**LogLik**	99.325	-5.044	107.242
Quint2	**Intercept**	-0.004 (0.003)	0.004 (0.021)	-0.005** (0.002)	**n**	49	49	49
	β	1.674*** (0.427)	11.810*** (3.104)	1.110*** (0.386)	**AIC**	-220.077	-26.188	-228.907
	γ	0.866*** (0.296)	2.949 (2.256)	0.746*** (0.262)	**LogLik**	115.039	18.094	119.453
Quint3	**Intercept**	-0.004** (0.002)	-0.002 (0.020)	-0.004** (0.002)	**n**	49	49	49
	β	0.836** (0.339)	3.397 (3.212)	0.639** (0.292)	**AIC**	-238.247	-17.555	-251.970
	γ	0.367 (0.237)	2.240 (2.241)	0.264 (0.201)	**LogLik**	124.124	13.778	130.985
Quint4	**Intercept**	-0.004** (0.002)	0.001 (0.015)	-0.005*** (0.002)	**n**	49	49	49
	β	1.249*** (0.353)	4.798* (2.590)	1.040*** (0.289)	**AIC**	-230.293	-35.918	-249.315
	γ	0.319 (0.219)	1.159 (1.622)	0.270 (0.179)	**LogLik**	120.146	22.959	129.658
Quint5	**Intercept**	-0.004 (0.003)	0.007 (0.017)	-0.005** (0.002)	**n**	49	49	49
	β	0.921** (0.425)	7.609*** (2.708)	0.413 (0.361)	**AIC**	-218.976	-37.708	-234.209
	γ	0.064 (0.169)	-0.409 (1.089)	0.092 (0.142)	**LogLik**	114.488	23.854	122.104

Notes: Standard errors are in the parentheses
, **, and * stand for two-tailed significance at 10%, 5%, and 1% levels*

Table 1.6: US Risk Sharing Regression w/o Income component

		Coeficients				Goodness-of-fit		
		Total	**Durables**	**Others**		**Total**	**Durables**	**Others**
Average	**Intercept**	-0.006***	-0.019**	-0.005***	**n**	55	55	55
		(0.002)	(0.009)	(0.002)	**AIC**	-302.454	-123.951	-303.998
	β	1.662**	7.800**	1.272*	**LogLik**	155.227	65.976	155.999
		(0.665)	(3.442)	(0.664)				
Quint1	**Intercept**	0.006	-0.006	0.007	**n**	55	55	55
		(0.012)	(0.038)	(0.012)	**AIC**	-121.708	48.961	-141.353
	β	-1.197	4.324	-1.443	**LogLik**	64.854	-20.480	74.677
		(3.388)	(15.964)	(2.720)				
Quint2	**Intercept**	-0.005	-0.012	-0.005	**n**	55	55	55
		(0.004)	(0.019)	(0.003)	**AIC**	-206.576	-19.630	-230.812
	β	-1.486	-2.537	-0.986	**LogLik**	107.288	13.815	119.406
		(1.576)	(8.163)	(1.309)				
Quint3	**Intercept**	-0.006*	-0.005	-0.006**	**n**	55	55	55
		(0.003)	(0.017)	(0.003)	**AIC**	-234.454	-29.951	-259.835
	β	0.174	-6.867	0.955	**LogLik**	121.227	18.976	133.918
		(1.249)	(7.559)	(1.005)				
Quint4	**Intercept**	-0.006**	-0.019	-0.004**	**n**	55	55	55
		(0.003)	(0.016)	(0.002)	**AIC**	-254.592	-55.078	-278.799
	β	0.496	8.845	-0.307	**LogLik**	131.296	31.539	143.399
		(1.049)	(6.437)	(0.812)				
Quint5	**Intercept**	-0.007***	-0.024**	-0.005**	**n**	55	55	55
		(0.002)	(0.011)	(0.002)	**AIC**	-276.660	-83.801	-273.839
	β	2.038**	12.064**	1.164	**LogLik**	142.330	45.900	140.920
		(0.811)	(4.674)	(0.870)				

Notes: Standard errors are in the parentheses
, **, and * stand for two-tailed significance at 10%, 5%, and 1% levels*

Table 1.7: Japanese Risk Sharing Regression w/o Income Component

		Coeficients				Goodness-of-fit		
		Total	**Durables**	**Others**		**Total**	**Durables**	**Others**
Average	**Intercept**	-0.004***	0.003	-0.005***	**n**	49	49	49
		(0.001)	(0.009)	(0.001)	**AIC**	-271.188	-90.330	-282.861
	β	0.940***	6.361***	0.668***	**LogLik**	139.594	49.165	145.430
		(0.229)	(1.523)	(0.210)				
Quint1	**Intercept**	-0.004	0.003	-0.004	**n**	49	49	49
		(0.003)	(0.027)	(0.003)	**AIC**	-187.226	18.322	-202.200
	β	0.888	7.482	0.628	**LogLik**	97.613	-5.161	105.100
		(0.562)	(4.543)	(0.488)				
Quint2	**Intercept**	-0.004	0.003	-0.005*	**n**	49	49	49
		(0.003)	(0.020)	(0.002)	**AIC**	-213.791	-26.445	-222.984
	β	1.333***	10.730***	0.809**	**LogLik**	110.895	17.222	115.492
		(0.440)	(3.026)	(0.398)				
Quint3	**Intercept**	-0.004**	-0.003	-0.005**	**n**	49	49	49
		(0.002)	(0.020)	(0.002)	**AIC**	-237.791	-18.520	-252.166
	β	0.812**	3.151	0.618**	**LogLik**	122.895	13.260	130.083
		(0.344)	(3.216)	(0.294)				
Quint4	**Intercept**	-0.005**	0.001	-0.005***	**n**	49	49	49
		(0.002)	(0.015)	(0.002)	**AIC**	-230.132	-37.381	-249.010
	β	1.290***	4.887*	1.076***	**LogLik**	119.066	22.690	128.505
		(0.360)	(2.580)	(0.296)				
Quint5	**Intercept**	-0.004	0.006	-0.005**	**n**	49	49	49
		(0.003)	(0.016)	(0.002)	**AIC**	-220.826	-39.558	-235.768
	β	0.961**	7.370***	0.471	**LogLik**	114.413	23.779	121.884
		(0.410)	(2.611)	(0.350)				

Notes: Standard errors are in the parentheses
, **, and * stand for two-tailed significance at 10%, 5%, and 1% levels*

For robustness check, we drop our income variable as well. The results are reported in Tables 1.6 and 1.7.

All the significant β estimates in Tables 1.4 and 1.5 remain significant in Tables 1.6 and 1.7, and have very similar values. The disconnect between income and international risk sharing is still apparent in both the US and Japanese households.

1.5 Concluding Remarks

In order to look into the relationship between asset cross-holdings and international consumption risk sharing, we investigate the level of consumption insurance between households with different income levels, using income as an indicator for the probability of foreign asset holdings. Although Nechio (2014) claims the positive relationship between income and foreign asset holding, our analysis shows that the highest-earning US households have the lowest level of international consumption insurance. This suggests that asset cross-holdings are either inadequate at the current level or ineffective. Either highest earners might bear more country-level risks and need a greater share of foreign assets in their household portfolio to hedge the risk, or asset holdings itself is not as effective in risk sharing as suggested by the theory. Future studies on consumption risk sharing need to start with measuring the different exposure to the shocks for different households, and consider its relationship with the necessary level of foreign stock holdings.

On the other hand, Japanese households' income–risk sharing relationship is more complicated and puzzling. While risk sharing is rejected for all but the lowest income quintile, the median households show the lowest sensitivity to Japan-specific shocks. Unlike in the case of the US households with Nechio (2014) establishing income as a reliable predictor for asset holdings, we cannot be certain for the Japanese households whether the lack of relationship between income and risk sharing is due to income's poor predictive power or it is because asset cross-holdings are not an effective consumption insurance mechanism.

Chapter 2

Japanese Households' Asset Holding Decision

Abstract

Evidence in Chapter 1 does not support any positive relationship between income and international consumption risk sharing. In this chapter, we further investigate Japanese households' portfolio choice by performing a logit regression. We show that income is a weak predictor of asset cross-holdings. The regression also suggests total asset value, savings deposit, and business ownership as strong predictors of Japanese households' foreign stock market participation.

2.1 Introduction

In comparison to the extensive literature of US households' asset participation decision, Japanese households' asset participation decision is not as fully studied. Iwaisako (2009) provides a detailed and valuable investigation of Japanese household portfolio decisions but the study is mostly descriptive and does not consider income. We provide an investigation of Japanese households' portfolio decision by performing a logit model on the 2013 dataset from the Nikkei Radar database.

Recall from Chapter 1 that if the evidence fails to establish a positive relationship between income level and international consumption risk sharing, there are two possible explanations: first, income as a predictor for foreign asset holdings is not good enough (henceforth Hypothesis 1), or secondly, income is a good predictor, but foreign asset holdings are either inadequate or ineffective to completely insure against country-level shocks (Hypothesis 2).

Our evidence from the logit model confirms Hypothesis 1 for Japanese households; unlike the US, income is not a good predictor of Japanese households' foreign asset holdings. But income is a strong predictor of direct domestic stock holdings. We also discover that generally speaking, unsurprisingly, total asset value reliably predicts asset holdings of any kind (both domestic and foreign, bond and equity). Age helps positively predict domestic bond and equity holdings but not so much for foreign ones. Homeownership has a positive and significant effect on both domestic and foreign stock holdings but is powerless in predicting either bond holding, and female household heads seem to demonstrate an aversion of stock investing of any kind. Most interesting is the discovery that employers like to directly invest in foreign stocks but at the same time dislike domestic stocks.

When Hypothesis 1 cannot be rejected for Japanese households, we cannot make any conjecture on the second one. Our logit model reveals several predictors of foreign asset holding decision for Japanese households and this can be helpful for future studies to perform a test of international consumption risk sharing with endogenous foreign asset holding decision.

The next two sections describe the dataset and the methodology. Section 2.4 summarizes the data. Regression results are listed and interpreted in Section 2.5. After the robustness check in Section 2.6, we conclude.

2.2 Data

We use the data from the Nikkei Radar database. Nikkei Radar annually documents detailed cross-sectional portfolio choice from 1,500 to 2,700 households sampled from the five prefectures around the Tokyo metropolitan area. The most attractive feature is that, as far as we know, it is the only Japanese database that distinguishes both between domestic and foreign assets and between direct and indirect holdings. It is a repeated cross section and we are using the 2013 data. The focus on the five out of the 47 prefectures in all of Japan means an over-representation of urban households and an under-representation of rural ones. Iwaisako (2003) compares the household characteristics of Nikkei Radar with other datasets and concludes that it represents the overall population well. We have the asset holding status for the year 2013 along with the 2,680 households' age, occupation, gender of the head, income, and total value of assets. All the asset holding information that we have is binary; we know whether a household holds a particular asset but not the exact amount. The amounts of income and asset holdings are censored into brackets.

2.3 Specification and Methodology

We apply a logit model to investigate a household's portfolio decision. Along with the validity of using income as a proxy for foreign asset holding, we also investigate other possible elements that affect household portfolio choice. For example, Iwaisako (2009) reports that a household's stock market participation decision is heavily influenced by their home ownership status because of the unique Japanese housing market regulations. The logit model can evaluate this hypothesis by including the ownership of both residential and commercial land as regressors. Age, gender, income, and asset are also included. Investing in safe assets such as savings account, and the existence of outstanding debt and mortgage the household needs to pay down could influence portfolio decisions as well. Other predictors are also considered, such as the employment status.

Besides the foreign stocks, other categories of financial assets are also considered for comparison, such as domestic stocks, foreign bonds, and domestic bonds. We also combine domestic and foreign stocks into "all stocks" category to represent investing in either one of the two markets. "All bonds" category is its counterpart for domestic and foreign bonds. For each asset category, we further divide the holdings into direct holdings, holdings through funds, and either of the two.

