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## Should Korea Worry about a Permanently Weak Yen?

Jack Joo K. Ree, Gee Hee Hong, Seo Eun (Thelma) Choi

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**I N T E R N A T I O N A L M O N E T A R Y F U N D**

## IMF Working Paper

Asia and Pacific Department

### Should Korea Worry about a Permanently Weak Yen?

Prepared by Jack Joo K. Ree, Gee Hee Hong, and Seo Eun (Thelma) Choi<sup>1</sup>

Authorized for distribution by Brian Aitken

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#### Abstract

Three years have passed since the Bank of Japan's asset purchase program was introduced in 2011, causing a sharp decline in the value of the Japanese Yen. What would be the implications for Japan and Korea's exporters if the weak Yen is here to stay? We explore this question by examining exporters' pricing behaviors and volume responses to exchange rate shocks. We find that if the weak Yen persists, it would strengthen Japan's price competitiveness over time as export prices respond with a lag. We also find that while direct boosts to export demand will be rather limited, a persistently weaker Yen would expand the Japanese exporters' profits lastingly, which could reinvigorate the ability, particularly of flagship exporting firms, to compete and grow in the global market over time. These findings suggest that the muted price and volume response so far to the sustained weakness of the Yen may mask a more fundamental shift in the relative competitiveness of Japanese and Korean exporters.

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## I. INTRODUCTION

Soon after his re-election in December 2012, Mr. Shinzo Abe, Japan's Prime Minister, announced a sweeping change in the direction of economic policy. His new policy has since been called 'Abenomics.' Among actions taken was the Bank of Japan (BOJ)'s 2011 asset purchase program, expanded in April 2013 (coined as Quantitative and Qualitative Easing; QQE) which led the Yen to depreciate sharply. In October 2014, the BOJ announced another round of the asset purchase program (called QQE2), precipitating further Yen depreciation. Since August 2011, the Japanese Yen has depreciated by a cumulative 36 percent against the dollar and about 25 percent in nominal effective terms.

Since the QQE2 announcement, market expectations have clearly shifted to prospects of a persistently weak Yen. This shift also reflected some later developments (e.g. further softening of commodity prices) that appear to weigh on the BOJ's commitment to achieving its two percent inflation target. What would be the consequences of these prospects being realized—not just for Japan, but also for countries like Korea, where the appreciation of the Won against the Yen could erode exporters' competitiveness due to a high export similarity in the global market with Japanese goods in the key exporting sectors (Deutsche Bank Market Research 2013)?<sup>1</sup>

Over the past two decades, Japan has experienced several episodes of large currency movements, with the current episode distinctive in terms of size and persistence. Yet Japan's real export volumes have remained largely flat. In previous episodes of Yen's depreciation, export volumes generally showed a boost within about three years from the beginning of the cycle. Why is this not happening this time? One possible answer may be that Japanese firms have held off passing exchange rate gains through to consumers—in a manner known as pricing-to-market (PTM)<sup>2</sup>—and instead replenished profits. Likewise, Korean export volumes have been relatively resilient despite the Won appreciating against the Yen by 67 percent since August 2011.<sup>3</sup> This might also reflect Korean exporters' limited price pass-through and their use of profits as a cushion.

With all of this in mind, we explore how exchange rate changes have affected price pass-through (or equivalently, margin adjustment) as well as export volumes in the near term and

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<sup>1</sup> We limit our analysis on the spillover effects from the Yen's depreciation given Korea's exceptionally high export similarity with Japan, although the recent depreciation of Euro has also attracted extensive discussion within Korea.

<sup>2</sup> Motivated by examples like stickiness in the price of luxury European cars in the U.S. market, despite dollar's large appreciation, Krugman (1987) introduced the concept of pricing-to-market to the trade literature. Krugman attributes PTM behavior to both supply and demand dynamics (e.g., capacity or supply chain constraints, reputational relationships with clients). Another important reason can be product differentiation (or lack of it), which would have an effect on demand elasticity.

<sup>3</sup> While the Won has also strengthened, the latest Won-Yen episode seems to be primarily driven by the Yen's weakening (see Appendix 8). For linkage between the Yen's depreciation and Korea's exports see Box 1.

over time.<sup>4</sup> We address this question by using a set of exports, domestic prices, and volume data for Japan (1989 to 2013) and Korea (2001 to 2014)'s selected sectors.

In what follows, we first take stock of the impact of the Yen's weakening so far on export prices, export volumes, profits, and market shares (section II). We then show that the limited price pass-through and high correlation between profit margin and exchange rate movements are in line with exporters' historical PTM behavior, where they are slow to change prices in the short-run but do so over time as exchange rate shocks become locked in (section III). Then we show that if the weak Yen persists, it would strengthen Japan's price competitiveness over time, although by how much would differ across sectors, likely reflecting different degrees of product differentiation (section III). We also find that while the direct effect on export demand will be rather limited, a weak Yen would boost Japanese exporters' profits lastingly, which could reinvigorate the ability, particularly of Japan's flagship exporting firms, to compete and grow in the global market over time. Some of the negative effects on Korea's price competitiveness can be mitigated by Korea's value chain integration with Japan, although evidence suggests that this might play only a minor role (section IV). These finding have competitiveness implications for Korea (section V).

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<sup>4</sup> A number of recent studies have examined the lackluster response of Japan's export volume from angles that are related to but differentiated from ours. For example, Constantinescu, Mattoo and Ruta (2015) and IMF (April 2015b) find that trade income elasticity has declined due to structural factors, such as the maturation of global value chain. Previous studies on Japanese exporting firms' pricing behaviors include Athukorala and Menon (1994), Gagnon and Knetter (1995), Loopesko and Johnson (1988), Marston (1990), Ohno (1991) and Tange (1997).

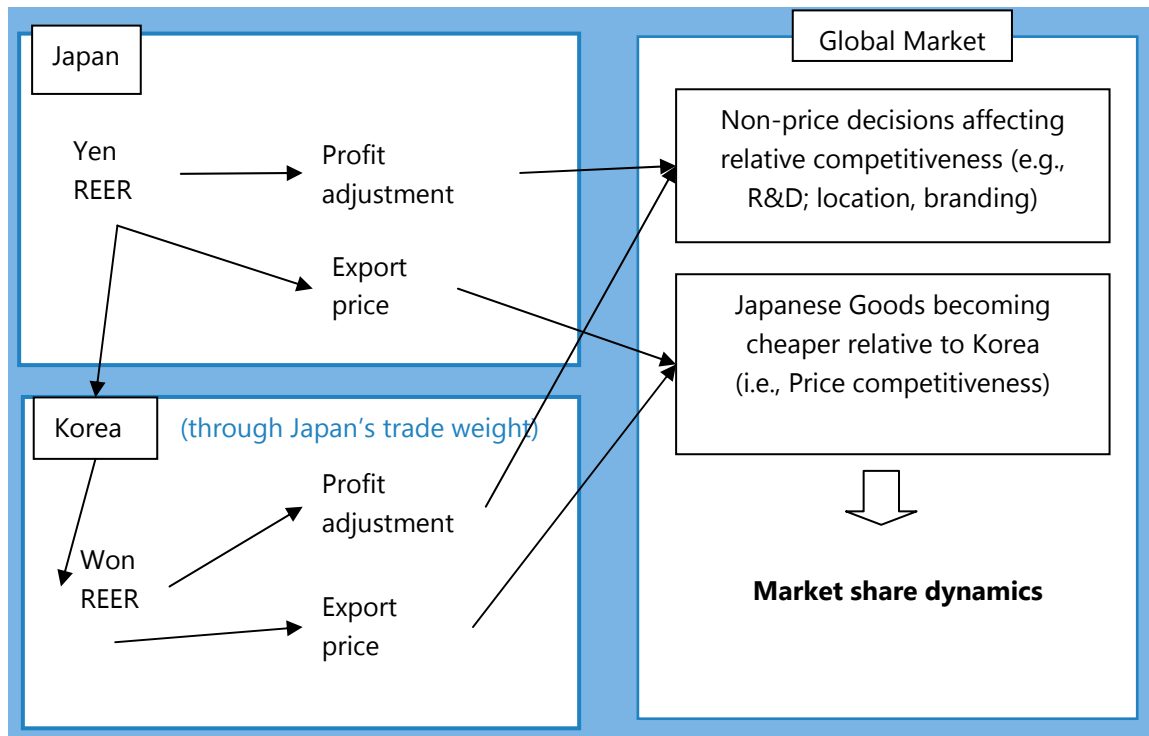
### Box 1. The Link between Yen and Korean Price Competitiveness

The Won-Yen cross rate can affect Korean exports' price competitiveness through two channels: (i) its impact on Korea's real effective exchange rate (REER), in proportion to Japan's trade weight in its basket, and export prices and (ii) its correlations with Japan's export prices (which would affect Korea's price competitiveness relative to Japan in the third country markets). Section III of the paper examines both channels.

The impact of the Yen's depreciation to Korean exporters is not limited to the reduced competitiveness in the global market. Yen depreciation could have a positive boost to Korean exports when Japanese and Korean products are complementary, as in the case of the linkages through the global value chain. The potential significance of such counter-balancing forces is explored in Section IV.

However, beyond the short-term, the weak Yen could affect Korea's export competitiveness not only by shifting relative prices, but also by changing relative profit prospects of the exporters of the two countries, which will feed into non-price decisions such as investment in R&D, where to locate production, and product branding.

#### Yen's Depreciation and Korean exports' Competitiveness: What's the Link?

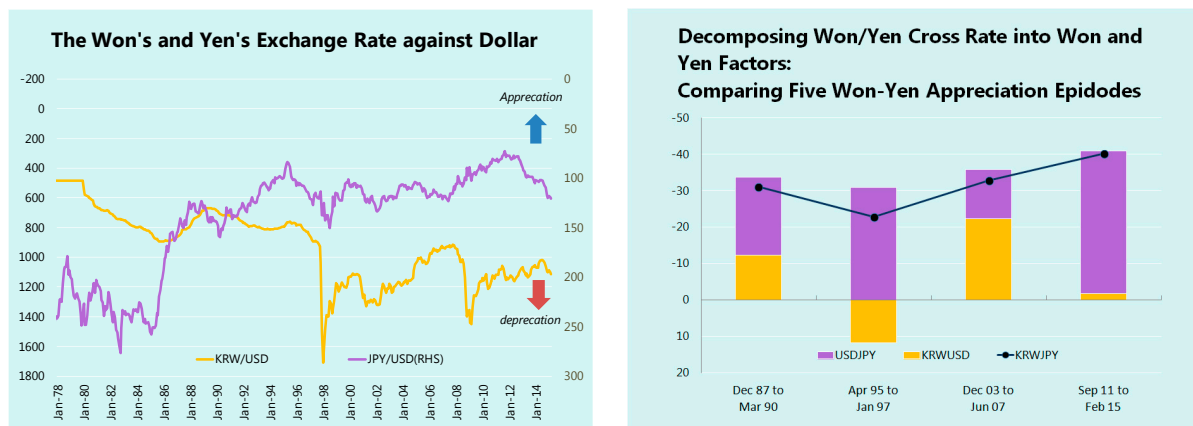


Source: Authors' illustration.

