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Abstract

In this paper, we explore whether unconventional monetary policy in Japan had a negative spillover effect on the rest of the world. After Prime Minister Abe advocated the new policy regime, the Japanese yen depreciated substantially which raised a concern that it would have a beggar-thy-neighbor effect in the region. However, despite the yen's depreciation, Japan's exports did not show significant improvement. To explain why the exports did not increase, this paper focuses on weak external demand and increased overseas production. Our theoretical model shows that a small change of the exchange rate has no effect on exports because of fixed costs when shifting the plant location across the countries. However, it also implies that a change of the exchange rate has a significant effect on the exports either when the exchange rate depreciation coincides with strong external demand or when the appreciation coincides with weak external demand. In the latter part of the paper, we examine the validity of these theoretical implications through estimating a simple export function in Japan and through calibrating our export function. In both of the experiments, we confirm that the model can track Japan's exports reasonably well especially after the new policy regime started.

Key words: export function, fixed costs, unconventional monetary policy
JEL classification number: F10, F32, E52

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1. Introduction

After the global financial crisis (GFC) in 2008, central banks in advanced countries adopted a series of unconventional monetary policies. These policies largely succeeded at achieving their domestic goals, and were especially effective at the time of financial turmoil. However, they had a mixed effect on the rest of the world. They buoyed asset prices globally. But they also depreciated currencies and increased capital flows to the rest of the world. When flows become excessive, with the risk of sudden reversals, they can give rise to policy strains in recipient countries.

Among unconventional policies in advanced countries, a number of studies suggested that highly accommodative monetary policy in the United States has created major challenges for policymakers in the rest of the world, especially in emerging market economies (EMEs) (see, for example, Neely [2010], Fratzscher et al. [2013], Chen et al. [2014], and Bowman et al. [2014]). Quite a few of EMEs experienced rapid capital inflows and strong currency appreciation pressures during 2010-12, while they saw a sharp reversal in episodes of market volatility after FRB Chairman Bernanke's tapering comments on May 22, 2013. However, Rogers et al. (2014) find that the spillover effects of unconventional policy were not symmetric across the countries and that U.S. policy shocks had larger effects on the rest of the world than those of the other advanced countries.

The purpose of this paper is to explore whether unconventional monetary policy in Japan had a similar spillover effect on the rest of the world. Like other central banks, the Bank of Japan (BOJ) adopted unconventional monetary policy after the GFC. But it was after Prime Minister Abe advocated the new policy regime when the BOJ became more aggressive in its unconventional policy. Under the new regime which is called "Abenomics", the Japanese government tried to revive its economy through implementing bold economic policies that will pull its economy out of prolonged deflation, depreciate Japanese yen, and induce CPI inflation rate of 2% per year (see, for example, Fukuda [2014] for its details). In particular, on April 4th in 2013, BOJ Governor Kuroda introduced the "Quantitative and Qualitative Monetary Easing (QQE)" and committed to achieve 2% inflation target in 2 years.

Figure 1 depicts actual and predicted amount of base money in Japan from 2007 to 2015[1]. Like central banks in the other advanced countries, the BOJ increased its base money after the Lehman shock in September 2008. But compared with those in the other advanced countries, the changes had been very modest. This was true even after the BOJ announced the comprehensive monetary easing in October 2010. However, Japan's based monetary started to increase substantially since late 2012 when Abenomics started. The increases were accelerated when the BOJ introduced the QQE in April 2013 and expanded the QQE in October 2014.

The foreign exchange market reacted to the new policy regime very sensitively (see, for example, Kano [2014]). As in Figure 2, the yen-dollar rate, which had been stagnating around 80 yen per

[1] The predicted amount is calculated based on the BOJ's commitment.

dollar in 2012, depreciated to 88 yen at the beginning of January 2013 and to 102 yen on May 15, 2013. The expansion of the QQE on October 31 in 2014 led to further depreciation of the Japanese yen. The depreciation overall had positive effects on the Japanese economy (see, for example, Shioji [2014]). However, several Asian emerging countries showed a serious concern about the yen's depreciation because it may have a beggar-thy-neighbor effect and result in competitive devaluation in the region.

However, despite the dramatic yen's depreciation, Japan's exports did not show significant improvement. Figure 3 depicts Japan's exports in terms of their yen-denominated amount, their dollar-denominated amount, and their volume from January 2011 to December 2014. Soon after the new regime "Abenomics" started, Japan's exports made modest improvement from January 2013 to March 2013. However, after March 2013, it did not persist even if the Japanese yen remained weak. Comparing those in pre-Abenomics period, the amount of yen-denominated exports increased on average. But we can see no significant increases in the volume. More importantly, the amount of dollar-denominated exports showed significant declines on average after Abenomics started.

The results are essentially the same even for exports to Japan's Asian emerging countries whose share in Japan's total exports has exceeded 50% since 2009. For example, Figure 4 depicts the dollar-denominated amount of Japan's exports to Asia, South Korea, and China from January 2011 to December 2014. The exports increased soon after Abenomics started in December 2012 and after BOJ expanded QQE at the end of October 2014. But the improvement was modest. More importantly, the improvement did not persist even if the yen depreciated substantially. The dollar-denominated amount of Japan's exports to Asia on average rather declined after Abenomics started.

Declined exports accompanied by increased imports deteriorated Japan's current account surplus in the same period. This is especially true for international trade with Asian countries. For example, Figure 5 depicts Japan's yen-denominated trade balanced with Asia from January 2010 to December 2014. In pre-Abenomics period, Japan had large trade surplus against Asian countries except in February 2012. But the trade account against Asian countries turned into deficit in January 2013 and remained almost balanced since then. As a result, Japan's external imbalances were more stabilized in the Abenomics period than in the pre-Abenomics period. Despite a serious concern, the yen's depreciation did not have a beggar-thy-neighbor effect in the region.

Why did the yen's depreciation driven by unconventional monetary expansion have no significant negative spillover effect on the rest of the world? To answer this question, the following analysis focuses on weak external demand and increased overseas production. We first show that once we allow these two factors, a simple model where exports under weak external demand do not show significant improvement even if the exchange rate depreciates. In the model, a small change of the exchange rate has no effect on the exports because there are fixed costs when shifting the plant location across the countries[2]. However, a change of the exchange rate has larger effect on the exports either when the exchange rate depreciation coincides with strong external demand or when the appreciation coincides with weak external demand. The latter part of the paper explores the validity of these theoretical implications through estimating a simple export function in Japan and through calibrating our export function. In both of the experiments, we see that the model can track Japan's exports reasonably well especially after the new policy regime started.