Some statistical difficulties arise due to the format and property of the dataset. Because the amounts of income and asset are censored, we cannot use them as numerical variables. Instead, we turn them into quintiles, which conforms with our exercise in Chapter 1. Also, due to the relatively small number of households who hold foreign assets, the issues of complete separation and rare event both could potentially bias the estimate. For this reason, we apply penalized likelihood method introduced by Firth (1993).

2.4 Descriptive Statistics

Tables 2.1, 2.2, and 2.3 summarizes the percentage of households in each quintile who are holders of a particular asset class. The averages over all households in the sample are replicated in the first column of every table for comparison with the broken-down percentages. From the entire sample, we can see that domestic stocks, including both direct and indirect holdings, are the most popular investment in financial assets, at 34.93%, far more than any other financial category. 35.86% hold at least one kind of stock, either di-

Table 2.1: Share of Households Holding Assets by Each Asset Quintile

	All	Asset Quintiles				
	Households	**Quint 1**	**Quint 2**	**Quint 3**	**Quint 4**	**Quint 5**
A. Asset Classes (%)						
Foreign Stock Direct	4.55	1.54	3.28	4.62	7.33	12.54
Foreign Stock Fund	9.85	0.86	5.81	8.67	17.03	30.75
Foreign Stock Direct/Fund	12.91	2.40	8.84	12.14	21.98	36.72
Foreign Bond Direct	14.93	3.42	10.10	15.03	24.18	40.30
Foreign Bond Fund	9.25	1.20	3.79	7.80	16.67	30.15
Foreign Bond Direct/Fund	19.51	4.45	12.63	19.94	32.23	53.13
Domestic Stock Direct	31.98	14.90	29.55	37.28	48.35	66.87
Domestic Stock Fund	11.01	2.40	5.56	9.83	18.68	34.03
Domestic Stock Direct/Fund	34.93	16.10	31.06	42.20	53.30	73.13
Domestic Bond Direct	10.11	2.41	5.58	7.02	16.76	33.84
Domestic Bond Fund	7.35	1.03	2.53	6.36	12.82	25.07
Domestic Bond Direct/Fund	15.19	2.93	7.61	12.87	26.34	48.64
All Stock Direct	32.57	15.24	30.30	38.44	49.08	67.46
All Stock Fund	12.72	2.40	7.58	11.27	21.25	38.81
All Stock Direct/Fund	35.86	16.44	32.32	43.35	54.76	73.73
All Bond Direct	21.54	5.69	14.47	20.76	36.10	57.40
All Bond Fund	9.74	1.54	3.79	8.09	17.40	31.94
All Bond Direct/Fund	25.00	6.72	16.75	25.73	41.80	65.56
Savings Deposit	10.94	2.58	3.80	12.50	16.73	35.03
Residential Property	63.54	52.78	66.92	66.28	74.40	84.19
Commercial Land	7.81	3.47	4.87	7.62	13.17	18.54
Paid Off Mortgage	66.47	54.73	52.15	64.33	75.51	87.99
No Other Debt	93.10	88.53	93.18	93.06	96.34	98.81
Real Estate Investment Trust	3.06	0.34	1.26	1.73	5.13	11.34
B. Household Characteristics						
Number of Households	2680	584	396	346	546	335
Average Age	50.67	44.68	48.70	52.45	55.08	60.65
Share of Married Households (%)	81.12	80.14	84.60	83.82	84.80	85.07

Table 2.2: Share of Households Holding Assets by Each Income Quintile

	All Households	Income Quintiles Quint 1	Quint 2	Quint 3	Quint 4	Quint 5
A. Asset Classes (%)						
Foreign Stock Direct	4.55	4.36	2.84	3.98	5.51	8.04
Foreign Stock Fund	9.85	7.80	9.48	8.68	9.38	17.86
Foreign Stock Direct/Fund	12.91	11.70	11.06	11.75	13.05	22.02
Foreign Bond Direct	14.93	10.32	10.90	16.09	14.34	30.65
Foreign Bond Fund	9.25	8.94	7.90	8.68	8.46	16.07
Foreign Bond Direct/Fund	19.51	15.37	15.96	20.98	18.20	35.71
Domestic Stock Direct	31.98	22.25	27.33	32.19	37.50	53.87
Domestic Stock Fund	11.01	9.17	9.79	10.31	9.56	21.73
Domestic Stock Direct/Fund	34.93	25.23	29.86	34.36	40.81	58.33
Domestic Bond Direct	10.11	9.98	10.16	11.11	9.07	12.57
Domestic Bond Fund	7.35	7.11	6.79	6.87	6.80	12.20
Domestic Bond Direct/Fund	15.19	15.08	14.92	15.66	13.70	21.26
All Stock Direct	32.57	22.71	27.80	32.55	38.42	54.17
All Stock Fund	12.72	9.86	11.85	11.93	11.58	24.11
All Stock Direct/Fund	35.86	26.15	30.96	35.26	41.73	58.63
All Bond Direct	21.54	17.87	17.94	22.59	20.93	36.83
All Bond Fund	9.74	9.40	8.21	9.22	9.38	16.37
All Bond Direct/Fund	25.00	21.35	21.75	26.23	24.07	40.72
Savings Deposit	10.94	7.59	8.74	11.59	12.52	18.26
Residential Property	63.54	49.07	56.82	66.24	73.10	84.80
Commercial Land	7.81	5.84	8.35	7.89	7.05	12.77
Paid Off Mortgage	66.47	90.05	77.62	60.55	47.32	46.69
No Other Debt	93.10	97.48	95.10	91.50	90.44	88.10
Real Estate Investment Trust	3.06	1.61	3.32	3.25	2.39	5.65
B. Household Characteristics						
Size	2680	436	633	553	544	336
Average Age	50.67	54.56	51.82	48.91	48.47	50.20
Share of Married Households (%)	81.12	53.21	78.20	90.96	95.40	94.94

Table 2.3: Share of Households Holding Assets - Employees vs Employers

	All	Employee vs Employer		
	Households	**Unemployed**	**Employees**	**Employers**
A. Asset Classes (%)				
Foreign Stock Direct	4.55	4.85	3.92	7.61
Foreign Stock Fund	9.85	14.12	9.22	4.15
Foreign Stock Direct/Fund	12.91	16.83	11.93	10.03
Foreign Bond Direct	14.93	17.40	14.64	11.42
Foreign Bond Fund	9.25	14.55	7.83	5.54
Foreign Bond Direct/Fund	19.51	24.68	18.55	13.84
Domestic Stock Direct	31.98	36.38	31.63	23.53
Domestic Stock Fund	11.01	15.55	10.18	5.54
Domestic Stock Direct/Fund	34.93	40.37	34.58	24.22
Domestic Bond Direct	10.11	14.39	8.86	6.94
Domestic Bond Fund	7.35	11.41	6.51	3.11
Domestic Bond Direct/Fund	15.19	22.88	13.18	8.68
All Stock Direct	32.57	36.66	32.35	24.22
All Stock Fund	12.72	17.40	11.99	6.57
All Stock Direct/Fund	35.86	40.94	35.66	25.26
All Bond Direct	21.54	26.76	20.46	15.63
All Bond Fund	9.74	15.12	8.37	5.54
All Bond Direct/Fund	25.00	32.66	23.25	17.36
Savings Deposit	10.94	16.14	9.33	8.30
Residential Property	63.54	70.29	61.14	60.42
Commercial Land	7.81	9.42	6.55	9.89
Paid Off Mortgage	66.47	81.75	59.39	70.38
No Other Debt	93.10	97.00	91.87	91.00
Real Estate Investment Trust	3.06	5.14	2.41	1.73
B. Household Characteristics				
Number of Households	2680	701	1660	289
Average Age	50.67	59.52	46.49	52.85
Share of Married Households (%)	81.12	86.16	79.52	78.55

rectly or through funds and that is higher than the 25% to 30% range in Iwaisako (2009), reversing the downward trend in the 1990s reported in his study. Home owners account for 63.54% of the total households, which is roughly in line with the US home ownership of 65% in 2013[1]. However, Iwaisako (2009) reports Japanese home ownership at 39% to 45% during the 1990s, which is significantly lower. We do not have the historical data and cannot explain the discrepancy. Also noteworthy is that Japanese households prefer direct holdings over indirect holdings through funds in all financial asset categories but foreign stocks, which is the only exception; households are twice as likely to hold foreign stocks through funds than directly.

Table 2.1 illustrates how the level of asset is a strong predictor of the holding of every single asset class; higher amount of total asset leads to higher asset holding, no matter which asset it is. There is absolutely no reversal in any stock and bond category. In comparison, income quintiles have many reversals and close values in many categories in Table 2.2; for the three foreign stock categories where our particular interest lies, 3 reversals can be found. Also, Quintile 3, our special case in the last chapter, does not have anything that consistently stands out; in most cases, they are less likely to hold any asset than households with higher income. At least from Table 2.2, the 2013 data does not show anything exceptional for Quintile 3 that can explain what we found in Chapter 1.

Table 2.3 splits households into three groups based on one dimension of occupation: unemployed, employees, and employers. Compared to households that are made up entirely by employees, households that have at least one employer are more likely to directly hold foreign stocks, but their investment in every other bond or stock category is less frequent.

Iwaisako (2009) discovers a hump-shaped age profile of stock holding in the 1990s. But the hump is not present in 2013 data. As can be seen from Figure 2.1, except for a dip in the 70s, the increase in asset holdings is roughly linear with age. Figure 2.2 confirms

