Dollar Funding of Global banks and Regulatory Reforms: Evidence from the Impact of Monetary Policy Divergence

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The views expressed in this presentation are those of the author and do not necessarily reflect those of the BOJ.

Outline of paper

(1) Why do we care about CIP deviations?

(2) What we do.

✓ Construct a simple model with U.S. and JPN banks extending the model of Ivashina et al. (2015).

✓ Derive two predictions from the model.

1. Determinants of CIP deviations.

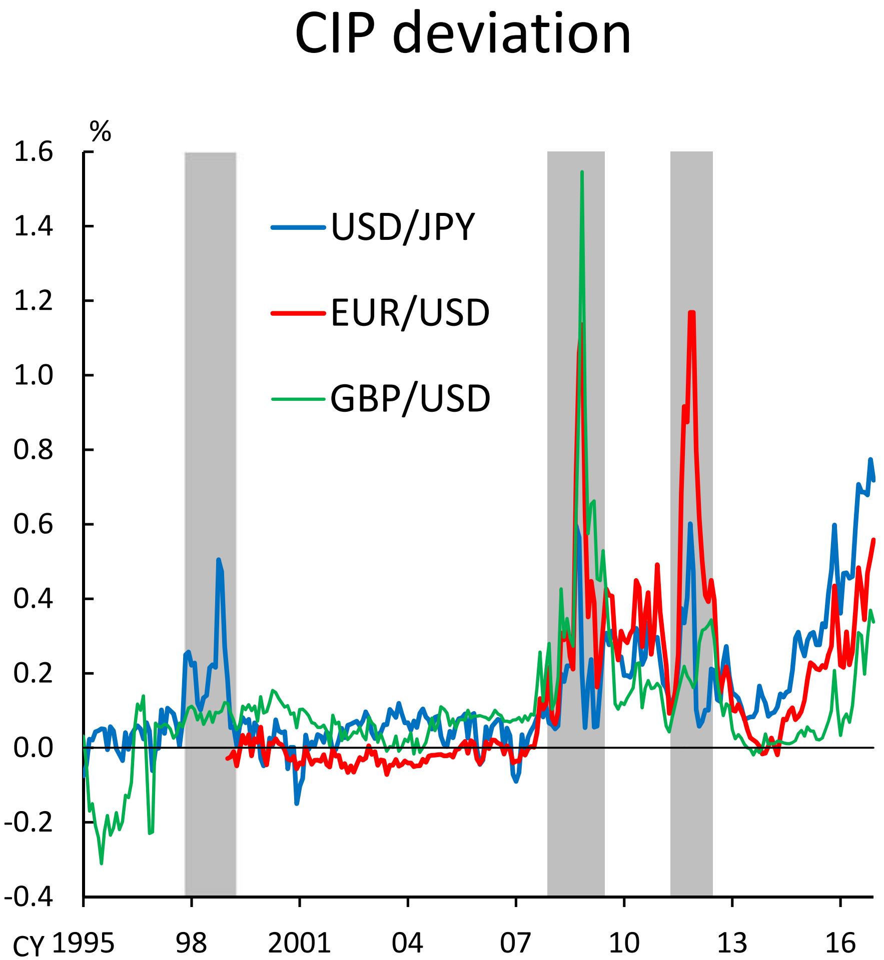
2. Effects of regulatory reforms.

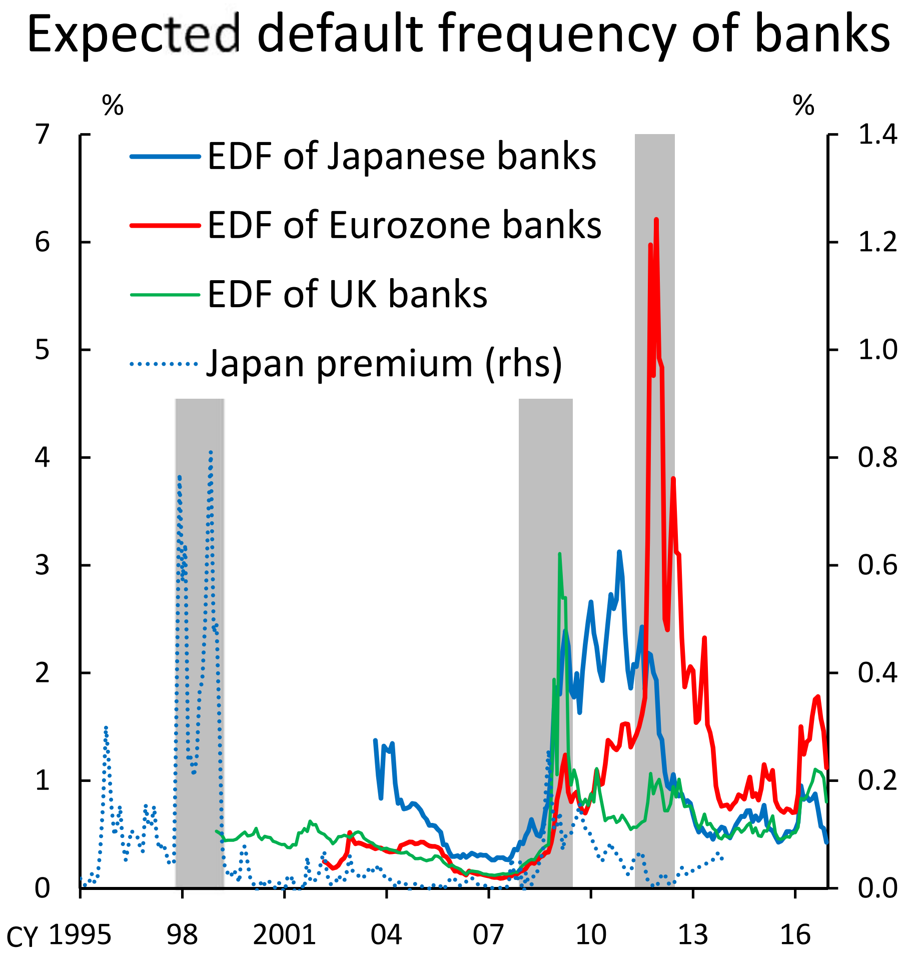
✓ Check if the model accords with the data, using four currency pairs (CHF, EUR, GBP, JPY with USD)

Motivation

Why do we care about CIP deviations?

Reason 1: Historically, CIP deviations and banking crisis often came together.





Notes: *1*. The shadow areas correspond to the period of the Japan's financial crisis (November 1997 through January 1999) , the global financial crisis (December 2007 through June 2009), and the Eurozone sovereign crisis (May 2011 through June 2012).

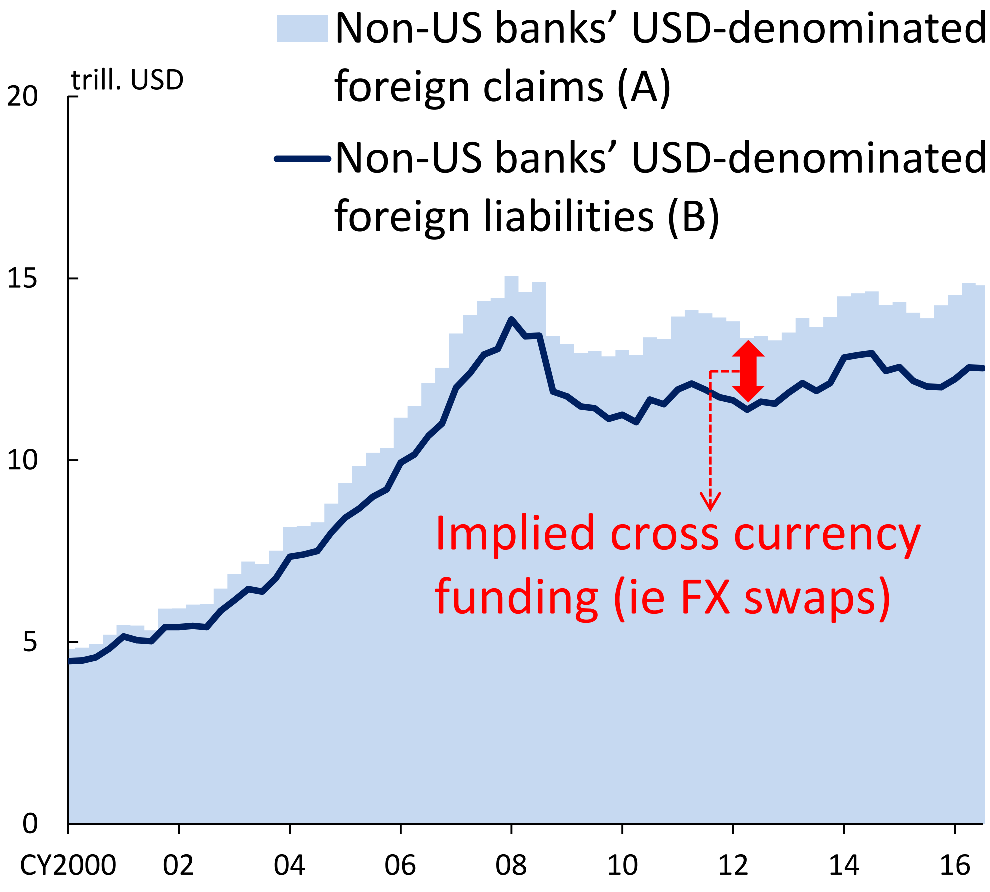
2. A CIP deviation is computed from FX swap-implied dollar rates and Libor rates.