## II. HOW HAVE FIRMS RESPONDED SO FAR?

The pass-through of the weaker Yen and stronger Won to export prices (in contract currency terms) has been timid so far, as has been the export volume response. The effect has been largely felt in the profit margins of Korean and Japanese exporters.

Figure 1. Exchange Rates of the Won and the Yen



### A. Price Pass-through and Volume Response

While Table 1 shows that both Korean and Japanese exporters have decreased export prices since September 2011—cuts by Japan's exporters have been somewhat higher than Korea's in key sectors where product similarity is high (metal, electronics, and transportation equipment)—these cuts are fairly modest given the size of the movement in exchange rates, particularly the Yen. Moreover, they happened against a backdrop of declining prices of oil and electronic products, which suggests that the pure effects of the exchange rate movements may be quite limited.

Table 1. Changes in Exchange Rate and Export Prices (In percent)

	Korea					Japan				
	Export Prices					Export Prices				
	KRWUSD	Overall	Metal	Electronics	Transportation	JPYUSD	Overall	Metal	Electronics	Transportation
Dec. 87 - Mar 90	-12.3	17.0	27.7	4.0	15.6	27.2	2.8	8.0	-3.4	3.2
Apr. 95 - Jan. 97	10.8	-12.5	-3.5	-22.3	1.8	42.0	-8.2	-7.1	-14.8	-3.4
Dec. 03 - Jun. 07	-22.2	10.1	43.4	-35.2	6.7	15.8	3.2	78.3	-17.4	-2.5
Sep. 11 - Feb. 15	-1.8	-13.3	-6.4	-9.6	4.6	63.9	-9.5	-21.8	-10.2	-0.4

Percentage change in the Won-Yen Exchange Rate and the Export Volume of Korea and Japan since September 2011.



Export volumes have also been slow to respond (see Table 2). Japan's real export volumes continued to decline until late 2012, and then stayed mainly stagnant. Korea's real exports have largely traced a trend similar to the one before the Global Financial Crisis (GFC).

**Table 2. Changes in Exchange Rate and Export Volume (In percent)**

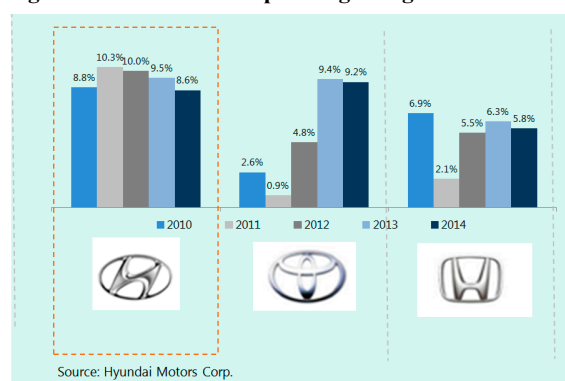
	KRWJPY	Export Volume			
		Overall	Metal	Electronics	Transportation
Korea	-40.1	-2.1	-0.5	-10.2	-12.7
Japan		-3.2	-0.5	-24.9	-15.6

Percentage change in the Won-Yen Exchange Rate and the Export Volume of Korea and Japan from September 2011 to February 2015.

## B. Profit Margin and Stock Price

With the limited volume and price response, exchange rate movements have been mostly reflected in exporters' profits margins. Japanese exporters appear to have used the exchange rate gains to decompress their profits that had been squeezed after the GFC, while Korean companies appear to have used their existing profit and cash buffers to absorb exchange rate losses.

**Figure 2. Consolidated Operating Margin Trend**



One striking example is the behavior of profit ratios of car makers. For selected Korean and Japanese car makers, profit margin developments in recent years paint quite contrasting pictures—Hyundai Motors showing a decline in operating margins, while Toyota and Honda experiencing a sharp pick-up since 2013 (Figure 2). Furthermore, as shown in Figure 3, the quarterly operating margins of Hyundai Motors showed a correlation of 0.8 with the Won's exchange rate against dollar (KRWUSD) since the first quarter of 2012. During this time, Hyundai Motors' operating margin (three quarter centered average) decreased by 19 percent, while that of Toyota increased by 63 percent. Toyota's operating margins have shown a correlation of 0.7 with the Yen's exchange rate against dollar (JPYUSD).

The correlation between exchange rates and forward looking profitability is demonstrated, too, by the close co-movement between Nikkei 225 index and JPYUSD (correlation is -0.98 from November 1, 2011 to April 22, 2015) (see Figure 4).<sup>5</sup> The correlation between KOSPI and KRWUSD has been far less clear, likely reflecting Korea-specific factors such as the influence of emerging market-focused global fund flows.

<sup>5</sup> Liquidity resulting from QQE may also be a contributing factor to Japan's recent stock market performance.

Figure 3. Exchange Rates and Profits

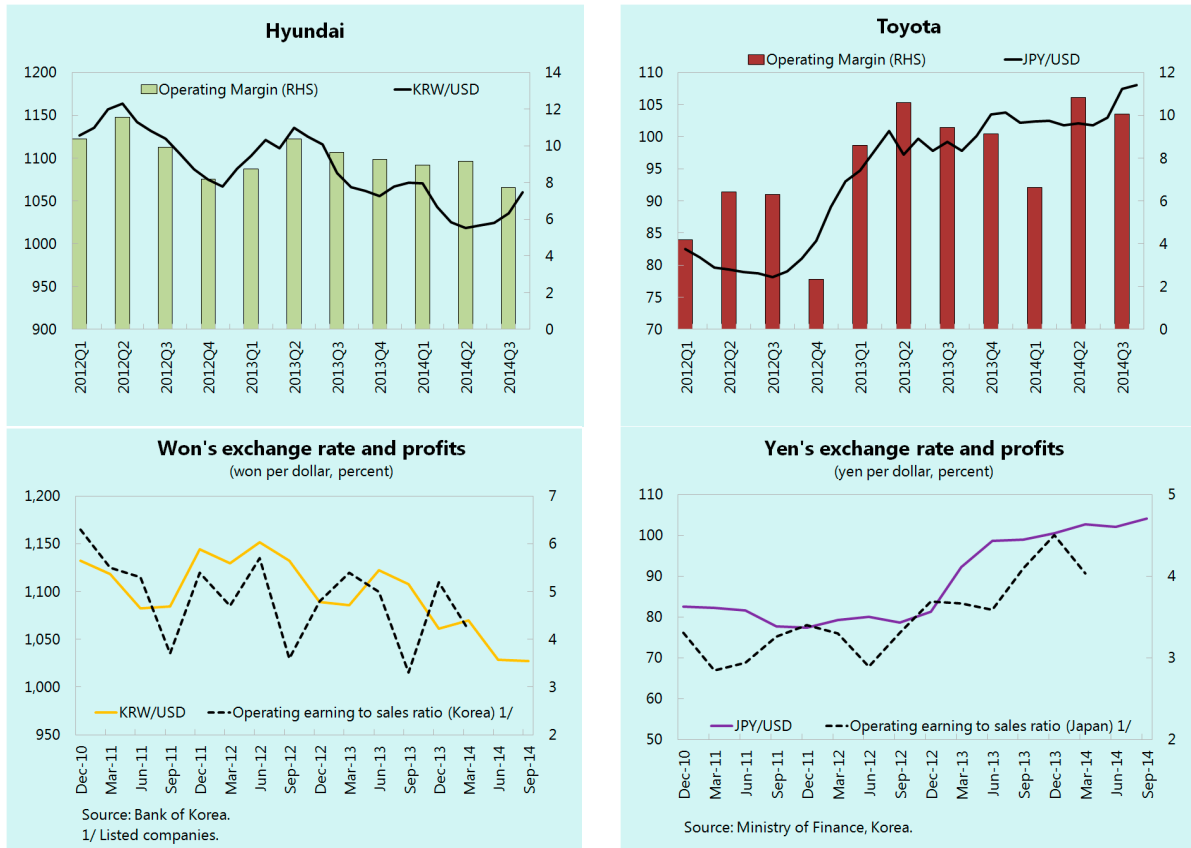
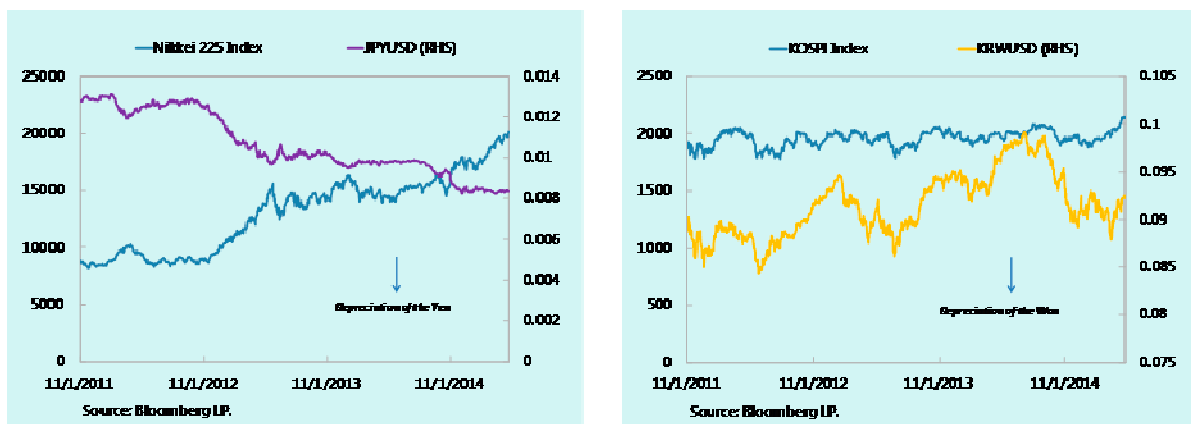


Figure 4. Exchange Rates and Stock Prices

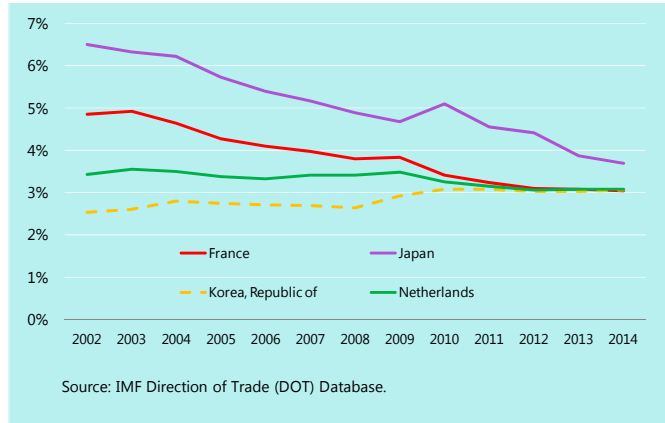


C. What Happened to Market Shares?

The timid response of export volumes is an intriguing puzzle. A naturally related question would then be what has happened to the market shares. In this subsection, we do a market share analysis, adopting a decomposition technique proposed by Ree and Choi (2014). Our objective is to see, since August 2011, if Korea's post-GFC market share gains have unwound, and if so whether that has benefited Japan.