[1] Source: US Bureau of the Census

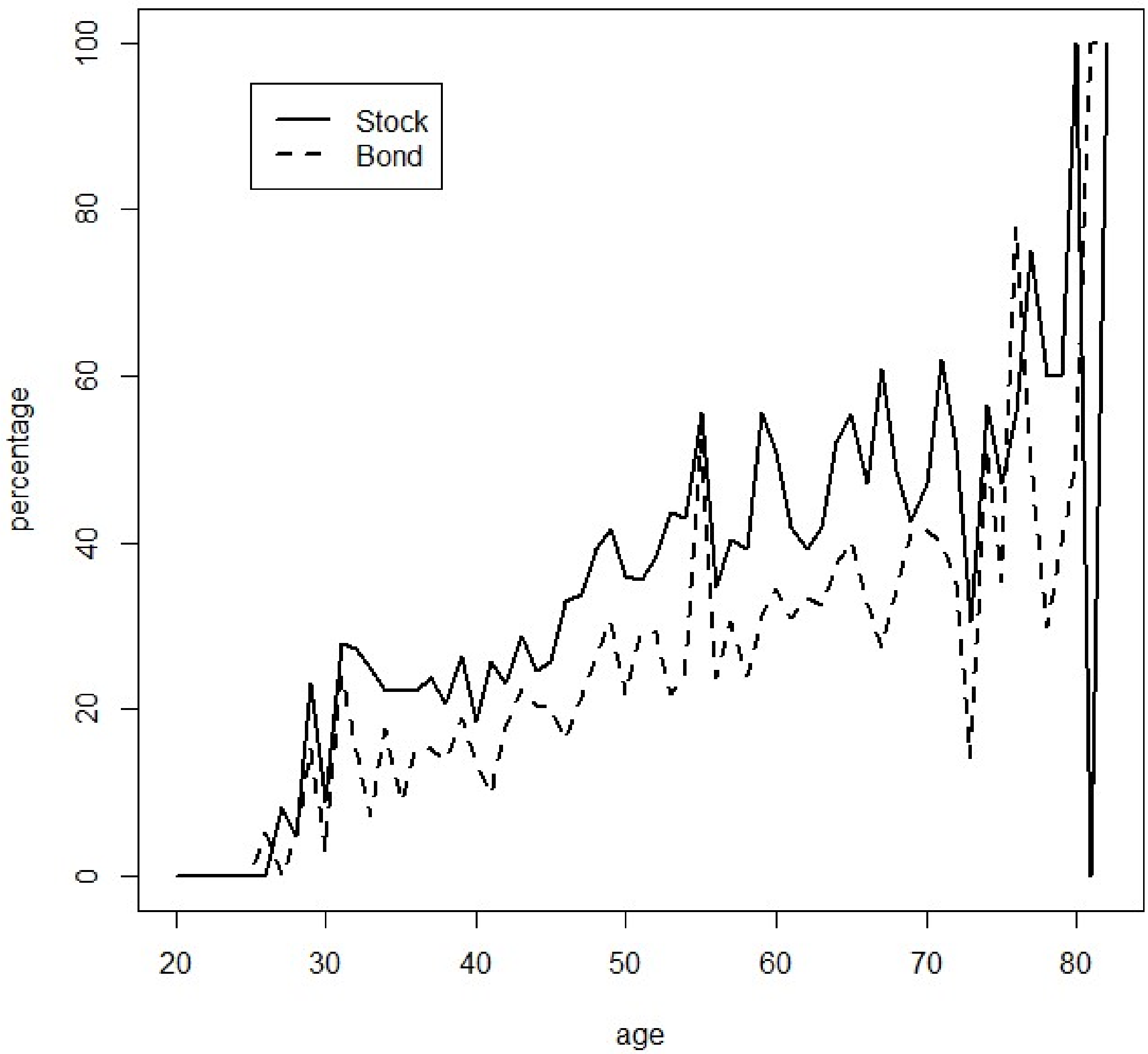

Figure 2.1: Age Profile of Asset Holding for Japanese Households

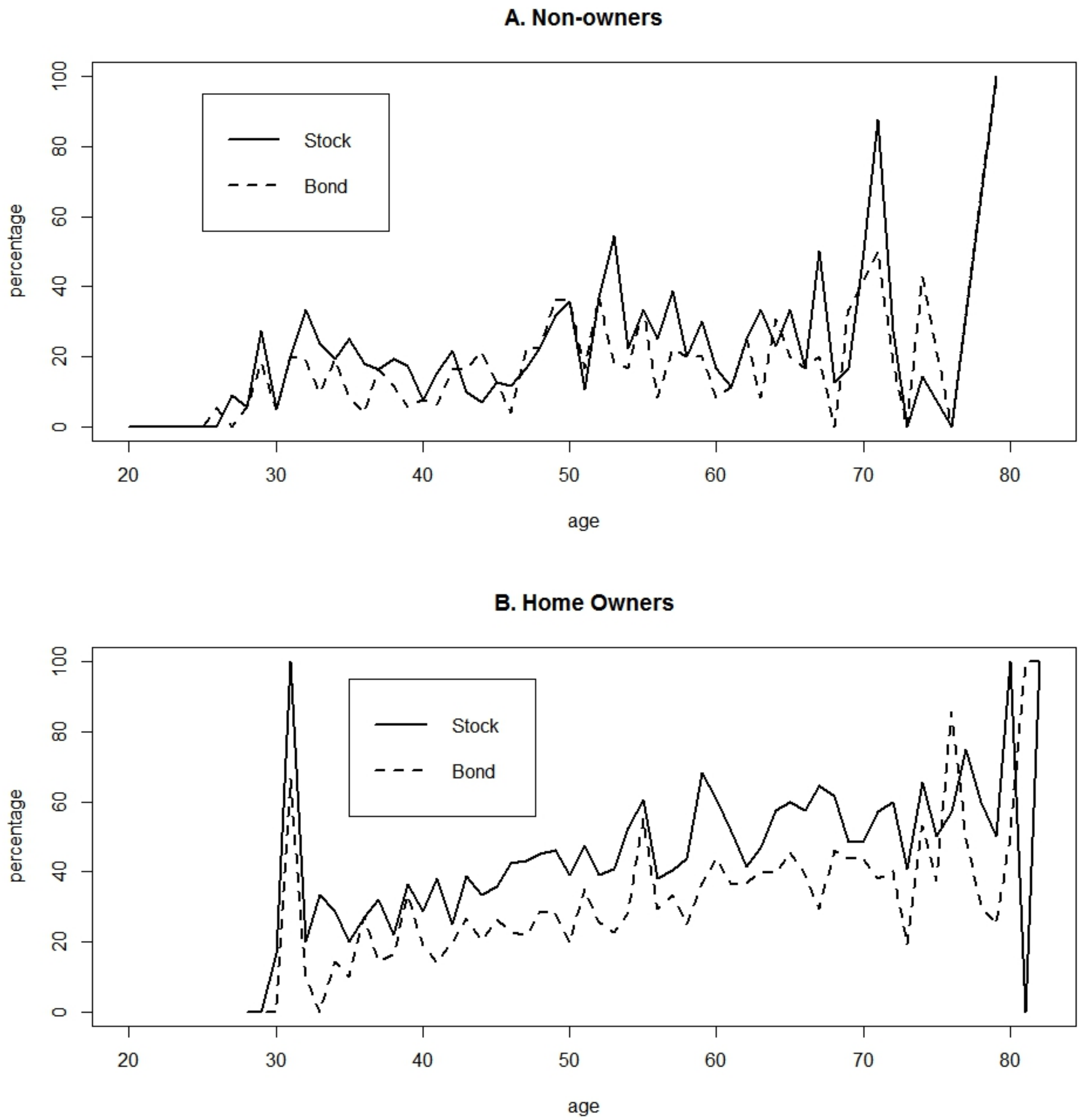

Figure 2.2: Age Profile of Asset Holding: Home Owners vs Non-owners

home ownership's impact on the age profile also found in Iwaisako (2009). The age profile of non-owners is relatively flat and close to zero whereas for homeowners it is higher and increasing. Also, notable from both Figures 2.1 and 2.2 is how stock and bond holdings closely follow each other; they seem to fluctuate together over different age groups.

2.5 Regression Results

Regression coefficients are recorded in Tables 2.4, 2.5, and 2.6. The likelihood ratio test statistics are calculated using Firth's penalized likelihood.

2.5.1 Foreign and Domestic Stock Holding

Table 2.4 reports households' decision in investing in various categories of stocks. Total asset value is an excellent predictor of stock investing, and its impact is nicely monotonic: higher the value, more likely to hold every kind of stock. Asset quintiles' coefficients are among the highest in each regression, representing the highest positive impact on stock holdings. In comparison, income does not perform as well. It is a strong indicator only for direct domestic stock holdings (which drives the combined "D. Stock Direct+Fund" column). It is not significant for foreign asset holdings, direct or indirect, failing all Wald tests[2]. This result supports our suspicion of income as an invalid indicator for foreign asset holdings for Japanese households in Chapter 1. But the regression fails to pinpoint anything special for the 3rd income quintile; we are still unclear why the median earners exhibit the lowest sensitivity to Japan-specific shocks as shown in the last chapter.

Nechio (2014) reports that both income and total asset value are significant and positive in predicting US households' holdings in both domestic and foreign stocks, with asset value being the stronger predictor of the two. However, for Japanese households, income predicts domestic stock holdings but not the foreign ones. Total asset value is a strong

[2] All Wald test results are available upon request.

Table 2.4: Logit Estimation Results - Foreign and Domestic Stock Holdings

	F. Stock Drct+Fnd	F. Stock Direct	F. Stock Fund	D. Stock Drct+Fnd	D. Stock Direct	D. Stock Fund
Income (lowest as base)						
Income Quintile 2	-0.189	-0.673*	0.254	0.301*	0.349*	0.006
	(0.228)	(0.348)	(0.260)	(0.183)	(0.184)	(0.248)
Income Quintile 3	-0.223	-0.496	0.095	0.392**	0.494**	-0.074
	(0.247)	(0.355)	(0.286)	(0.199)	(0.199)	(0.269)
Income Quintile 4	-0.251	-0.271	0.072	0.506**	0.584***	-0.341
	(0.260)	(0.363)	(0.302)	(0.208)	(0.208)	(0.288)
Income Quintile 5	0.031	-0.208	0.490	0.850***	0.896***	0.289
	(0.277)	(0.392)	(0.317)	(0.228)	(0.227)	(0.298)
Asset (lowest as base)						
Asset Quintile 2	1.178***	0.573	1.721***	0.710***	0.708***	0.775**
	(0.321)	(0.431)	(0.475)	(0.169)	(0.171)	(0.352)
Asset Quintile 3	1.316***	0.912**	1.826***	0.983***	0.837***	1.119***
	(0.323)	(0.432)	(0.471)	(0.178)	(0.180)	(0.339)
Asset Quintile 4	1.887***	1.306***	2.376***	1.285***	1.173***	1.670***
	(0.303)	(0.397)	(0.453)	(0.169)	(0.171)	(0.318)
Asset Quintile 5	2.227***	1.695***	2.713***	1.771***	1.574***	2.158***
	(0.329)	(0.440)	(0.473)	(0.210)	(0.208)	(0.342)
Employer vs Employee (unemployed as base)						
Employee	0.165	-0.157	0.175	-0.096	-0.125	0.233
	(0.219)	(0.339)	(0.238)	(0.188)	(0.185)	(0.232)
Employer	0.070	0.812**	-0.623**	-0.489**	-0.385*	-0.446
	(0.259)	(0.345)	(0.321)	(0.213)	(0.210)	(0.298)
Residential Property	0.434**	0.528*	0.361*	0.458***	0.419***	0.198
	(0.190)	(0.299)	(0.214)	(0.137)	(0.138)	(0.203)
Age (household average)	0.006	-0.011	0.015	0.016***	0.018***	0.015*
	(0.008)	(0.012)	(0.010)	(0.006)	(0.006)	(0.009)
Gender (female)	-0.157	-0.591***	0.068	-0.481***	-0.514***	-0.114
	(0.140)	(0.223)	(0.156)	(0.107)	(0.107)	(0.150)
Married (yes)	-0.147	0.244	-0.381	-0.102	-0.093	-0.015
	(0.209)	(0.340)	(0.230)	(0.163)	(0.163)	(0.230)
Savings Deposit	1.329***	0.955***	1.490***	1.729***	1.425***	1.466***
	(0.157)	(0.225)	(0.168)	(0.187)	(0.167)	(0.162)
Other Real Estate	0.074	-0.029	0.028	0.595***	0.492***	0.140
	(0.202)	(0.299)	(0.223)	(0.184)	(0.178)	(0.212)
No Other Debt	0.417	0.056	0.397	-0.426**	-0.371*	-0.127
	(0.354)	(0.457)	(0.415)	(0.206)	(0.205)	(0.330)
Paid Off Mortgage	0.113	0.020	0.214	-0.122	-0.123	-0.041
	(0.180)	(0.257)	(0.208)	(0.136)	(0.136)	(0.195)
Likelihood Ratio Statistics	294.609	98.964	299.541	555.375	478.966	306.970
Degrees of Freedom	18	18	18	18	18	18
p-value (χ^2)	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

predictor in stock holdings of any kind, and it is more powerful than income even when income is significant.

Savings deposit positively and significantly predicts stock holdings of every kind with coefficient values second only to asset quintiles, which is to be expected. One is more likely to invest in risky assets when they have money in the bank, all else being equal.

Home ownership positively predicts all stock holding with various significance (two at 1%, one at 5%, two at 10%, and one insignificant), confirming the pattern described in Iwaisako (2009) and our Figure 2.2. The variable "Paid Off Mortgage" which represents that the household has no outstanding mortgage has no predictive power. On the other hand, real estate other than home has a significant and positive effect on direct domestic stock holding, whereas households with no other debt are less likely to directly invest in domestic stocks.

Employer status is of particular interest in Table 2.4. As the summary statistics pointed out in Table 2.3, if a household owns a business, it is less likely to invest in every kind of stock except for direct holdings of foreign stocks. Guvenen (2007) argues that, in a one-country setting, business owners shoulder heavy risks that cannot be easily diversified by investing in stocks. We conjecture that since both their own business and domestic stocks are exposed to domestic country-level shocks, if business owners intends to diversify, they might invest away from domestic stocks and into foreign stocks. Although the estimate is negative for foreign stock fund holding, direct investing better reflects the household's own willingness to invest abroad compared to indirect investing.