3. As regards banks' default probability, an average of the EDF (Expected Default Frequency) of all GSIBs that are headquartered in each jurisdiction is shown. "Japanese Premium" is calculated as 3-month USD TIBOR rate minus 3-month USD LIBOR rate.

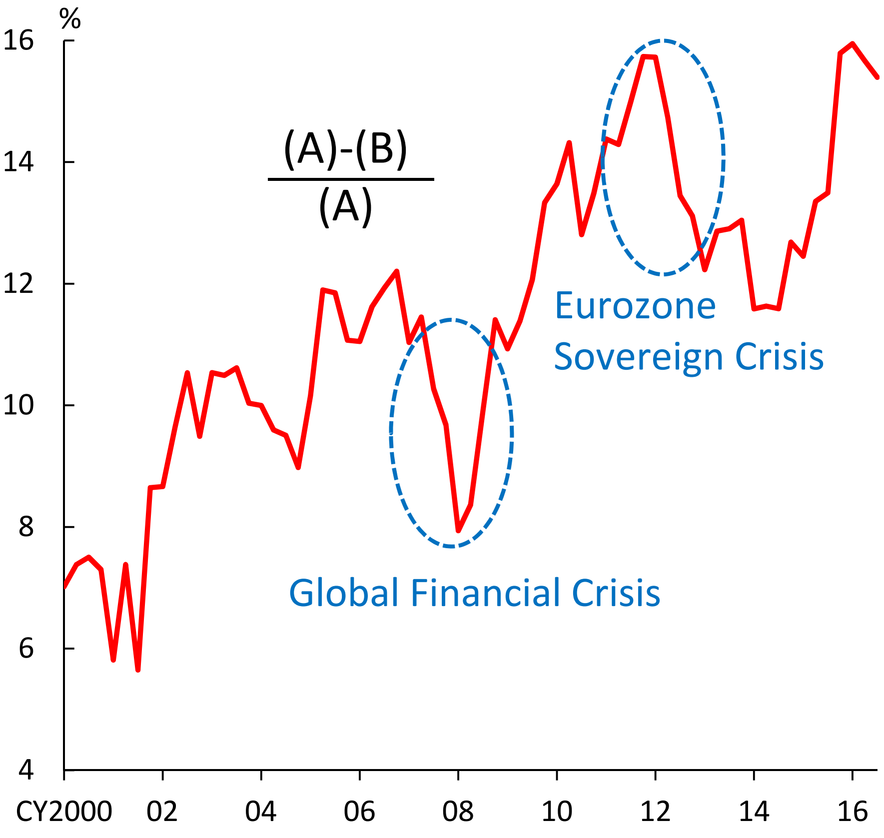
Sources: Bloomberg; Moody's; BOJ

Reason 2: CIP deviation is a measure of funding liquidity risks associated with global banks' cross-border lending.

USD-denominated foreign positions



Non-US banks' implied cross-currency funding ratio

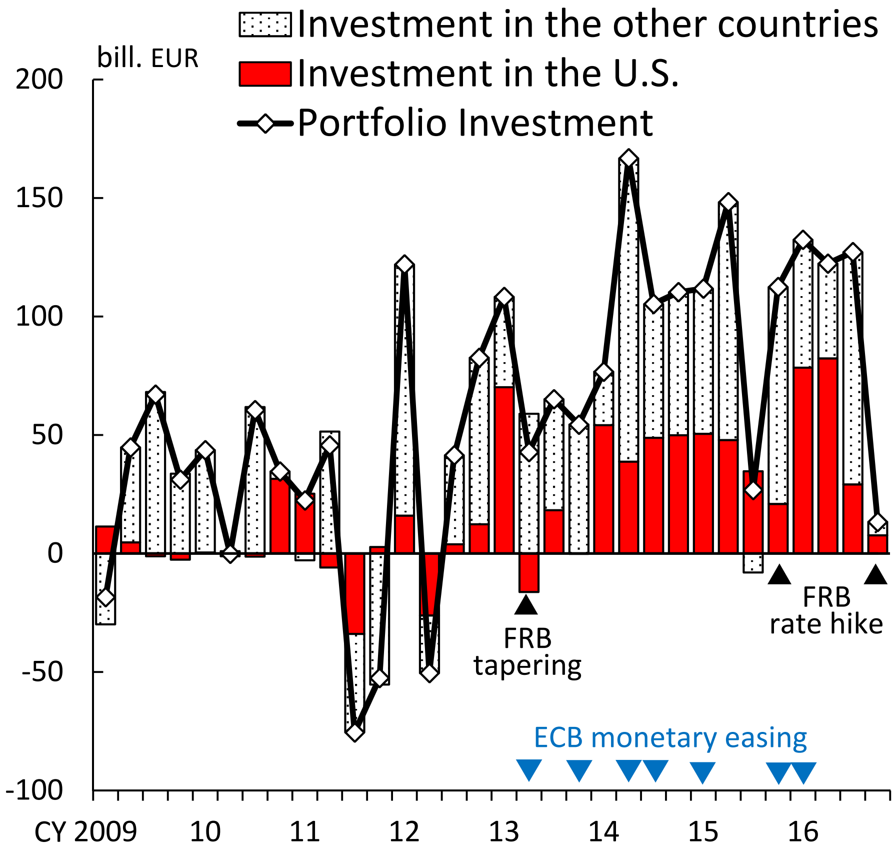


Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics

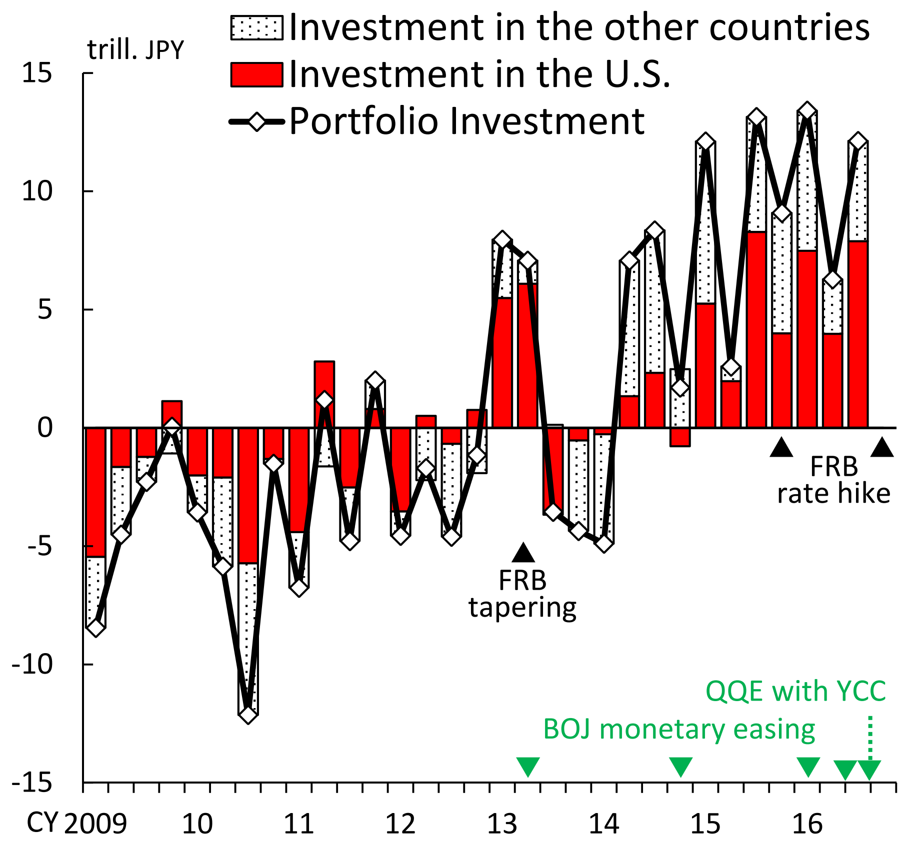
Reason 3: CIP deviations nowadays reflect reactions of global banks to a change in cross-border investments due to a change in monetary policy.

