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Exchange Rate Risk Management of Export Firms: New findings from a questionnaire survey

ITO Takatoshi
RIETI

KOIBUCHI Satoshi
Chuo University

SATO Kiyotaka
Yokohama National University

SHIMIZU Junko
Gakushuin University

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
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Exchange Rate Risk Management of Export Firms:[1†] New findings from a questionnaire survey

ITO Takatoshi (University of Tokyo／RIETI)
KOIBUCHI Satoshi (Chuo University)
SATO Kiyotaka (Yokohama National University)
SHIMIZU Junko[§](Gakushuin University)

Abstract

In this paper, we present new findings of Japanese firms' exchange rate risk managements based on a questionnaire survey sent to all Tokyo Stock Exchange listed firms in 2009. Using their responses, we conduct empirical analysis to investigate the relation between respective risk management tools including the choice of invoice currency and the price revision strategy (pass-through). Results show the following: first, firms with higher sales and greater dependency on foreign markets more actively engage in currency hedging including financial and operational hedging. Second, Japanese firms use both financial and operational hedging complementarily. Third, U.S. dollar invoicing is supported by both financial and operational hedging. Fourth, yen-invoicing substitutes for both financial and operational hedging. Fifth, pass-through also substitutes for financial hedging. These findings indicate that Japanese firms use operational hedging, financial hedging strategies, and pass-through policies depending on their choice of invoicing currency.

Keywords: Exchange rate risk management; Invoice currency; Operational hedge; Financial hedge; Exchange rate pass-through

JEL classification: G32, G15, F41

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§ Corresponding Author: junko.shimizu@gakushuin.ac.jp

1. Introduction

Volatile foreign exchange rate fluctuation causes a large influence on both the business performance of globally active firms in the short term and the corporate strategies including the placement of the production base in the medium term to long term. The degree of these influences might depend on each firm's exchange rate risk management. It is said that firms use a combination of financial hedges and operational hedges to manage their currency exposure. Although financial hedges are conducted to hedge their currency exposure using foreign exchange derivatives in foreign exchange markets, operational hedges are used among the firm's international subsidiaries to reduce their foreign exchange exposure. With the development of sophisticated financial hedge techniques in foreign exchange markets, such as forward contracts, currency swaps, and currency options, firms can hedge their currency exposure. However, these transactions can only ensure a certain amount of earnings in terms of the home currency in a certain period. They cannot fully avoid the influence of appreciation of the home currency itself. For example, in response to the yen's appreciation in 1995, Japanese exporting firms promoted the transfer of production bases overseas, or increased the capacity of existing overseas bases, and increased the share of imported components from overseas. They took those measures and others to ensure the benefits.

Another reason why a strong currency quickly turns into economic and political issues in countries having massive export sectors such as Japan and other East Asian countries is that many Asian export firms invoice their exports in US dollars. A stronger home currency reduces overseas sales income of exporting firms when they convert their foreign currency earnings into home currency. If their exports are invoiced in the home currency, their business performance would not be strongly affected by currency appreciation, at least in the short run. Consequently, the choice of invoicing currency is strongly related to the choice of exchange rate risk management tools. Furthermore, whether firms can make their price revisions in response to foreign exchange fluctuations (exchange rate pass-through) and how frequently they can do so are to some degree related to their exchange rate risk management. If firms have a sufficiently competitive product that it is possible to revise their prices to maintain constant earnings, then exchange rate fluctuations would not cause any severe impact on their performances, at least in a certain period while the trading volume does not change. Accordingly, the effectiveness of exchange risk management, the choice of invoicing currency and the decision of exchange rate pass-through are strongly related mutually.

As described in this paper, we investigate the exchange rate risk management of Japanese firms based on responses to a questionnaire survey. Questionnaires were sent to all Japanese manufacturing firms listed in the stock exchanges in September 2009 with the cooperation of

the Research Institute of Economy, Trade, and Industry (RIETI). The questionnaire survey (henceforth, 2009 RIETI survey) covers rich information not only on the firms' foreign exchange rate risk management but also on the firms' choice of invoicing currency and price revision (pass-through) strategy. The survey results are classified by industry and by firm size using annual financial reports of sample firms, through which new evidence of Japanese firms' exchange rate risk management, such as the usage of financial and operational hedging and price revision are presented. Our analysis shows how Japanese firms combine three different tools of exchange rate risk management policies, operational and financial hedging and exchange rate pass-through under their own choice of invoicing currency, to mitigate the influence of exchange rate risk. Given a growing regional production network of Japanese firms, our findings based on the questionnaire study will present important implications for future exchange rate policies to propose more effective exchange rate risk management.

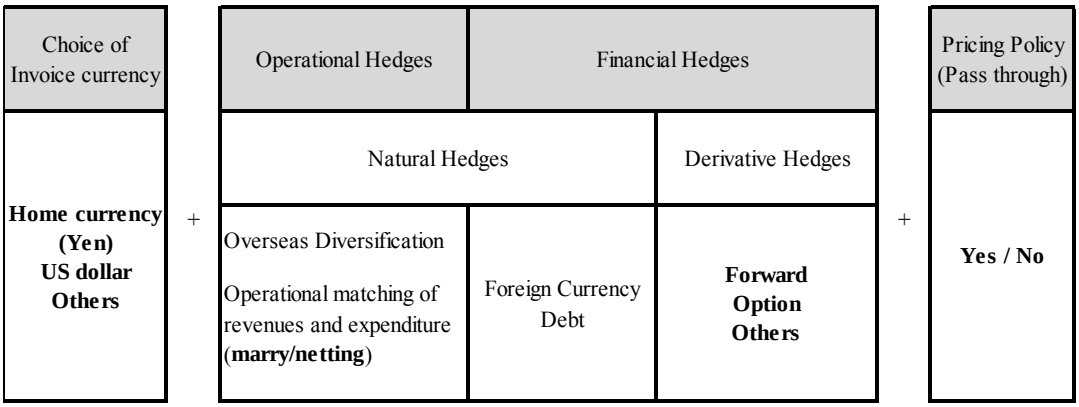
The remainder of this paper is organized as follows. Section 2 presents a review of earlier studies of firms' foreign exchange risk management and presents discussion of the relation between the variety of exchange rate risk management and the invoicing currency choice conducted by globally operating firms. Section 3 briefly presents the 2009 RIETI survey results. Section 4 describes an empirical analysis conducted to ascertain the relation between exchange rate risk management tools including the choice of invoicing currency and pass through. Section 5 concludes with a presentation of the results.

2. Exchange Rate Risk Management, Currency Invoicing, and Pricing Policy

2-1. Variety of Exchange Rate Risk Management

A number of empirical studies have examined the question of how firms deal with the foreign exchange rate risk. Figure 1 shows a conceptual diagram of corporate exchange rate risk management by partly employing the framework of Döhring (2008).

Figure 1. Concept of Exchange Rate Risk Management



Note: The part of "Operational hedges" and "Financial Hedges" is from Döhring (2008).

Usually, firms use two different ways to hedge the exchange rate risk. One is a financial hedge through financial market instruments, such as exchange rate derivatives or foreign currency debt, and the other is an operational hedge through the operational setup of the exporting firm. To effectively manage long-term exchange rate risks, firms should build operational hedging strategies in addition to widely used financial hedging strategies. Most studies specifically examine currency hedging[1]. These studies analyze the relationship between operational hedging and financial hedging and underscore the effectiveness of both strategies by conducting empirical analysis based on firms' stock return. For example, Pantzalis, Simkins, and Laux (2001), using a sample of 220 US multinational firms, find that operational and financial hedges are complementary risk management strategies. Hommel (2003) shows that operational hedging creates flexibility, a strategic complement to financial hedging. Allayannis, Ihrig and Weston (2003) also investigate both financial and operational exchange-rate risk management strategies of multinational firms and confirm that operational hedging strategies benefit shareholders only when used in combination with financial hedging strategies. On the other hand, Kim, Mathur and Nam (2006) investigate how operational hedging is related to financial hedging. They confirm that although operational and financial hedging strategies are complementary, firms using operationally hedging are less dependent on the use of financial derivatives[2].