In comparison, business ownership has a different effect on US households. Nechio (2014) reports that US households are significantly less likely to hold both domestic and foreign stocks when they own a business, while Japanese business owners like to diversify into foreign stocks in our results.

Age seems to only matter for domestic stock investing, with a very small impact; households with a higher average age are more likely to invest in domestic stocks both directly and indirectly (significant at 10% level). Age does not have a significant impact on foreign stock holdings. The age profiles in Figures 2.1 and 2.2 are likely driven by the age effect on domestic stocks. Again, age has a different effect for the US households in Nechio (2014); while it is insignificant in predicting US households' foreign stock holding, it has a small but significantly negative coefficient on US domestic stock holdings. Japanese households headed by women have lower tendency to hold any stock directly, while the gender of the household head is insignificant in predicting any stock holdings for US households.

2.5.2 Foreign and Domestic Bond Holding

Compared with Table 2.4, Table 2.5 shows that the regression does a much poorer job pinpointing variables with predictive power in the case of bond holdings. First of all, although asset quintiles remain the perfect predictor, none of the income quintiles is significant and they all fail the Wald test. Home ownership, mortgage, and their interaction are as weak as before. Employer status has consistently negative effect on every kind of bond holding, but they are too insignificant to be reliable predictors. Age is the only variable besides asset that has significance but that is only limited to domestic bond holding.

2.5.3 All Stock and All Bond Holding

In Table 2.6, we replace the left-hand side with stock and bond variables that contain both foreign and domestic holdings so that we can gauge the combined or contradicting effects of the variables.

Age's positive effect on direct domestic stock holdings dominate its negative and insignificant effect on direct foreign stock holdings. Households with female heads are less likely to directly hold both domestic and foreign stocks, so the combined effect on all direct holding is unsurprisingly and significantly negative.

The significance of income variables in combined stock holding is driven by their effect

Table 2.5: Logit Estimation Results - Foreign and Domestic Bond Holdings

	F. Bond Drct+Fnd	F. Bond Direct	F. Bond Fund	D. Bond Drct+Fnd	D. Bond Direct	D. Bond Fund
Income (lowest as base)						
Income Quintile 2	-0.060	-0.160	-0.083	-0.049	-0.023	-0.009
	(0.211)	(0.236)	(0.258)	(0.216)	(0.242)	(0.278)
Income Quintile 3	0.278	0.256	0.096	-0.002	0.112	-0.017
	(0.224)	(0.244)	(0.278)	(0.236)	(0.260)	(0.304)
Income Quintile 4	-0.115	-0.051	-0.087	-0.364	-0.295	-0.179
	(0.241)	(0.261)	(0.300)	(0.255)	(0.285)	(0.326)
Income Quintile 5	0.401	0.507*	0.287	-0.259	-0.312	0.089
	(0.253)	(0.273)	(0.316)	(0.275)	(0.310)	(0.347)
Asset (lowest as base)						
Asset Quintile 2	0.979***	1.015***	0.875**	0.832***	0.715**	0.711
	(0.255)	(0.285)	(0.451)	(0.310)	(0.343)	(0.497)
Asset Quintile 3	1.310***	1.296***	1.383***	1.113***	0.682*	1.330***
	(0.254)	(0.284)	(0.422)	(0.303)	(0.351)	(0.454)
Asset Quintile 4	1.896***	1.899***	1.987***	1.899***	1.611***	1.905***
	(0.240)	(0.268)	(0.398)	(0.279)	(0.309)	(0.429)
Asset Quintile 5	2.553***	2.455***	2.398***	2.603***	2.297***	2.377***
	(0.267)	(0.296)	(0.419)	(0.303)	(0.333)	(0.451)
Employer vs Employee (unemployed as base)						
Employee	-0.025	-0.158	0.183	0.261	0.272	0.409
	(0.203)	(0.221)	(0.238)	(0.207)	(0.228)	(0.257)
Employer	-0.258	-0.204	-0.387	-0.388	-0.034	-0.524
	(0.240)	(0.258)	(0.310)	(0.262)	(0.281)	(0.360)
Residential Property	0.141	0.067	0.238	0.165	0.176	0.022
	(0.162)	(0.176)	(0.214)	(0.177)	(0.202)	(0.231)
Age (household average)	0.004	-0.007	0.024**	0.024***	0.021**	0.030***
	(0.007)	(0.008)	(0.010)	(0.008)	(0.009)	(0.011)
Gender (female)	-0.033	-0.049	0.171	0.019	0.053	0.094
	(0.123)	(0.133)	(0.158)	(0.134)	(0.151)	(0.173)
Married (yes)	-0.275	-0.207	-0.289	-0.092	0.030	-0.352
	(0.185)	(0.202)	(0.233)	(0.201)	(0.229)	(0.250)
Savings Deposit	1.503***	1.342***	1.256***	1.238***	0.921***	1.364***
	(0.154)	(0.154)	(0.171)	(0.158)	(0.171)	(0.182)
Other Real Estate	0.116	0.137	0.055	-0.116	-0.191	0.030
	(0.188)	(0.197)	(0.223)	(0.201)	(0.226)	(0.242)
No Other Debt	-0.007	-0.216	0.600	0.655*	0.838*	0.286
	(0.270)	(0.279)	(0.466)	(0.385)	(0.496)	(0.469)
Paid Off Mortgage	-0.149	-0.277	0.210	0.057	0.044	0.008
	(0.160)	(0.170)	(0.215)	(0.178)	(0.202)	(0.235)
Likelihood Ratio Statistics	440.797	321.294	279.393	416.051	247.558	239.927
Degrees of Freedom	18	18	18	18	18	18
p-value (χ^2)	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

Table 2.6: Logit Estimation Results - All Stock and All Bond Holdings

	All Stock Drct+Fnd	**All Stock Direct**	**All Stock Fund**	**All Bond Drct+Fnd**	**All Bond Direct**	**All Bond Fund**
Income (lowest as base)						
Income Quintile 2	0.276	0.327*	0.171	-0.125	-0.209	-0.121
	(0.182)	(0.183)	(0.239)	(0.196)	(0.203)	(0.255)
Income Quintile 3	0.352*	0.446**	0.037	0.068	0.025	0.028
	(0.197)	(0.198)	(0.261)	(0.211)	(0.216)	(0.275)
Income Quintile 4	0.460**	0.552***	-0.113	-0.267	-0.284	-0.096
	(0.206)	(0.207)	(0.277)	(0.226)	(0.231)	(0.295)
Income Quintile 5	0.777***	0.837***	0.429	0.069	0.053	0.161
	(0.227)	(0.226)	(0.289)	(0.243)	(0.247)	(0.313)
Asset (lowest as base)						
Asset Quintile 2	0.732***	0.705***	1.085***	0.874***	0.887***	0.629
	(0.168)	(0.170)	(0.336)	(0.220)	(0.234)	(0.421)
Asset Quintile 3	0.993***	0.853***	1.241***	1.191***	1.122***	1.172***
	(0.176)	(0.179)	(0.333)	(0.222)	(0.237)	(0.388)
Asset Quintile 4	1.317***	1.177***	1.779***	1.861***	1.878***	1.812***
	(0.168)	(0.170)	(0.314)	(0.208)	(0.220)	(0.362)
Asset Quintile 5	1.749***	1.560***	2.248***	2.596***	2.533***	2.242***
	(0.209)	(0.207)	(0.337)	(0.241)	(0.251)	(0.385)
Employer vs Employee (unemployed as base)						
Employee	-0.046	-0.104	0.226	0.032	0.063	0.235
	(0.187)	(0.185)	(0.223)	(0.195)	(0.198)	(0.237)
Employer	-0.459**	-0.359*	-0.482*	-0.259	-0.167	-0.435
	(0.212)	(0.209)	(0.287)	(0.229)	(0.233)	(0.311)
Residential Property	0.492***	0.438***	0.447**	0.195	0.125	0.242
	(0.137)	(0.137)	(0.197)	(0.152)	(0.156)	(0.212)
Age (household average)	0.016***	0.017***	0.012	0.007	0.004	0.024**
	(0.006)	(0.006)	(0.009)	(0.007)	(0.007)	(0.010)
Gender (female)	-0.452***	-0.520***	-0.115	-0.036	-0.013	0.160
	(0.107)	(0.107)	(0.144)	(0.117)	(0.119)	(0.156)
Married (yes)	-0.094	-0.049	-0.205	-0.075	0.040	-0.254
	(0.162)	(0.163)	(0.216)	(0.177)	(0.184)	(0.232)
Savings Deposit	1.750***	1.474***	1.529***	1.678***	1.384***	1.395***
	(0.190)	(0.169)	(0.159)	(0.164)	(0.154)	(0.168)
Other Real Estate	0.644***	0.555***	0.164	0.079	0.115	0.019
	(0.185)	(0.179)	(0.205)	(0.185)	(0.185)	(0.223)
No Other Debt	-0.392*	-0.340*	0.077	0.231	0.040	0.679
	(0.206)	(0.205)	(0.330)	(0.263)	(0.264)	(0.466)
Paid Off Mortgage	-0.087	-0.119	0.110	-0.122	-0.197	0.133
	(0.136)	(0.135)	(0.187)	(0.151)	(0.154)	(0.211)
Likelihood Ratio Statistics	554.883	484.887	352.778	533.774	434.156	301.459
Degrees of Freedom	18	18	18	18	18	18
p-value (χ^2)	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

on direct domestic stock investing. Their predictive power on combined stock fund investing remains weak. And as shown in Tables 2.4 and 2.5, total asset value and savings deposit have significant and positive effect on every asset holdings category, and they are the most impactful based on their high estimates. Their effects on combined classes are naturally significant and positive as well.

Home ownership is significant in positively predicting any kind of stock investing, which is expected from all the positive coefficients in Table 2.4. But it has no power in predicting bond holding. The effect of real estate other than home ownership on combined stock holding likely has its source in its effect on investing directly in domestic stocks. Mortgage and debt variables are weak as usual.

As can be seen from the coefficients of employer status in Table 2.6, its positive effect on investing directly in foreign assets is utterly dominated by its negative effect on every other asset class.

Results here are comparable to Campbell (2006), who uses 2001 SCF data for the US households and without distinguishing between foreign and domestic, direct and indirect. In Campbell's study, age has a weak (significant at 10%) but negative effect on stock holdings for US households, income has a weak and positive effect, and total asset value ("wealth" variable in his study) has no effect. In comparison, Japanese households from 2013 are quite different. For them, age, income, and total asset value all have strong and positive effects on stock holdings[3].