Outward portfolio investment

Euro area



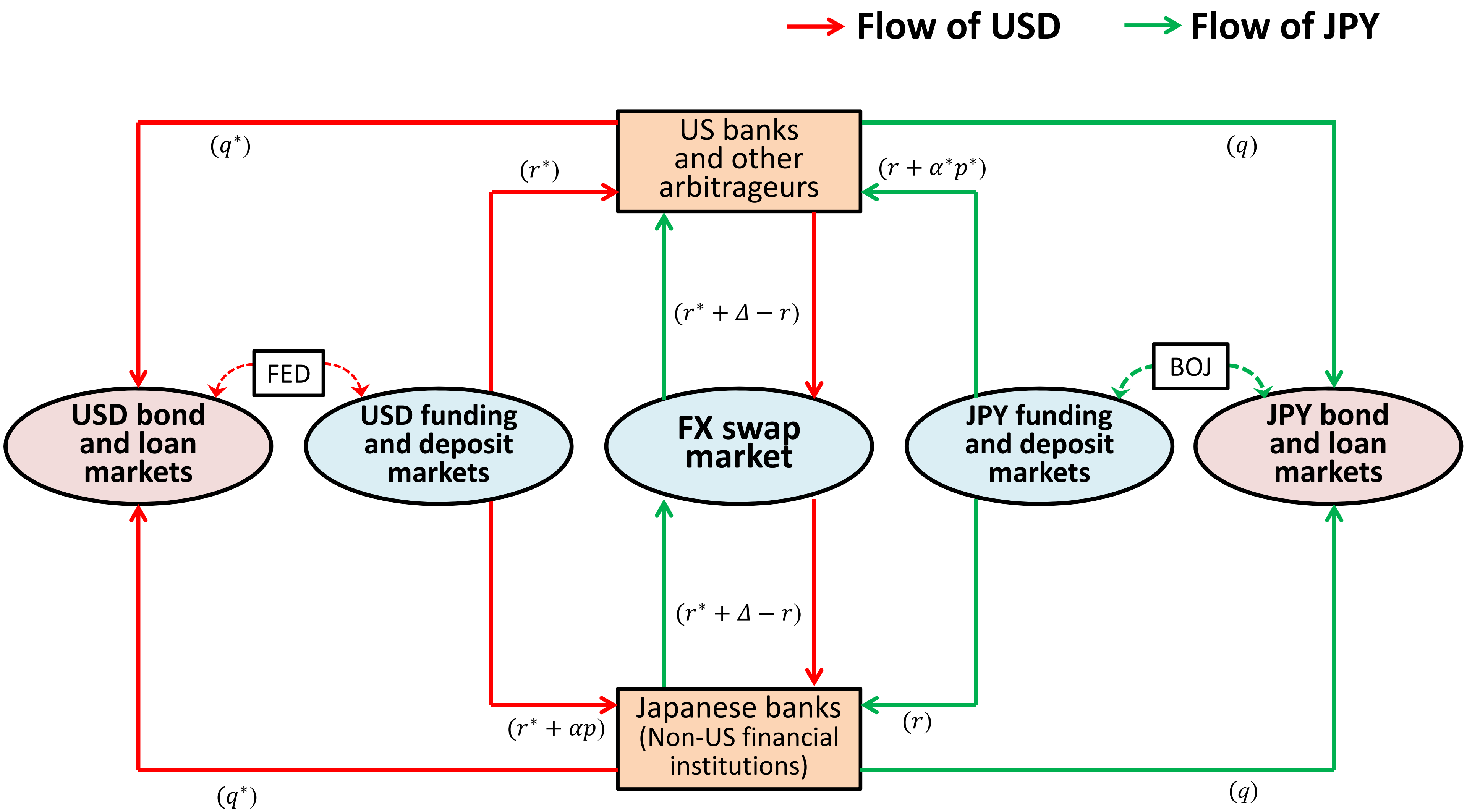
Japan



Sources: ECB, BOJ, "Balance of Payments"

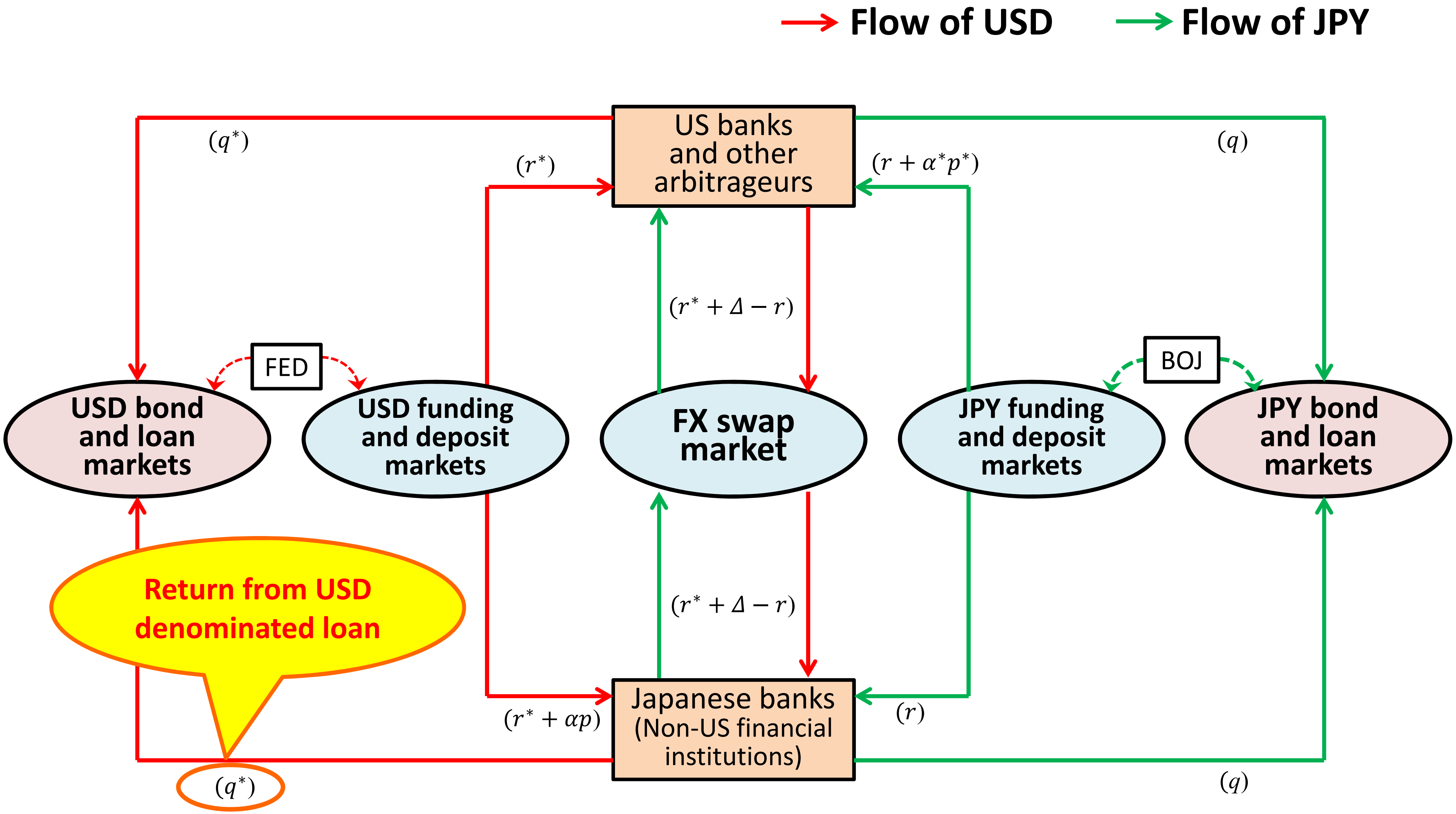
Model Settings

Simple equilibrium model of FX swap market



Notes: 1. Figures in parentheses are interest rates.
2. Δ is CIP deviation. r and r^* are risk-free rates. $\alpha^* p^*$ and αp are risk premiums.