As a first check, we examine the headline figures (see Figure 5). Korea's global market share increased from 2.6 percent in 2008 to 3.1 percent in 2010. Since 2011, however, it has remained flat. In contrast, Japan's global market share slid from 4.9 percent in 2008 to 3.7 percent in 2014, with the weak Yen providing little cushion. Key findings are as follows:

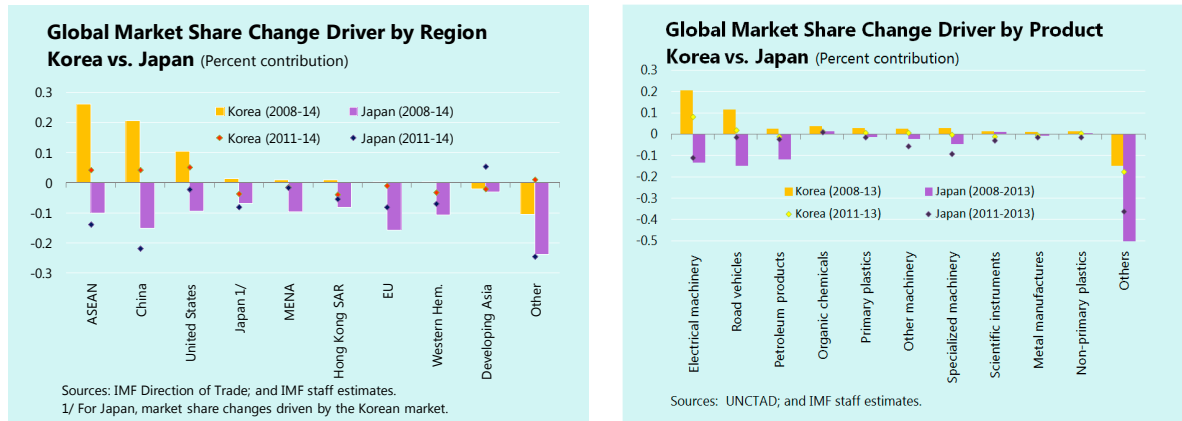
**Figure 5. World Market Share** (In percent of total world exports)



- The post-GFC boost to Korea's market share gains have stalled since 2011. Gains continue in three leading export destinations<sup>6</sup>—China, ASEAN, and the U.S.—but they are being offset by slippages elsewhere (Figure 6).
- This does not appear to have benefited Japan. Japan endured sharp losses in China and ASEAN where Korea continued to gain. And it also lost its market shares elsewhere where Korea lost them too. This indicates that there is little correlation between market share movements for Korea and Japan.
- The only place where the impact of the weak Yen stood out was the Japanese market itself, where since 2011 Korean exporters' post-GFC gains have fully reversed. Surprisingly, however, Japan's share in the Korean market fell rapidly during this period despite the weak Yen, possibly reflecting sluggish manufacturing investment in Korea (which tends to have high import contents from Japan).
- With regard to individual products, Korea has continued to expand its market share in electronics, offsetting flat or declining shares in other leading export items, while Japan's market share declined across a broad range of products.

<sup>6</sup> During the period from 2008 to 2014, 86 percent of Korea's total market share gain was made in China and ASEAN markets.

Figure 6. Global Market Share Change Drivers



### III. HOW DO FIRMS ADJUST TO EXCHANGE RATE SHOCKS?

In this section we explore exporters' profit margin adjustment (or equivalently price pass-through) and export volume response to exchange rate shocks. Our aim is to shed light on why Japan's export volumes have responded timidly so far to the weak Yen, and how it could affect competitiveness of Korea's exporters.<sup>7</sup>

#### A. Are Profit Margins Absorbing the Exchange Rate Movements?

We first ask if the timid response of export volumes so far can be explained by exporters' PTM behaviors. If exporters behave as price takers, gains or losses caused by changes in exchange rates will be absorbed primarily by margins, rather than passed through to prices. How strongly exporters do PTM (or the strength of PTM) thus would determine how exchange rates influence export volumes over time.

Specifically, we estimate the historical PTM behavior using a regression model that connects profit margins with exchange rates and other relevant variables. As is common in the existing studies, we use what we refer to as 'relative profit margins' as our dependent variable. Relative profit margins are profit margins on export prices in excess of those on domestic prices, and their proxy can readily be obtained from macroeconomic data.

While doing so, we also explore how PTM behaviors vary across industries and over time. Intuitively, those who export homogenous products (e.g., corn) are more likely to behave as price takers—thus having stronger tendency for PTM—than those who offer differentiated products (e.g., designer purses). Also, one would expect that the strength of PTM would diminish over time if an exchange rate shock (or shocks accumulated over a period) begins to lock in.<sup>8</sup>

<sup>7</sup> See footnote 3 for the linkage between the weak Yen and Korea's price competitiveness.

<sup>8</sup> To gauge how exporters respond to exchange rate shocks through profit margin adjustment, we use a model developed by Marston (1990), which assumes that manufacturers produce all goods locally but sell them in both domestic and export markets applying differentiated prices. We use dynamic OLS (DOLS) to obtain long-run elasticity of relative profit margin to changes in REER and error correction models (ECMs) to estimate both the short term elasticity and transition dynamics (see Appendix 9 for technical details).

Our key findings are as follows:

First, the long-run effects of exchange rate shocks on relative profit margins are smaller than the short-run effect, but more than zero (Figures 7 and 8). In case of Japanese manufacturers, a 10 percent depreciation of the Yen in real terms, all else equal, increases the relative profit margin by 3–5 percent in the long run. Korean manufacturers' relative margins show higher long-run elasticity to exchange rate movements—thus stronger tendency to PTM.

Second, the initial (positive) gaps between short-term and long-term elasticity of the relative profit margins in response to exchange rate shocks—what we refer to as “overshooting”—tend to be larger for the Korean manufacturers (Figure 7 and 8). There are significant variations in PTM transition dynamics across industries, indicating some correlation between PTM and product differentiation.

- In case of electronics and metal, initial overshooting dynamics are quite evident for both Korean and Japanese exporters (Figure 7). Especially, in electronics, Korean exporters seem to be able to unwind the initial overshooting more than their Japanese counterparts, hence, over time, being able to pass through more to prices. This is consistent with recent achievements made by Korea's leading manufacturers (e.g., Samsung and LG) in product differentiation and branding—a broadly recognized market fact.<sup>9</sup>
- In textile and transportation sectors, Korea and Japan's exporters show different behavioral patterns. In case of Korea, there is either little overshooting (textiles), or its undoing is too slow to be relevant (transportation). These are sectors where Korea's main products have so far achieved limited degree of differentiation. Japan, too, shows no perceptible overshooting in textiles, but its tendency to PTM looks smaller than Korea both in the short and the long run (Figure 7). This result would be in line with Japan focusing more on high-tech products (e.g., industrial fibers).<sup>10</sup> In transportation, Japanese exporters show substantially larger overshooting than the Korea counterparts, which too is consistent with their product mix stressing luxury cars more.<sup>11</sup>

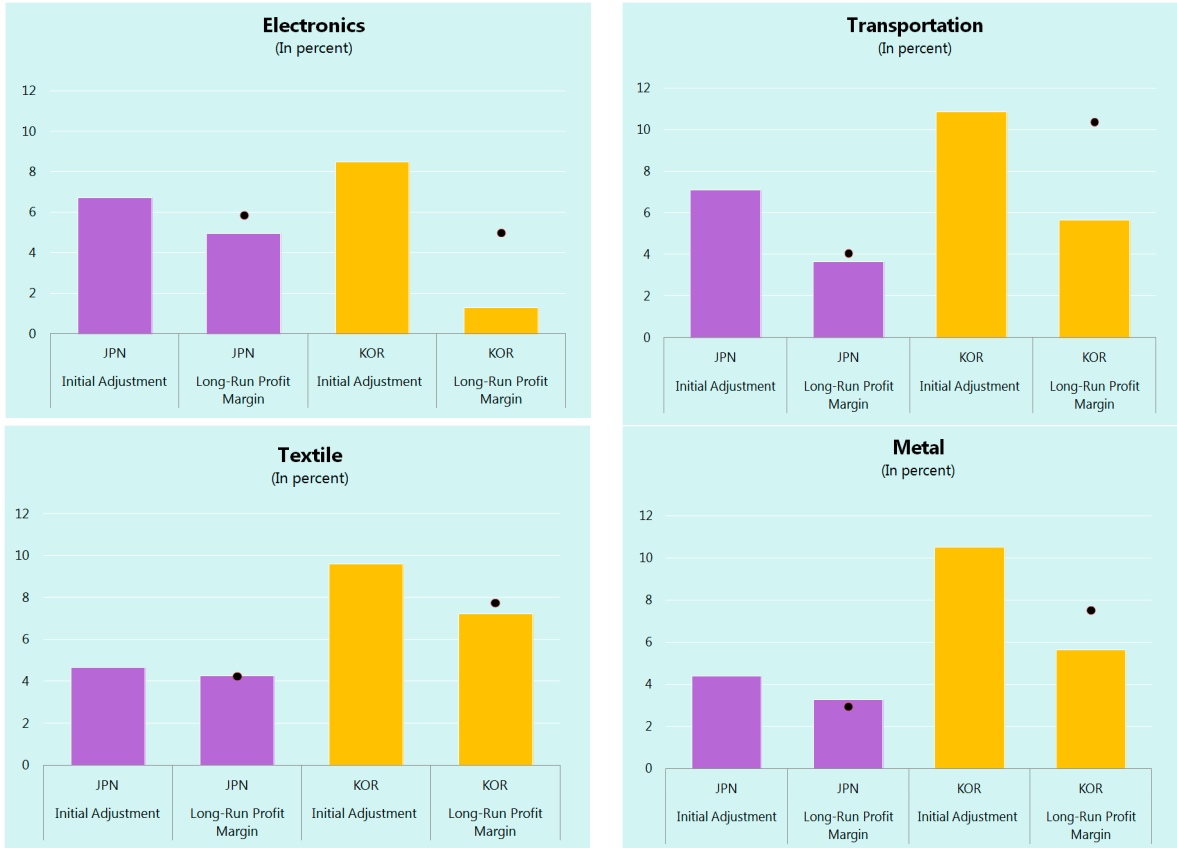
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<sup>9</sup> In marketing, the strategy of product differentiation has always existed (e.g., designer brand apparels such as Channel or Dior). However, Apple's success in i-brand (i-pods, i-phones, i-pads) has been an important turning point in spreading such strategy to mass electronic products. Apple founder Steve Jobs' strategy focused on creating halo effects, which prompt people to pay premiums for the i-brands. Samsung has also managed to create similar premiums (e.g. Galaxy-brands) during the last decade. However, halos that had existed in products like TVs for Japanese electronics companies have faded.