Our model is too simple to describe export function in the Japanese economy. For example, our model is a partial equilibrium model where the price and the exchange rate are exogenously given. It does not allow the role of domestic market explicitly. Thus, it has limited implications for describing more general features in Japan's exports. However, it is worthwhile to be noted that even the simple framework could track Japan's exports in the new policy regime. It is likely that it captures a key feature to explain why yen's depreciation driven by Japan's unconventional monetary expansion had no significant negative spillover effect on the rest of the world.

In literature, there are a huge number of studies that estimated Japanese export functions (see, for example, Ando and Kimura [2012], Chinn [2013], and Thorbecke [2014] for recent contribution). In particular, Cabinet Office (2013) estimated Japanese export function taking into account overseas production of Japanese corporations, while Shimizu and Sato (2015) estimated Japanese export functions including the sample period of Abenomics. However, to our best knowledge, there is no study that estimated Japanese export functions taking into account the fixed costs explicitly. This paper, thus, casts a new insight on recent Japanese export behavior.

2. Why Didn't Japan's Exports Increase?

The purpose of this paper is to explore why the yen's depreciation driven by unconventional monetary policy did not increase Japan's exports and had no significant spillover effect on the rest of the world. In the following analysis, we focus on two factors to explain why Japan's exports did not increase even if the yen depreciated substantially. One is weak external demand in the world economy. The US economy accomplished relatively fast recovery from the GFC. But European economies remained weak after the Euro crisis, while emerging economies, especially China, slowed down their growth rates since 2012. Thus, overall demand in the world economy was weak, which resulted in weak demand for Japanese export goods.[3]

However, even comparing exports in other countries, the amount of Japan's exports declined more substantially after the new policy regime started. For example, Figure 6 depicts Japan's exports,

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[2] The feature was originally pointed out by Baldwin and Krugman (1989). See also Melitz (2003) and Helpman et al. (2004) for recent contributions.

[3] The world growth rate which was around 5% in 2010 declined to around 2.5% in 2013. In particular, China's growth rate which was over 10% in 2010 became less than 8% in 2012.

world total exports, and aggregated exports in advanced economy from January 2011 to December 2014. All of the exports are the amount denominated in the US dollar. In pre-Abenomics period when the yen was very strong, we can see no significant difference among these exports. But after late 2012, while both world total exports and aggregated exports in advanced economy only showed limited decline, Japan's exports declined significantly.

Thus, the following analysis also focuses on increases in overseas production and outsourcing of Japanese manufacturing as the other important factor to explain Japan's slow export recovery. Due to growing emerging markets and shrinking internal markets, a number of Japanese corporations not only expanded overseas consignment production but also increased their FDIs and shifted their plants from home to abroad. The yen's appreciation after the GFC accelerated the trend. Because the investment is irreversible, this made Japan's exports weak even if unconventional monetary policy depreciated the Japanese yen substantially.

Figure 7 shows overseas production ratio in Japanese manufacturing from 1986 to 2013. It depicts not only actual ratio but also its 5-year forecast. The ratio, which was negligible in the 1980s, increased steadily throughout the last two decades. The ratio exceeded 15% in 2005 and 20% in 2012 and is forecasted to be more than 25% in 2018. It is true that the yen's appreciation after the GFC accelerated the upward trend. But it is noteworthy that even in 2013 when the yen depreciated substantially, Japanese manufacturing corporations forecasted that overseas production would expand steadily in next five years. This implies that Japan's exports will remain weak under increasing overseas production even if unconventional monetary policy depreciates the Japanese yen substantially.

In addition to the two factors mentioned above, one may argue that several other factors may partly explain the weak Japan's exports under yen's depreciation. For example, the J-curve effect may explain slow export recovery in the short-run. Immediately following the depreciation of the currency, the volume of exports may remain largely unchanged partly due to pre-existing trade contracts and partly due to price inelastic demand for exports. However, over the longer term, depreciation in the exchange rate should have the desired effect of increasing exports. Since the weak yen did not improve Japan's exports volume for nearly two years, it is thus unlikely that the J-curve effect is a primary factor for slow recovery of Japan's exports under Abenomics.

Deteriorated international competitiveness of Japanese manufacturing could be another factor. Due to a rise of emerging economies, price competitiveness of Japan's exports recently declined substantially in the international markets. When price competitiveness deteriorated, the volume of exports became less inelastic to a large decline of export prices. But this is also unlikely to be a primary factor for slow recovery because the depreciated yen did not reduce Japan's dollar-denominated export prices substantially during the period under Abenomics.

Therefore, in the following analysis, we construct a model that only allows the above mentioned two factors. We then investigate how well the model explains Japan's exports in the 2000s through estimating the export function and calibrating the model.

3. The Model

We consider an open economy, where the price of tradable goods is exogenously given and is equal to p when denominated in the foreign currency. The economy, which produces perfectly differentiated tradable goods, faces the exogenous volume of external demand ED (>0) in the international market. To fulfil the demand, the volume of EX_t is produced in home country and the volume of OP_t is produced in a foreign country in period t, where $ED = EX_t + OP_t$. This implies that EX_t denotes the volume of exports in period t, while OP_t denotes the volume of overseas production in period t.

In the economy, each firm in the tradable sector can produce a unit of output either in home country or in a foreign country. Denoting the exchange rate denominated in the foreign currency by e, its production cost denominated in the foreign currency is Ae when producing in home country and is $C(OP_t)$ when producing in a foreign country, where $C'(OP_t) > 0$. The production cost is constant and equals to A denominated in home currency when producing in home country. In contrast, it depends on the total overseas production OP_t when producing in a foreign country. This implies that aggregate production is constant returns-to-scale when producing in home country but is decreasing returns-to-scale when producing in a foreign country.

At the beginning of each period, each firm chooses the location of its plan so as to maximize its profit. However, there exists a fixed cost when shifting its plant location across the countries. That is, each producer needs to pay θ_1 when shifting its plant from home country to a foreign country and θ_2 when shifting its plant from a foreign country to home country, where both θ_1 and θ_2 are denominated in the foreign currency. Thus, the production cost in period t differs depending on where the firm produced in period t-1 (see Figure 8).