Simple equilibrium model of FX swap market



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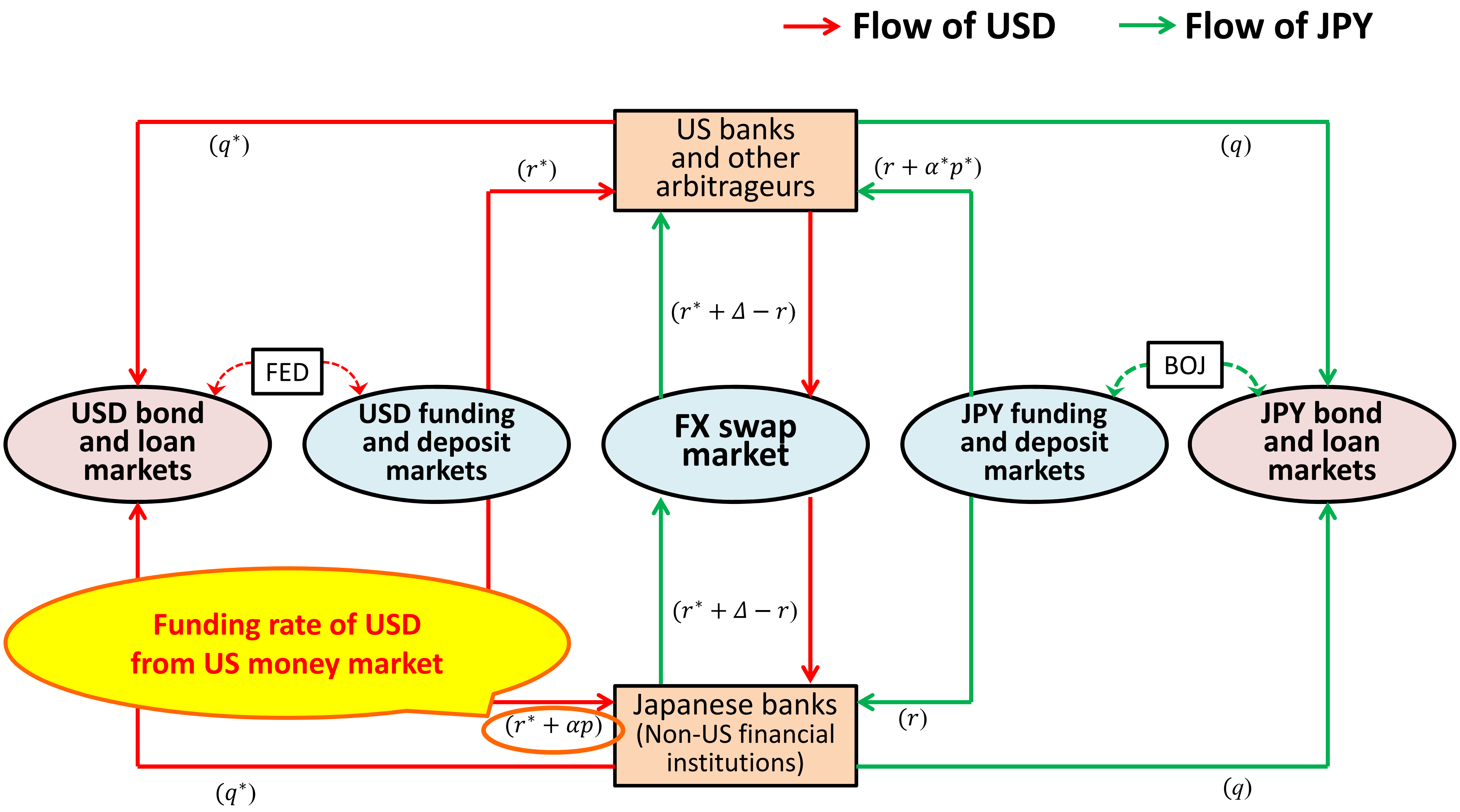
Simple equilibrium model of FX swap market



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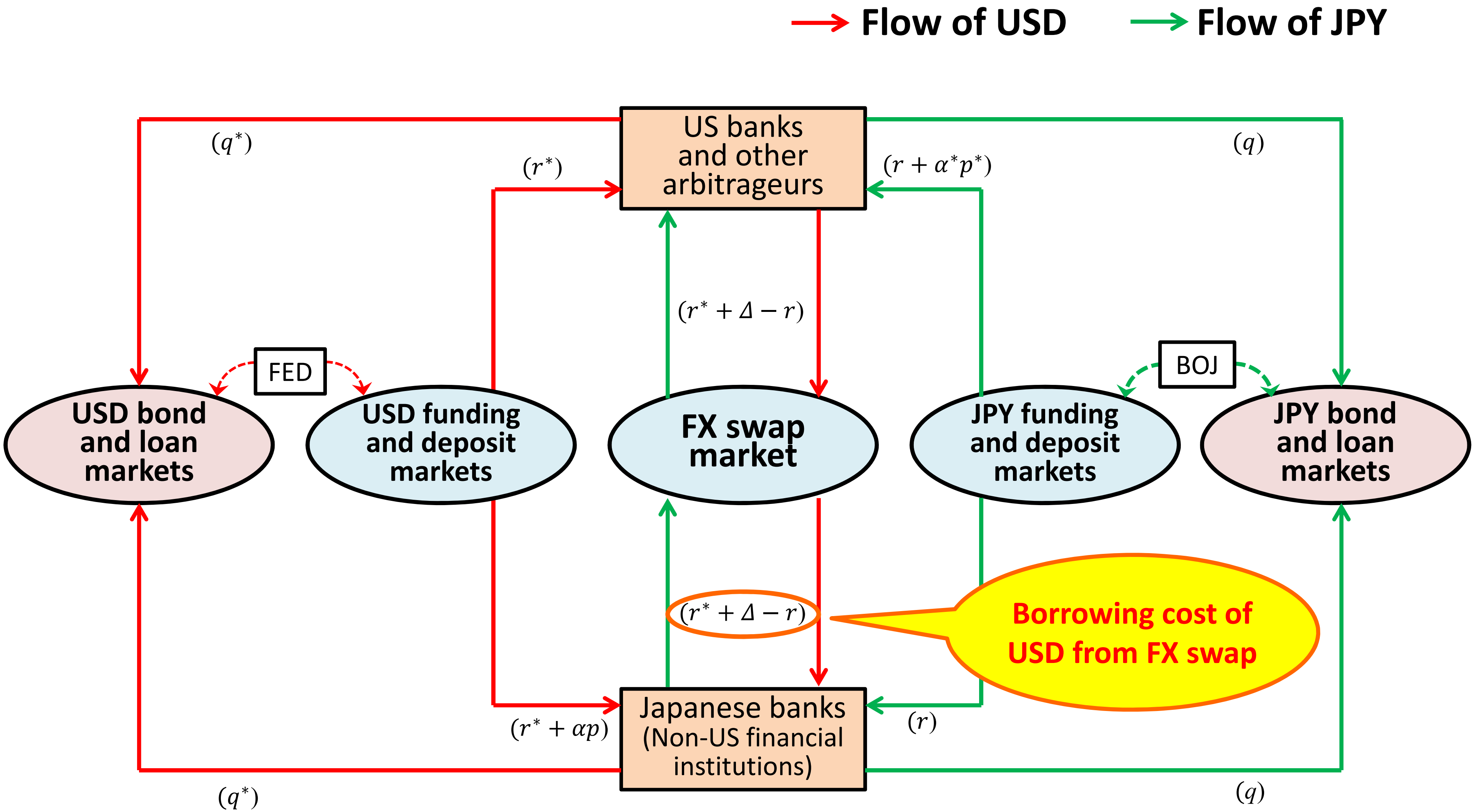