<sup>10</sup> While Korean textile companies still focus on intermediary inputs for garments, Japanese companies' business portfolio has, since 1970s and 80s, shifted to inputs for general industrial production. For example, Teijin company is a globally dominant supplier of Aramid fiber (along with Dupont), which is sturdier than steel and resistant to heat and chemical. Toray Industries has been the global leader of carbon fiber composite, which can replace metal as the exterior material for aircrafts.

<sup>11</sup> This result is somewhat different from those of Hong and Ree (2015), which showed little overshooting dynamics. This is likely explained by their using a sample period starting 1980, which produces a higher estimated long-run response of the relative profit margins to exchange rate changes. This paper uses data from 1989 to 2013 for the Japan regression. The lower long term elasticity estimated by this paper seems to be consistent with the fact that Japanese car companies started their differentiation strategy only in 1989—the year Toyota first launched Lexus.

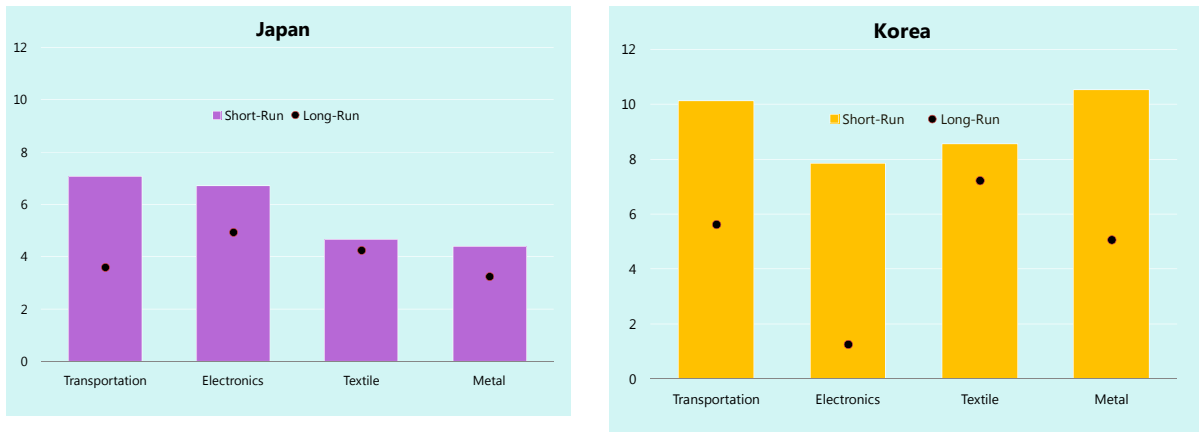
**Figure 7. Profit Margin Adjustment in Response to a 10 Percent REER Depreciation 1/**



1/ The magnitudes of initial adjustments correspond to the largest response of profit margin to a 10 percent exchange rate depreciation within the first 4 quarters. The profit margin adjustments within the first 20 quarters (5 years) are represented in the diamonds.

Source: Authors' estimation.

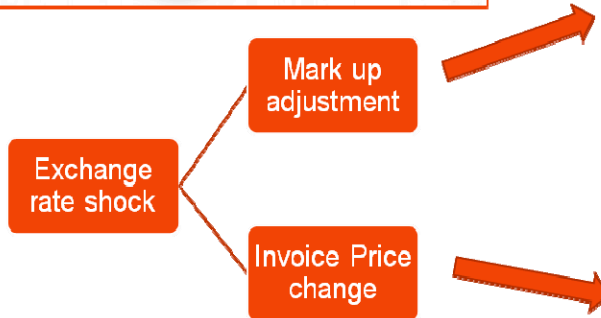
**Figure 8. Responses to a 10 percent depreciation: Japan vs. Korea**



## Box 2. Margin-Price Response to an Exchange Rate Shock (A Numerical Example)

In this box, we construct a numerical example to demonstrate how exporters respond to exchange rate shocks—through profit margin adjustment, export prices, or both. The example is based on actual data disclosed by Samsung Electronics, in the company’s extranet posting.

### Exporter Response to a 5 percent Decrease of the Won-Dollar Exchange Rate: An Illustration



#### One extreme: 5 percent currency appreciation; no change in invoice price

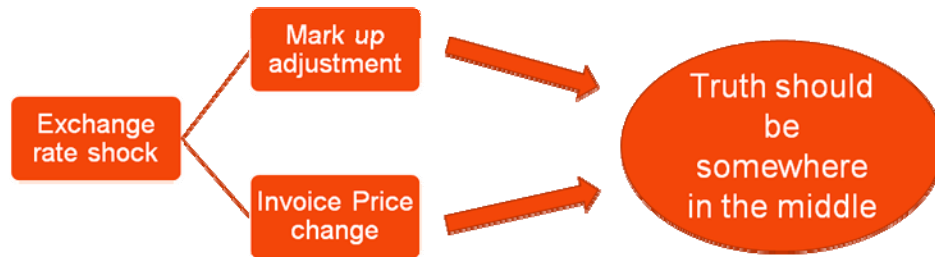
	KRW		Change
Exchange rate	1060	1007	-5.0%
Export price (USD)	825.99	825.99	0.0%
Export price (KRW)	875,549	831,772	-5.0%
Domestic price	870,000	870,000	0.0%
Relative profit margin	0.6%	-4.5%	-5.1%
Cost-imported	278,400	264,480	-5.0%
Cost-Total	696,000	682,080	-2.0%
Absolute profit	174,000	149,692	-14.0%
Absolute profit margin	20%	18%	-1.9%

#### Another extreme: 5 percent currency appreciation; 5% increase in invoice price

	KRW		Change
Exchange rate	1060	1007	-5.0%
Export price (USD)	825.99	869.46276	5.3%
Export price (KRW)	875,549	875,549	0.0%
Domestic price	870,000	870,000	0.0%
Relative profit margin	0.6%	0.6%	0.0%
Cost-imported	278,400	264,480	-5.0%
Cost-Total	696,000	682,080	-2.0%
Absolute profit	174,000	193,469	11.2%
Absolute profit margin	20%	22%	2.2%

- Initial price and markup.** The factory shipping price of Samsung Galaxy Note 4 32 GB memory (the company's flagship smart phone) to Korea's top 3 domestic mobile service carriers was 870,000 Won (excluding VAT) as of October 13, 2014. The corresponding shipping price to the U.S. carrier AT&T, on the same day, was 825.99 dollars (also excluding VAT), which amounts to 875,549 Won (1USD=1060KRW). Lacking information on marginal costs, we cannot uncover the markup from this data. However, we can compute relative export markup of the Galaxy Note 4's based on Martson's methodology (see Appendix 9). This markup is defined as 'log(export price) minus log(domestic price)' and was 0.6 percent on the same day.
- Exchange rate shock and exporter reaction.** Now let's assume a 5 percent appreciation of the Won's exchange rate against dollar, which brings it to 1,007 Won/dollar. How would the exporter respond?

**Exporter Responses to a 5 Percent Decrease of Won-dollar Exchange Rate:  
An Illustration (continued)**



**Middle solution: 5 percent currency appreciation; 3% increase in invoice price**

	KRW		Change
Exchange rate	1060	1007	-5.0%
Export price (USD)	825.99	850.7697	3.0%
Export price (KRW)	875,549	856,725	-2.2%
Domestic price	870,000	870,000	0.0%
Relative profit margin	0.6%	-1.5%	-2.2%
Cost-imported	278,400	264,480	-5.0%
Cost-Total	696,000	682,080	-2.0%
Absolute profit	174,000	174,645	0.4%
Absolute profit margin	20%	20%	0.5%

- *No change in invoice price*: One possibility is the exporter doing nothing. In fact, this is not unrealistic as exporters generally cannot adjust invoice price in the short run due to contractual obligations. In this case, the entire 5 percent shock is absorbed by the relative profit margin which shrinks by 5 percent (we also assume no change in domestic invoice price). However, the hit on the absolute profit margin on exports will be offset to the extent that the exchange rate shock is passed through to the imported contents cost. For illustration, suppose that imported contents took up 40 percent of the marginal cost (of Galaxy Note 4), and marginal cost were 80 percent of the price (the same for both exported and domestically supplied ones). If all of the imported contents were invoiced in dollars and fixed in the short run, then the absolute export margin will shrink by only 2 percentage points, with the import price effect providing a 3 percentage points offset (we assume no change in import price invoice price).
- *No change in the relative mark up*: The exporter can increase export prices and hold profit margins on exports steady. Our analysis in this paper shows that exporters would generally move in that direction over time, although they are not likely to go as far as fully passing through exchange rate gains or losses to export prices. Suppose that the export prices of Samsung Galaxy S4 increases by 5 percent to 870 dollars. The relative profit margin would (by design) remain unchanged at 0.6 percent. With the same assumptions on the import price effects as in the previous case, the absolute margin would increase by 2 percentage points (relative margin will remain unchanged if we assume no change in domestic shipping price despite a fall in imported cost).
- *Middle solution*: In reality, exporters would likely to choose somewhere in between the two extreme responses described above.

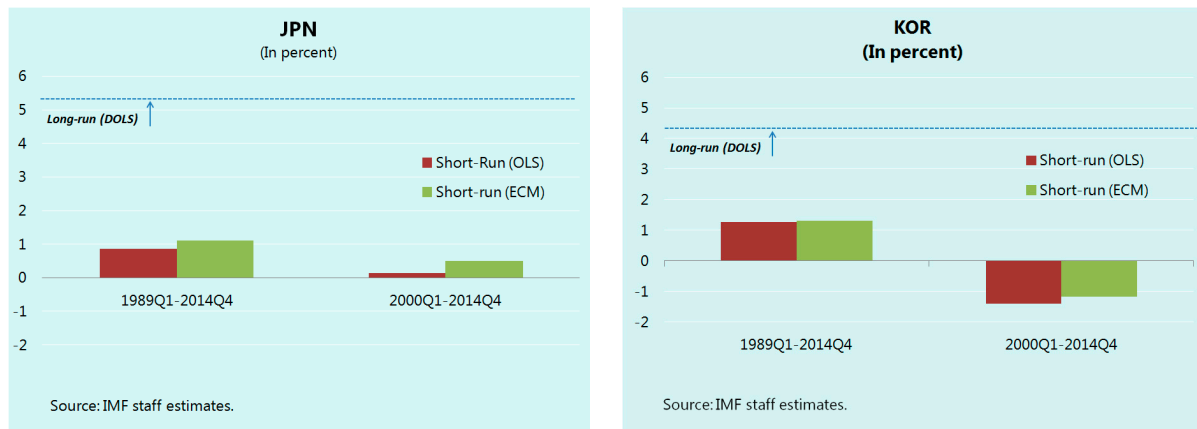


These findings, put together, suggest that if the weak Yen persists, it would strengthen Japan's price competitiveness over time as export prices respond with a lag. It will also affect Korea's REER (in proportion to Japan's trade weight in Korea's REER basket) and—through that—lead to similar, albeit smaller, response of Korea's export prices. The overall responses of export prices of the two countries will determine relative price advantage of the two countries' exports in the markets in third countries, particularly where exporters of the two countries aggressively compete.