The relationship between invoicing currency and hedging is rarely investigated. The exception is, to our knowledge, Döhring (2008) that is the first survey study of both the choice

[1] For example, Carter, Pantzalis, and Simkins (2001) investigate the impact of firmwide risk management practices for US multinational corporations and report that currency risk can be reduced effectively through transactions in the forward exchange market.

[2] They use a sample of 424 firm observations from the COMPUSTAT Geographic Segment files for 1998.

of invoicing currency and financial/operational hedging. It is shown that invoicing choice is substitute to derivative hedging such as exchange rate forward in eliminating transaction risk and also that firms would be expected to opt for either of them depending on the relative cost of these strategies. Conducting a survey of actual hedging strategies and techniques of large corporations from a euro-area perspective, Döhring (2008) concludes that whether a domestic currency invoicing and hedging are substitutes or complements depends crucially on the size and geographical orientation of the exporting firm and on the structure of the destination market.

Regarding the relationship between pass-through and hedging, Bartram, Brown and Minton (2010) shows empirically that firms pass-through some porting of currency changes to customers and use both operational and financial hedges for the remainder of foreign exchange exposure. They assume that corporate financial managers can use pricing (pass-through) policy, operational hedging and financial hedging strategies to mitigate the impact of currency fluctuations. Using a sample of 1,150 manufacturing firms in 16 countries, it is empirically shown that pass-through and operational hedging each reduce exposure by 10–15% whereas financial hedging with foreign debt lowers exposure by 40%.

As for recent country specific studies, Chiand and Lin (2007) examine financial and operational hedge strategies of foreign exchange exposures using multiple-horizon data of Taiwan non-financial firms during 1998–2005 and find that the use of operational hedging strategies does not help reduce foreign exchange exposures for Taiwan firms. Pramborg (2005) compares the hedging practices between Swedish and Korean nonfinancial firms and shows that Korean firms used much smaller financial derivatives than Swedish firms with more dependence on foreign debt than derivatives. Both studies indicate that the difficulties of exchange rate risk management in underdeveloped foreign exchange market like Taiwan and Korea. Although Japanese exporting firms tend to face large volatility of yen/US dollar exchange rate, surprisingly few studies conduct firm level analysis of hedging and exchange rate risk management of Japanese firms[3].

2-2. Japanese Firms' Feature of Currency Invoicing and Pricing Policy

Japan is well-known for its unique pattern of the choice of trade invoice currency, which is an overdependence of the US dollar invoicing in spite of an economically advanced country. According to the "stylized facts" on the choice of invoice currency based on the empirical

[3] As for a research using Japanese data, Jayasinghe and Tsui (2008) examine the exchange rate exposure of sectoral indexes in Japanese industries and report significant evidence of exposed returns and its asymmetric conditional volatility of exchange rate exposure by employing a bivariate GJR-GARCH model.

research in the 1970s such as Grassman (1973) and Page (1977), trade between two economically advanced countries tends to be invoiced in the exporter's currency. Trade between economically advanced and economically developing countries is generally invoiced in the economically advanced country's currency. However, Japan's currency invoicing pattern evidently contradicts the stylized facts. First, Japanese exporters have a strong tendency to choose importer's currency for their exports to economically advanced countries such as the United States and EU. Second, US dollar invoicing is prevalent in Japan's exports to Asia.

There has been growing literature on the determinants of currency invoicing. Then they typically use the data on the share of currency invoicing at a country level, however, there were not many empirical studies of Japanese firms level[4]. One of the latest exceptions is Ito et al. (2012), which employed an interview survey of leading Japanese exporters to overcome the data constraint[5]. Because of the interview survey related to about the firm-level information related to the exchange rate risk management, the destination breakdown data on the choice of invoice currency, and the underlying reason for their invoicing choice, Ito et. al. (2010) confirmed new determinants of Japanese firms' invoice currency as follows: (1) export channel of the type , for instance, intra-firm trade, inter-firm trade, or trade via a trading company; (2) each currency's transaction cost; (3) the intensity of competition in the export destination markets and the degree of product differentiation; and (4) the structure of production and distribution network in which goods are produced in Asia and shipped to the United States as the final destination.

In the case of intra-firm trade, importer's currency invoicing is prevalent in Japanese exports to economically advanced countries. Because the exports are destined for local subsidiaries that face severe competition in the local markets, Japanese parent firms have a strong tendency to take an exchange rate risk by invoicing in the importer's currency. It also makes economic sense to concentrate currency risk at the headquarters, because it is better equipped with risk management expertise and with scale economies. Especially if the local subsidiaries are production base and their final destination is US, their choice of US dollar invoicing is rational as a part of their strategy of exchange rate risk management.

On one hand, some Japanese firms that export highly differentiated products or have a dominant share in global markets choose yen invoicing. In addition, the small size firms, that have no their own treasury department because of a budget constraint, usually ask a trading

[4] Goldberg and Tille (2009) used highly detailed Canadian import data at a customs level with rich information on the source country, invoice currency, value of transactions, etc. In addition, Friberg and Wilander (2008) conducted a questionnaire survey analysis with Swedish exporting firms for empirical tests on determinants of currency invoicing, which is a useful approach to obtain detailed data at a firm level.

[5] Ito et al.(2012) interviewed the treasurers of 23 Japanese companies from four major export industries (automobile, electrical machinery, general machinery, and electronic components) over the one-year period between autumn 2007 and autumn 2008.

company to manage their foreign exchange business. In this case, they also tend to use yen invoicing in their transactions with a trading company. Accordingly, Japanese firms' choice of invoice currency is rather complicated, but should be considered with other risk management tools.

Japanese firms' strong tendency of invoicing in the importer's currency is consistent with the pricing-to-market (PTM) behavior discussed in the literature. As Goldberg and Tille (2004) show, currency invoicing choice affects the degree of pass-through. Theoretically, pass-through is unity under the producer currency pricing (PCP) if prices are fixed, although pass-though is zero under the local currency pricing (LCP) in the short run. Empirically, however, firms adjust their prices in response to the movement of exchange rates. For example, if Japanese exporters choose US dollar invoicing (LCP) and raise their prices according to the yen's appreciation, then the pass-through effect of yen/dollar exchange rate increases from zero. In contrast, if Japanese exporters choose yen invoicing (PCP) and lower their prices according to the yen's appreciation, then the pass-through effect decreases from unity. Whether they can raise the price (in the case of LCP) or keep the price unchanged (in the case of PCP) to secure their constant revenue in terms of the home currency or not depends on the degree of competition they face, in other words, how differentiated the products are that they export. Furthermore, firms' price revision depends on how effectively they hedge their exchange rate risk in advance.

Similar to Bartram, Brown and Minton (2010), we assume that Japanese firms have four options of exchange rate risk management: (1) choice of invoice currency, (2) pricing (pass-through) policy, (3) operational hedging, and (4) financial hedging, to mitigate the impact of currency fluctuations, based on which we analyze the results of 2009 RIET survey to clarify the notable characteristics of the Japanese firms' exchange rate risk management.

Compared with the related studies described above, the novelties of this paper are three-fold: (i) This is the first detailed investigation of the exchange rate risk management of Japanese firms from three different tools, such as invoicing currency choice, pricing (pass through) strategy and financial/operational hedging policy; (ii) Each exchange rate risk management policy is analyzed by firm size, (iii) The robustness of each exchange rate risk management policy is scored and compared by firm size.

3. Questionnaire Survey – the Case of Japanese Exporters' risk management

In this section, we present the results of 2009 RIETI Survey related to Japanese firms' exchange rate risk management. To elucidate their features, we classify our results by the firm size. Regarding the size, we set two different measures, firm size, and the foreign sales ratio.

The former is a category based on total consolidated sales immediately before the survey (mostly as of March 2009) that splits all listed manufacturers into three categories consisting of large (upper 1/3), medium (middle 1/3), and small (lower 1/3). The latter is also a category based on foreign sales ratio (total foreign sales / total consolidated sales) splitting all listed manufacturers into high (upper 1/3), medium (middle 1/3), and low (lower 1/3).