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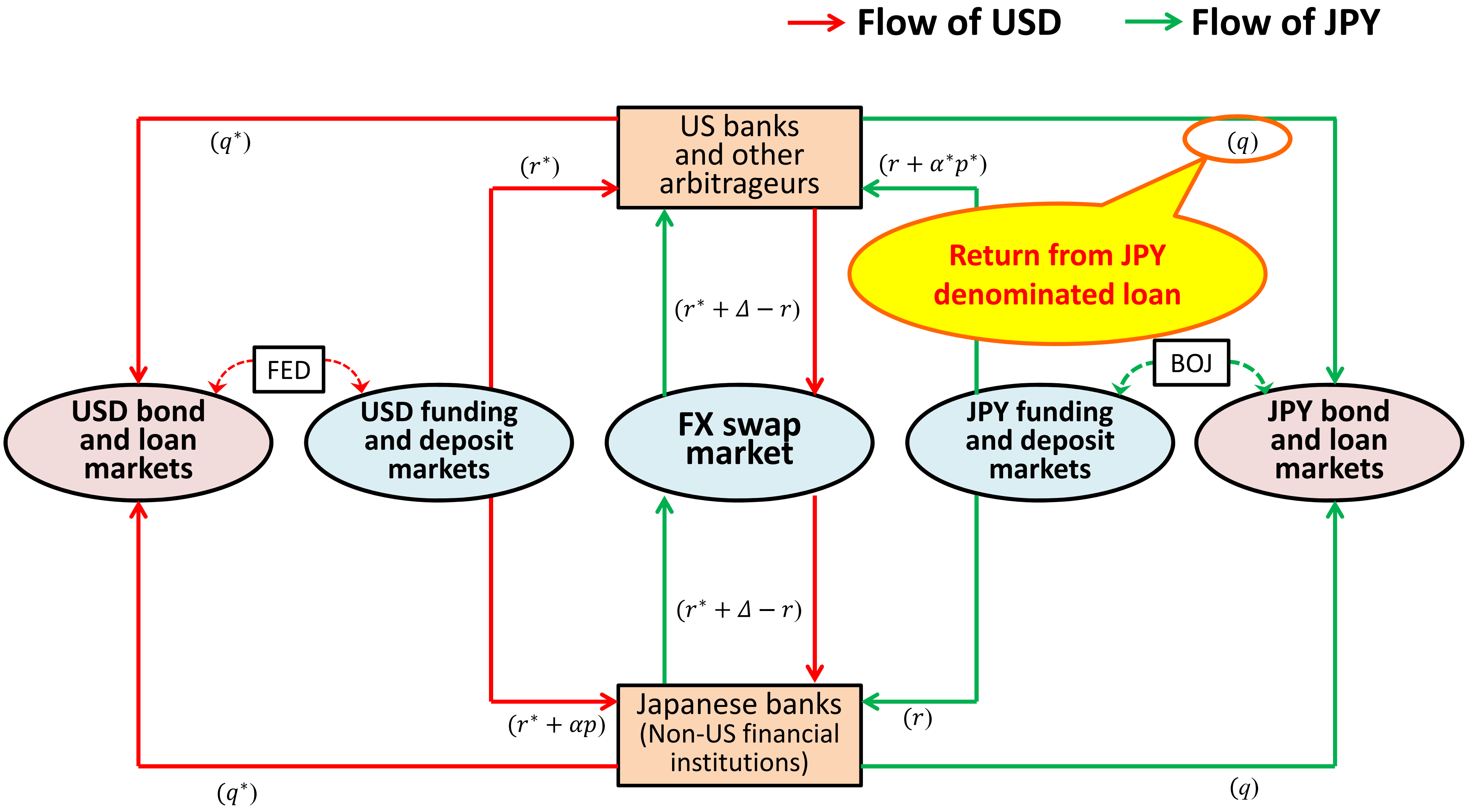
Simple equilibrium model of FX swap market



Notes: 1. Figures in parentheses are interest rates.

2. Δ is CIP deviation. r and r^* are risk-free rates. $\alpha^* p^*$ and αp are risk premiums.

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},S\ and\ M} \left\{ \begin{array}{c} g_f(L_{\$}) + g_h(L_{\backslash}) - c_f(D_{\$}) - c_h(D_{\backslash}) \\ -(r^* + \Delta - r)S \end{array} \right\}$$

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},S \text{ and } M} \left\{ \begin{matrix} \boldsymbol{g_f(L_{\$})} + g_h(L_{\backslash}) - c_f(D_{\$}) - c_h(D_{\backslash}) \\ -(r^* + \Delta - r)S \end{matrix} \right\}$$

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

$$\boldsymbol{g_f(L_{\$}) = (1 + q^*)L_{\$} - \frac{\tau^*}{2}(L_{\$})^2,}$$

$L_{\$}$: USD denominated loan

Japanese banks increase $L_{\$}$ when interest rate q^* is high.

Lending becomes costly when is τ^* high.

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},S \text{ and } M} \left\{ \begin{array}{c} g_f(L_{\$}) + \boldsymbol{g_h(L_{\backslash})} - c_f(D_{\$}) - c_h(D_{\backslash}) \\ -(r^* + \Delta - r)S \end{array} \right\}$$

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

$$\boldsymbol{g_h(L_{\backslash}) = (1+q)L_{\backslash} - \frac{\tau}{2}(L_{\backslash})^2,}$$

$L_{\backslash}$: JPY denominated loan

Japanese banks increase $L_{\backslash}$ when interest rate q is high.

Lending becomes costly when is τ high.

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},S \text{ and } M} \left\{ \begin{array}{c} g_f(L_{\$}) + g_h(L_{\backslash}) - \boldsymbol{c_f(D_{\$})} - c_h(D_{\backslash}) \\ -(r^* + \Delta - r)S \end{array} \right\}$$

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

$D_{\$}$: USD funding from money markets

Funding rate increases with banks' default probability α.

Funding is costly when η^* is high.

$$\boldsymbol{c_f(D_{\$}) = (1 + r^* + p\alpha)D_{\$} + \frac{\eta^*}{2}(D_{\$})^2,}$$

r^*: risk-free rate in USD
$p\alpha$: premium

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},S \text{ and } M} \left\{ \begin{array}{c} g_f(L_{\$}) + g_h(L_{\backslash}) - c_f(D_{\$}) - \boldsymbol{c_h(D_{\backslash})} \\ -(r^* + \Delta - r)S \end{array} \right\}$$

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

r: risk-free rate in JPY

$D_{\backslash}$: JPY funding from money markets in Japan

Funding is costly when η is high.

$$\boldsymbol{c_h(D_{\backslash}) = (1+r)D_{\backslash} + \frac{\eta}{2}(D_{\backslash})^2.}$$

Optimization problem of Japanese banks

$$\max_{L_{\$}, L_{\backslash}, D_{\$}, D_{\backslash}, S \text{ and } M} \left\{ \begin{array}{c} g_f(L_{\$}) + g_h(L_{\backslash}) - c_f(D_{\$}) - c_h(D_{\backslash}) \\ -(\boldsymbol{r}^* + \Delta - \boldsymbol{r})\boldsymbol{S} \end{array} \right.$$

S: Funding of USD from FX swap

Δ: CIP deviation

Subject to

$$M \geq V$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

Optimization problem of Japanese banks

$$\max_{L_{\$}, L_{\backslash}, D_{\$}, D_{\backslash}, S \text{ and } M} \begin{cases} g_f(L_{\$}) + g_h(L_{\backslash}) - c_f(D_{\$}) - c_{\cdot}(\\ -(r^* + \Delta - r)S \end{cases}$$

M: Cash holding in USD due to precautionary motives

(1) M yields zero return

(2) V captures degree of uncertainty

Subject to

$$\boldsymbol{M \geq V}$$

$$L_{\$} + M = D_{\$} + S$$

$$L_{\backslash} = D_{\backslash} - S,$$

Optimization problem of Japanese banks

$$\max_{L_{\$},L_{\backslash},D_{\$},D_{\backslash},M,and\ S} \left\{ \begin{matrix} g_f(L_{\$}) + g_h(L_{\backslash}) - c_f(D_{\$}) - c_h(D_{\backslash}) \\ -(r^* + \Delta - r)S \end{matrix} \right\}$$