### B. What Could Happen to Future Export Volumes?

An exchange rate shock, over time, shifts export prices to new equilibrium levels through price pass-through relationship. The move eventually pushes export volumes, also, to their new equilibrium values through demand curve relationship. Having estimated the price pass-through relationship, or equivalently the degree of PTM, we gauge how export volumes react to changes in export prices. Our estimation suggests that Japan's export volumes are unlikely to garner large gains from the weak Yen in the short run, but competitiveness gains can build up over time. It also indicates that a persistently weaker Yen could leave a lasting impacts on the Japanese exporters' profits.<sup>12</sup>

**Figure 9. Short-Run and Long-Run Response of Export Volume to a 10 percent REER Depreciation**



### Export Elasticity

Using the DOLS model similar to what was used in the previous subsection for the profit margin analysis we estimated both the long-run and short-run elasticity of export volumes to REER (see Appendices 1 and 5).<sup>13</sup> Main findings are twofold (Figure 9): (i) short-run elasticity is low for both Korea and Japan; and (ii) elasticity tends to increase in the longer run.

<sup>12</sup> Our analysis in the subsection focuses mainly on Japan, given that Korea's worries are mainly on competitive gains from the weak Yen that Japanese exporters may be poised to harness (i.e., Japan's export elasticity).

<sup>13</sup> DOLS specification for estimating long-run elasticity regresses export volumes ( $EX\_VOL\_i$ ) on trading partner outputs ( $Y\_STAR\_i$ ) and REER ( $REER\_i$ ) with  $i$  being Korea (KOR) and Japan (JP). OLS specification for estimating short run elasticity regresses export volumes (differenced) on trading partner outputs (differenced) and REER (differenced and lagged). For short term elasticity, we use both ECM and a simple ordinary least squares model (see Appendices 3–4 and 6–7).

### Out-of-sample Analysis

We then carried out an out-of-sample forecast of Japan's export volumes based on DOLS models using two different control variables: one using REER (Appendix 1) and another using the export prices (Appendix 2).<sup>14</sup> In a nutshell, the exercise compares the actual export volumes since 2012 with their path predicted from the historical regression relationship before 2012. There are three main findings.

- First, there are large persistent gaps between the actual export volumes and those that would be predicted by our model (**A+B** in Figure 10).<sup>15</sup>
- Second, a quarter of the total gap may be attributed to slow or low response of price to exchange rate shocks (**B** in figure 10). The out-of-sample forecast from our relative margin regressions suggests that the traditional relationship between export price and REER did not change (see Figure 11). A cautious case then can be made that **B** likely is set to close if the Yen's recent depreciation persists.
- Third, it is difficult to make any meaningful prediction on what is going to happen to the portion of the total gap that reflects slow or low response of export volumes to export price changes (**A** in figure 10). The recent sharp pick up in export volumes point to a possibility that **A** may have at last begun to close. However it is equally possible that this be transitory and that this portion of the gap instead reflects structural changes.<sup>16</sup>

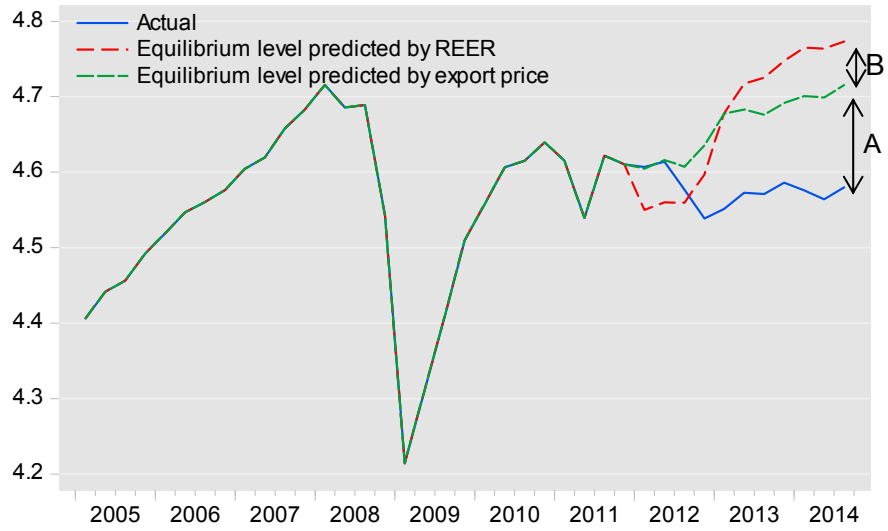
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<sup>14</sup> The alternative DOLS model for estimating long-run elasticity regresses export volumes (EX\_VOL\_JPN) on export prices (EP\_JPN) and trading partner outputs (Y\_STAR\_JPN).

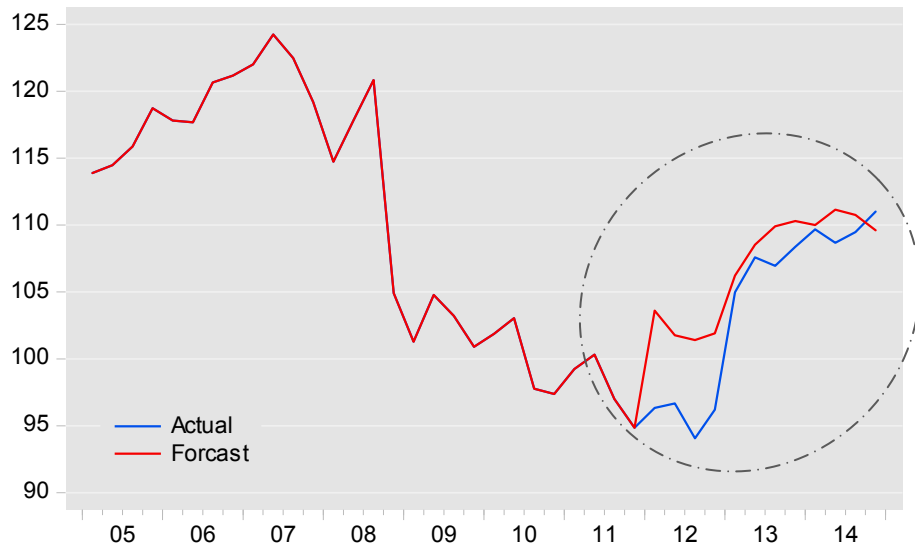
<sup>15</sup> Figure 10 shows the out-of-sample forecasts from the two DOLS models explained above. Note the following: (i) A+B is the gap between the actual export volume and the level it needs to go back to restore its long run relationship with the current levels of exchange rates; (ii) A is the gap between the actual export volume and the level it needs to go back to restore its long run relationship with the current levels of export prices; (iii) The residual B represents the portion of the total gap A+B that owes to a delayed or weaker (than predicted by history) responses of prices to exchange rate shocks. Note that the current levels of export prices may not yet have attained the long-run equilibrium level relative to the exchange rates.

<sup>16</sup> One possible explanation can be a break in conventional export to trading partner output relationship. This can result from the increase in value-chain related activities or off-shoring productions, among many other factors. (See IMF (April 2015a)). Another possibility is simply that Japan's quality excellence has ebbed, and an estimation of the price-volume relationship should take that into account. An interesting future avenue would be to include export quality variables (see Henn and others (2013) for a readily available database) in the regression.

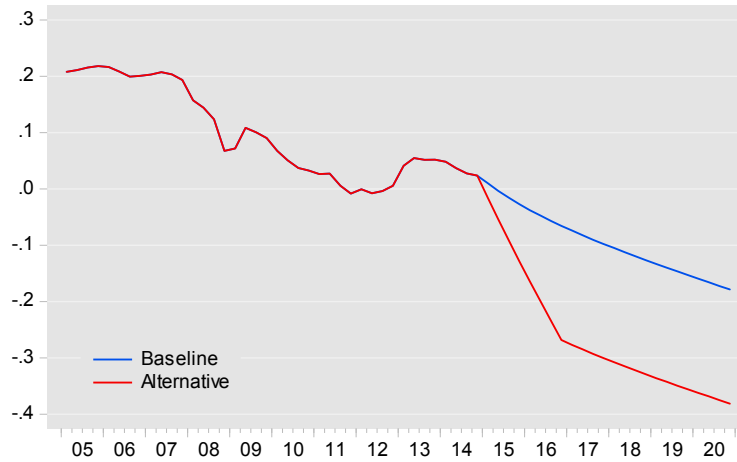
**Figure 10. Japan: Out-of-sample Forecasts for Export Volume**  
(estimation based on 1989q1-2011q4)



**Figure 11. Japan: Out-of-sample Forecasts for Export Prices**  
(estimation based on 1989q1-2011q4)



**Figure 12. Japan: Simulated Relative Export Margin  
(Estimation based on 1989q1-2011q4)**



### Scenario Analysis

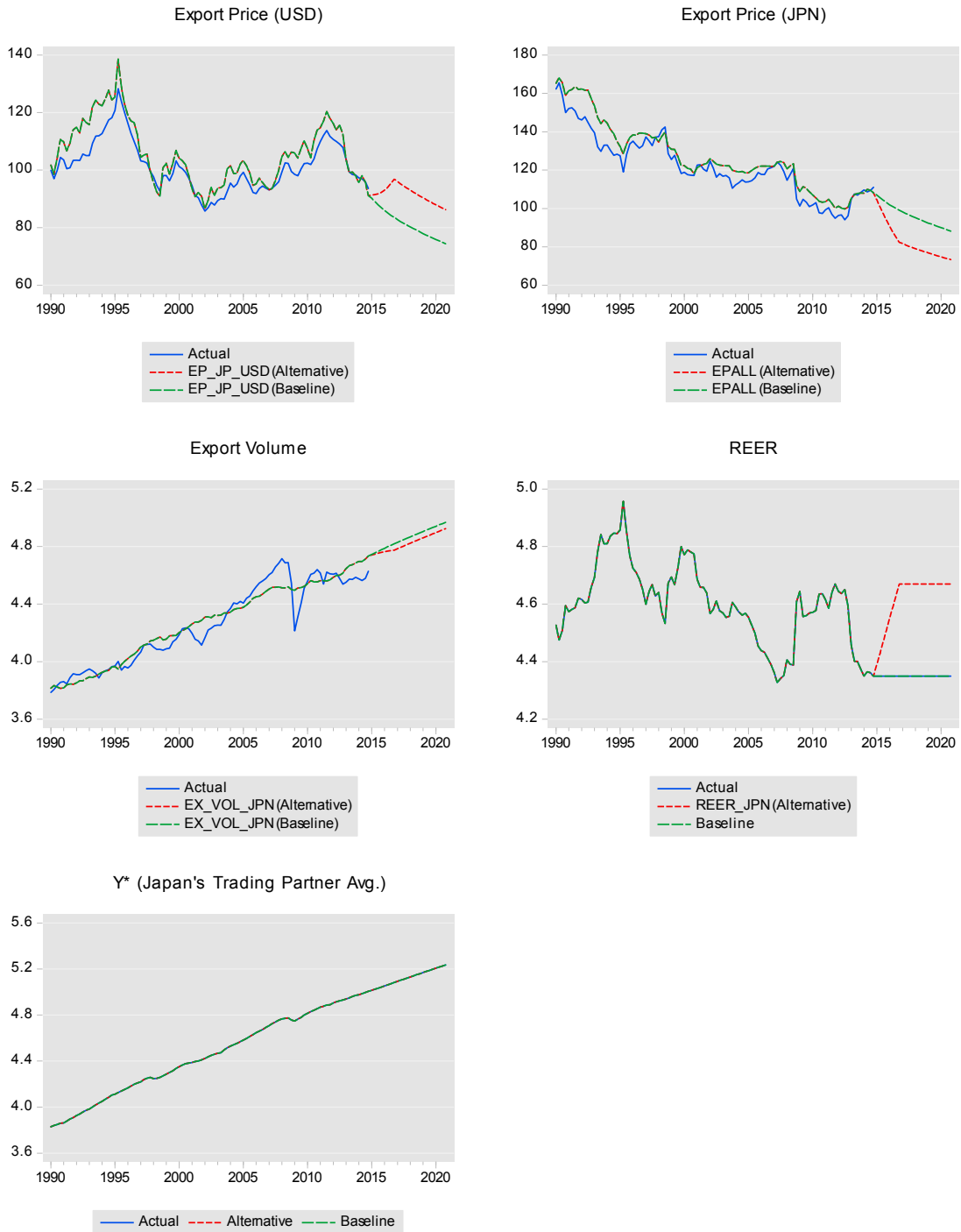
To see what trajectory Japan's export volumes and prices would take in case that **A** is indeed closing, we did a simulation analysis using both the relative mark up regressions (table 3) and the export volume regressions (Appendix 2):