Define the value function of each firm in period t by $V_H(EX_t)$ when producing in home country in period t-1 and by $V_F(EX_t)$ when producing in a foreign country in period t-1. Both of the value functions are denominated in the foreign currency. Assume that $Ae < p$ and $C(ED) < p$. Then, since $OP_t = ED - EX_t$, it holds that

(1) $V_H(EX_t) = p + \max[- Ae + \beta V_H(EX_{t+1}), - C(ED - EX_t) - \theta_1 + \beta V_F(EX_{t+1})]$,

(2) $V_F(EX_t) = p + \max[- Ae - \theta_2 + \beta V_H(EX_{t+1}), - C(ED - EX_t) + \beta V_F(EX_{t+1})]$,

where β is discount factor which lies between 0 and 1.

Define the steady state value of EX_t by EX. Then, since $EX_t = EX_{t+1} = EX$ in the steady state equilibrium, equations (1) and (2) imply that $V_H(EX) = (p - Ae)/(1-\beta)$ and $V_F(EX) = (p - C(ED - EX))/(1-\beta)$ in the steady state equilibrium To rule out a corner solution, we assume that $C(0) < Ae - \theta_1 (1-\beta)$ and $Ae + \theta_2 (1-\beta) < C(ED)$. Thus, the steady state equilibrium always has an interior solution that satisfies the following inequalities.

(3) $Ae - \theta_1 (1-\beta) \leq C(ED - EX) \leq Ae + \theta_2 (1-\beta)$.

It is noteworthy that any EX that satisfies the condition (3) can be the steady state equilibrium. This implies that the steady state equilibrium is path-dependent in the sense that history chooses one of infinite number of steady state equilibria.[4]

Define EX^U and EX^L so as to satisfy $C(ED - EX^U) \equiv Ae - \theta_1 (1-\beta)$ and $C(ED - EX^L) \equiv Ae + \theta_2 (1-\beta)$. Since $\partial C(ED - EX)/\partial EX < 0$, it is easy to see that $EX^U > EX^L$ and that both EX^U and EX^L are decreasing in e and increasing in ED. We can also show that

(4a) $\partial EX / \partial e|_{\Delta e \to -0} < 0$ and $\partial EX / \partial e|_{\Delta e \to +0} = 0$ when $EX = EX^L$,

(4b) $\partial EX / \partial e = 0$ when $EX^L < EX < EX^U$,

(4c) $\partial EX / \partial e|_{\Delta e \to -0} = 0$ and $\partial EX / \partial e|_{\Delta e \to +0} > 0$ when $EX = EX^U$.

Noting that the volume of the exports is EX, the above result implies that a small change of the exchange rate has no effect on the exports in the steady state unless $EX = EX^U$ or EX^L. It also implies that the exchange rate depreciation (that is, $e_0 > e_1$) has a positive effect on the exports if and only if $EX = EX^L$, while the exchange rate appreciation (that is, $e_0 < e_1$) has a negative effect on the exports if and only if $EX = EX^U$.

4. The Effect of A Large Change in the Exchange Rate

4-1. The Case Where Only the Exchange Rate Changes

In the last section, we specified the model and showed that a small change of the exchange rate has no effect on the exports in the steady state unless $EX = EX^U$ or EX^L. The purpose of this section is to explore what effect a large change of the exchange rate has on the exports. Specifically, we investigate what happens to the steady state value of the exports when there is an unanticipated change of the exchange rate from e_0 to e_1.

Suppose that the steady state value of EX is equal to EX_0 when $e = e_0$ and EX_1 when $e = e_1$. Define EX^U and EX^L by EX^{U0} and EX^{L0} when $e = e_0$, and by EX^{U1} and EX^{L1} when $e = e_1$ respectively. Then, it holds that

[4] Since $\theta_1 > 0$ and $\theta_2 > 0$, the status quo is always optimal when the condition (3) is satisfied.

$$\begin{aligned}(5)\quad EX_1 - EX_0 &= EX^{L1} - EX_0 > 0 \quad \text{when } EX^{L1} > EX_0,\\ &= 0 \quad \text{when } EX^{L1} \le EX_0 \le EX^{U1},\\ &= EX^{U1} - EX_0 < 0 \quad \text{when } EX^{U1} < EX_0.\end{aligned}$$

Since $EX^{L0} \le EX_0 \le EX^{U0}$, it is easy to see that $EX_0 \le EX^{U0} < EX^{U1}$ and $EX^{L0} < EX^{L1}$ when $e_0 > e_1$, while $EX^{U0} > EX^{U1}$ and $EX_0 \ge EX^{L0} > EX^{L1}$ when $e_0 < e_1$. Thus, the exchange rate depreciation (that is, $e_0 > e_1$) has a positive effect on EX if $EX_0 < EX^{L1}$ but no effect on EX if $EX_0 \ge EX^{L1}$. Similarly, the exchange rate appreciation (that is, $e_0 < e_1$) has a negative effect on EX if $EX_0 > EX^{U1}$ but no effect on EX if $EX_0 \le EX^{U1}$.

These results imply that even if the exchange rate change is large, the effect of an exchange rate change on the exports is path-dependent in the sense that the effect depends on the initial steady state equilibrium value of EX. That is, large exchange rate depreciation tends to have a large positive effect on the exports when EX_0 is close to EX^{L0}, while large exchange rate appreciation tends to have a large negative effect on the exports when EX_0 is close to EX^{U0}.

For example, suppose that $C(OP_t) = OP_t/\alpha$ where α is a positive parameter. Then, by definition, we obtain $EX^{U} = ED - \alpha eA + \alpha\theta_1 (1-\beta)$ and $EX^{L} = ED - \alpha Ae - \alpha\theta_2 (1-\beta)$. Thus, $EX_0 < EX^{L1}$ if and only if $\alpha A(e_0 - e_1) > EX_0 - EX^{L0}$. This implies that the exchange rate depreciation (that is, $e_0 > e_1$) has a positive effect on EX if and only if $\alpha A(e_0 - e_1) > EX_0 - EX^{L0}$. In other words, the exchange rate depreciation has a positive effect on EX either when e declines dramatically or when EX_0 is close to EX^{L0}. In particular, since $EX_1 - EX_0 = EX^{L1} - EX_0$, the exchange rate depreciation has a larger positive effect either when e declines more dramatically or when EX_0 is closer to EX^{L0}.

Similarly, $EX_0 > EX^{U1}$ if and only if $\alpha A(e_1 - e_0) > EX^{U0} - EX_0$. This implies that the exchange rate appreciation (that is, $e_0 < e_1$) has a negative effect on EX either when e rises dramatically or when EX_0 is close to EX^{U0}. The effect is larger either when e rises more dramatically or when EX_0 is closer to EX^{U0}.