Subject to

$$M \geq V$$

$$\boldsymbol{L_{\$} + M = D_{\$} + S}$$

$$\boldsymbol{L_{\backslash} = D_{\backslash} - S,}$$

Upper equality: BS of USD
Lower equality: BS of JPY

Optimization problem of US banks

$$\max_{L_\$^*, L_\backslash^*, D_\$,^* D_\backslash^*, M^*, and\ S} \left\{ \begin{matrix} h_f\left(L_\$^*\right) + h_h\left(L_\backslash^*\right) - \kappa_f\left(D_\$^*\right) - \kappa_h\left(D_\backslash^*\right) \\ -(r^* + \Delta - r)S \end{matrix} \right\}$$

Subject to

$$M^* \geq V^*$$

$$L_\$^* + M^* = W^* + D_\$^* + S$$

$$L_\backslash^* = D_\backslash^* - S,$$

where

$$h_f\left(L_\$^*\right) = (1 + q^*)L_\$^* - \frac{\gamma^*}{2}\left(L_\$^*\right)^2,$$

$$h_h\left(L_\backslash^*\right) = (1 + q)L_\backslash^* - \frac{\gamma}{2}\left(L_\backslash^*\right)^2,$$

$$\kappa_f\left(D_\$^*\right) = (1 + r^*)D_\$^* + \frac{\theta^*}{2}\left(D_\$^*\right)^2,$$

$$\kappa_h\left(D_\backslash^*\right) = (1 + r + p^*\alpha^*)D_\backslash^* + \frac{\theta}{2}\left(D_\backslash^*\right)^2.$$

Optimization problem of US banks

$$\max_{L^*_{\$},L^*_{\backslash},D_{\$},^*D^*_{\backslash},M^*,and\ S} \begin{cases} h_f\left(L^*_{\$}\right) + h_h\left(L^*_{\backslash}\right) - \kappa_f\left(D^*_{\$}\right) - \kappa \ldots \\ -(r^* + \Delta - r \ldots \end{cases}$$

W* : USD provided by "Real money investors" to FX markets

The amount of W* is exogenously given.

Subject to

$$M^* \geq V^*$$

$$L^*_{\$} + M^* = \boldsymbol{W^*} + D^*_{\$} + S$$

$$L^*_{\backslash} = D^*_{\backslash} - S,$$

where

$$h_f\left(L^*_{\$}\right) = (1 + q^*)L^*_{\$} - \frac{\gamma^*}{2}\left(L^*_{\$}\right)^2,$$

$$h_h\left(L^*_{\backslash}\right) = (1 + q)L^*_{\backslash} - \frac{\gamma}{2}\left(L^*_{\backslash}\right)^2,$$

$$\kappa_f\left(D^*_{\$}\right) = (1 + r^*)D^*_{\$} + \frac{\theta^*}{2}\left(D^*_{\$}\right)^2,$$

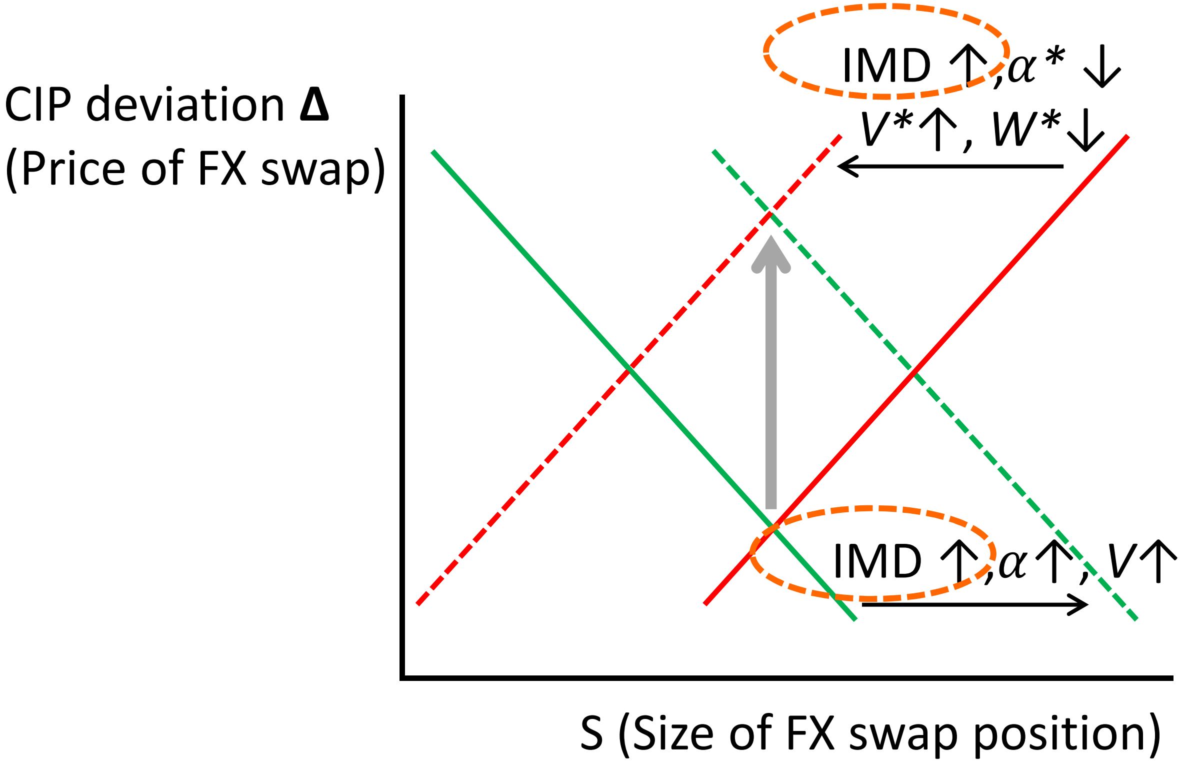
$$\kappa_h\left(D^*_{\backslash}\right) = (1 + r + p^*\alpha^*)D^*_{\backslash} + \frac{\theta}{2}\left(D^*_{\backslash}\right)^2.$$

Model Predictions

Determinants of CIP deviations: model prediction

$$\Delta = \frac{\eta\theta}{(\tau+\eta)\gamma\theta + (\gamma+\theta)\tau\eta} \left\{ \begin{array}{c} (\tau+\gamma)[(q^* - r^*) - (q - r)] \\ + \frac{\tau\gamma p}{\eta}\alpha - \frac{\tau\gamma p^*}{\theta}\alpha^* + \tau\gamma(V + V^* - W^*) \end{array} \right\}.$$

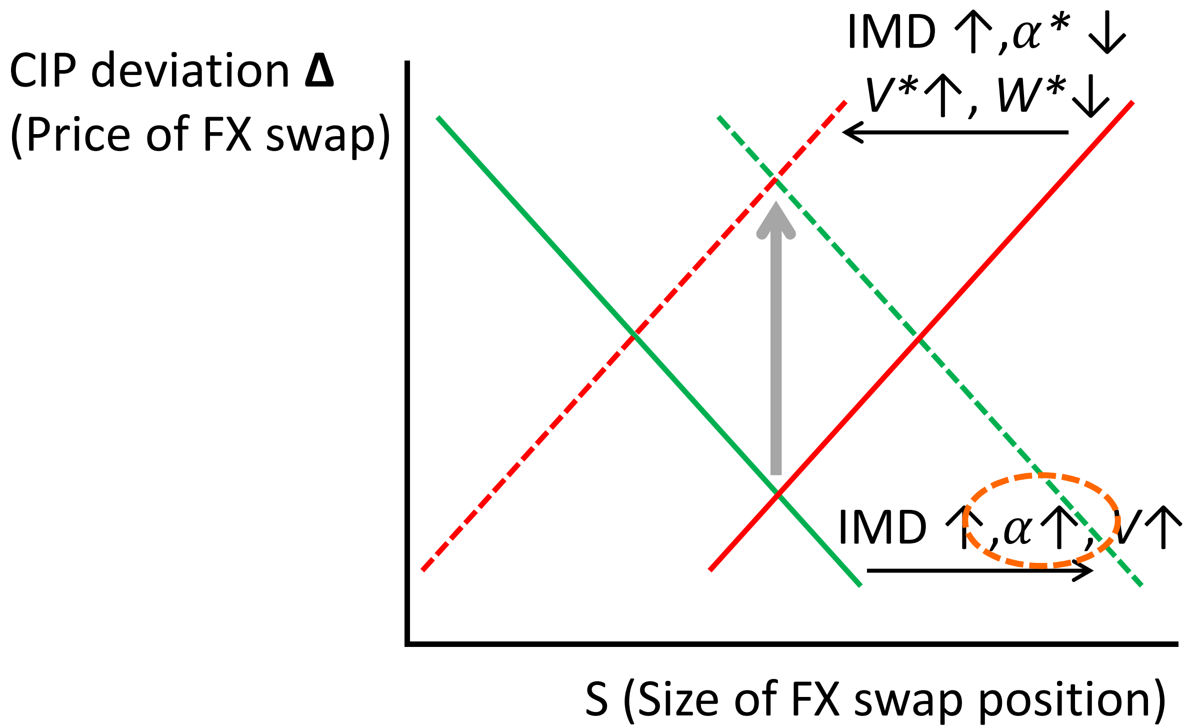
Prediction I: A widening in interest margin differential (IMD) <u>increases</u> Δ since it is more profitable for Japanese banks to invest in USD denominated assets, and less profitable for US banks to invest in JPY denominated assets.