- If Japan's export volumes fully come back to their equilibrium level (relative to the export prices), it is going to increase by about 30–33 percent until end-2020 (left mid chart, Figure 13).<sup>17</sup>
- Exchange rate scenarios affect the path of export volumes to a limited extent. For example, the export volume at the end of the simulation horizon would be 3–4 percent less (left mid chart, Figure 13) when assuming a full unwinding of the Yen's depreciation since the third quarter of 2011 relative to the baseline scenario that assumes a zero unwinding (right mid chart, Figure 13).<sup>18</sup>
- A permanent exchange rate shock could cause a permanent shift in profits. As an illustration, the relative profit margins of Japanese firms would be 20 percent (permanently) lower than in the baseline scenario if the Yen's depreciation since August 2011 fully unwinds (Figure 12).

<sup>17</sup> During this time horizon, Japan's trading partner GDP is assumed to increase by 38 percent in line with IMF's World Economic Outlook.

<sup>18</sup> The result reflects the dominant role of trading partner output (estimated by our regression models) in determining Japan's export volumes.

**Figure 13. Japan: Export Volume and Price Simulation 1/**



1/ Both the relative mark up regression (Table 3) and export volume regression (Appendix 2) has been used to generate simulated paths of five endogenous variables.

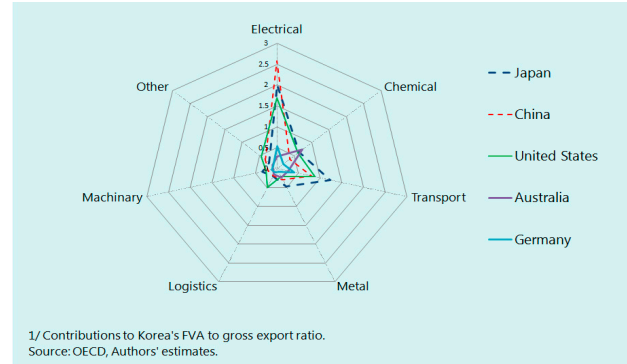
2/ Baseline assumes that the current level of REER (as well as Yen-dollar exchange rate) is locked in, while the alternative scenario assumes that the depreciation of Yen since 2011q3 is fully unwound over 8 quarters beginning from the first quarter of 2015.

#### IV. WHAT TO EXPECT FROM IMPORTED CONTENTS?

The effects of exchange rate appreciation on profit margins and price competitiveness of exporters can be partially offset by these effects also making imported contents cheaper.

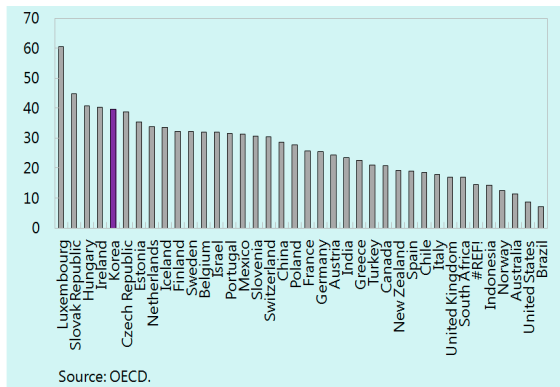
In this section, we examine how significant the offsetting effects of the Won's appreciation of this sort would be in the context of the Yen's depreciation against the Won.<sup>19</sup> Traditionally, Korean manufacturers have had substantial upstream supply chain links to the Japanese companies. For example, Korean electronics companies continue to rely on Japanese precision equipment for producing semiconductors and Liquid Crystal Displays.

**Figure 14. Korea's FVA by Source Country and Sector** (In percent of gross exports, 2009)



However, OECD's latest value-added-based trade statistics suggest that Japan is no longer the predominant player in Korea's upstream supply chain (See Figure 14).<sup>20</sup> For example, in electronics, China has, by a good margin, surpassed Japan in that role. In chemicals, Australia is taking the lead, and the United States in logistics. How important are Japan contents in overall costs of Korea's exports, and how much offset would that generate?:

**Figure 15. Korea's Foreign Value-Added (FVA) Exports** (In percent of gross exports, 2009)



(i) Korea's interconnectedness through value chain is on the high side, with foreign value added (FVA) accounting for 40 percent of Korea's gross export value (Figure 15). This makes Korea fifth among the OECD countries on that aspect.

(ii) The FVA sourced from Japan amounts to 5.1 percent of Korea's overall exports. This is only moderately larger than FVA sourced from China (4.8 percent) and the United States (4.6 percent). Hence, the cost savings caused by the weak Yen through imported inputs from Japan would be modest.<sup>21</sup>

(iii) The Yen's depreciation will result in larger trickle down effects through the imported cost channel to Korea than Korea's non-Japan competitors (see Table 3).

<sup>19</sup> This section draws heavily on Ree and Choi (2014).

<sup>20</sup> The data allows one to disentangle gross export value, first into domestic and foreign value added, and then, within the foreign value added, value components generated from some 40 source countries.

<sup>21</sup> Moreover, most of the gains from the Yen's depreciation would, in fact, be soaked up by the Japanese exporters, given that domestic value-added contents account for 85 percent of Japan's exports.

In all, Korea's relatively large FVA to gross export ratio means that the negative competitive effects of a Won appreciation will be significantly offset through the imported cost channel. However, this would do little to arrest the negative competitive effects from the Yen's depreciation.

**Table 3. Comparison of Japan Contents: Korea's Top Export Sectors**  
(In percent, share of FVA to gross exports)

	<b>Korea</b>	<b>Japan</b>	<b>China</b>	<b>Indonesia</b>	<b>U.S.</b>	<b>Germany</b>	<b>France</b>
Overall	<b>5.1</b>	<b>85.2</b>	<b>4.4</b>	<b>1.4</b>	<b>0.9</b>	<b>0.8</b>	<b>1.8</b>
Electrical	6.8	82.2	6.3	4.1	1.6	1.7	1.1
Transport	6.8	85.9	6.9	3.0	2.5	1.2	0.2
Chemical	4.1	78.9	4.0	0.9	0.8	0.7	0.9
Logistics	2.4	93.2	1.5	1.5	0.3	0.6	2.0
Metal	6.1	80.5	3.5	1.6	1.0	0.6	0.8

Sources: OECD; and IMF staff estimates.

## V. CONCLUSION

Our study suggests that a persistently large depreciation of the Yen would strengthen Japan's price competitiveness, through delayed responses of export prices. The extent and the timing of price pass-through seem to be related to the degree of product differentiation. The study also indicates that the direct boost from the weak Yen on Japan's export may likely be restricted, given relatively small contribution of price variables in driving the export demand. Price pass-through effects can also be partially mitigated by offsets from the costs of imported inputs.

We also find that a persistently weak Yen could lastingly boost the profits of Japan's exporters, and correspondingly, if this coincides with a strong Won, Korean companies could suffer enduringly lower profits. The profit prospects faced by the Korean and Japanese companies would likely affect non-price decisions like where to invest new capacity and how much to invest in R&D, which would eventually drive underlying competitiveness of the two countries, going beyond the narrow bounds of simple price competition.

This suggest that the limited export volume response to the Yen depreciation against the Won could mask what could result in a fundamental shift in competitiveness, if this were to persist, in two ways. First, our results show that Japanese and Korean exchange rate elasticities are low in the short run but they build up over time, albeit with a fairly long lag—so we would expect the price pass through and volume responses to grow as time passes. Second, persistent profit margin changes could lead to more fundamental and difficult to forecast non-price investment decisions which would take a long time to reveal themselves. For example, their result could be more outsourcing by Korean firms or better product development by Japanese firms, which would affect the value-added produced domestically of the countries' exports, with corresponding implications for future productivity and output growth.

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### Appendix 1 Japan Export Volume regression (DOLS): REER

Dependent Variable: EX\_VOL\_JPN

Method: Dynamic Least Squares (DOLS)

Date: 03/13/15 Time: 11:45

Sample (adjusted): 1989Q1 2011Q3

Included observations: 91 after adjustments

Cointegrating equation deterministics: C

Automatic leads and lags specification (lead=12 and lag=12 based on AIC criterion, max=12)

Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REER_JPN	-0.561458	0.089975	-6.240179	0
Y_STAR_JPN	0.699512	0.029046	24.08267	0
C	3.725076	0.537375	6.93199	0
R-squared	0.996267	Mean dependent var		4.197701
Adjusted R-squared	0.991158	S.D. dependent var		0.2801
S.E. of regression	0.026338	Sum squared resid		0.02636
Durbin-Watson stat	1.210845	Long-run variance		0.001214

### Appendix 2 Japan Export Volume regression (DOLS): Export Price

Dependent Variable: EX\_VOL\_JPN

Method: Dynamic Least Squares (DOLS)

Date: 03/13/15 Time: 11:40

Sample: 1989Q1 2011Q4

Included observations: 92

Cointegrating equation deterministics: C

Automatic leads and lags specification (lead=11 and lag=5 based on AIC criterion, max=11)

Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth =4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EP_JP_USD)	-0.299789	0.141564	-2.11769	0.0387
Y_STAR_JPN	0.753667	0.033646	22.39969	0
C	2.314748	0.763023	3.033654	0.0037
R-squared	0.984491	Mean dependent var		4.202184
Adjusted R-squared	0.974339	S.D. dependent var		0.281856
S.E. of regression	0.045151	Sum squared resid		0.112123
Durbin-Watson stat	0.679844	Long-run variance		0.005027