4-2. The Case Where Both the Exchange Rate and the External Demand Change

The effect of the exchange rate change, however, becomes very different when the external demand changes simultaneously. This is because a change of the external demand also affects EX^{U} and EX^{L}. For example, when the external demand increases simultaneously, both EX^{U} and EX^{L} increase. In this case, even a small exchange rate depreciation may have a positive effect on EX because it is likely that $EX_0 < EX^{L1}$. In contrast, when the external demand decreases simultaneously, both EX^{U} and EX^{L} decrease. In this case, even a large exchange rate depreciation may not have a positive effect on EX because it is likely that $EX_0 > EX^{L1}$. Similarly, when the external demand decreases simultaneously, even a small exchange rate appreciation may have a negative effect on EX

because it is likely that $EX_0 > EX^{U1}$. In contrast, when the external demand decreases simultaneously, even a large exchange rate appreciation may not have a negative effect on *EX* because it is likely that $EX_0 > EX^{L1}$.

To see the above results more clearly, suppose that $C(OP_t) = OP_t/\alpha$ again. Suppose also that the external demand changed unexpectedly from ED_0 to ED_1 simultaneously when the exchange rate changed unexpectedly from e_0 to e_1. Then, $EX_0 < EX^{L1}$ if and only if $\alpha A(e_0 - e_1) > (ED_0 - ED_1) + (EX_0 - EX^{L1})$. This implies that even if EX_0 is not close to EX^{L1}, moderate exchange rate depreciation may have a large positive effect on *EX* when *ED* rises simultaneously. In contrast, even if EX_0 is close to EX^{L1}, large exchange rate depreciation may not have a positive effect on *EX* when *ED* declines simultaneously. Similarly, $EX_0 > EX^{U1}$ if and only if $\alpha A(e_1 - e_0) > (ED_1 - ED_0) + (EX^{U0} - EX_0)$. This implies that given $EX^{U0} - EX_0$, moderate exchange rate appreciation tends to have a large negative effect on *EX* when *ED* declines simultaneously but large exchange rate appreciation may have no effect on *EX* when *ED* rises simultaneously.

5. The Estimation

In the last two sections, we described a simple open economy where the tradable goods are produced either in home country or in a foreign country. In the economy, a small change of the exchange rate has no effect on the exports because there are fixed costs when shifting the plant location across the countries. It is especially true either when the exchange rate depreciation coincides with weak external demand or when the appreciation coincides with strong external demand. However, a change of the exchange rate has larger effect on the exports either when the exchange rate depreciation coincides with strong external demand or when the appreciation coincides with weak external demand. The purpose of this section is to explore the validity of these theoretical implications through estimating a simple export function in Japan.

Denote Japan's exports by EX_t, the yen's exchange rate denominated a foreign currency by e_t, and Japan's external demand by ED_t, where subscript *t* denotes time period. We then estimate the following export function:

$$(6) \quad \Delta log\, EX_t = \alpha + \sum_{j=1}^{3}(\gamma_j + \delta_j D_{t-j})\Delta log\, e_{t-j} + \sum_{j=1}^{3}\varphi_j \Delta log\, ED_{t-j} + \eta\, Earthquake_t,$$

where D_t is the dummy variable that takes one when $(\Delta log\, e_t)(\Delta log\, ED_t) < 0$ but zero otherwise. $Earthquake_t$ is the dummy variable that takes one on March 2011 (the month of "Tohoku-Pacific Ocean Earthquake") but zero otherwise. To avoid simultaneous bias, lagged values are used for explanatory variables except for $Earthquake_t$.

Except that the coefficient dummy variable is included, the export function is standard in literature. However, our export function allows a possibility that the export's elasticity to the exchange rate rises either when depreciation (that is, decline in e_t) coincides with strong external demand (that is, rise of ED_t) or when appreciation (that is, rise in e_t) coincides with weak external demand (that is, decline of ED_t). To the extent that our model is correct, we can expect that δ_j is significantly negative, while γ_j is less significantly negative.

In the estimation, we use Japan's seasonally adjusted real exports for EX_t, yen's real effective exchange rate for e_t, and seasonally adjusted total exports of G6 (G7 minus Japan) countries deflated by US production price for ED_t. All of the data are monthly. We retrieved the first two data series from the BOJ data base, and both OECD total exports and the US production price from OECD data base. For comparison, we estimated equation (6) not only with the coefficient dummy but also without the coefficient dummy. The sample period of estimation is from January 1979 to December 2014. But to check the robustness, we also estimated equation (6) for two sub-sample periods: from January 1979 to December 1994 and from January 1995 to December 2014.

Table 1 summarizes the estimation results with the coefficient dummy and without the coefficient dummy for the whole sample period and for the two sub-sample periods. In all of the estimations, we took three month lags for both e_t and ED_t. The export's elasticity to the exchange rate was very different depending on whether the choice of the coefficient dummy and the sample period.

Without the coefficient dummy, two of the lagged values of the exchange rate took significantly negative sign regardless of the sample periods. This supports the traditional view that exports increase when the exchange rate depreciates and decreases when the exchange rate appreciates. However, the estimation results with the coefficient dummy suggest that the view no longer holds true when the coefficient dummy $D_t = 0$, that is, either when the exchange rate depreciation coincides with weak external demand or when the appreciation coincides with strong external demand.

In the estimation with the coefficient dummy, the one-lagged value of the exchange rate still took significantly negative sign even when $D_t = 0$. But its absolute value is much smaller than that in the estimation without the coefficient dummy especially for the whole sample period and for the second sub-sample period. More importantly, regardless of the sample periods, the other lagged values of the exchange rate never took significantly negative sign when $D_t = 0$. In contrast, two of the lagged values of the exchange rate took significantly negative sign when $D_t = 1$ for the whole sample period and for the second sub-sample period, while none of the lagged values of the exchange rate never took significant sign even when $D_t = 1$ for the first sub-sample period. Noting that overseas production of Japanese corporations had been limited until the mide-1990s, this supports our model in the sense that after overseas production increased, Japan's exports became elastic to the exchange rate either when depreciation (that is, decline in e_t) coincides with strong external demand (that is, rise of ED_t) or when appreciation (that is, rise in e_t) coincides with weak external demand (that is, decline of ED_t) but inelastic otherwise.

6. Calibration for the Japanese Economy

In the last section, we confirmed the validity of our theoretical implications through estimating a simple export function in Japan. The purpose of this section is to explore how well the export function derived from our theoretical model can track Japan's exports after the new policy regime started in the late 2012. Specifically, we calibrate how the exports will change in the model when the real exchange rate and the external demand changed exogenously and compare the calibrated exports with actual exports in Japan.