Determinants of CIP deviations: model prediction

$$\Delta = \frac{\eta\theta}{(\tau+\eta)\gamma\theta + (\gamma+\theta)\tau\eta}\left\{ \begin{array}{c} (\tau+\gamma)[(q^* - r^*) - (q - r)] \\ + \frac{\tau\gamma p}{\eta}\alpha - \frac{\tau\gamma p^*}{\theta}\alpha^* + \tau\gamma(V + V^* - W^*) \end{array} \right\}.$$

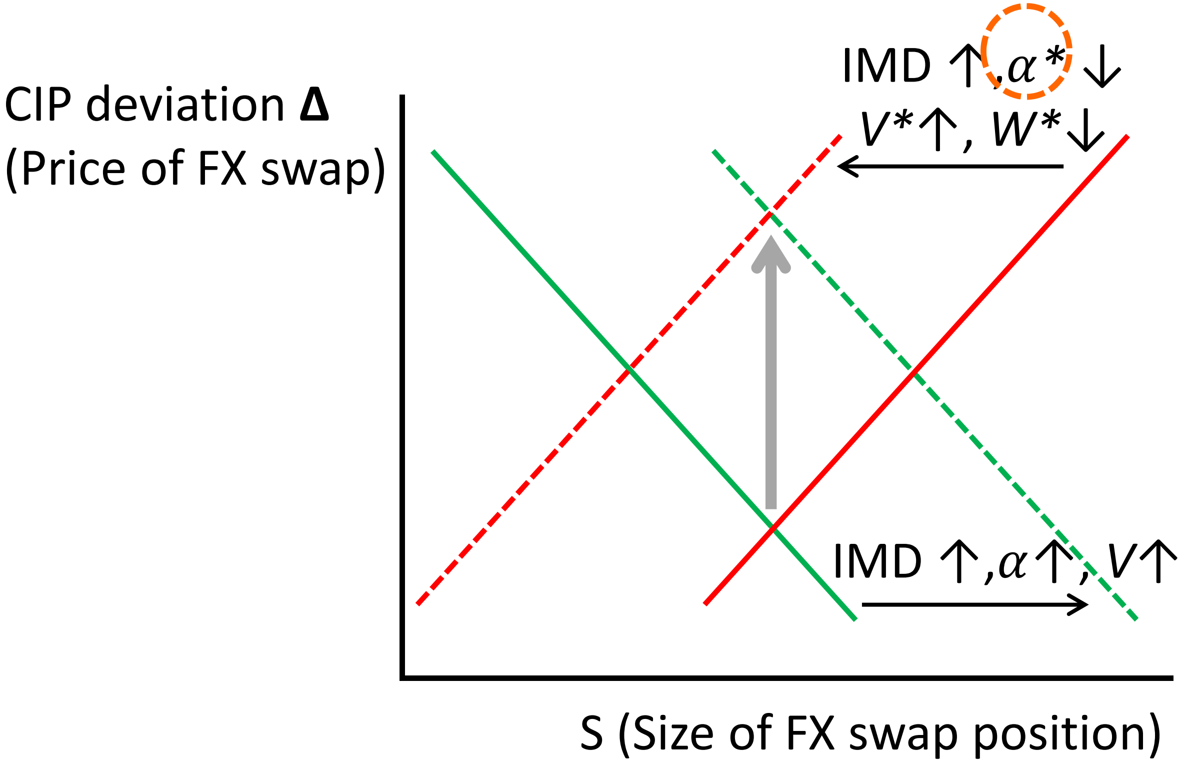
Prediction II: A higher default probability of Japanese banks <u>increases</u> Δ since it is more costly for Japanese banks to fund USD from US money market.



Determinants of CIP deviations: model prediction

$$\Delta = \frac{\eta\theta}{(\tau+\eta)\gamma\theta + (\gamma+\theta)\tau\eta}\left\{\begin{array}{c}(\tau+\gamma)[(q^* - r^*) - (q - r)] \\ + \frac{\tau\gamma p}{\eta}\alpha - \frac{\tau\gamma p^*}{\theta}\alpha^* + \tau\gamma(V + V^* - W^*)\end{array}\right\}.$$

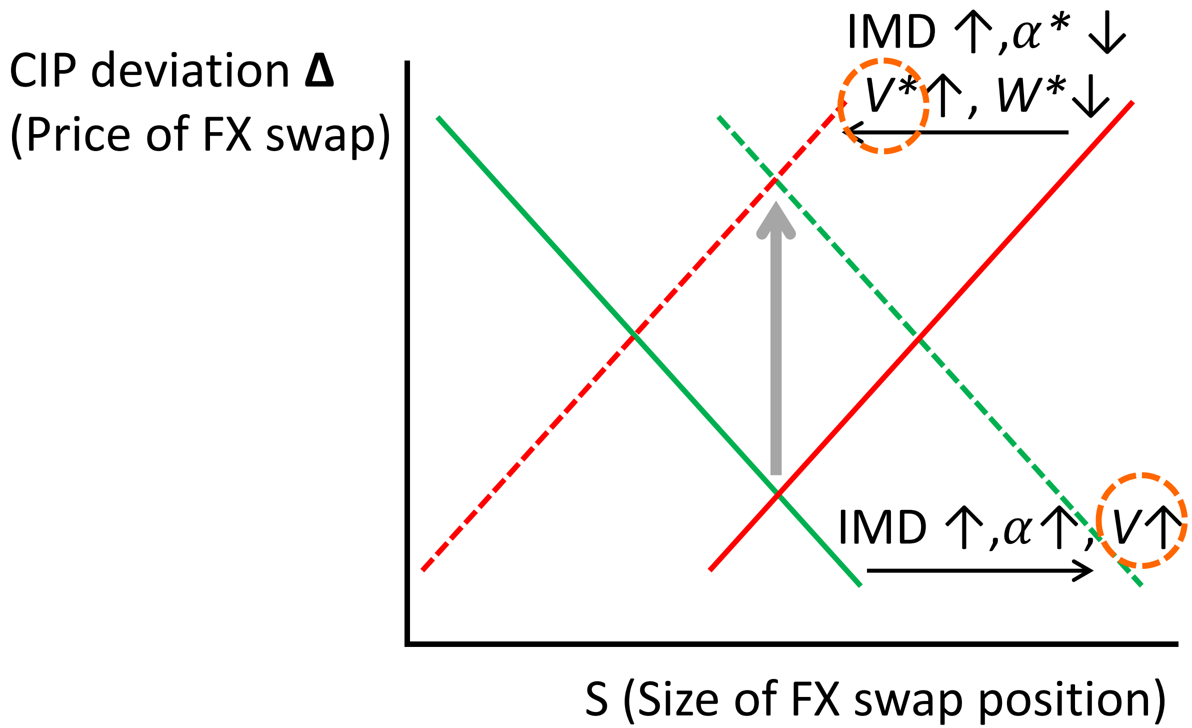
Prediction III: A higher default probability of US banks <u>decreases</u> Δ since it is more costly for US banks to fund JPY from Japanese money market.