Table 2.7: Income as the Only Predictor

	F. Stock Drct+Fnd	F. Stock Direct	F. Stock Fund	D. Stock Drct+Fnd	D. Stock Direct	D. Stock Fund
Income (lowest as base)						
Income Quintile 2	-0.066	-0.441	0.208	0.231*	0.271*	0.068
	(0.195)	(0.331)	(0.223)	(0.140)	(0.146)	(0.212)
Income Quintile 3	0.004	-0.098	0.113	0.437***	0.504***	0.126
	(0.199)	(0.317)	(0.233)	(0.142)	(0.147)	(0.216)
Income Quintile 4	0.123	0.238	0.197	0.712***	0.738***	0.043
	(0.195)	(0.298)	(0.230)	(0.141)	(0.145)	(0.220)
Income Quintile 5	0.754***	0.643**	0.937***	1.419***	1.402***	1.005***
	(0.198)	(0.306)	(0.227)	(0.156)	(0.159)	(0.211)
Likelihood Ratio Statistic	967.519	461.828	809.999	1626.614	1580.146	875.436
Degrees of Freedom	4	4	4	4	4	4
p-value (χ^2)	0.000	0.007	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

Table 2.8: Income as the Only Predictor - Marginal Effects

	F. Stock Drct+Fnd	F. Stock Direct	F. Stock Fund	D. Stock Drct+Fnd	D. Stock Direct	D. Stock Fund
Income Quintile 2	-0.007	-0.015	0.016	0.046*	0.051*	0.006
Income Quintile 3	0.000	-0.004	0.009	0.091***	0.099***	0.011
Income Quintile 4	0.013	0.011	0.016	0.155***	0.152***	0.004
Income Quintile 5	0.103***	0.037**	0.101***	0.330***	0.315***	0.125***

*Notes: *, **, and *** stand for significance at 10%, 5%, and 1% levels*

2.6 Robustness Check

The results in Section 2.5 are all conditional estimates, but in Chapter 1, we use income as an unconditional predictor when we divide households into quintiles and compare their sensitivity to shocks. The first robustness check that we perform here is a logit regression that only has income quintiles as the regressor. Tables 2.7 and 2.8 show that even without any other effective regressors such as total asset and savings, income is still a poor predictor for foreign stock holdings. Only the top earners show a significantly increased probability of holding foreign stocks. But the evidence from Table 1.5 does not show any increased level of consumption insurance against country-level shocks. So at least for the households in the top income quintile, an increased probability of holding foreign stocks does not help with hedging against country-level shocks. They might be similar to their US counterparts who may be more exposed to their country's economic fluctuations. On the other hand, income in every other quintile does not provide any indication of foreign stock participation for the Japanese households.

In addition, in order to test the robustness of our specification, we regress each dependent variable on 4 sets of independent variables. Set 1 is the full set of variables that we used in Section 2.5 and our benchmark regression. Set 2 only includes income, asset, home ownership, and business owner, which are the core set of variables we are most interested in. Set 3 adds to Set 2 household characteristics including age, household head's gender, and marital status. Set 4 adds other household finance status to Set 2, namely savings deposit, other real estate, debt, and mortgage.

The coefficients are very robust to the change in specification for every dependent variable, as can be shown in Tables 2.9 through 2.12. We only report foreign and domestic

[3]Campbell (2006) also includes risk tolerance, age squared, race, education, log income squared, and log wealth squared as independent variables, with only education having a significantly positive effect and risk tolerance significantly negative. Our RADAR dataset does not include education or risk tolerance information. Income and Asset levels come as intervals so we cannot replicate log income squared or log wealth squared. Age squared is never significant for any dependent variable so we did not include it in our specification. Results including age squared are available upon request.

Table 2.9: Robustness Check - Direct Foreign Stock Holdings

	(1)	(2)	(3)	(4)
Income (lowest as base)				
Income Quintile 2	-0.673*	-0.540	-0.667*	-0.548
	(0.348)	(0.343)	(0.346)	(0.344)
Income Quintile 3	-0.496	-0.249	-0.432	-0.315
	(0.355)	(0.340)	(0.352)	(0.343)
Income Quintile 4	-0.271	0.021	-0.189	-0.069
	(0.363)	(0.340)	(0.356)	(0.348)
Income Quintile 5	-0.208	0.087	-0.161	0.040
	(0.392)	(0.357)	(0.377)	(0.372)
Asset (lowest as base)				
Asset Quintile 2	0.573	0.579	0.582	0.572
	(0.431)	(0.434)	(0.433)	(0.432)
Asset Quintile 3	0.912**	0.906**	1.020**	0.795*
	(0.432)	(0.426)	(0.431)	(0.428)
Asset Quintile 4	1.306***	1.378***	1.473***	1.217***
	(0.397)	(0.375)	(0.386)	(0.389)
Asset Quintile 5	1.695***	1.942***	2.058***	1.591***
	(0.440)	(0.387)	(0.410)	(0.425)
Employer vs Employee (unemployed as base)				
Employee	-0.157	-0.132	-0.189	-0.089
	(0.339)	(0.306)	(0.337)	(0.308)
Employer	0.812**	0.810**	0.794**	0.840**
	(0.345)	(0.336)	(0.342)	(0.337)
Residential Property	0.528*	0.617**	0.581**	0.519*
	(0.299)	(0.268)	(0.281)	(0.282)
Age (household average)	-0.011		-0.009	
	(0.012)		(0.012)	
Gender (female)	-0.591***		-0.637***	
	(0.223)		(0.222)	
Married (yes)	0.244		0.246	
	(0.340)		(0.338)	
Savings Deposit	0.955***			0.979***
	(0.225)			(0.224)
Other Real Estate	-0.029			-0.072
	(0.299)			(0.297)
No Other Debt	0.056			0.096
	(0.457)			(0.457)
Paid Off Mortgage	0.020			-0.054
	(0.257)			(0.247)
Likelihood Ratio Statistics	98.964	73.033	82.430	90.935
Degrees of Freedom	18	11	14	15
p-value (χ^2)	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

Table 2.10: Robustness Check - Foreign Stock Holding through Funds

	(1)	(2)	(3)	(4)
Income (lowest as base)				
Income Quintile 2	0.254	0.162	0.266	0.138
	(0.260)	(0.246)	(0.252)	(0.253)
Income Quintile 3	0.095	0.032	0.236	-0.099
	(0.286)	(0.261)	(0.276)	(0.270)
Income Quintile 4	0.072	-0.028	0.218	-0.150
	(0.302)	(0.269)	(0.289)	(0.282)
Income Quintile 5	0.490	0.220	0.507*	0.234
	(0.317)	(0.275)	(0.300)	(0.293)
Asset (lowest as base)				
Asset Quintile 2	1.721***	1.787***	1.721***	1.761***
	(0.475)	(0.477)	(0.475)	(0.476)
Asset Quintile 3	1.826***	2.181***	2.053***	1.915***
	(0.471)	(0.468)	(0.469)	(0.471)
Asset Quintile 4	2.376***	2.844***	2.675***	2.475***
	(0.453)	(0.445)	(0.448)	(0.453)
Asset Quintile 5	2.713***	3.533***	3.293***	2.853***
	(0.473)	(0.452)	(0.459)	(0.469)
Employer vs Employee (unemployed as base)				
Employee	0.175	-0.067	0.143	0.046
	(0.238)	(0.206)	(0.228)	(0.215)
Employer	-0.623**	-0.695**	-0.609**	-0.677**
	(0.321)	(0.306)	(0.310)	(0.317)
Residential Property	0.361*	0.447**	0.390**	0.405**
	(0.214)	(0.186)	(0.198)	(0.199)
Age (household average)	0.015		0.020**	
	(0.010)		(0.009)	
Gender (female)	0.068		-0.007	
	(0.156)		(0.150)	
Married (yes)	-0.381		-0.378*	
	(0.230)		(0.220)	
Savings Deposit	1.490***			1.500***
	(0.168)			(0.167)
Other Real Estate	0.028			0.060
	(0.223)			(0.222)
No Other Debt	0.397			0.349
	(0.415)			(0.415)
Paid Off Mortgage	0.214			0.305
	(0.208)			(0.201)
Likelihood Ratio Statistics	299.541	219.085	225.743	295.647
Degrees of Freedom	18	11	14	15
p-value (χ^2)	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

Table 2.11: Robustness Check - Direct Domestic Stock Holding

	(1)	(2)	(3)	(4)
Income (lowest as base)				
Income Quintile 2	0.349*	0.388**	0.388**	0.363**
	(0.184)	(0.175)	(0.179)	(0.180)
Income Quintile 3	0.494**	0.564***	0.640***	0.454**
	(0.199)	(0.182)	(0.193)	(0.188)
Income Quintile 4	0.584***	0.649***	0.721***	0.560***
	(0.208)	(0.185)	(0.199)	(0.195)
Income Quintile 5	0.896***	0.950***	1.022***	0.879***
	(0.227)	(0.202)	(0.215)	(0.215)
Asset (lowest as base)				
Asset Quintile 2	0.708***	0.722***	0.673***	0.746***
	(0.171)	(0.166)	(0.168)	(0.170)
Asset Quintile 3	0.837***	0.994***	0.920***	0.873***
	(0.180)	(0.169)	(0.173)	(0.177)
Asset Quintile 4	1.173***	1.380***	1.257***	1.239***
	(0.171)	(0.153)	(0.159)	(0.167)
Asset Quintile 5	1.574***	2.033***	1.842***	1.682***
	(0.208)	(0.180)	(0.189)	(0.202)
Employer vs Employee (unemployed as base)				
Employee	-0.125	-0.428***	-0.119	-0.389**
	(0.185)	(0.161)	(0.179)	(0.168)
Employer	-0.385*	-0.504***	-0.341*	-0.527***
	(0.210)	(0.197)	(0.202)	(0.205)
Residential Property	0.419***	0.661***	0.514***	0.589***
	(0.138)	(0.115)	(0.123)	(0.126)
Age (household average)	0.018***		0.021***	
	(0.006)		(0.006)	
Gender (female)	-0.514***		-0.524***	
	(0.107)		(0.104)	
Married (yes)	-0.093		-0.106	
	(0.163)		(0.158)	
Savings Deposit	1.425***			1.471***
	(0.167)			(0.166)
Other Real Estate	0.492***			0.537***
	(0.178)			(0.176)
No Other Debt	-0.371*			-0.440**
	(0.205)			(0.204)
Paid Off Mortgage	-0.123			-0.013
	(0.136)			(0.130)
Likelihood Ratio Statistics	478.966	345.327	383.505	447.769
Degrees of Freedom	18	11	14	15
p-value (χ^2)	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

Table 2.12: Robustness Check - Domestic Stock Holding through Funds

	(1)	(2)	(3)	(4)
Income (lowest as base)				
Income Quintile 2	0.006	0.054	0.051	-0.006
	(0.248)	(0.234)	(0.239)	(0.242)
Income Quintile 3	-0.074	0.012	0.060	-0.120
	(0.269)	(0.247)	(0.258)	(0.255)
Income Quintile 4	-0.341	-0.183	-0.125	-0.390
	(0.288)	(0.259)	(0.274)	(0.272)
Income Quintile 5	0.289	0.324	0.410	0.222
	(0.298)	(0.259)	(0.280)	(0.278)
Asset (lowest as base)				
Asset Quintile 2	0.775**	0.828**	0.770**	0.817**
	(0.352)	(0.351)	(0.351)	(0.352)
Asset Quintile 3	1.119***	1.403***	1.299***	1.188***
	(0.339)	(0.331)	(0.333)	(0.337)
Asset Quintile 4	1.670***	2.019***	1.875***	1.757***
	(0.318)	(0.302)	(0.307)	(0.315)
Asset Quintile 5	2.158***	2.765***	2.562***	2.280***
	(0.342)	(0.311)	(0.321)	(0.337)
Employer vs Employee (unemployed as base)				
Employee	0.233	-0.041	0.201	0.051
	(0.232)	(0.201)	(0.221)	(0.210)
Employer	-0.446	-0.531*	-0.411	-0.539*
	(0.298)	(0.284)	(0.286)	(0.295)
Residential Property	0.198	0.445***	0.306*	0.321*
	(0.203)	(0.176)	(0.187)	(0.189)
Age (household average)	0.015*		0.019**	
	(0.009)		(0.008)	
Gender (female)	-0.114		-0.191	
	(0.150)		(0.145)	
Married (yes)	-0.015		0.013	
	(0.230)		(0.221)	
Savings Deposit	1.466***			1.495***
	(0.162)			(0.162)
Other Real Estate	0.140			0.171
	(0.212)			(0.211)
No Other Debt	-0.127			-0.171
	(0.330)			(0.330)
Paid Off Mortgage	-0.041			0.047
	(0.195)			(0.188)
Likelihood Ratio Statistics	306.970	221.587	227.979	304.396
Degrees of Freedom	18	11	14	15
p-value (χ^2)	0.000	0.000	0.000	0.000

Notes: Standard errors are in the parentheses
, **, and * stand for significance at 10%, 5%, and 1% levels*

stock holdings both directly and through funds. Checks on other assets are available from the author.