In the calibration, we suppose that $C(OP_t) = OP_t/\alpha$ in the model. We also assume that the economy adjusts to the new steady state every year after the exogenous shocks are realized. Then, denoting the calibrated exports in period t by EX_t^C, our theoretical model leads to

$$
\begin{aligned}
(7)\quad EX_t^C &= EX_t^{L1} && \text{when } EX_t^{L1} > EX_{t-1}^C, \\
&= EX_{t-1}^C && \text{when } EX_t^{L1} \le EX_{t-1}^C \le EX_t^{U1}, \\
&= EX_t^{U1} && \text{when } EX_t^{U1} < EX_{t-1}^C.
\end{aligned}
$$

where $EX_t^{L1} \equiv ED_t - \alpha A\, e_t - \alpha\theta_2 (1\text{-}\beta)$ and $EX_t^{U1} \equiv ED_t - \alpha A\, e_t + \alpha\theta_1 (1\text{-}\beta)$.

We set the parameters as follows: $\alpha = 1$, $\beta = 0.9$, $A = 0.05$, $\theta_1 = 10$, and $\theta_2 = 25$. We also use the yen's real effective exchange rate for e_t and total exports of G6 countries deflated by US production price for a proxy of ED_t.[5] We then investigate how well the calibrated exports EX_t^C can track actual Japan's real exports for EX_t. All of the data are annual data from 2001 to 2014. We suppose that $EX_t^C = EX_t$ in 2001 as the initial condition.

Figure 9 shows the calibrated and actual growth rates of Japan's exports in the 2000s. For comparison, it also depicts the calibrated growth rates of Japan's exports for the case where $\theta_1 = \theta_2 = 0$ (that is, no fixed costs). We can characterize their features in three different periods: the period before the global financial crisis, the period from 2009 to 2011, and the period from 2012 to 2014. In the first two periods, the calibrated exports did not show significant different performance with and without the fixed costs. In particular, both of the calibrated series had a very strong correlation with actual series from 2005 to 2008. In contrast, in the third period about which this paper has a big concern, the calibrated exports with the fixed costs showed better performance than the calibrated exports without the fixed costs.

In the first half of the 2000s, because of the zero interest rate policy and the quantitative easing

5 We adjusted its scale multiplied by 14.5.

policy by the Bank of Japan, the carry trade prevailed, which made the yen very weak in the mide-2005s. At the same time, reflecting booming global economy, the external demand increased steadily. In particular, there was a dramatic increase in Japan's exports to China. As a result, the yen depreciated gradually, while the exports increased steadily in the period before the global financial crisis. The synchronized changes in the yen and the external demand led to substantial increases in Japan's exports in the three series from 2003 to 2008.

In the period from 2009 to 2011, both the calibrated and actual exports show a sharp decline in 2009 and a modest recovery in 2010. The changes of the calibrated exports are less dramatic than the actual exports after the GFC. In addition, they did not track a sharp export drop after the Tohoku-Pacific Ocean Earthquake. This is probably because our model is too simple to capture the effects of the two unprecedented shocks. But the fixed costs did not make the two calibrated series move differently during the turbulence. Soon after the Lehman shock, the external demand dropped substantially in the global economy, while the yen appreciated because it was regarded as a safe currency. The synchronized changes led to dramatic decline in Japan's exports in the three series. However, in 2010, while the global economy recovered, the yen remained strong. As a result, Japan's exports only showed a slow recovery afterward. The less synchronized changes led to less dramatic recovery in the calibrated series than the actual exports.

Unlike in previous two sub-periods, the calibrated exports with the fixed costs showed better performance than the calibrated exports without the fixed costs in the period from 2012 to 2014. Before Abenomics started in December 2012, the yen remained strong and did not show any significant change. Thus, even though external demand declined, Japan's actual exports did not decline significantly. In contrast, after Abe announced his new policy to overcome deflation and to adopt unlimited monetary expansion, the yen depreciated substantially. However, since external demand also declined at the same time, the effect of the yen's depreciation on Japan's actual exports were negligible. The yen's depreciation was accelerated after the Bank of Japan introduced the "Quantitative and Qualitative Monetary Easing (QQE)". But despite the weak yen, the change of the exports was limited. The less synchronized changes between the external demand and the exchange rate led to better performance in the calibrated exports with the fixed costs than those without the fixed costs. Our model which allows the fixed costs is useful to explain Japan's exports under unconventional monetary policy in the new regime.

7. Concluding Remarks

In this paper, we explored why unconventional monetary policy in Japan did not have a negative spillover effect on the rest of the world. Focusing on weak external demand and increased overseas production, our theoretical model showed that a small change of the exchange rate has no effect on exports because there are fixed costs when shifting the plant location across the countries. However, it also suggested that a change of the exchange rate has larger effect on the exports either when the exchange rate depreciation coincides with strong external demand or when the appreciation coincides with weak external demand. In the latter part of the paper, we examined the validity of these theoretical implications through estimating a simple export function in Japan and through calibrating our export function. In both of the experiments, we confirmed that the model can track Japan's exports reasonably well especially after the new policy regime started.

After Prime Minister Abe advocated the new policy regime, the Japanese yen depreciated substantially which raised a concern that it would have a beggar-thy-neighbor effect in the region. However, despite the dramatic yen's depreciation, Japan's exports did not show significant improvement. This implies that unlike the US unconventional policy, Japan's unconventional monetary policy had no significant spillover effect on the rest of the world. The US dollar is dominant international currency in the world. This is still true in Asian region. Thus, highly accommodative monetary policy in the United States could have large impacts on the rest of the world, including emerging Asian economies. In contrast, the internationalization of the Japanese yen is limited even in Asian region. One may argue that this could explain why Japan's unconventional monetary policy had smaller spillover effect than the US unconventional monetary policy. However, our empirical results suggest that the spillover effect of Japan's unconventional monetary policy might have been larger unless the external demand was so weak in the period of Abenomics.

References

Ando, M., and Kimura, F., (2012), "How Did the Japanese Exports Respond to Two Crises in the International Production Networks? The Global Financial Crisis and the Great East Japan Earthquake," Asian Economic Journal, v. 26, iss. 3, pp. 261-87.

Baldwin, R., and Krugman, P., (1989), "Persistent Trade Effects of Large Exchange Rate Shocks," The Quarterly Journal of Economics Vol. 104, No. 4, 635-654.