<b>Appendix 3: Japan Export Volume Regression (Error-Correction Model) with REER</b>			
Dependent Variable: D(EX_VOL_JPN)			
<b>Sample: 1989Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_JPN)	-0.11	0.08	-1.32
D(Y_STAR_JPN)	3.64	0.70	5.21
D(Y_STAR_JPN(-1))	1.89	0.83	2.29
UHAT_JPN	0.06	0.09	0.63
C	-0.06	0.01	-6.48
R-squared	0.4		
Adjusted R-squared	0.4		
<b>Sample: 2000Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_JPN)	-0.05	0.14	-0.36
D(Y_STAR_JPN)	5.41	1.06	5.09
D(Y_STAR_JPN(-1))	2.18	1.16	1.88
UHAT_JPN	0.08	0.11	0.74
C	-0.09	0.01	-7.09
R-squared	0.62		
Adjusted R-squared	0.59		

<b>Appendix 4: Japan Export Volume Regression (OLS) with REER</b>			
Dependent Variable: D(EX_VOL_JPN)			
Method: Least Squares			
<b>Sample: 1989Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_JPN)	-0.09	0.07	-1.16
D(Y_STAR_JPN)	3.61	0.69	5.20
D(Y_STAR_JPN(-1))	2.17	0.69	3.14
C	-0.06	0.01	-6.96
R-squared	0.44		
Adjusted R-squared	0.43		
<b>Sample: 2000Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_JPN)	-0.01	0.13	-0.10
D(Y_STAR_JPN)	5.32	1.05	5.06
D(Y_STAR_JPN(-1))	2.67	0.94	2.83
C	-0.08	0.01	-7.47
R-squared	0.62		
Adjusted R-squared	0.60		

### Appendix 5 Korea Export Volume regression (DOLS)

Dependent Variable: EX\_VOL\_KOR

Method: Dynamic Least Squares (DOLS)

Date: 04/16/15 Time: 18:24

Sample (adjusted): 1988Q1 2013Q3

Included observations: 103 after adjustments

Cointegrating equation deterministics: C

Fixed leads and lags specification (lead=4, lag=4)

Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REER_KOR	-0.441861	0.335386	-1.317472	0.1913
Y_STAR_KOR	2.34795	0.067425	34.82304	0
C	-4.782286	1.713532	-2.790893	0.0065
R-squared	0.991706	Mean dependent var		3.473862
Adjusted R-squared	0.989683	S.D. dependent var		0.915913
S.E. of regression	0.093033	Sum squared resid		0.709716
Durbin-Watson stat	0.151126	Long-run variance		0.037187

<b>Appendix 6: Korea Export Volume Regression (Error-Correction Model) with REER</b>			
Dependent Variable: D(EX_VOL_KOR)			
<b>Sample: 1989Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_KOR)	-0.13	0.07	-1.71
D(Y_STAR_KOR)	2.76	0.74	3.71
D(Y_STAR_KOR(-1))	0.25	0.69	0.37
UHAT_KOR	0.01	0.02	0.71
C	-0.01	0.01	-1.29
R-squared	0.19		
Adjusted R-squared	0.16		
<b>Sample: 2000Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_KOR)	0.14	0.11	1.26
D(Y_STAR_KOR)	2.95	0.90	3.29
D(Y_STAR_KOR(-1))	0.40	0.79	0.51
UHAT_KOR	-0.01	0.06	-0.11
C	-0.02	0.01	-1.66
R-squared	0.49		
Adjusted R-squared	0.45		

<b>Appendix 7: Korea Export Volume Regression (OLS) with REER</b>			
Dependent Variable: D(EX_VOL_KOR)			
Method: Least Squares			
<b>Sample: 1989Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_KOR)	-0.13	0.07	-1.88
D(Y_STAR_KOR)	2.92	0.62	4.73
C	-0.01	0.01	-1.14
R-squared	0.18		
Adjusted R-squared	0.17		
<b>Sample: 2000Q1 2014Q3</b>			
Variable	Coefficient	Std. Error	t-Statistic
D(REER_KOR)	0.12	0.10	1.18
D(Y_STAR_KOR)	3.22	0.64	5.07
C	-0.01	0.01	-1.81
R-squared	0.48		
Adjusted R-squared	0.47		



## Appendix 8. What's Driving the Won/Yen Cross Rate?

Since September 2011, Yen has depreciated against the won by near 70 percent. With no direct market for Won-to-Yen trading, the Won exchange rate against Yen is determined by the cross rate between Won-dollar (KRWUSD) and Yen-dollar (JPYUSD) exchange rates. If the cross rate shows particularly strong association with one of the two currencies, then it can be seen as being driven by factors specific to that currency (e.g., Korea's current account surplus, safe-haven capital flow to Japan, Abenomics).<sup>1</sup>

Using monthly exchange rates during January 2000 to March 2015, we investigated whether that was the case. We too examined the correlation between KRWUSD and JPYUSD.

### Correlation between the Won and the Yen

**Jan-2000 to Feb-2006:** The correlation between the cross rate and KRWUSD was 0.6. Strengthening of the Won against the US dollar thus seems to have caused its appreciation against the Yen. The Yen's exchange rate move against dollar seems to have triggered a recoupling shift by the Won (e.g., weak Yen causes Won to weaken too against dollar), thus hardly moving the cross rate. This is indicated by the cross rate's near zero correlation with JPYUSD, as well as a relatively high correlation of 0.7 between JPYUSD and KRWUSD. The recoupling shifts may have resulted from both Korean authorities' FX intervention behavior and sensitivity of Korea's current account to the Yen-dollar exchange rates during this period. During Dec-2003 to June 2007, the Won has appreciated against Yen by 33 percent, with the KRWUSD accounting for about 60 percent of the appreciation.

#### Jan-2000 to Oct-2014

	KRWJPY	JPYUSD	KRWUSD
KRWJPY	1.000		
JPYUSD	-0.828	1.000	
KRWUSD	0.551	-0.013	1.000

#### Jan-2000 to Feb-2006

	KRWJPY	JPYUSD	KRWUSD
KRWJPY	1.000		
JPYUSD	-0.127	1.000	
KRWUSD	0.599	0.706	1.000

#### Mar-2006 to Mar-2015

	KRWJPY	JPYUSD	KRWUSD
KRWJPY	1.000		
JPYUSD	-0.928	1.000	
KRWUSD	0.814	-0.556	1.000

1/ Monthly average exchange rates.

**Mar-2006 to Mar-2015:** The correlation between the cross rate and JPYUSD jumped to -0.9, indicating that factors specific to the Yen (e.g., monetary easing since late 2011) may have been driving the Won/Yen cross exchange rate. At the same time, the Won tended to move in the opposite direction to Yen. For example, while the Won tumbled during the global financial crisis, the Yen saw a sustained boost owing to both safe-haven flows, and the retrenchment of overseas investments. The Yen's sharp depreciation since late 2011 was accompanied by the Won's moderate appreciation against dollar due to current account surplus and repricing of Korea risks. During Nov-2011 to [Feb]-2015, the Won has appreciated against Yen by 40 percent, with the JPYUSD accounting for 97 percent of the appreciation.

<sup>1</sup> The cross rate may also be affected by factors common to dollar as the Won and Yen may have different betas. For example, consider the following simple model:  $\text{Log}(E_j) = \text{Log}(a_j) + b_j * \text{Log}(E) + \text{Log}(U_j)$ , where  $E_j$  is dollar's exchange rate against country  $j$ ,  $E$  U.S. dollar index or dollar's NEER,  $a$  and  $b$  constants, and  $U_j$  a random variable representing stochastic shocks specific to currency  $j$ . Then  $\text{Log}(E_1/E_2) = \text{Log}(a_1/a_2) + (b_1 - b_2) * \text{Log}(E) + \text{Log}(U_1/U_2)$ . If  $b_1$  and  $b_2$  are both positive and relatively close, the cross rate will be mainly driven by  $U_1/U_2$ . However, if  $b_1$  and  $b_2$  are of different signs (which is possible in view of Yen's safe haven behavior after the crisis), the cross rate can also be heavily driven by  $E$ .

## Appendix 9. Estimation of PTM—Technical Note

To gauge how exporters respond to exchange rate shocks through profit margin adjustments, we use a model developed by Marston (1990). Assume a manufacturer that produces all goods locally and sells them in both domestic and export markets applying differentiated prices. In this setting, relative profit margins are simply the difference between export and domestic prices, which we call ‘relative profit margins’, as marginal costs (the unobservable) are assumed to be the same.

Using data on four key export sectors (transportation, electronics, metals and textiles) that account for about 40 percent of the Japanese and Korean exports, we as the first step employ a dynamic ordinary least squares (DOLS, hereafter) model, developed by Stock and Watson (1993), for the relative profit margin.<sup>2</sup> By its nature (i.e., cointegrating relationship) the DOLS model allows us to tease out the long run elasticity of relative margins to REER. Then to obtain the short-run elasticity and also to gauge the speed with which the dependent variable goes back to the long-run equilibrium (i.e., value predicted by cointegrating relation estimated by the DOLS at the first step), we estimate an error correction model (ECM) as the second step.<sup>3</sup>

The dynamic ordinary least squares regression specification is as follows:

$$P_{x,it} - P_{h,it} - P_{h,it} = \beta_0 + \beta_1(s_t) + \beta_2(c_t) + \beta_3y_t + \beta_4y_t^* + u_t \quad (1)$$

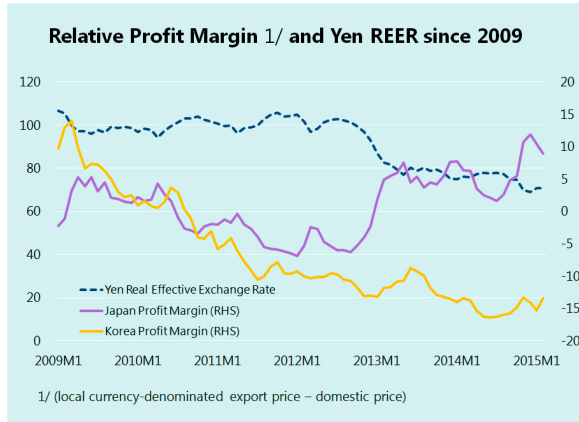
where  $P_{x,it}$  is the export prices described in the domestic currency for sector  $i$  (i.e. sectoral Yen-based export prices in the case of Japan and sectoral Won-based export prices in the case of Korea),  $P_{h,it}$  is the price of goods sold in the domestic market for sector  $i$  (PPI series available at sectoral level),  $s_t$  is the real effective exchange rate,  $c_t$  is real production costs (proxied by the input price index of imported inputs),  $y_t$  is income represented by the

<sup>2</sup> There are several conditions to be satisfied when conducting a DOLS regression: (1) non-stationarity of the level data, while the first differences of the variables should be stationary and (2) residuals from DOLS regressions should be stationary. The data used satisfy the (1) requirement (which we omit to report) and the ADF test statistics are reported in Tables 3 and 4.