In Table 2.9, income levels are powerless in predicting direct foreign stock holding in all specifications. Total asset value's coefficients, on the other hand, are monotonically and significantly positive. The coefficient of employer status shows minimal changes across specifications and is always significant, suggesting its orthogonality with both household characteristic and other finance variables. The increased standard error of home ownership's coefficient suggests multicollinearity with one of the other finance variables. Among the non-core variables, the gender of the household head and savings deposit both show the same effect and significance.

The comparison between coefficients of core variables is roughly the same in Tables 2.10, 2.11, and 2.12. Total asset value is always an excellent predictor. Income is only useful in predicting holding domestic stocks directly. Home ownership sees increased standard error due to multicollinearity and possibly lose some significance. But the bottom line is the same, the significant predictors discovered in Section 2.5 are robust across the different specifications.

2.7 Concluding Remarks

We apply a logit model on Radar 2013 data and confirm that income is not significantly related to foreign stock holdings for Japanese households. We also discover that total asset value and savings deposit are significant predictors for any kind of asset holdings. Iwaisako (2009) documents the importance of home ownership in portfolio decision and our analysis confirms that. A new discovery is made about business owners' preference in stock investing. They tend to engage in more direct foreign stock investing and less domestic stock investing. We suspect that it is because both their business and domestic stocks are exposed to domestic macro shocks, which agrees with Guvenen (2007). Business owners who seek to diversify from country-level shocks are more willing to invest in foreign stocks.

This study is only a snapshot of Japanese households' asset holding decision in one year, 2013, so many important questions are left unanswered. For example, we are not certain how representative the year we used in this study is for Japanese households throughout history; there are patterns in Chapter 1 that cannot be explained by our 2013 RADAR data. Also, we do not know the asset participation pattern and its change over time. Future studies are needed to answer these questions.

Chapter 3

Out-of-Range Exchange Rate Pass-Through: a Test of Multi-Country Effect

Abstract

Previous studies on exporters' pricing-to-market behavior have significant estimates that are out of the reasonable range; when an exporter's home currency appreciates by, say, 10%, the exporter can be found to adjust its selling price in foreign markets up by more than 10% in some cases, and down in others. Based on the latest theoretical development in the exchange rate pass-through literature, I test if the estimates are improved when competition from exporters from competing countries is controlled for. With imperfect measure in the control for competition, many out-of-range estimates disappear. Exporters in different industries respond to competitor's exchange rate shocks differently, with those who produce more homogeneous goods more likely to have a negative estimate.

3.1 Introduction

Under the assumption of the Law of One Price (LOP), if a manufacturer sells its products in both domestic and foreign markets, the price in the foreign market would change accordingly when the exchange rate between the two countries fluctuates. Krugman (1986) documents a phenomenon that exporters typically absorb at least a part of the exchange rate shock in an effort to maintain a relatively steady price in the importing country. He calls this a pricing-to-market (PTM) behavior[1]. The discovery of such a behavior inspired an entire PTM literature, which uses exchange rate pass-through (ERPT) to measure the magnitude of PTM. Various theories[2] have been proposed to explain the PTM behavior, but curiously none of them address a seemingly abnormal pattern shown by the most frequently cited empirical work by Knetter (1993) that a large number of exporter-industry pairs have an ERPT estimate outside the theoretically reasonable range: some estimates indicate that the exporter absorb more than 100% of exchange rate shock in their markup while others imply that the exporter totally discard the exchange rate shock and move towards the opposite direction in pricing. Dornbusch (1987) is one the earliest effort in looking into competitors' role in exporters' pricing decisions. In the theoretical work of Naknoi (2015), it is suggested that exporters not only respond to the change in exchange rate between themselves and the destination countries, but they are also influenced by other exporters selling the same product in the same market. This chapter first replicates Knetter (1993)'s result with more recent data and investigate the existence of out-of-range ERPT estimates. We then attempt to contribute to the literature by testing whether the estimation can be improved when competitors are introduced in the regression. Our results show that in the original two-country setup, out-of-range estimates do exist and many are significant. When competitors' exchange rates are controlled for, the statistical sig-

[1] More broadly, PTM can refer to a practice of price discrimination of which contracts are market specific. Such contracts may involve currency of denomination, delivery services, etc. In this chapter, we refer to PTM in a narrow sense in the context of exchange rate pass-through.

[2] Feenstra (1989), Marston (1990), Wei and Parsley (1995), Devereux and Engel (2003), etc.

nificance in most cases disappear. Competitors' impact on exporters' pricing decision is shown to be significant in many cases and there is a pattern that exporters of homogeneous goods tend to respond to competitors' exchange rate shocks negatively whereas car exporters lean towards the opposite.

A brief review of the ERPT and PTM literature is included in Section 3.2. We choose to use the estimation method of Knetter (1993), and modify it according to Naknoi (2015). We take the exporter's point of view, structuring a panel of multiple importing countries per industry per exporter, and use a time fixed-effect regression to obtain our results. Naknoi (2015) empirically tests one country, Canada, as the exporter and includes the US as the only importer, taking into account all competing exporters. Our study expands to three exporters (US, UK, and Germany) and include every destination country that imports as least 1% of the total exports from its exporting partners. This approach is different from the empirical approach of Bergin and Feenstra (2009), a relevant work to our study that focuses on the effect of competing exporters on ERPT. Although they also consider competition's effect on ERPT, their primary focus is on the impact of one fixed-exchange-rate competitor's market share on the ERPT of a floating-rate exporter. Section 3.3 explains the data in detail. Section 3.4 presents the results and discussion. As the first step we run exactly the same regression as Knetter (1993) on our new, more recent dataset and compare it to Knetter (1993). A second regression is then carried out using the model proposed by Naknoi (2015). Given the current data and its limitations, we cannot say that the out-of-range issue is conclusively resolved by the introduction of competitors in the regression. But there is evidence that supports the significant importance of competition from other exporters. We conclude in Section 3.5.

3.2 Literature and Estimation Method

The numerous studies of prices and exchange rates invariably have their origin in the concept of the LOP, which is formally expressed as

$$P_x = P_m / E_{xm} \tag{3.1}$$

where P_x is the price at which the exporter sells its product in its own country, denominated in the exporter's currency, and P_m is the import price denominated in importer or buyer's currency. E_{xm} is the exchange rate between the seller and the buyer, expressed as the number of importer's currencies per exporter's currency[3]. If P_x remains relatively stable within a short period of time, under the LOP, one would expect P_m to respond positively to E_{xm}.

In reality, although the LOP might hold for a few cases, such as precious metal, this law is almost always rejected by empirical studies[4]. The reason might be imperfect competition, costly arbitrage, and location-specific characteristics of the product, just to name a few. One of the most typical examples is automobile industry. The transportation cost of automobiles is significant, making it costly for arbitrage. Additionally, regulations vary from country to country, therefore differences, though perhaps minor, exist between the Honda Accords sold in the US and those in Germany. Also, services which are a big part of car purchase decision making are provided locally.

Cases like these are seen as evidence against the LOP and, further, against perfect competition and a fully integrated international market. Furthermore, the PTM behavior discovered by Krugman (1986) seems prevalent and inspired many studies to follow. The importance of PTM can be felt by both the importers and the exporters. From an importer's standpoint, it studies whether or how inflation of one country can find its way to that of

[3]From the exporter's standpoint, E_{xm} is a direct quote.
[4]Giovannini (1988) and Rogoff (1996)

another. And for exporters, PTM can reduce or boost their profit margin, depending on the direction of the exchange rate change and how they typically respond to that change.

In the literature of ERPT and PTM, exporters' pricing behavior is composed of two parts, the marginal cost and the mark-up, with the latter subject to changes in the face of an exchange rate shock. The generic form of the regression specification has the following form:

$$\Delta p_{k,t} = \theta_{k,t} + \beta_k \Delta e_{k,t} + \epsilon_{k,t} \tag{3.2}$$

where p can be the log of either import or export prices and e is the exchange rate between two trading partners. t indexes time and k indexes the trading partners. $\theta_{k,t}$ is the (noisy) control for changes in marginal cost over time and β_k, the ERPT, is what ultimately tells us how much exchange rate changes are passed through prices.

There are no set standards in the literature in regard to using whether import prices or export prices for p or direct quote or indirect quote for e, the estimated β_k might take different values while meaning the same thing. Table 3.1 can help us translate different studies into the same language, with the third column listing the theoretical range in each case.

Table 3.1: Regression Estimate Ranges and Interpretations

P	**E**	β **range**	**Full PTM No pass-through**	**No PTM Complete pass-through**
In importer currency	**# of im. cur. per ex. cur.**	$[0, 1]$	$\beta = 0$	$\beta = 1$
In importer currency	**# of ex. cur. per im. cur.**	$[-1, 0]$	$\beta = 0$	$\beta = -1$
In exporter currency	**# of im. cur. per ex. cur.**	$[-1, 0]$	$\beta = -1$	$\beta = 0$
In exporter currency	**# of ex. cur. per im. cur.**	$[0, 1]$	$\beta = 1$	$\beta = 0$

Many studies have been dedicated to this issue starting from the 1980s. The early studies, such as Hooper and Mann (1989) and Melick (1989), focus on analyzing the pass-through into US import prices. A serious empirical challenge in the literature is controlling of the marginal cost $\theta_{k,t}$ in Equation (3.2). Cost indices are commonly used. But as pointed out by Goldberg and Knetter (1997), this is problematic since they are measures of average cost instead of marginal cost which is what really affects the pricing behavior. Recent studies, such as Bergin and Feenstra (2009), focus on ERPT into import prices rely heavily on the cost structure assumed in various theoretical frameworks.

Starting from Feenstra (1989), there has been a clear shift in the literature to focusing on the industry level, which was itself a response and adaption to the rising imperfect competition theory during that period. Knetter (1993) explores taking on the angle of a single exporter selling its product to a variety of destinations over time and hereby mitigates the marginal cost issue; unlike in the import price analysis where different exporters have different marginal costs, now we can safely assume the one exporter's marginal cost is the same across all destinations. So the subscript k can be dropped from θ turning Equation (3.2) into

$$\Delta p_{k,t} = \theta_t + \beta_k \Delta e_{k,t} + \epsilon_{k,t} \tag{3.3}$$

With a panel of a source country exporting to various destinations, a time-fixed effect regression can be used to estimate both θ_t and β_k, avoiding the marginal cost issue faced by the import pricing analysis.

Knetter (1993) uses his regression results from 52 exporter-industry pairs to show that from all four exporters he studied, the US, Japan, Germany, and the UK, the majority of industries show a strong PTM behavior. Another finding was that out of the 52 exporter-industry pairs, only eight can reject the null hypothesis that ERPT estimate of β is the same across all destinations. In other words, in most cases, a single exporter does not differentiate between destinations when adjusting its mark-up in response to exchange rate changes. This is a significant finding as now we can further drop the subscript k for the β in the regression equation and turn it into a pooled OLS with year dummies

$$\Delta p_{k,t} = \theta_t + \beta \Delta e_{k,t} + \epsilon_{k,t} \tag{3.4}$$

which further reduces the computational complexity of the regression.

Although the change of angle and the improvement of methodology have made Knetter (1993) one of the most influential and best received empirical studies in the PTM literature, one singularity seems to have failed to raise the curiosity it deserves in later studies. As mentioned before, Knetter (1993) chooses the exporter's currency as the denomination of prices and the exchange rates are expressed as the number of importer currency per exporter currency. According to Table 3.1, β is supposed to lie in the theoretical range of [-1, 0]. But two out of 18 German exporting industries have an estimated β outside of the range and it gets even worse with other countries: five out of 14 for Japan, four out of nine for the UK, and seven out of 11 for the US. The highest out-of-range estimate is 1.73, while the lowest is -2.26. Under a two-country setup, why would an exporter pass more than 100% exchange rate shock into the prices? Why would another exporter move to the other direction in face of exchange rate shocks, i.e. lowering their local prices when their currency appreciates? Knetter (1993) does not provide any explanation for this and no later research addresses this issue.