Bowman, D., Londono, J. M., and Sapriza, H., (2014), "U.S. Unconventional Monetary Policy and Transmission to Emerging Market Economies," Board of Governors of the Federal Reserve System (U.S.), International Finance Discussion Papers: 1109.

Cabinet Office, (2013), Annual Report on the Japanese Economy and Public Finance 2013 — For Establishing a Positive Cycle of the Economy —, Cabinet Office, Government of Japan.

Chen, J., Griffoli, T., and Sahay, R., (2014), "Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?" IMF Working Paper 14/240.

Chinn, M. D., (2013), "Export and Import Elasticities for Japan: New Estimates" La Follette School

Working Paper No. 2013-004, University of Wisconsin-Madison.

Fratzscher, M., Duca, M. L., and Straub, R., (2013), "On the International Spillovers of US Quantitative Easing," European Central Bank Working Paper No. 1557.

Fukuda, S., (2014), "Abenomics: Why was it so successful in changing market expectations?" Paper Presented at TCER 'Abenomics' conference.

Helpman, E., Melitz, M. J., and Rubinstein, Y., (2004), "Export Versus FDI with Heterogeneous Firms," American Economic Review 94, 300-316.

Kano, T., and Morita H., (2014), "An Equilibrium Foundation of the Soros Chart," Paper Presented at TCER 'Abenomics' conference.

Melitz, M. J., (2003), "The Impact of Trade on Intra-Industry. Reallocations and Aggregate Industry Productivity," Econometrica 71, 1695-1725.

Neely, C. J., (2010), "Unconventional Monetary Policy had Large International Effects," Federal Reserve Bank of St. Louis Working Paper 2010-018G (forthcoming in the Journal of Banking & Finance).

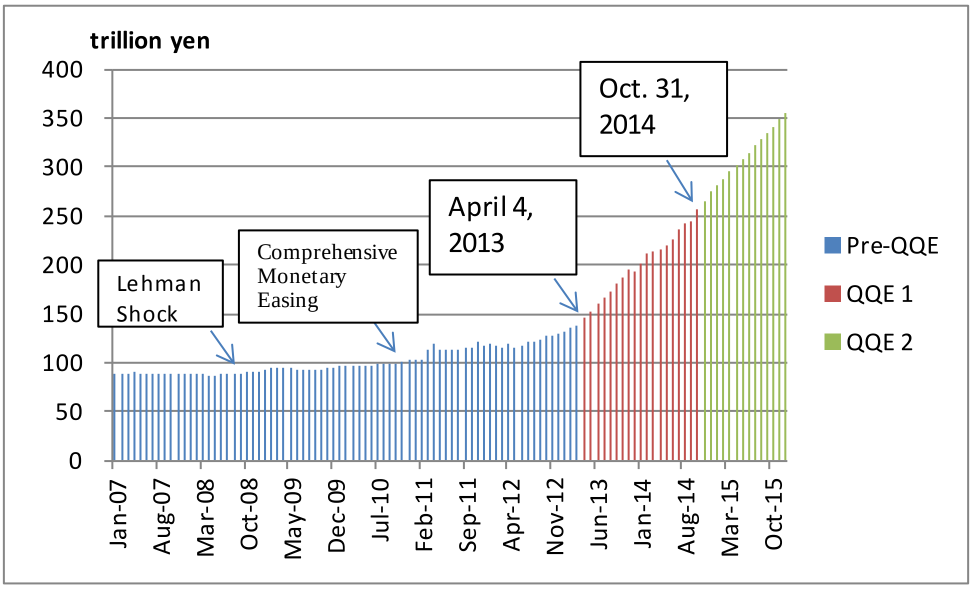
Rogers, J. H., Scotti, C., and Wright J. H., (2014), "Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Cross-Country Comparison," International Finance Discussion Papers 1101, Board of Governors of the Federal Reserve System (U.S.).

Shimizu, J., and Sato, K., (2015), "Abenomics, Yen Depreciation, Trade Deficit, and Export Competitiveness," RIETI Discussion Paper Series 15-E-020.

Shioji, E., (2014), "Time varying pass-through: Will the yen depreciation help Japan hit the inflation target?" Paper Presented at TCER 'Abenomics' conference.

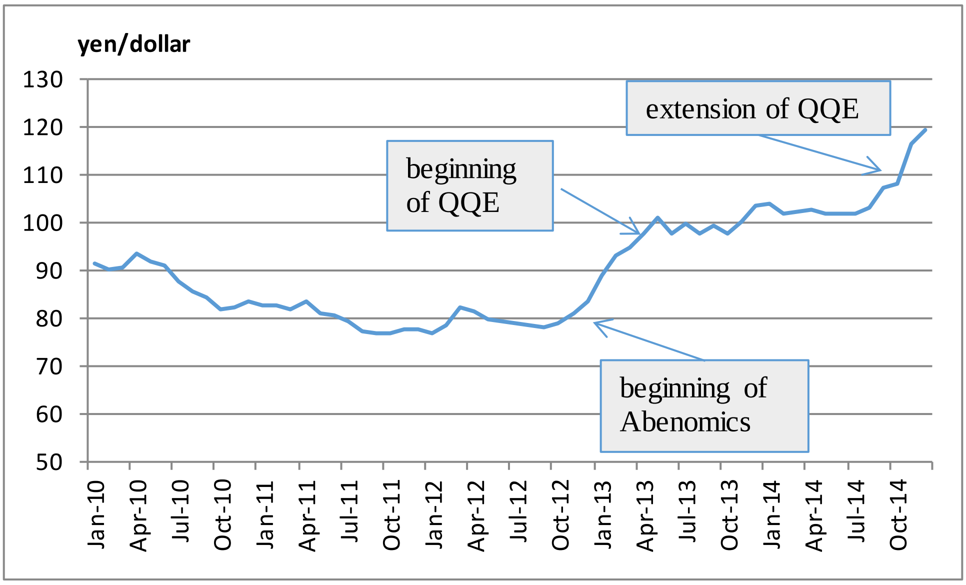
Thorbecke, W., (2014), "The Contribution of the Yen Appreciation Since 2007 to the Japanese Economic Debacle", Journal of the Japanese and International Economies, Volume 31, March 2014, Pages 1-15.