3-1. Share of Currency Invoicing in Japanese Exports to the World

Table 3-1 presents the results of questionnaires upon the invoicing choice of Japanese firms' exports to the world, where a simple arithmetic average of the invoicing share is reported. First, in all manufacturing industries, where 217 firms responded, the share of yen-invoicing is the largest (48.2%). That of US dollar invoicing is the next largest (42.2%). The share of euro invoicing accounts for only 7.1%; the share of other currency invoicing is very low (2.7%). Second, when looking at industry breakdown data, the share of yen-invoicing is large in the glass and ceramics, metal products, machinery, and transport equipment industry. On the other hand, the share of US dollar invoicing is largest in the rubber product, steel products, nonferrous metals, and electrical machinery industries. Third, other currency invoicing typically accounts for a small share, although the share of Euro invoicing is around 10% or more in the pharmaceuticals and machinery industries.

Table3-1
Currency invoicing share in exports from Japan to the World (by industry) Sample average (Unit: %)

Type of industry		All manufacturers	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal Products	Rubber Products	Glass & Ceramics
# of firms		217	2	7	36	3	1	4	6
Currency invoicing share	JPY	48.2	50.0	50.0	50.4	54.0	0.0	38.0	57.2
	USD	42.1	50.0	41.3	41.0	20.3	100.0	54.3	40.8
	Euro	7.1	0.0	3.7	7.7	17.0	0.0	7.5	1.0
	Others	2.7	0.0	5.0	0.9	10.0	0.0	0.3	1.0

Type of industry		Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
# of firms		6	5	9	38	51	27	14	8
Currency invoicing share	JPY	35.7	23.6	57.2	56.2	38.8	56.3	44.4	53.9
	USD	63.5	70.4	41.7	29.7	50.7	33.3	44.3	38.3
	Euro	0.0	5.0	1.0	11.0	8.2	4.5	9.0	5.3
	Others	0.8	1.0	0.1	3.2	2.5	5.9	2.3	2.6

Let us next examine the invoicing share across the firm size (Table 3-2). In terms of the consolidated sales, it is shown clearly that the smaller the firm, the higher its share of yen-invoicing. In contrast, the larger the firm size, the higher the share of US dollar invoicing. In terms of the foreign sales ratio, however, no clear pattern of the invoicing choice is observed.

Result 1: The yen and the US dollar are mainly used in Japanese total exports to the world. The smaller (larger) the firm, the higher the share of yen (US dollar) invoicing is.

Table3-2
Currency invoicing share in exports from Japan to the World (by firm category) Sample average (Unit: %)

	Total consolidated sales			Total foreign sales / Total consolidated sales		
	Large (upper 1/3)	Medium (middle 1/3)	Small (lower 1/3)	High (upper 1/3)	Medium (middle 1/3)	Low (lower 1/3)
# of sample firms	80	70	67	64	70	83
JPY						
All manufacturers	38.1	50.0	58.3	41.2	52.2	50.2
Chemicals	33.1	54.2	66.8	52.1	50.1	49.8
Machinery	36.8	73.8	56.5	47.5	67.3	55.0
Electrical Machinery	25.7	36.5	54.3	25.1	48.9	50.7
Transport Equipment	49.0	71.9	56.6	47.5	47.0	77.9
Precision Instruments	29.8	40.4	55.0	43.8	63.5	21.3
USD						
All manufacturers	47.8	41.7	35.8	45.5	39.0	42.1
Chemicals	55.9	38.7	25.9	39.4	41.7	40.9
Machinery	41.0	18.0	31.1	31.3	19.8	35.8
Electrical Machinery	59.2	51.4	41.5	62.4	41.8	40.7
Transport Equipment	35.3	23.4	41.2	40.2	38.0	19.5
Precision Instruments	42.6	51.6	39.2	37.8	27.3	73.8
Euro						
All manufacturers	10.5	5.1	5.2	11.0	5.7	5.3
Chemicals	10.5	5.1	7.3	8.4	6.4	9.2
Machinery	17.5	5.8	10.1	18.5	9.6	5.9
Electrical Machinery	12.8	7.8	3.8	10.3	6.8	6.2
Transport Equipment	6.1	2.7	2.1	7.0	4.4	1.3
Precision Instruments	25.4	3.0	5.8	16.8	8.5	0.0
Other currencies						
All manufacturers	3.7	3.3	0.7	2.5	3.0	2.5
Chemicals	0.6	2.1	0.0	0.1	1.8	0.1
Machinery	4.7	2.4	2.5	3.0	3.3	3.2
Electrical Machinery	2.3	4.9	0.3	2.6	2.6	2.4
Transport Equipment	9.6	2.0	0.1	5.3	10.6	1.3
Precision Instruments	2.2	5.0	0.0	1.6	0.7	5.0

3-2. Number of foreign currencies handled

We asked firms to choose its foreign currencies handled from 20 kinds of foreign currencies including the U.S. dollars from the multiple answers allowed. Table 3-3 shows results of 227 firms' responses. The mean of the number of the handling foreign currencies in the answered manufacturing industry is 3.1. We conclude that approximately three kinds of foreign currencies are used in one company on the average. An electric machinery firm answered that it

handles currencies of 15 kinds at the maximum.[6] According to a type of industry, the mean of the numbers of the handled foreign currencies is 4, 3.5, and 3, respectively, in "Transport Equipment", "Electrical Machinery" and "Machinery". That result indicates that Japanese representative industries, which develop production networks in abroad, handle foreign currencies of various kinds.[7]

Table 3-3
How many kinds of foreign currencies are used for international trade? (by industry)

	Type of Industry	All manufacturers	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal Products	Rubber Products	Glass & Ceramics
	# of answers	227	3	9	36	3	1	4	6
Number of foreign currencies for	Average	3.1	2.3	2.9	2.7	3.7	1.0	3.0	2.7
	Max	15	3	6	9	5		5	7
	Min	0	2	1	1	2		1	1

	Type of Industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
	# of answers	6	5	9	40	55	27	15	8
Number of foreign currencies for	Average	2.0	2.8	2.3	3.3	3.5	4.0	2.1	2.8
	Max	6	4	8	12	15	14	4	5
	Min	1	1	0	0	0	0	1	1

Table 3-4 presents a summary of the number of the handling foreign currencies of five major types of industry by firm size (total consolidated sales) and foreign sales ratio (total foreign sales/total consolidated sales). The number of foreign currencies handled tends to increase monotonously as the firm size becomes large. According to the type of industry, this tendency is particularly remarkable in "Chemical", "Machinery", and "Electrical Machinery" (upper table). In addition, the number of the handled foreign currencies tends to increase monotonously as the ratio of total foreign sales over total consolidated sales becomes larger. This tendency is remarkable in "Transport Equipment" (lower table).

Result 2: The average Japanese firm uses three foreign currencies for exports. Larger firms or firms with higher exposure to foreign markets use more currencies.

[6] The number 0 denotes that no foreign currency is handled; Japanese yen are used for all trade.
[7] Although the number of answers is only 3, the mean of "Pharmaceutical" is 3.7, which is higher than other industries, too.