The problem probably lies in the two-country setup, which assumes that exporters respond only to the exchange rate between themselves and the importers. In reality, exporters have to consider competing exporters in their pricing. Bergin and Feenstra (2009) is one step towards addressing this by introducing competition among exporters into the model. But the theory was restricted to a scenario with a fixed exchange rate exporter vs a floating exchange rate exporter. Naknoi (2015) develops a more general model and suggests a regression equation by adding exchange rates from countries other than the exporter-importer pair into Equation (3.4) in order to pick up the competition from other exporters.

$$\Delta p_{kx,t} = \theta_t + \beta_{x1}\Delta e_{kx,t} + \beta_{x2}\sum_{h\neq x}\frac{C_{h,t}E_{kh,t}}{C_{x,t}E_{kx,t}}\Delta e_{kh,t} + \epsilon_{x,t} \tag{3.5}$$

where x represents the exporter whose point of view we take and h's are its competitors also selling to importing country k. $C_{x,t}$ is the marginal cost of the exporting firms and $C_{h,t}$ is that of country h's. $E_{kh,t}$ and $E_{kx,t}$ serve to convert the marginal costs into the same importer k's currency.

With international exchange rate changes often correlated, estimated β from Equation (3.4) is essentially a biased estimator of β_{x2} in Equation (3.5). And since the correlation between exchange rate changes can be positive and negative, both upward and downward biases are possible, which can explain out-of-range estimates that are too big and too small. With competition from other exporters accounted for and controlled for with β_{x2}, β_{x1} should fall in the much studied and believed theoretical range of [-1, 0]. β_{x1} is the original ERPT that measure the impact of changes in the exporter's own exchange rate, and can be named self-ERPT in contrast to β_{x2}, which is the common factor of the competitors' cross-ERPT. Naknoi (2015) shows that if the importer's demand for competitor's products is elastic, β_{x2} would take a positive value. Consider the case in which the US exporters sell in the Japanese market, with the UK exporters being their major competitors. When the British pound appreciates against the yen, assuming at least a part of the exchange rate shock is passed through the price of UK exports, with an elastic demand from the importer, the residual demand faced by the US exporter would increase, giving them an advantage and room to raise their own export price, implying a positive β_{x2}. Conversely, when the pound depreciates, the UK exports become more competitive in pricing, squeezing the residual demand for the US exporters, again indicating a positive estimate.

The empirical portion of Naknoi (2015) only includes Canada as the only main exporter and the US as the only importer, taking into account of competing exporters, from 1990 to 2009. This study incorporates three main exporters (US, UK, and Germany) and every major importer they export to from 1991 to 2016.

3.3 Data

The trade data used in this study is compiled from the UN COMTRADE database through the World Bank's WITS system. We obtain the export unit price series from the annual freight-on-board (FOB) export value and quantity for these exporters: 19 industries in the US, 18 in the UK, and 19 in Germany. The choice of exporters comes from the motivation to replicate the results of Knetter (1993). However, as Japan persistently manages its exchange rate, we exclude it from our choice of exporting countries. It is important to note that Knetter (1993) does not disclose his choice of destination countries for any of the exporters, and a request for his dataset remains unanswered. Therefore, we have to come up with our own criterion for destination selection. In this study, an importer is selected if it accounts for at least 1% of the total value of exports from the exporter in this industry. And all the selected importers combined should cover at least 80% of industry-specific exports from the exporting country. Otherwise, we go on and include the next importer in line. This importer selection procedure explains the majority of the variation in sample sizes across industries. It should be noted that the difference between Knetter's results and the estimation from our dataset might be due to the selection of destinations. Our importer selection is also different from that of Naknoi (2015), in which only the US is considered as the importing country.

The sample periods for all three exporters are from 1991 to 2016. But for some industries from German and UK exporters such as car industries, quantities were first reported in kilograms before 2000, then in units since. Since car price per kilogram is hardly sensible and a change in unit renders price growth nonsensical, entries before 2000 are dropped for those industries[5]. In order to achieve uniformity, the UN COMTRADE records all values in US dollar (USD) and that includes export data from non-US exporters. For

[5]The HS codes for the truncated industries are: 870321, 870322, 870323, 870324, 870333, 880240 for Germany and 270900, 840734, 841112, 847120, 847191, 854211, 870321, 870322, 870323, 870324 for UK.

countries that report in other currencies, they convert the annual values into USD using a specially calculated "currency conversion factor", which is the average monthly exchange rate between the reporting currency and USD weighted by "relevant" monthly trade which is not disclosed. However, the conversion factors are disclosed so we can use them to convert the USD values into their respective currencies except for the case of Germany. Germany's export data are inconsistent due to this practice. The data for some years are reported in Deutsche Marks (DEM) and later euros (EUR), while for some years they are reported in USD, presumably using an exchange rate by the German reporting agency that is different from the currency conversion factor used in the DEM and EUR years. In our estimation, we need to use the conversion factor for some years and the exchange rate for others in the same time series which might cause errors. One needs to take caution when drawing inferences from the estimates for Germany.

One advantage of our dataset over that in Knetter (1993) is Harmonized System (HS) classification, which allows us to compare the same industry from different exporters using the same classification and measure. We use HS1988/1992 (HS0) as it is the oldest HS system and has the longest available time period. But this also introduces possible discrepancy from Knetter (1993) as his dataset uses anything but HS, and some of the categorizations are no longer in use. For example, in Knetter (1993) the US differentiates automobiles with cylinder count, whereas in all HS categorizations displacement is used as the main difference. Even if we match his results with the same industry names, the measurement practice might still be different.

As for the selection of industries, apart from trying to match Knetter's work, we also include at least ten 6-digit industries that have the largest country-specific value of total exports in the chosen time period, given the availability of the data.

Exchange rates are obtained from the World Bank database. Exchange rates for currencies of euro-zone countries are available before the countries adopted the euro. We stick to their original currency even after they joined the euro-zone and manually calculate the exchange rates for the original currency using the euro's exchange rates and the fixed rate, also from the World Bank database, between the euro and the original currency at the time of each country's euro adoption.

3.4 Estimation Results

Table 3.2: Estimated ERPT Elasticity for US Exports

Industry	HS Code	ERPT	(Std. Err.)	R Sqrd.	No. Obs.
Seeds	100190	***0.049****	(0.016)	0.73	457
Maize	100590	***0.161****	(0.059)	0.21	345
Soybeans	120100	-0.625	(0.347)	0.23	270
Gasoline	271000	-0.005	(0.089)	0.88	314
Aluminum oxide	281810	*0.026*	(0.238)	0.33	268
Titanium oxide	282300	*0.003*	(0.020)	0.15	319
Non-monetary gold	710812	***0.310****	(0.063)	0.27	214
Aluminum foil	760711	-0.064	(0.039)	0.17	245
Computers	847120	-0.030	(0.064)	0.27	500
CPU	847191	-0.042***	(0.014)	0.48	373
Air coolers and purifiers	847989	***0.062****	(0.036)	0.40	230
Integrated circuits, digital	854211	-0.427***	(0.155)	0.32	301
Integrated circuits, other	854219	***0.080****	(0.040)	0.20	315
Cars under 1L	870321	***0.143****	(0.055)	0.09	490
Cars 1L to 1.5L	870322	-0.045	(0.039)	0.07	275
Cars 1.5L to 3L	870323	-0.150**	(0.069)	0.15	249
Cars over 3L	870324	***0.143****	(0.057)	0.30	273
Airplanes over 15 tons	880240	*0.080*	(0.075)	0.27	371
Aircraft parts	880330	*0.095*	(0.137)	0.28	348

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant.

Tables 3.2 to 3.4 are the results from the estimation of the panel data described in the last section using Equation (3.4). Equation (3.3) is also estimated, but the F-tests show that there is no significant difference between different importers' ERPT's from the same exporter, so the results are not shown here[6]. In the third column where ERPT

[6] The estimates for Equation (3.3) and the F-tests between models of Equation (3.3) and Equation (3.4) are available upon request.

Table 3.3: Estimated ERPT Elasticity for UK Exports

Industry	**HS Code**	**ERPT**	**(Std. Err.)**	**R Sqrd.**	**No. Obs.**
Whiskeys	220830	-0.113***	(0.024)	0.71	529
Crude oil from bituminous†	270900	*0.055*	(0.041)	0.14	140
Gasoline	271000	-0.096	(0.137)	0.60	191
Medicine	300490	-0.055	(0.148)	0.13	385
Books	490199	-0.033	(0.112)	0.08	523
Car engines†	840734	*0.641*	(0.508)	0.16	205
Turbo-jets†	841112	***0.275****	(0.070)	0.07	205
Turbo-jet parts	841191	-0.067	(0.377)	0.13	322
Computers†	847120	***-3.291****	(0.885)	0.13	303
CPU†	847191	-0.650	(0.665)	0.21	304
Computer accessories	847330	-0.359	(0.358)	0.20	408
Switches	853650	-0.218	(0.236)	0.08	499
Integrated circuits, digital†	854211	-0.029	(0.023)	0.37	239
Cars under 1L†	870321	***0.239***	(0.093)	0.20	176
Cars 1L to 1.5L†	870322	*0.375*	(0.248)	0.10	316
Cars 1.5L to 3L†	870323	-0.053	(0.249)	0.10	336
Cars over 3L†	870324	-0.457**	(0.180)	0.20	240
Motor vehicle parts	870899	*0.064*	(0.059)	0.13	454

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant.
†indicates industries with a time period from 2000 to 2016.

Table 3.4: Estimated ERPT Elasticity for German Exports

Industry	HS Code	ERPT	(Std. Err.)	R Sqrd.	No. Obs.
Beers	220300	-0.178	(0.134)	0.10	376
Gasoline	271000	-0.250**	(0.106)	0.67	266
Aluminum oxide	281810	-0.135*	(0.075)	0.08	507
Antisera	300210	-0.292	(0.249)	0.54	409
Medicine	300490	-0.271**	(0.107)	0.86	511
Chemical products, other	382390	-0.032***	(0.011)	0.11	567
Engine parts	840991	*0.018*	(0.038)	0.04	499
Diesel engines	840999	-0.049**	(0.020)	0.05	499
Panels	853710	-0.030***	(0.010)	0.06	618
Cars under 1L†	870321	***0.538****	(0.310)	0.93	248
Cars 1L to 1.5L†	870322	*0.000*	(0.000)	1.00	338
Cars 1.5L to 3L†	870323	*0.000*	(0.000)	1.00	272
Cars over 3L†	870324	0.000	(0.000)	1.00	240
Diesel cars over 2.5L†	870333	-0.003	(0.006)	1.00	288
Parts for special purpose vehicles	870829	-0.054	(0.039)	0.09	506
Car transmission	870840	-0.026	(0.026)	0.11	590
Motor vehicle parts	870899	-0.052**	(0.025)	0.13	562
Aircrafts over 15 tons†	880240	*0.020*	(0.096)	0.92	166
Aircraft parts	880330	-0.400	(0.261)	0.25	168

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant
†indicates industries with a time period from 2000 to 2016.

estimates are given, statistical significance is from a two-tailed test due to the existence of positive ERPT's. An italic number means this estimate lies out of the [-1, 0] theoretical range, whereas a bold number is both out of range and significant. As Equation (3.4) is essentially an OLS with year dummies, the standard errors in Tables 3.2 to 3.4 are clustered by importing countries.

In terms of the overall magnitude of the PTM behavior, for each country's top exporting industries, Germany exhibits the greatest number of PTM leaning industries, with seven out of 19 industries demonstrating a significant tendency of absorbing at least a part of the exchange rate shocks to maintain stable local prices. Three out of 19 US top industries demonstrate strong PTM behavior, compared to two out of 18 UK industries. Knetter (1993) concludes that the UK, as a relatively weaker competitor in international trade compared to the US and Germany, should demonstrate stronger tendency towards PTM to maintain a stable foreign pricing. We cannot find support in our data.