Figure 1. Base Money in Japan



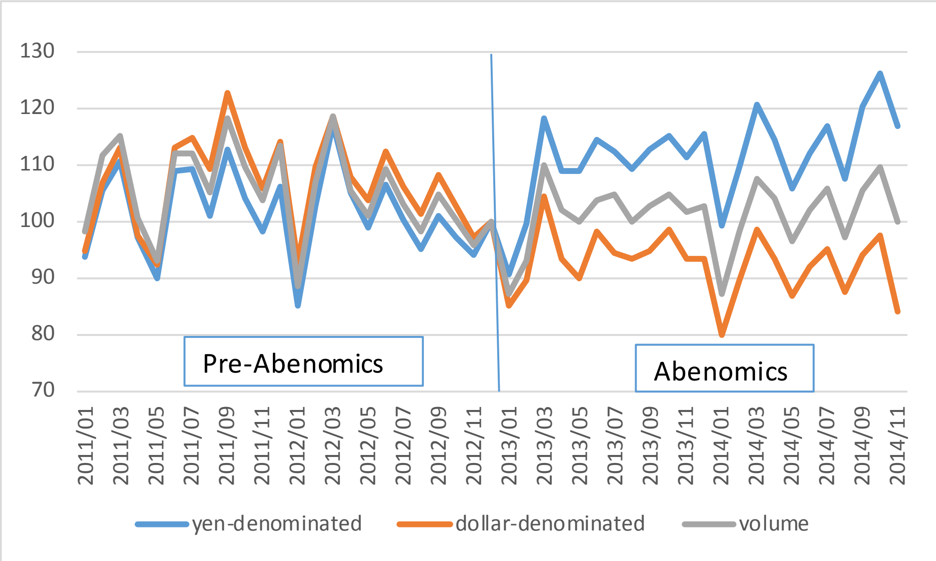
Source: Bank of Japan.

Figure 2. The Yen-dollar Exchange Rate before and after Abenomics



Source: Bank of Japan.

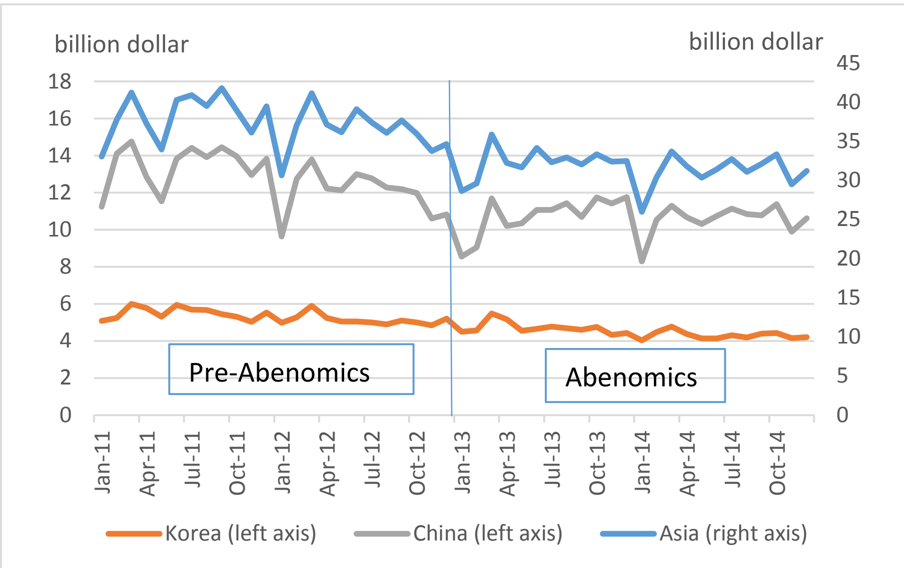
Figure 3. Japan's Exports from January 2011 to December 2014



Note) Each of the exports is normalized to be 100 in December, 2012.

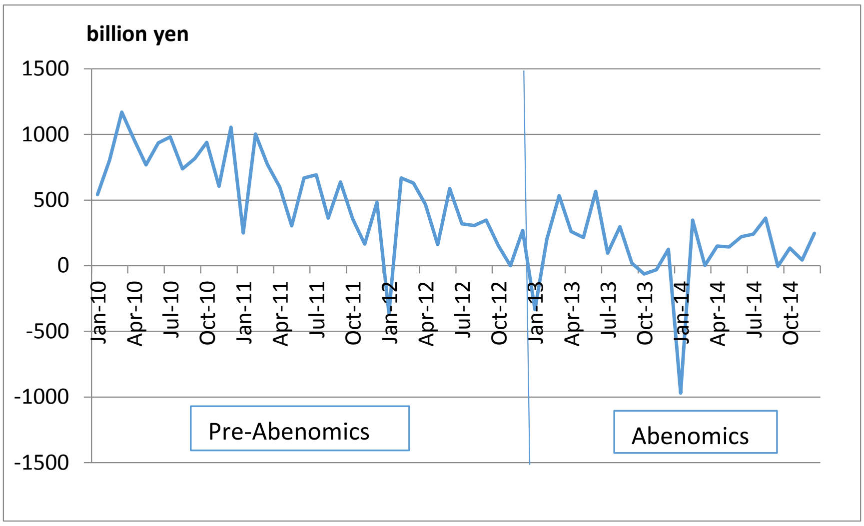
Source: Ministry of Finance, Trade Statistics of Japan. IMF, International Financial Statistics.

Figure 4. Japan's Exports to Asia, Korea, and China



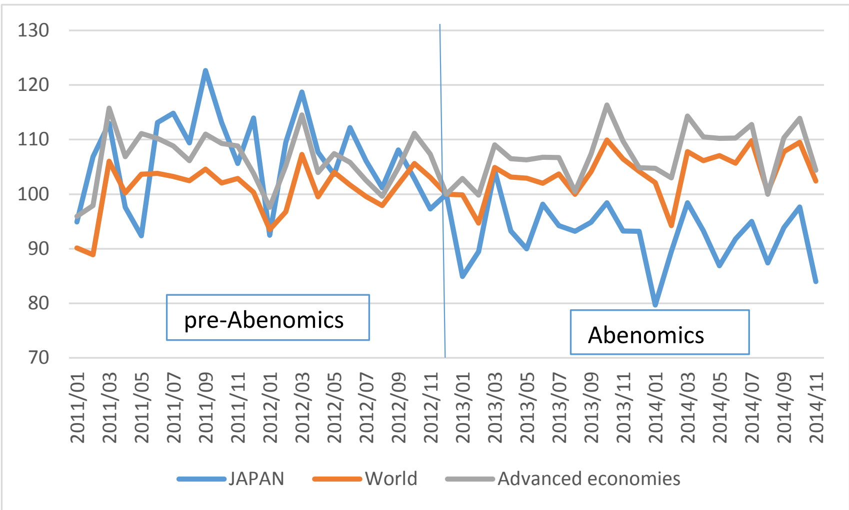
Source: Ministry of Finance, Trade Statistics of Japan.