Table3-4
How many kinds of foreign currencies are used for international trade? (by firm category / by 6 major types of industry

	Type of Industry	All manufacturers	All manufacturers	Chemicals	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments
	Total consolidated sales	# of firms	Average	Average	Average	Average	Average	Average
Number of foreign currencies for international	Large (upper 1/3)	86	4.4	3.2	5.0	5.5	5.5	3.0
	Medium (middle 1/3)	73	2.7	2.8	3.2	2.9	1.7	1.8
	Small (lower 1/3)	68	1.9	2.0	1.7	1.8	3.0	2.0

	Type of Industry	All manufacturers	All manufacturers	Chemicals	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments
	Total foreign sales / Total consolidated sales	# of firms	Average	Average	Average	Average	Average	Average
Number of foreign currencies for international	High (upper 1/3)	69	3.7	2.6	3.7	3.5	6.4	2.7
	Medium (middle 1/3)	71	3.2	3.3	3.0	4.6	3.0	2.2
	Low (lower 1/3)	87	2.5	1.9	3.2	3.0	2.3	1.3

3-3. Financial hedging

Instruments of financial hedging

Regarding financial hedging through the foreign exchange market, we ask what kind of instruments a firm uses. Table 3-5 presents a summary of the results by type of industry. Among 166 answered firms, 73.1% of firms use hedging instruments of some kind through the foreign exchange market. Specifically, using "Forward" is the highest ratio (95.2%) followed by "Currency Option" (24.1%), and "Other currency derivatives" (3.0%). According to industry brackets, "Pharmaceutical", "Steel Products", and "Nonferrous Metals" use "Forward" only, whereas almost 40% firms of "Electrical Machinery", "Transport Equipment" and "Precision Instruments" use "Currency Option" in combination with "Forward".

Table 3-5
Instruments of currency hedging through exchange rate markets (by industry)

	Type of industry	All manufacturers	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal Products	Rubber Products	Glass & Ceramics
	Number of sample firms (A)	227	3	9	36	3	1	4	6
Firms to answer any instrument of currency hedging	# of answers (B)	166	3	8	24	3	1	3	4
	(B)/(A)(%)	73.1	100.0	88.9	66.7	100.0	100.0	75.0	66.7
Forward	# of answer "yes" (C)	158	2	8	24	3	1	2	4
	(C)/(B)(%)	95.2	66.7	100.0	100.0	100.0	100.0	66.7	100.0
Currency option	# of answer "yes" (D)	40	1	1	4	0	1	1	2
	(D)/(B)(%)	24.1	33.3	12.5	16.7	0.0	100.0	33.3	50.0
Other currency derivatives	# of answer "yes" (E)	5	1	0	2	0	0	0	0
	(E)/(B)(%)	3.0	33.3	0.0	8.3	0.0	0.0	0.0	0.0

	Type of industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
	Number of sample firms (A)	6	5	9	40	55	27	15	8
Firms to answer any instrument of currency hedging	# of answers (B)	4	4	3	33	42	18	9	7
	(B)/(A)(%)	66.7	80.0	33.3	82.5	76.4	66.7	60.0	87.5
Forward	# of answer "yes" (C)	4	4	3	32	38	18	8	7
	(C)/(B)(%)	100.0	100.0	100.0	97.0	90.5	100.0	88.9	100.0
Currency option	# of answer "yes" (D)	0	0	1	4	13	7	4	1
	(D)/(B)(%)	0.0	0.0	33.3	12.1	31.0	38.9	44.4	14.3
Other currency derivatives	# of answer "yes" (E)	0	0	0	0	2	0	0	0
	(E)/(B)(%)	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0

In Table 3-6, we present a summary of results above by firm size (total consolidated sales) and foreign sales ratio (total foreign sales/total consolidated sales). The ratio of using some kind of currency hedging instruments increases monotonously as a firm size becomes greater. In addition, the ratio of using "Forward" and "Currency Option" tends to become higher as a firm size becomes larger. Firms with large consolidated sales or large foreign sales actively use currency hedging instruments through foreign exchange markets.

Result 3: Around three quarters of Japanese firms use some foreign exchange hedging instruments through the foreign exchange market. Larger firms or firms with higher exposure to foreign markets use more hedging instruments for their foreign exchange risk management.

Table 3-6
Instruments of currency hedging through exchange rate markets (by firm category)

	Firm category	Total consolidated sales			Total foreign sales / Total consolidated sales		
		Large (upper 1/3)	Medium (middle 1/3)	Small (lower 1/3)	High (upper 1/3)	Medium (middle 1/3)	Low (lower 1/3)
	Number of sample firms (A)	86	73	68	69	71	87
Firms to answer using any instrument of currency hedging	# of answers (B)	79	51	36	58	51	57
	(B)/(A)(%)	91.9	69.9	52.9	84.1	71.8	65.5
Forward	# of answer "yes" (C)	79	47	32	55	49	54
	(C)/(B)(%)	100.0	92.2	88.9	94.8	96.1	94.7
Currency option	# of answer "yes" (D)	27	6	7	23	8	9
	(D)/(B)(%)	34.2	11.8	19.4	39.7	15.7	15.8
Other currency derivatives	# of answer "yes" (E)	2	2	1	1	2	2
	(E)/(B)(%)	2.5	3.9	2.8	1.7	3.9	3.5

Internal rule for the hedging ratio

We wonder whether firms hedge their foreign currency exposures by an internal rule or discretionarily, and wonder how high is the average hedging ratio of Japanese exporters. We first ask if firms have any internal rule for a hedging ratio. Then, we ask affirmatively responding firms about their hedging ratio on their foreign currency exposures. Table 3-7 presents a summary of the results by type of industry. Among 212 answered firms, 54.2% firms have an internal rule, whereas 45.8% firms have no internal rule. Among the firms which have some internal rule on their hedging foreign currency exposures, the ratio of "around 50%" hedging is the highest (41.7%) followed by "around 100%" hedging (23.5%). We can confirm that almost one-quarter of foreign currency exposures are hedged 100%, and that more than 60% of foreign currency exposure are hedged more than 50%. According to industry brackets, no specific choice exists by industry type, which suggests that deciding a hedging ratio depends on each firm's foreign exchange risk management strategy.

Table 3-7
Is there an internal rule dictating the percentage of foreign exchange exposure? (by industry)

		Type of industry	All manufacturers	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal Products	Rubber Products	Glass & Ceramics
Firms to answer whether they have an internal rules on FX		# of firms (A)	212	3	9	34	3	1	4	6
1. Yes, we have the rule.		# of answers	115	2	3	21	0	1	3	3
		(B)/(A)(%)	54.2	66.7	33.3	61.8	0.0	100.0	75.0	50.0
Hedge ratio on FX exposure	around 30%	# of answers	13	0	0	1	0	0	0	1
		(C)/(B)(%)	11.3	0.0	0.0	4.8		0.0	0.0	33.3
	around 50%	# of answers (D)	48	0	3	7	0	0	1	2
		(D)/(B)(%)	41.7	0.0	100.0	33.3		0.0	33.3	66.7
	almost 100%	# of answers (E)	27	2	0	7	0	1	2	0
		(E)/(B)(%)	23.5	100.0	0.0	33.3		100.0	66.7	0.0
	others	# of answers (F)	26	0	0	6	0	0	0	0
		(F)/(B)(%)	22.6	0.0	0.0	28.6		0.0	0.0	0.0
2 No, we do not have a rule.		# of answers	97	1	6	13	3	0	1	3
		(G)/(A)(%)	45.8	33.3	66.7	38.2	100.0	0.0	25.0	50.0

		Type of industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
Firms to answer whether they have an internal rules on FX		# of firms (A)	6	4	7	39	54	24	12	6
1. Yes, we have the rule		# of answers	2	1	4	22	29	12	9	3
		(B)/(A)(%)	33.3	25.0	57.1	56.4	53.7	50.0	75.0	50.0
Hedge ratio on FX exposure	around 30%	# of answers	2	0	0	2	3	1	3	0
		(C)/(B)(%)	100.0	0.0	0.0	9.1	10.3	8.3	33.3	0.0
	around 50%	# of answers (D)	0	0	2	13	11	6	2	1
		(D)/(B)(%)	0.0	0.0	50.0	59.1	37.9	50.0	22.2	33.3
	almost 100%	# of answers (E)	0	1	0	2	7	2	2	1
		(E)/(B)(%)	0.0	100.0	0.0	9.1	24.1	16.7	22.2	33.3
	others	# of answers (F)	0	0	2	5	7	3	2	1
		(F)/(B)(%)	0.0	0.0	50.0	22.7	24.1	25.0	22.2	33.3
2 No, we do not have a rule.		# of answers	4	3	3	17	25	12	3	3
		(G)/(A)(%)	66.7	75.0	42.9	43.6	46.3	50.0	25.0	50.0

In Table 3-8, we present the results presented above by firm size (total consolidated sales) and foreign market ratio (total foreign sales/total consolidated sales). The ratio of having an internal rule for the hedge ratio of foreign currency exposure increase monotonously as the firm size becomes large. That result indicates that larger firms or firms with higher exposure to foreign markets are more likely to adopt the internal rule for the hedge ratio. The firms with no internal rule for the hedging ratio answer that they choose their hedging ratio depending on the condition and prospect of the foreign exchange market.