Out of the 19 US exporting industries, 11 are out of range, seven of which are significant. The significant out of range estimates are all positive, indicating that for the US seed, maize, gold, air cooler, non-digital circuits, small cars, and large cars exporters, when the USD appreciates, instead of lowering their exporting USD price to maintain a relative stable local price, they actually increase it, exacerbating the local price increase denominated in the importer's currency. In the case of the UK exporters, seven out of 18 are out of range, three of which are significant; for the UK turbo jet and small car exporters, when the British pound (GBP) appreciates, they would increase the GBP prices they charge the importers. On the other hand, the UK computer exporters lower their export prices more than the magnitude of any GBP appreciation, which significantly reduces their mark-up and profit. German exporters, in comparison, are the most "normal", with only one, the small car exporters, out of 19 industries have out-of-range estimate. In a two-country setup where exporters are implied as the only seller in the importer market, it is difficult to explain such behaviors.

When we move on to estimate Equation (3.5), an immediate difficulty arises. The marginal costs of the main exporting country and its competitors are not observed. One might be tempted to use Producer Price Indices (PPI) for the exporting countries, which have two problems. First, the theory requires industry-level costs, which cannot be adequately represented by the available country-level PPI's. Secondly, as mentioned in Section 3.2, Goldberg and Knetter (1997) argue that PPI's are average costs instead of the marginal costs needed in our estimation.

Naknoi (2015) argues that if all exporters have the same own-price elasticity, relative market shares are determined by the relative marginal costs, therefore we can approximate the relative cost term $\frac{C_{h,t}E_{kh,t}}{C_{x,t}E_{kx,t}}$ by the relative market share and turn Equation (3.5) into

$$\Delta p_{kx,t} = \theta_t + \beta_{x1}\Delta e_{kx,t} + \beta_{x2}\sum_{h\neq x}\frac{M_{kh,t}}{M_{kx,t}}\Delta e_{kh,t} + \epsilon_{x,t} \tag{3.6}$$

where $M_{kx,t}$ is the exporter x's share in importer k's market, and $M_{hx,t}$ the market share of x's competitor h. Intuitively, the second regressor is the average of all competitors' exchange rate growth, weighted by their importance in the importing country, measured by their relative market share. In practice, we choose the 25 countries[7] with the highest global aggregate export excluding Belgium due to its reporting inconsistencies.

Table 3.5 reports the estimates of β_{x1} and β_{x2} in Equation (3.6) for US exporting industries. Out of the seven industries significantly out of range in Table 3.2, four lose their statistical significance, and one switches to significantly in-range, Two industries, seed and air cooler, remain significantly out-of-range while large airplane exporters switch from in-range to out-of-range with the inclusion of competitors. Explanatory power is generally improved, reflected by increased R-squares. Curiously, the seed industry's self-ERPT is even more positive. Currently, we could not provide any explanation and future study is

[7]The countries are (from highest to lowest in aggregate export value from 1991 to 2016) Germany, the US, China, Japan, France, the UK, Canada, Italy, Netherlands, South Korea, Singapore, Russia, Spain, Mexico, Switzerland, Saudi Arabia, Malaysia, Australia, Brazil, Sweden, Thailand, India, Indonesia, and Poland.

Table 3.5: Estimated Self- and Cross-ERPT's for US Exports

Industry	**HS Code**	**Self**	**(Std. Err.)**	**Cross**	**(Std. Err.)**	**R Sqrd.**	**No. Obs.**
Seeds	100190	***0.067****	(0.009)	0.001	(0.002)	0.73	424
Maize	100590	-0.117	(0.170)	-0.032***	(0.001)	0.38	317
Soybeans	120100	-0.018	(0.024)	0.014	(0.010)	0.87	252
Gasoline	271000	*0.008*	(0.089)	-0.004	(0.011)	0.88	314
Aluminum oxide	281810	*0.051*	(0.158)	-0.087	(0.073)	0.37	246
Titanium oxide	282300	-0.020	(0.032)	0.005***	(0.001)	0.17	293
Non-monetary gold	710812	*0.169*	(0.396)	0.000***	(0.000)	0.24	200
Aluminum foil	760711	-0.218***	(0.079)	0.004	(0.004)	0.17	226
Computers	847120	*0.006*	(0.088)	0.010	(0.012)	0.27	460
CPU	847191	*0.133*	(0.090)	-0.003	(0.047)	0.48	342
Air coolers and purifiers	847989	***0.547****	(0.243)	0.104**	(0.048)	0.42	231
Integrated circuits, digital	854211	-0.570**	(0.239)	-0.054***	(0.012)	0.37	274
Integrated circuits, other	854219	*0.189*	(0.524)	-0.002***	(0.001)	0.20	289
Cars under 1L	870321	-0.289*	(0.175)	0.000	(0.000)	0.08	452
Cars 1L to 1.5L	870322	-0.193	(0.283)	0.002***	(0.001)	0.15	253
Cars 1.5L to 3L	870323	-0.068	(0.071)	-0.006***	(0.002)	0.15	229
Cars over 3L	870324	*0.185*	(0.160)	-0.002	(0.003)	0.36	253
Airplanes over 15 tons	880240	***0.134****	(0.074)	-0.211*	(0.126)	0.30	333
Aircraft parts	880330	*0.092*	(0.139)	0.001	(0.002)	0.28	348

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant.

needed to resolve this issue. The cross-ERPT estimates are significant in nine out of nineteen industries, four of which are positive, implying an elastic importer demand, while the remaining five negative β_{x2} estimates indicate the opposite is true for those industries.

The estimation with the inclusion of competition for UK exporting industries is shown in Table 3.6. Out of the three industries originally with out-of-range ERPT's, turbo jet and small car exporters now have insignificant self-ERPT's, whereas CPU exporters now exhibit significant and in-range PTM behavior. Half of the six significant cross-ERPT estimates indicate an inelastic importer demand for the competitor's product.

In the case of German exporters, out-of-range industry switched from small car makers to engine manufactures with the inclusion of competition in the estimation. In Table 3.7, four out of the six significant cross-ERPT estimates indicate elastic demand for competitor's exports.

In general, many exporting industries respond strongly to competitors' exchange rate shocks, although in different directions. Car industries mostly have a positive or insignif-

Table 3.6: Estimated Self- and Cross-ERPT's for UK Exports

Industry	**HS Code**	**Self**	**(Std. Err.)**	**Cross**	**(Std. Err.)**	**R Sqrd.**	**No. Obs.**
Whiskeys	220830	*0.184*	(0.143)	-0.001***	(0.000)	0.24	355
Crude oil from bituminous†	270900	*-3.080*	(2.738)	0.000***	(0.000)	0.35	54
Gasoline	271000	-0.163	(0.166)	-0.015***	(0.001)	0.82	223
Medicine	300490	-0.254	(0.226)	0.044	(0.081)	0.88	431
Books	490199	-0.083	(0.065)	0.007	(0.014)	0.16	339
Car engines†	840734	*0.000*	(0.000)	0.000	(0.000)	1.00	238
Turbo-jets†	841112	*0.011*	(0.015)	0.000	(0.001)	1.00	100
Turbo-jet parts	841191	-0.833	(0.860)	0.004	(0.006)	0.12	244
Computers†	847120	-0.006	(0.009)	-0.001***	(0.000)	0.99	320
CPU†	847191	-0.224***	(0.084)	-0.005	(0.006)	0.92	102
Computer accessories	847330	-0.267	(0.203)	-0.005	(0.006)	0.14	454
Switches	853650	-0.115**	(0.058)	-0.023	(0.016)	0.35	569
Integrated circuits, digital†	854211	*0.281*	(0.323)	0.001	(0.011)	0.80	63
Cars under 1L†	870321	*0.119*	(0.112)	0.000*	(0.000)	0.84	249
Cars 1L to 1.5L†	870322	*0.004*	(0.006)	0.000***	(0.000)	0.99	344
Cars 1.5L to 3L†	870323	*0.000*	(0.000)	0.000	(0.000)	1.00	272
Cars over 3L†	870324	*0.000*	(0.000)	0.000	(0.000)	1.00	240
Motor vehicle parts	870899	-0.008	(0.035)	-0.005	(0.004)	0.37	454

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant.
†*indicates industries with a time period from 2000 to 2016.*

Table 3.7: Estimated Self- and Cross-ERPT's for German Exports

Industry	**HS Code**	**Self**	**(Std. Err.)**	**Cross**	**(Std. Err.)**	**R Sqrd.**	**No. Obs.**
Beers	220300	-0.062	(0.052)	-0.004	(0.002)	0.06	316
Gasoline	271000	-0.163	(0.164)	-0.015***	(0.001)	0.83	226
Aluminum oxide	281810	-0.320*	(0.185)	0.002	(0.015)	0.10	427
Antisera	300210	*0.076*	(0.374)	-0.043	(0.106)	0.64	339
Medicine	300490	-0.254	(0.226)	0.044	(0.081)	0.88	431
Chemical products, other	382390	-0.124***	(0.042)	0.009	(0.017)	0.11	477
Engine parts	840991	***0.063****	(0.036)	0.007***	(0.003)	0.07	391
Diesel engines	840999	*0.184*	(0.112)	-0.024	(0.025)	0.05	414
Panels	853710	-0.028	(0.034)	-0.002	(0.010)	0.06	523
Cars under 1L†	870321	*0.089*	(0.087)	0.000	(0.000)	0.89	248
Cars 1L to 1.5L†	870322	*0.003*	(0.006)	0.000***	(0.000)	0.99	344
Cars 1.5L to 3L†	870323	*0.000*	(0.000)	0.000	(0.000)	1.00	272
Cars over 3L†	870324	*0.000*	(0.000)	0.000	(0.000)	1.00	240
Diesel cars over 2.5L†	870333	*0.006*	(0.004)	-0.002**	(0.001)	1.00	272
Spcl. prps. vehicle parts	870829	-0.051	(0.125)	0.009	(0.024)	0.08	431
Car transmission	870840	-0.075	(0.087)	0.008*	(0.004)	0.09	500
Motor vehicle parts	870899	-0.008	(0.035)	-0.005	(0.004)	0.12	454
Aircrafts over 15 tons†	880240	*0.126*	(0.132)	0.007	(0.020)	0.92	167
Aircraft parts	880330	-0.599	(0.611)	0.013***	(0.004)	0.28	138

*Notes: *, **, and *** stand for two-tailed significance at 10%, 5%, and 1% levels.*
Italic entries are out of the expected [-1, 0] range.
Bold entries are both out of range and significant.
†*indicates industries with a time period from 2000 to 2016.*

icant response to exchange rate shocks from the competitors, as proposed in Naknoi (2015), whereas more homogeneous products, such as maize, gasoline, circuits, alcohol, and computers tend to have negative estimates.

3.5 Concluding Remarks

This chapter studies the self- and cross-ERPT for exporters from three countries (the US, the UK, and Germany) from 1991 to 2016. We select 19, 18, and 19 industries for the exporting countries respectively based on their importance and in attempt to replicate the result of Knetter (1993). Importing countries are selected based on their importance to the exporters, and the 25 countries with the highest global aggregate export excluding Belgium are included as the competitors to the exporters.

Our evidence confirms the existence of out-of-range estimates in the two-country setup, many of which are significant. With the introduction of competitors' exchange rate shocks, most of the significance disappears. But there are two instances where originally in-range ERPT's move out-of-range with the control of competition. Further research is needed to investigate such a pattern.

The evidence also confirms the competitors' impact on exporters' pricing decisions; many exporters respond significantly to competitors' exchange rate changes. Industries of more homogeneous goods tend to have negative responses whereas car industries typically respond positively. The relationship between the direction of response and the market structure can be further investigated in later studies.

It is worth noting the limitations of this study. The application of the relative market share as a proxy for relative marginal costs from competing exporters is the result of the unavailability of marginal cost data. One needs to keep in mind this issue when interpreting the evidence and future studies are needed to resolve this obstacle.

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