Figure 5. Japan's Trade Balance with Asian Countries



Source: Ministry of Finance, Trade Statistics of Japan.

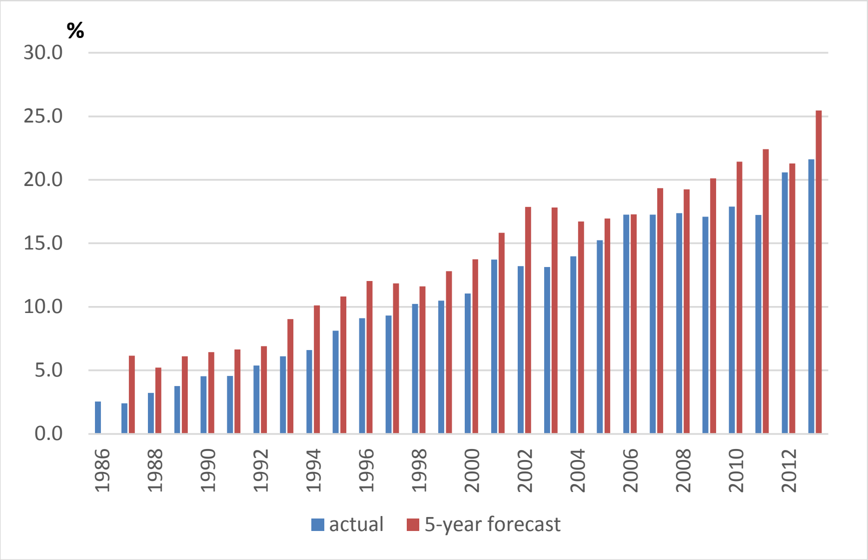
Figure 6. Dollar-denominated Exports in Japan and in Other Countries



Note: Each of the exports is normalized to be 100 in December, 2012.

Source: IMF, International Financial Statistics.

Figure 7. Overseas production ratios of Japanese Corporations



Source: Cabinet Office, Annual Survey of Corporate Behavior.

Figure 8. The Cost Structure of the Model

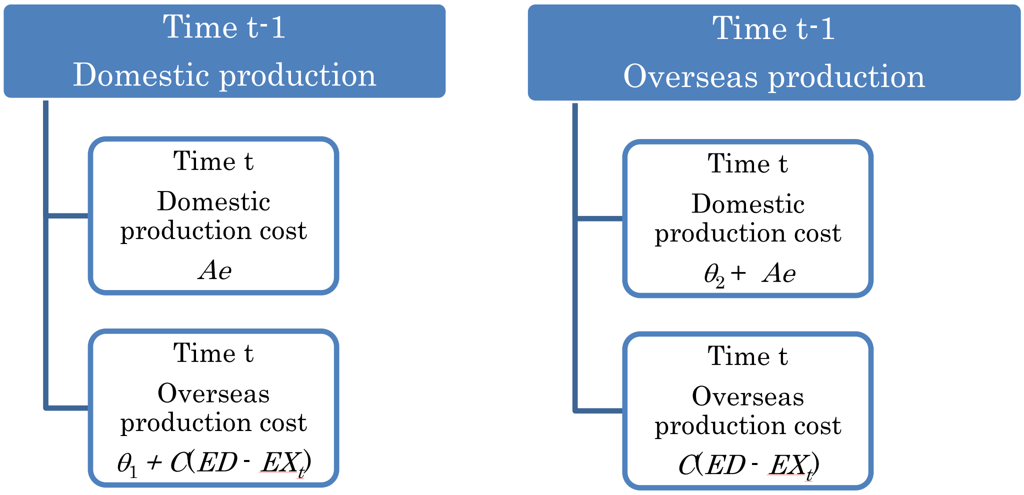


Figure 9. The Calibrated and Actual Growth Rates of Japan's Exports in the 2000s

Table 1. The Estimation Results

(1) Without Coefficient Dummy

	Whole Sample Period			Sub-Sample Periods					
	1979 – 2014			1979 – 1994			1995 – 2014		
	coefficient	t-value		coefficient	t-value		coefficient	t-value	
constant	0.002	1.92	**	0.005	2.57	**	0.000	0.15	
Δlog e(−1)	−0.370	−7.06	***	−0.297	−3.72	***	−0.410	−6.00	***
Δlog e(−2)	0.007	0.13		0.095	1.15		−0.035	−0.48	
Δlog e(−3)	−0.166	−3.17	***	−0.135	−1.70	*	−0.169	−2.45	**
Δlog ED(−1)	0.129	2.73	***	−0.012	−0.20		0.266	3.68	***
Δlog ED(−2)	0.187	3.93	***	0.073	1.16		0.279	3.83	***
Δlog ED(−3)	0.033	0.70		−0.094	−1.54		0.158	2.19	**
Earthquake dummy	−0.125	−4.90	***				−0.125	−4.92	***
Adj. R^2	0.193			0.082			0.302		
D.W.	2.307			2.806			2.082		

(2) With Coefficient Dummy

	Whole Sample Period			Sub-Sample Periods					
	1979 – 2014			1979 – 1994			1995 – 2014		
	coefficient	t-value		coefficient	t-value		coefficient	t-value	
constant	0.002	1.98	**	0.000	2.55	**	0.000	0.23	
Δlog e(−1)	−0.296	−3.92	***	−0.249	−3.25	***	−0.249	−2.51	**
Δlog e(−2)	0.126	1.63		0.078	1.33		0.078	0.77	
Δlog e(−3)	0.059	0.77		0.081	−0.23		0.081	0.81	
D(−1)*Δlog e(−1)	−0.142	−1.17		−0.339	1.01		−0.339	−2.13	**
D(−2)*Δlog e(−2)	−0.261	−2.15	**	−0.214	−0.89		−0.214	−1.35	
D(−3)*Δlog e(−3)	−0.446	−3.70	***	−0.509	−1.26		−0.509	−3.23	***
Δlog ED(−1)	0.075	1.32		0.127	0.42		0.127	1.44	
Δlog ED(−2)	0.108	1.87	*	0.178	0.53		0.178	2.01	**
Δlog ED(−3)	−0.097	−1.70	*	−0.007	−1.95	*	−0.007	−0.08	
Earthquake dummy	−0.129	−5.14					−0.130	−5.27	***
Adj. R^2	0.222			0.084			0.341		
D.W.	2.349			2.805			2.112		

Note: * = significant at 10%, ** = significant at 5%, and *** = significant at 1%,