Result 4: Around half of Japanese firms have internal rules for the hedge ratio of foreign exchange exposure. Larger firms or firms with higher exposure to foreign markets are more likely to adopt the internal rule for the hedge ratio.

Table 3-8
Is there an internal rule dictating the percentage of foreign exchange exposure? (by firm category)

		Firm category	Total consolidated sales			Total foreign sales / Total consolidated sales		
			Large (upper 1/3)	Medium (middle 1/3)	Small (lower 1/3)	High (upper 1/3)	Medium (middle 1/3)	Low (lower 1/3)
Firms to answer whether they have an internal rules on FX		# of firms (A)	82	68	62	66	67	79
1. Yes, we have the rule.		# of answers	64	32	19	47	36	32
		(B)/(A)(%)	78.0	47.1	30.6	71.2	53.7	40.5
Hedge ratio on FX exposure	around 30%	# of answers	5	4	4	4	5	4
		(C)/(B)(%)	7.8	12.5	21.1	8.5	13.9	12.5
	around 50%	# of answers (D)	27	15	6	17	14	17
		(D)/(B)(%)	42.2	46.9	31.6	36.2	38.9	53.1
	almost 100%	# of answers (E)	15	7	5	12	9	6
		(E)/(B)(%)	23.4	21.9	26.3	25.5	25.0	18.8
	others	# of answers (F)	16	6	4	13	8	5
		(F)/(B)(%)	25.0	18.8	21.1	27.7	22.2	15.6
2 No, we do not have a rule.		# of answers	18	36	43	19	31	47
		(G)/(A)(%)	22.0	52.9	69.4	28.8	46.3	59.5

3-4. Operational hedging – Marry and netting

Along with the above-described hedging instruments through the foreign exchange market, another solution to hedge the foreign exchange exposure is operational hedging. Operational hedging is a strategy designed to manage risks through operational means, such as provides firms with flexibility in their supply chains, financial positions, distribution patterns and market-facing activities by allowing dynamic adjustments in the locations used to manufacture, source, and sell. When deployed carefully, such flexibility can help to reduce the impact of large and long-term shifts in currency values on costs and revenues. Facing volatile foreign exchange fluctuations for a long time, many Japanese exporting firms have built overseas production networks to use several operational hedging techniques. For example "marry and netting", are commonly used in Japanese exporting firms. "Marry and netting" is the practice of offsetting foreign receivables against foreign payables to avoid the foreign exchange risk completely. In our questionnaire survey, we ask whether a firm uses "marry and netting" as a currency risk management technique.

Table 3-9 presents answers related to performing "marry and netting" for what kind of foreign currency and for what kind of transaction by industry type. Among 222 responding firms, 40.15% of firms use "marry and netting". According to industry brackets, the ratio of affirmative answers is greater than 50% in "Electrical Machinery" and "Transport Equipment".

Regarding the target currency for marry and netting, the U.S. dollar is the highest (97.8%) followed by the euro (41.6%). Furthermore, marry and netting is used mainly for trade between the head office and subsidiaries (85.4%).

Table 3-9
Do you use marry and/or netting as a means of exchange rate risk managements? (by industry)

		Type of industry	All manufact	Foods	Textiles &	Chemicals	Pharmaceuticals	Oil & Coal	Rubber Products	Glass & Ceramics
Firms to answer whether they conduct marry and/or netting		# of firms (A)	222	3	9	36	3	1	4	6
1. Yes, we do.		# of answers	89	1	4	13	1	0	0	1
		(B)/(A)(%)	40.1	33.3	44.4	36.1	33.3	0.0	0.0	16.7
For what kind of currency?	US dollar	# of answers (C)	87	1	4	13	1	0	0	1
		(C)/(B)(%)	97.8	100.0	100.0	100.0	100.0			100.0
	Euro	# of answers (D)	37	1	0	3	1	0	0	0
		(D)/(B)(%)	41.6	100.0	0.0	23.1	100.0			0.0
	Other currencies	# of answers (E)	8	0	0	0	0	0	0	0
		(E)/(B)(%)	9.0	0.0	0.0	0.0	0.0			0.0
For what kind of transaction?	Trade between head office and	# of answers	76	0	3	11	1	0	0	1
		(F)/(B)(%)	85.4	0.0	75.0	84.6	100.0			100.0
	Others	# of answers (G)	15	1	1	2	0	0	0	0
		(G)/(B)(%)	16.9	100.0	25.0	15.4	0.0			0.0
2. No, we don't.		# of answers	133	2	5	23	2	1	4	5
		(H)/(A)(%)	59.9	66.7	55.6	63.9	66.7	100.0	100.0	83.3

		Type of industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
		# of firms (A)	6	5	9	39	55	25	13	8
1. Yes, we do.		# of answers (B)	0	1	1	14	32	14	3	4
		(B)/(A)(%)	0.0	20.0	11.1	35.9	58.2	56.0	23.1	50.0
For what kind of currency?	US dollar	# of answers (C)	0	1	1	13	32	13	3	4
		(C)/(B)(%)		100.0	100.0	92.9	100.0	92.9	100.0	100.0
	Euro	# of answers (D)	0	0	0	10	15	5	2	0
		(D)/(B)(%)		0.0	0.0	71.4	46.9	35.7	66.7	0.0
	Other currencies	# of answers (E)	0	0	0	2	2	4	0	0
		(E)/(B)(%)		0.0	0.0	14.3	6.3	28.6	0.0	0.0
For what kind of transaction?	Between head office and	# of answers	0	1	1	14	26	11	3	4
		(F)/(B)(%)		100.0	100.0	100.0	81.3	78.6	100.0	100.0
	Others	# of answers (G)	0	0	0	0	5	6	0	0
		(G)/(B)(%)		0.0	0.0	0.0	15.6	42.9	0.0	0.0
2. No, we don't.		# of answers (H)	6	4	8	25	23	11	10	4
		(H)/(A)(%)	100.0	80.0	88.9	64.1	41.8	44.0	76.9	50.0

In Table 3-10, we summarize results presented above by firm size (total consolidated sales and total foreign sales/total consolidated sales). The share of firms using "marry and netting" increases monotonously as the total consolidated sales increase and the degree of the exposure to the overseas markets becomes greater.

Result 5: Around 40% of Japanese firms use “marry and netting” as a means of foreign

exchange risk management. Larger firms or firms with higher exposure to foreign markets are more likely to use “marry and netting”.