<sup>3</sup> The two step method used by this paper is a well established approach in the literature, first proposed by Engle and Granger (1987). With the first step estimator proven super-consistence (i.e., converging to the true coefficient value at a rate  $T^{-1}$ , where  $T$  is the sample size; Stock 1987), the second step estimator has been shown to be statistically consistent. However, Banerjee et al (1993) illustrated that Engle and Granger’s simple (OLS) estimator can suffer significant small sample bias. In response, Stock and Watson (1993) and Saikkonen (1991) proposed simple method to correct this problem, called DOLS (dynamic ordinary least squares). We adopt Stock and Watson’s version of DOLS in this paper. An alternative is use of multivariate cointegration models. The advantage of the alternative is that it is flexible in terms of the number of cointegrating relationships (in contrast, the two step approach assumes at most one cointegrating relationship and hence is more restrictive). However, it is well known that the second approach is subject to serious size and power distortions (Donaldo et al 1999, Ogaki 1993). In this paper, we choose the standard two step approach considering all the above. Our pre-tests point to at most one co-integrating relationship, strengthening the case for this choice. The theoretical model (Marston 1990) adopted here also supports it (i.e., the use of a single equation cointegration model).

manufacturing industrial production,  $y_t^*$  is the partner country's income represented by the partner country demand series (from IMF's GAS-GEE database). It is important to note that the only sign implied by the model is that of the coefficient on the real exchange rate,  $\beta_1$ , which is negative. The DOLS model includes both leads and lags of the first difference of all explanatory variables, the notation for which is suppressed in (1) for the sake of simplicity.<sup>4</sup>

### Relative Profit Margin 1/ and Yen REER since 2009



We first examine trends of the relative profit margins. The figure in the left reveals a close co-movement between the relative profit margins of the Japanese companies and the Yen's real effective exchange rate, suggesting Japanese companies' PTM behaviors. It also shows that the relative margins of Korea and Japan have visibly diverged in an opposite direction in recent years. This may be either because Korean companies have maintained invoice price despite the Won's appreciation,

or have been forced to cut invoice price as the destination market prices have gradually reflected the Yen's depreciation. In either case, the divergence is indicative of PTM behaviors by the Korean exporters.<sup>5</sup>

### Long-run Equilibrium

The model explains the behavior of the relative profit margins well, as indicated by adjusted- $R^2$  being mostly above 0.95 (Table A.1). The ADF statistics reject the null hypothesis of a unit root in residuals at 1% in most industries.

The estimation results show that a 10 percent depreciation of the Yen in real terms, all else equal, increases the Yen-denominated export prices by 3-5 percent relative to the price Japanese manufacturers charge domestically<sup>6</sup>. Japanese manufacturers, electronics respond through profit margin adjustment the most, while metal the least. On the other hand, Korea manufacturers generally show higher long-run equilibrium elasticity, ranging from 5–7 percent, except for electronics. In other words, the Korean exporters, except for electronics, tend to adjust more through profit margin adjustment in the long-run.

<sup>4</sup> Some readers may wonder why we are analyzing a conceptual construct like relative margins based on macro data when more direct profit data are available at micro levels. In fact, a few previous studies have examined PTM behaviors using micro firm level data (e.g., Burstein and Jaimovich (2012), Fitzgerald and Haller (2013)). In this paper, however, our main interest is to compare short-term and long-term responses of exporters for which micro data does not work given their limited length in time. Firm level profit data also can be misleading for global companies where profits are consolidated globally.

<sup>5</sup> See Box 2 for an illustration of exporters' pricing decisions (including those of a pure PTM) in the face of exchange rate movements.

<sup>6</sup> The relative profit margin is equivalent to the margin between export price and domestic price, and we use both interpretations interchangeably.

**Table A.1. Japan: Dynamic Ordinary Least Squares Estimation Results**

	<b>Transportation</b>	<b>Textile</b>	<b>Metal</b>	<b>Electronics</b>
Real Exchange Rate	-0.36	-0.43	-0.33	-0.49
	(0.04)	(0.15)	(0.27)	(0.08)
Imported Input Price	-0.44	-0.31	1.68	-0.92
	(0.06)	(0.09)	(0.16)	(0.12)
Partner Country Demand	0.00	-0.20	1.48	-0.16
	(0.02)	(0.48)	(0.85)	(0.03)
Industrial Production	0.08	1.02	-0.85	1.63
	(0.09)	(0.32)	(0.56)	(0.17)
Adjusted R-Square	0.95	0.93	0.97	0.90
Error-Correction Coefficient	-0.06	-0.10	-0.09	-0.03
	(0.02)	(0.06)	(0.04)	(0.02)
Augmented Dickey-Fuller	-4.12	-7.47	-3.05	-3.23

Footnote: The rows below the coefficients report standard errors. Critical values for augmented Dickey-Fuller test with constant and linear trend with maximum lags 12 are -3.50, -2.89, -2.58 at 1%, 5% and 10% respectively.

**Table A.2. Korea: Dynamic Ordinary Least Squares Estimation Results**

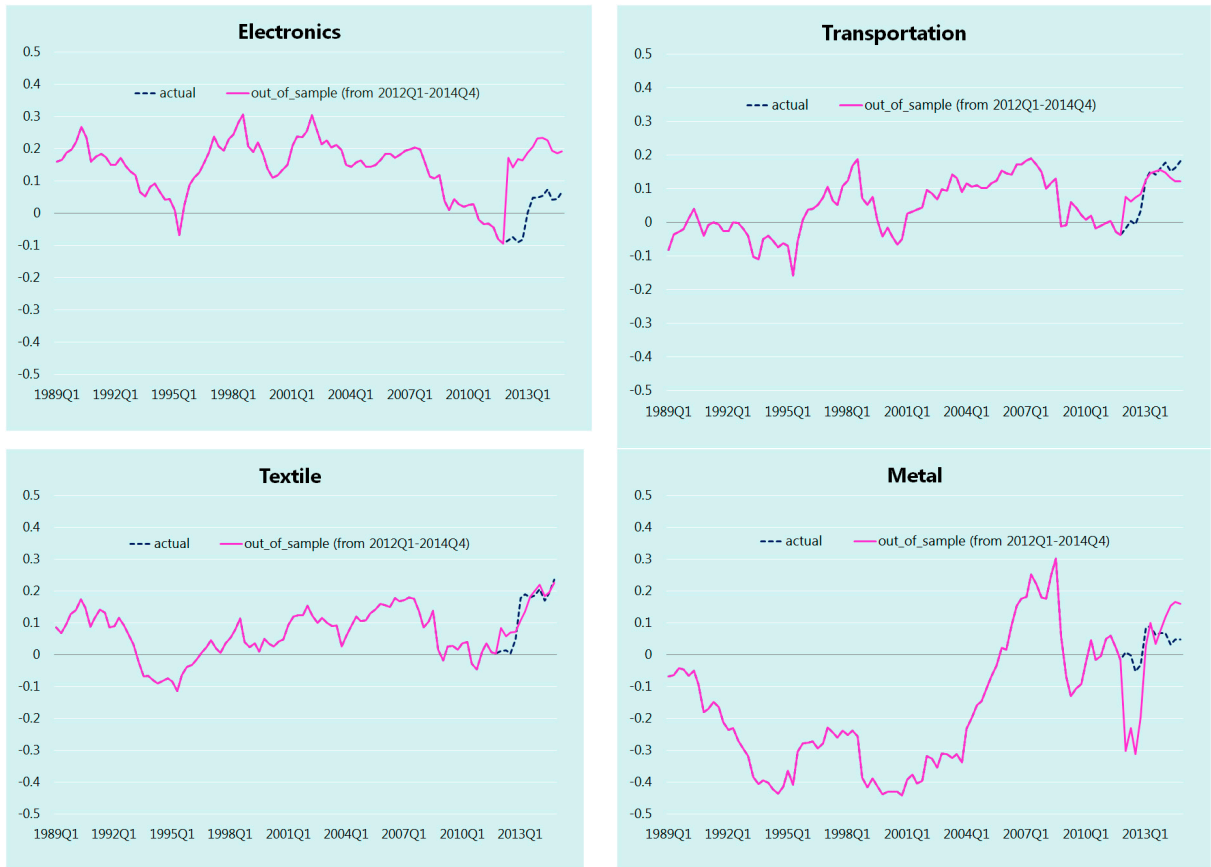
	<b>Transportation</b>	<b>Textile</b>	<b>Metal</b>	<b>Electronics</b>
Real Exchange Rate	-0.56	-0.72	-0.51	-0.13
	(0.08)	(0.08)	(0.10)	(0.14)
Imported Input Price	-0.61	0.08	-0.32	0.35
	(0.12)	(0.12)	(0.15)	(0.21)
Export Volume	0.28	-1.21	-0.49	-0.53
	(0.07)	(0.08)	(0.10)	(0.12)
Industrial Production	0.91	1.86	1.34	0.30
	(0.17)	(0.17)	(0.22)	(0.28)
Adjusted R-Square	0.98	0.99	0.98	0.98
Error-Correction Coefficient	-0.01	-0.03	-0.04	-0.02
	(0.01)	(0.01)	(0.01)	(0.02)
Augmented Dickey-Fuller	-7.45	-6.44	-4.62	-5.86

Footnote: The rows below the coefficients report standard errors. Critical values for augmented Dickey-Fuller test with constant with maximum lags 13 are -3.50, -2.89, -2.58 at 1%, 5% and 10% respectively.

How quickly do relative export prices return to the estimated long-run relationship after an exchange rate shock? Tables A.1 and A.2 present the estimates of the error-correction terms. A statistically significant negative coefficient indicates the relative export prices revert to a conditional mean defined by the cointegrating vector. The estimated ECM terms come with the correct sign and most are significant. The speed of adjustment toward the long-run equilibrium is higher for Japan than that of Korea, where almost all the adjustments to the long-run equilibrium are made within 20 quarters.

Finally, to see if the PTM behaviors have been different from previous episodes, we conducted an out-of-sample forecast based on the model estimated using observations through the third quarter of 2011 (when the Japanese REER began to depreciate steeply). We compared the forecasted relative profit margins and the actual ones since the fourth quarter of 2011.

**Out-of-Sample Forecast of Profit Margin Adjustment to a REER Shock  
(Forecast horizon: 2012Q1 to 2014Q4)<sup>7</sup>**



As shown in figure above, the comparison shows mixed results. For transportation and textile, recent pricing-to-market behaviors exhibited by the Japanese exporters are not different from what's predicted by the long-run relationship that existed before the Abenomics period. However, in electronics, exporters seem to be passing more exchange rate gains through to export prices than in the past. The past pricing behaviors also do not well predict the current behaviors of metal exporters. However, the gap is hard to interpret than in the case of electronics exporters. We omitted similar exercise for Korea given the limited REER shock to Won caused by Yen (which reflects Japan's relatively small weight as Korea's trading partner).

<sup>7</sup> Using the results from 1989Q1 to 2011Q4, out-of-sample forecasts are conducted using dynamic ordinary least squares (DOLS) for 2012Q1 to 2014Q4.