Table 3-10
Do you use marry and/or netting as a means of exchange rate risk managements? (by firm category)

		Firm category	Total consolidated sales			Total foreign sales / Total consolidated sales		
			Large (upper 1/3)	Medium (middle 1/3)	Small (lower 1/3)	High (upper 1/3)	Medium (middle 1/3)	Low (lower 1/3)
Firms to answer whether they conduct marry and/or netting		# of firms (A)	85	71	66	67	71	84
1. Yes, we do.		# of answers	49	23	17	45	22	22
		(B)/(A)(%)	57.6	32.4	25.8	67.2	31.0	26.2
For what kind of currency?	US dollar	# of answers (C)	47	23	17	44	21	22
		(C)/(B)(%)	95.9	100.0	100.0	97.8	95.5	100.0
	Euro	# of answers (D)	25	8	4	22	6	9
		(D)/(B)(%)	51.0	34.8	23.5	48.9	27.3	40.9
	Other currencies	# of answers (E)	8	0	0	4	2	2
		(E)/(B)(%)	16.3	0.0	0.0	8.9	9.1	9.1
For what kind of transaction?	Trade between head office and	# of answers	40	22	14	40	19	17
		(F)/(B)(%)	81.6	95.7	82.4	88.9	86.4	77.3
	Others	# of answers (G)	12	0	3	7	3	5
		(G)/(B)(%)	24.5	0.0	17.6	15.6	13.6	22.7
2. No, we don't.		# of answers	36	48	49	22	49	62
		(H)/(A)(%)	42.4	67.6	74.2	32.8	69.0	73.8

3-5. Pass-through of the exchange rate fluctuation to the export price

Exchange rate pass-through to the export price is one interesting topic related to the choice of invoicing currency. We ask whether firms execute a pass-through exchange rate fluctuation to the export price, and how often they do so. Table 3-11 summarizes the results by the type of industry. Among 215 answered firms, the share of firms that choose "It depends on the circumstances and management decision" is the highest (51.2%) followed by "No, we only slightly pass through to the export price" (32.1%). It is surprising that only 16.7% of firms have an internal rule to pass through the exchange rate fluctuation to the export price. These results suggest that Japanese exporters cannot change their export price easily even if there was a large fluctuation of foreign exchange rate.

Table3-11
Is there an internal rule to pass through the exchange rate fluctuation to the export price? (by industry)

	Type of industry	All manufactu	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal	Rubber Products	Glass & Ceramics
	# of firms (A)	215	3	7	35	3	1	4	6
1. Yes, there is a rule.	# of answers (B)	36	0	0	4	1	0	1	1
	(B)/(A)(%)	16.7	0.0	0.0	11.4	33.3	0.0	25.0	16.7
2 No, we hardly pass through to the export price.	# of answers (C)	69	0	3	10	2	1	2	0
	(C)/(A)(%)	32.1	0.0	42.9	28.6	66.7	100.0	50.0	0.0
3. It depends on the circumstances and maangement decisions	# of answers (D)	110	3	4	21	0	0	1	5
	(D)/(A)(%)	51.2	100.0	57.1	60.0	0.0	0.0	25.0	83.3

	Type of industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
	# of firms (A)	6	5	9	39	51	25	14	7
1. Yes, there is a rule.	# of answers (B)	0	2	1	8	9	6	3	0
	(B)/(A)(%)	0.0	40.0	11.1	20.5	17.6	24.0	21.4	0.0
2 No, we hardly pass through to the export price.	# of answers (C)	3	3	6	10	20	6	0	3
	(C)/(A)(%)	50.0	60.0	66.7	25.6	39.2	24.0	0.0	42.9
3. It depends on the circumstances and maangement decisions	# of answers (D)	3	0	2	21	22	13	11	4
	(D)/(A)(%)	50.0	0.0	22.2	53.8	43.1	52.0	78.6	57.1

In Table 3-12, we summarize results presented above by firm size (total consolidated sales and total foreign sales/total consolidated sales). Judging from firm size measured by total consolidated sales, the share of firms that have an internal price revision rule increases monotonously as the total consolidated sales become larger. Furthermore, judging from firm size measured by the ratio of total foreign sales to total consolidated sales, the share of firms that only slightly pass through the exchange rate fluctuation to the export price increases as the ratio of total foreign sales to total consolidated sale becomes lower.

Table3-12
Is there an internal rule to pass through the exchange rate fluctuation to the export price? (by firm category)

	Firm category	Total consolidated sales			Total foreign sales / Total consolidated sales		
		Large (upper 1/3)	Medium (middle	Small (lower	High (upper 1/3)	Medium (middle	Low (lower
	# of firms (A)	80	69	66	65	68	82
1. Yes, there is a rule.	# of answers (B)	18	10	8	17	4	15
	(B)/(A)(%)	22.5	14.5	12.1	26.2	5.9	18.3
2 No, we hardly pass through to the export price.	# of answers (C)	20	31	18	18	22	29
	(C)/(A)(%)	25.0	44.9	27.3	27.7	32.4	35.4
3. It depends on the circumstances and maangement decisions	# of answers (D)	42	28	40	30	42	38
	(D)/(A)(%)	52.5	40.6	60.6	46.2	61.8	46.3

Appreciation of Japanese yen in 2008

We now turn the second question of whether firms passed through substantial appreciation

of the Japanese yen in 2008 to the export price and if so, what kind of currency they did. Table 3-13 presents a summary of the results by type of industry. Among 209 answered firms, the share of firms that passed through the exchange rate fluctuation to the export price in 2008 is 43.1%, which is smaller than the negative answer (56.9%). A surprising result is that more than half of Japanese firms did not pass through even in circumstances where the Japanese yen appreciated approximately 20% against the US dollar. Regarding the target currency of the price revision (multiple answers allowed), the share of the U.S. dollar is the highest (84.4%) followed by the euro (47.8%). According to industry brackets, no firms in "Pharmaceuticals", "Oil &Coal Products" and "Steel Products") executed pass through whereas more than half of firms in "Textiles and Apparel", "Chemicals", "Machinery", and "Precision Instruments" executed pass through.

Table3-13
Did you pass through substantial appreciation of Japanese yen in 2008 to the export price? (by industry)

		Type of industry	All manufacturers	Foods	Textiles & Apparel	Chemicals	Pharmaceuticals	Oil & Coal Products	Rubber Products	Glass & Ceramics
		# of firms (A)	209	3	7	34	3	1	4	6
1. Yes, we did.		# of answers (B)	90	1	4	19	0	0	1	1
		(B)/(A)(%)	43.1	33.3	57.1	55.9	0.0	0.0	25.0	16.7
For what kind of currency?	US dollar	# of answers (C)	76	1	4	14	0	0	1	1
		(C)/(B)(%)	84.4	100.0	100.0	73.7			100.0	100.0
	Euro	# of answers (D)	43	0	3	10	0	0	0	0
		(D)/(B)(%)	47.8	0.0	75.0	52.6			0.0	0.0
	Other currencies	# of answers (E)	14	0	0	3	0	0	0	0
		(E)/(B)(%)	15.6	0.0	0.0	15.8			0.0	0.0
2. No, we didn't.		# of answers (F)	119	2	3	15	3	1	3	5
		(F)/(A)(%)	56.9	66.7	42.9	44.1	100.0	100.0	75.0	83.3

		Type of industry	Steel Products	Nonferrous Metals	Metal Products	Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
		# of firms (A)	6	5	8	36	50	25	14	7
1. Yes, we did.		# of answers (B)	0	2	3	18	16	12	8	5
		(B)/(A)(%)	0.0	40.0	37.5	50.0	32.0	48.0	57.1	71.4
For what kind of currency?	US dollar	# of answers (C)	0	1	3	16	15	10	6	4
		(C)/(B)(%)		50.0	100.0	88.9	93.8	83.3	75.0	80.0
	Euro	# of answers (D)	0	1	0	11	10	5	3	0
		(D)/(B)(%)		50.0	0.0	61.1	62.5	41.7	37.5	0.0
	Other currencies	# of answers (E)	0	0	0	2	1	5	1	2
		(E)/(B)(%)		0.0	0.0	11.1	6.3	41.7	12.5	40.0
2. No, we didn't.		# of answers (F)	6	3	5	18	34	13	6	2
		(F)/(A)(%)	100.0	60.0	62.5	50.0	68.0	52.0	42.9	28.6

Table 3-14, presents a summary of the results presented above by firm size (total consolidated sales and total foreign sales/total consolidated sales). Judging from firm size, the share of firms that pass through increases monotonously as the firm size becomes larger.

Result 6: Many Japanese firms do not pass through the exchange rate fluctuation to their export price. However, larger firms or firms with higher exposure to foreign markets are more likely to pass it through.

Table3-14
Did you pass through substantial appreciation of Japanese yen in 2008 to the export price? (by firm category)

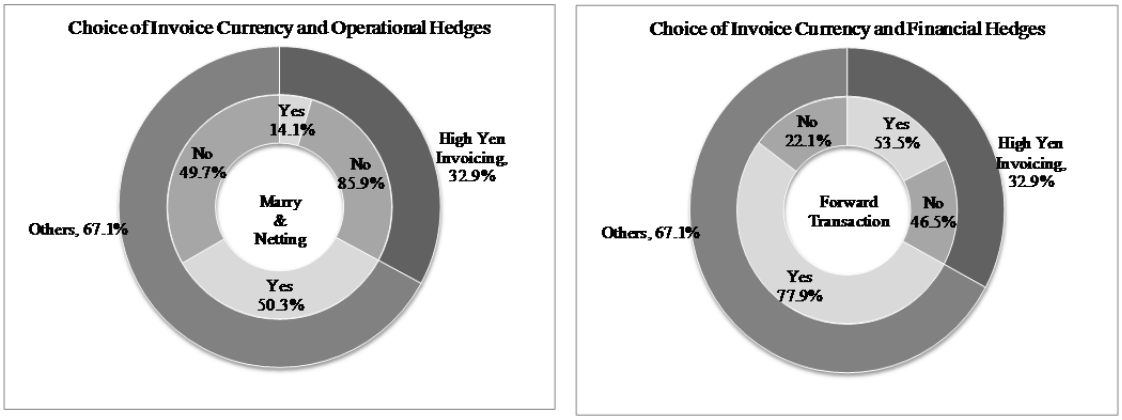
		Firm category	Total consolidated sales			Total foreign sales / Total consolidated sales		
			Large (upper 1/3)	Medium (middle 1/3)	Small (lower 1/3)	High (upper 1/3)	Medium (middle 1/3)	Low (lower 1/3)
		# of firms (A)	77	67	65	62	67	80
1. Yes, we did.		# of answers (B)	41	25	24	32	28	30
		(B)/(A)(%)	53.2	37.3	36.9	51.6	41.8	37.5
For what kind of currency?	US dollar	# of answers (C)	35	21	20	30	22	24
		(C)/(B)(%)	85.4	84.0	83.3	93.8	78.6	80.0
	Euro	# of answers (D)	27	7	9	18	14	11
		(D)/(B)(%)	65.9	28.0	37.5	56.3	50.0	36.7
	Other currencies	# of answers (E)	8	3	3	5	5	4
		(E)/(B)(%)	19.5	12.0	12.5	15.6	17.9	13.3
2. No, we didn't.		# of answers (F)	36	42	41	30	39	50
		(F)/(A)(%)	46.8	62.7	63.1	48.4	58.2	62.5

3-6. Relations among four tools of exchange rate risk management

Summarizing the results presented above, we seek out how each tool affects the others. We first classify the answers by the choice of invoicing currency, high share of yen invoicing, and others. The reason we do so is that the choice of invoicing currency is presumed to be crucial to determine the hedging policy. For example, a firm with 100% yen invoicing need not use financial hedging. Accordingly, the necessity of operational or financial hedging differs between firms with a high yen invoicing share and others.

Figure 2 shows the relation between the choice of invoice currency and operational hedges (in this case, Marry and Netting). Firms with more than 75% of yen invoicing share are classified into "High share of yen invoicing" and other firms into "Others". Results show that 85.9% of firms with a high share of yen invoicing implement no "marry and netting". In addition, although 53.5% of firms with a high share of yen invoicing implement forward transactions, 77.9% of firms without a high share of yen invoicing implement forward transactions. These are consistent with the assertion of Döhring (2008), which indicates that domestic currency invoicing allows the elimination of transaction risk, much like hedging with an exchange-rate forward.

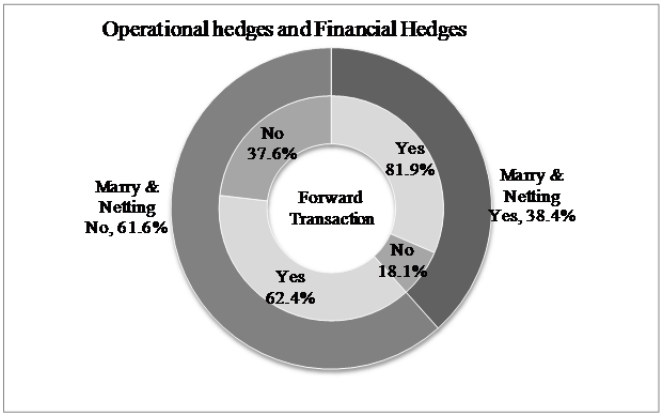
Figure 2. Relation between the Choice of Invoice Currency and Hedges.



Note: Firms with more than 75% of yen invoicing share are classified into "High share of yen invoicing" and other firms into "Others". The outer circle shows the choice of invoice currency. The inner circle shows the answer of hedges.

Figure 3 shows the relation between operational hedges and financial hedges. As previous studies have examined, our focus is whether operational and financial hedging strategies are complementary. Results show that more than 80% of firms with "marry and netting" use forward transactions. This share is higher than the share of using forward transactions by firms without "marry and netting" (62.4%). These results support that Japanese firms use both operational and financial hedging rather complementarily than substitutionally.

Figure 3. Relation between Operational Hedges and Financial Hedges.



Note: Outer circle shows the answer of Marry & Netting. The inner circle shows the answer of Forward Transactions.

It is difficult to clarify the relation between four tools of exchange rate risk management. However, the choice of invoicing currency is was apparently a key factor in deciding the usage of operational and financial hedges for Japanese firms. Regarding the relationship between operational and financial hedges, we confirm that Japanese firms use both operational and financial hedging rather complementarily than substitutionally. In addition, our results suggest

that some Japanese firms use the pricing policy (pass through) as one method of exchange rate risk management. Overall, to mitigate the impact of currency fluctuations, Japanese firms use operational hedging, financial hedging strategies, and pricing policies depending on their own choice of invoicing currency.

4. Determinants of financial and operational hedging

In this section, we conduct empirical analysis to investigate the determinants of financial and operational hedging from the results of a 2009 RIET survey. In relation to the previous studies, we specifically examine the following questions:

i) Does yen invoicing supplement hedging?
ii) Are operational and financial hedging strategies complements or substitutes?
iii) Does pass-through alternate financial hedging?

To explore these questions, we employ the following specification:

$$\begin{aligned}\text{Prob}(\beta^{FH}_i = 1) = {} & \alpha_0 + \alpha_1 Size_i + \alpha_2\, Foreign\ Sales\ Ratio + \alpha_3\, Number\ of\ Foreign\ Currency_i \\ & + \beta_1\, Share\ of\ Japanese\ yen\ Invoicing_i + \beta_2\, Share\ of\ US\ dollar\ Invoicing_i \\ & + \gamma_1\, Dummy\ of\ Marry/Netting_i + \gamma_2\, Dummy\ of\ Pass\text{-}through_i + \varepsilon_i\end{aligned}$$

where β^{FH}_i is a dummy of Financial Hedging for firm i on the left-hand-side, and Prob(β^{FH}_i =1) denotes the probability of a firm that uses at least one kind of financial hedging tool. Because the basic explanatory variables are on the right-hand-side, we first include a "size" of firm i measured by the log of total consolidated sales, "foreign sales ratio", which is a proximity for foreign market exposure and which is calculated as total foreign sales of firms i divided by total consolidated sales, and the "number of foreign currencies" used by firm i extracted from the questionnaire survey.

After controlling these basic variables, we examine the impacts of adoption of other hedging strategies on financial hedging. "Share of Japanese yen (US dollar) Invoicing" is defined as a percent of Japanese yen (US dollar) invoicing in all exports to the world of firm i extracted from the questionnaire survey. "Dummy for Marry/Netting" is a dummy variable that takes 1 if firm i answered that it conducted Marry/netting in its trade, whereas "Dummy for Pass-through" is also a dummy variable that takes 1 if firm i answered that it had the pricing policy as the internal rule to change export prices in the case of exchange rate fluctuation

between the time of contract and time of settlement. We ran both the probit estimation and the ordered probit estimation.

Table 4-1. Impacts of currency invoicing and pricing policy on the use of financial hedging

Determinants of the use of financial hedging

Dependant variable: Dummy for the use of financial hedging

Model	Probit Model					Ordered Probit model				
Dependent variable	0 = No use of financial hedging 1 = Use of financial hedging					0 = No use of financial hedging 1 = One kind of financial hedging 2 = More than two kinds of financial hedging				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log of total consolidated sales	0.230*** (0.080)	0.236*** (0.080)		0.253*** (0.083)	0.260*** (0.083)	0.245*** (0.062)	0.246*** (0.062)		0.237*** (0.062)	0.238*** (0.063)
Total foreign sales / total consolidated sales	0.008 (0.006)	0.008 (0.006)		0.010 (0.006)	0.010 (0.006)	0.011** (0.004)	0.011** (0.004)	0.011** (0.004)	0.011** (0.005)	0.011** (0.005)
Share of Japanese yen invoicing in total exports	-0.707** (0.309)			-0.788** (0.323)		-0.572** (0.258)			-0.598** (0.265)	
Share of USD invoicing in total exports		0.791** (0.333)	0.712** (0.301)		0.831** (0.346)		0.716*** (0.271)	0.756*** (0.274)		0.719** (0.279)
Number of foreign currencies to be used	0.139** (0.067)	0.156** (0.067)		0.154** (0.072)	0.172** (0.072)	0.085** (0.037)	0.092** (0.037)		0.100** (0.042)	0.109*** (0.042)
Dummy for marry & netting			0.390* (0.209)					0.368* (0.189)		
Dummy for pass-through				-0.600*** (0.231)	-0.579** (0.229)				-0.362** (0.182)	-0.348* (0.181)
# of observations	196	196	212	185	185	196	196	194	185	185
McFadden R-squared / Pseudo R-squared	0.171	0.173	0.053	0.186	0.185	0.162	0.167	0.075	0.157	0.161

1) Estimated coefficient and its standard error, (in parentheses), are reported in each column.
2) Asterisk(s), ***, ** and * mean that the estimated coefficients are statistically significant at 1%, 5% and 10%, respectively.

Table 4-1 presents the estimated results. Regarding the results of probit estimation, (1)–(5), the log of total consolidated sales has a positive and statistically significant coefficient at 1 percent level across specifications. This result means that larger firms use financial hedging more actively. The estimated coefficient of the foreign sales ratio is positive but not statistically significant. Regarding variables on currency invoicing, the share of Japanese yen invoicing has statistically significant negative coefficient at the 5 percent level in specifications (1) and (4). This result is consistent with the hypothesis that the firms with larger share of Japanese yen invoicing have a lower tendency to use financial hedging. In contrast, the share of US dollar invoicing has a statistically significant positive coefficient at the 5 percent level in the specification, (2) and (3), which suggests that firms with larger share of foreign currency more actively engage in the financial hedging through the market to address exchange rate risk. The number of foreign currencies that the firms use also has statistically significant positive impacts on the use of financial hedging. Dummy for marry/netting has a positive coefficient but is statistically significant only at the 10 percent level. Lastly, the dummy for pass-through pricing policy has a statistically significant negative coefficient, which means that the firms that enable

them to impose currency risks against their customers in the negotiation have less tendency to use financial hedging.

We also estimated the ordered probit model using a dependent variable that takes 2 if the firm uses more than financial hedging tools of two kinds, and 1 if only one kind of financial hedging tool is used. Alternatively, it is zero if there is no use of financial hedging. Estimated results are similar to those of the probit model except for the statistical significance of the estimated coefficient of the "foreign sales ratio." The foreign sales ratio in the specifications (6)–(10) has a statistically significant positive coefficient at the 5 percent level, which means that the firms that are more dependent on the overseas market more actively engage in financial hedging.

We also conducted the following estimation by replacing the dependent variable by the probability of the usage of operational hedging, which means implementation of marry/netting.

$$\begin{aligned}\text{Prob}(\beta^{OH}_i=1) = {} & \alpha_0 + \alpha_1 Size_i + \alpha_2\, Foreign\ Sales\ Ratio + \alpha_3\, Number\ of\ Foreign\ Currency_i \\ & + \beta_1\, Share\ of\ Japanese\ yen\ Invoicing_i + \beta_2\, Share\ of\ US\ dollar\ Invoicing_i \\ & + \gamma_1\, Number\ of\ Financial\ Hedging\ Tool_i \\ & + \gamma_2\, Dummy\ of\ Internal\ Rule\ of\ Hedging\ Ratio_i + \varepsilon_i\end{aligned}$$

where β^{OH}_i is Dummy of Operational Hedging in firm *i*.

Table 4-2 reports the main results of different specifications.

Table 4-2. Impacts of currency invoicing and financial hedging on the use of operational hedging

Dependant variable: Dummy for the use of operational hedging (marry & netting)

Model	Probit Model			
Dependent variable	0 = No use of operational hedging 1 = Use of operational hedging			
	(1)	(2)	(3)	(4)
Log of total consolidated sales	0.162*** (0.063)	0.143*** (0.064)		
Total foreign sales / total consolidated sales	0.022*** (0.005)	0.022*** (0.005)	0.022*** (0.005)	
Share of Japanese yen invoicing in total exports		-1.335*** (0.306)		
Share of USD invoicing in total exports	1.293*** (0.316)		1.309*** (0.319)	0.956** (0.420)
Number of financial hedging tool			0.309* (0164)	
Internal rule of hedge ratio (%)				0.010** (0.005)
# of observations	194	194	194	101
McFadden R-squared	0.201	0.211	0.188	0.067

1) Estimated coefficient and its standard error, (in parentheses), are reported in each colum
2) Asterisk(s), ***, ** and * mean that the estimated coefficients are statistically significant

In summarizing the results of this section, we confirm the following findings: first, Japanese firms use both operational and financial hedging complementarily; second, yen invoicing substitutes operational and financial hedging; third, adoption of pricing policy consistent with the Pass-Through also substitutes for financial hedging.

5. Conclusion

As described herein, we investigate the features of Japanese exporting firms' exchange rate risk management from the results of a 2009 RIETI survey. Results confirm that Japanese exporting firms use operational hedging, financial hedging strategies and pricing policies depending on their own choice of invoicing currency to mitigate the impact of currency fluctuation.

This is the first detailed investigation of the exchange rate risk management policy of Japanese firms. From results of a 2009 RIETI survey and subsequent empirical analysis using survey results, the features of Japanese exporting firms' exchange risk management were elucidated as follows. First, firms with larger sales and greater dependency on foreign markets more actively engage in exchange rate risk management. Second, Japanese firms use both financial and operational hedging complementarily. Third, yen invoicing itself can reduce firms' exposure. Our contribution is that we show how Japanese exporting firms combine three different tools of exchange rate risk management policies, operational and financial hedging and exchange rate pass-through under their own choice of invoicing currency. Given the growing regional production network of Japanese firms, our findings based on the questionnaire study will have important implications for exporting firms seeking to expand their overseas businesses in the future. As our results show, small size firms have little experience in conducting exchange rate risk management. Therefore, it is important for them to ascertain how large multinational firms use and combine the exchange rate risk management tools effectively. Additionally, the policymakers must recognize that the financial and operational hedge plays an important role in mitigating the exchange rate risk, especially for firms which choose US dollar invoicing. In the sense, promoting deregulation of foreign transactions and foreign exchange markets particularly for Asian countries is indispensable to support their exchange rate risk management. Consequently, our new findings will provide important implications not only for Japanese firms' exchange rate risk managers to built more efficient exchange risk management system, but also for policymakers to support the current and future expansion of regional production networks of Japanese firms.

Some results are not sufficiently strong because of insufficient items of the questionnaire

survey, which should be partially reinforced by another source such as firms' financial reports. Particularly for operational hedges, we use only "marry and netting" as a proxy of operational hedges. However, more aspects reflect firms' operational hedges. To confirm the robustness of our scoring procedures, the effects of the above tools of exchange rate risk management should be tested empirically using firms' stock returns as many previous studies have tested. These remain as issues to be explored in future investigations.

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