Determinants of CIP deviations: model prediction

$$\Delta = \frac{\eta\theta}{(\tau+\eta)\gamma\theta + (\gamma+\theta)\tau\eta}\left\{ \begin{array}{c} (\tau+\gamma)[(q^* - r^*) - (q - r)] \\ + \frac{\tau\gamma p}{\eta}\alpha - \frac{\tau\gamma p^*}{\theta}\alpha^* + \tau\gamma(V + V^* - W^*) \end{array} \right\}.$$

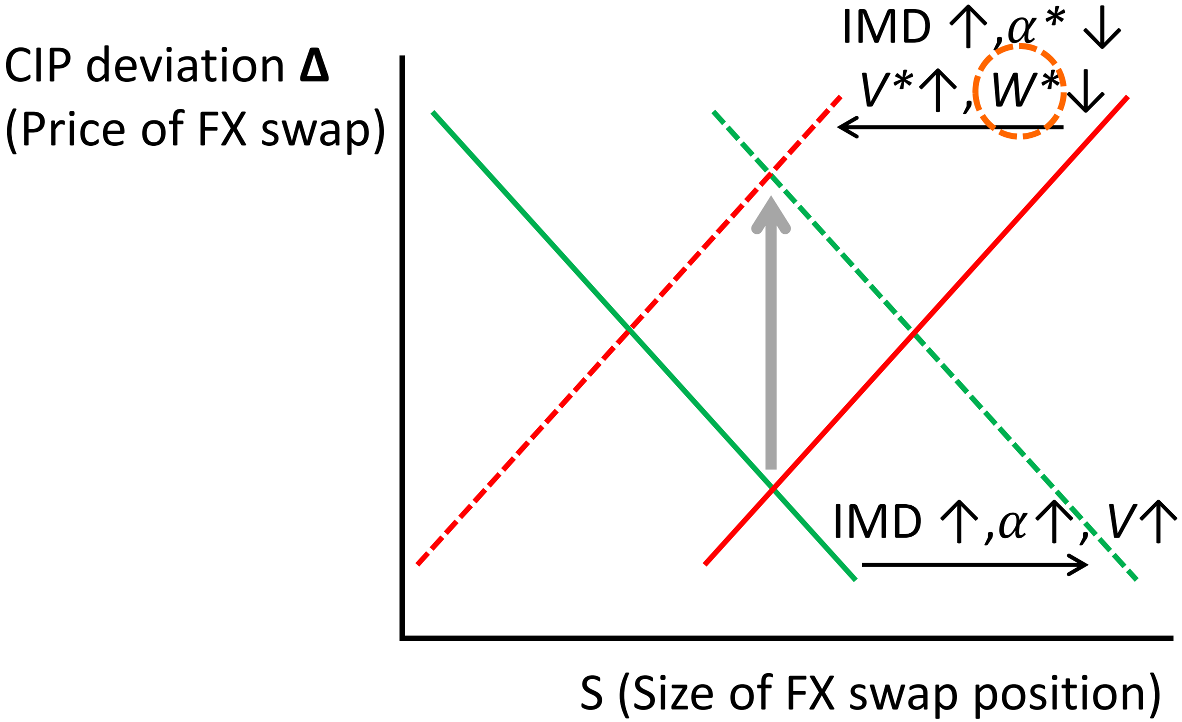
Prediction IV: A larger uncertainty increases Δ since it increases precautionary demand for USD of both US and Japanese banks.



Determinants of CIP deviations: model prediction

$$\Delta = \frac{\eta\theta}{(\tau+\eta)\gamma\theta + (\gamma+\theta)\tau\eta}\left\{\begin{matrix} (\tau+\gamma)[(q^* - r^*) - (q - r)] \\ + \frac{\tau\gamma p}{\eta}\alpha - \frac{\tau\gamma p^*}{\theta}\alpha^* + \tau\gamma(V + V^* - W^*) \end{matrix}\right\}.$$

Prediction V: A decline in endowment of real money investors <u>increases</u> Δ since it decreases USD supplied in FX markets.



Effects of Regulatory reforms: model prediction

Cost function of USD funding

- Non-US banks: $(1 + r^* + \alpha p)D_\$ + \frac{\eta}{2}(D_\$)^2$
- USD suppliers: $(1 + r^*)D_\$^* + \frac{\theta}{2}\left(D_\$^*\right)^2$

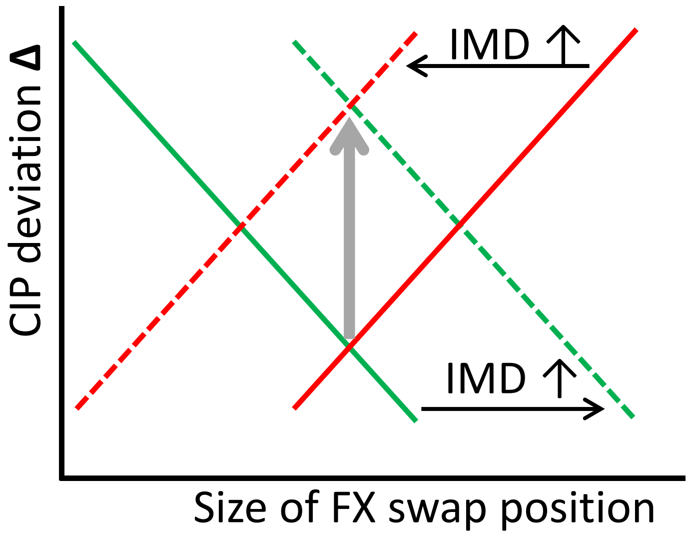
Regulatory reform makes USD funding and/or expanding the size of BS more costly for banks.

Effects of Regulatory reforms: model prediction

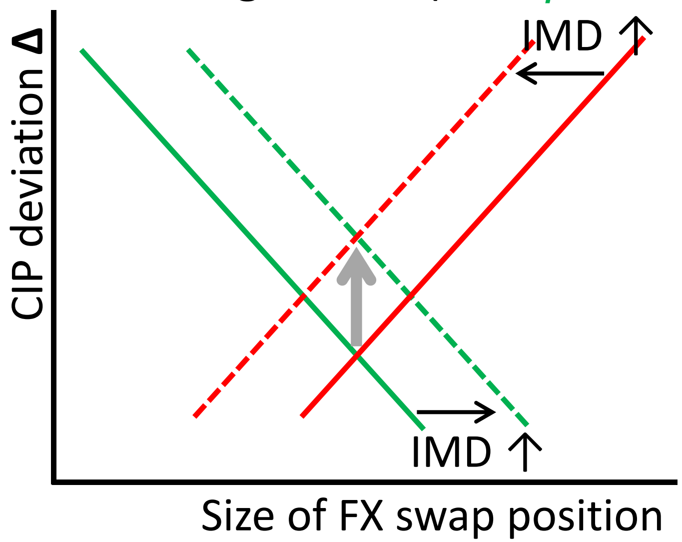
Prediction: Δ becomes more responsive to a change in economic environments when θ or η is higher

Ex. $\dfrac{\partial\left(\frac{\partial\Delta}{\partial(\mathrm{IMD})}\right)}{\partial\theta} = \dfrac{(\eta^2\gamma\theta+\tau\gamma\eta^2)(\tau+\gamma)}{\left((\tau+\eta)\gamma\theta+\tau(\gamma+\theta)\eta\right)^2} > 0,\quad \dfrac{\partial\left(\frac{\partial\Delta}{\partial(IMD)}\right)}{\partial\eta} = \dfrac{(\eta^2\gamma\theta+\tau\gamma\eta^2)\tau\gamma}{\left((\tau+\eta)\gamma\theta+\tau(\gamma+\theta)\eta\right)^2} > 0.$

Strict regulation (high η and θ)



Loose regulation (low η and θ)



Empirical results

Determinants of CIP deviations:

Panel regressions of CIP deviations (3M)

in four currency pairs, EUR/USD, USD/JPY, GBP/USD, and USD/CHF

		Model 1	Model 2			
			EUR/USD	USD/JPY	USD/CHF	GBP/USD
Policy divergence	Interest margin differential	0.06 ***	0.06 ***	0.07 ***	0.04 **	0.10 ***
Default probability of banks	EDF of US banks	-0.05 ***	-0.04 **	-0.06 ***	-0.16 ***	
	EDF of non-US banks	0.09 ***	0.12 ***	-0.02	0.53 ***	0.13 ***
	VIX (Proxy for precautionary demand for USD)	0.01 ***	0.02 ***	0.01 *	0.01 ***	0.01 ***
	Fixed effects	Yes	Yes			
	R-squared	0.35	0.54			
	RMSE	0.17	0.07	0.08	0.08	0.06
	No. of observations	480	480			

Notes: *1*. Sample period: 2007M1-2016M12.
2. ***, **, and * respectively indicate significance at the 1%, 5%, and 10% level.

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Panel regressions of CIP deviations (3M)

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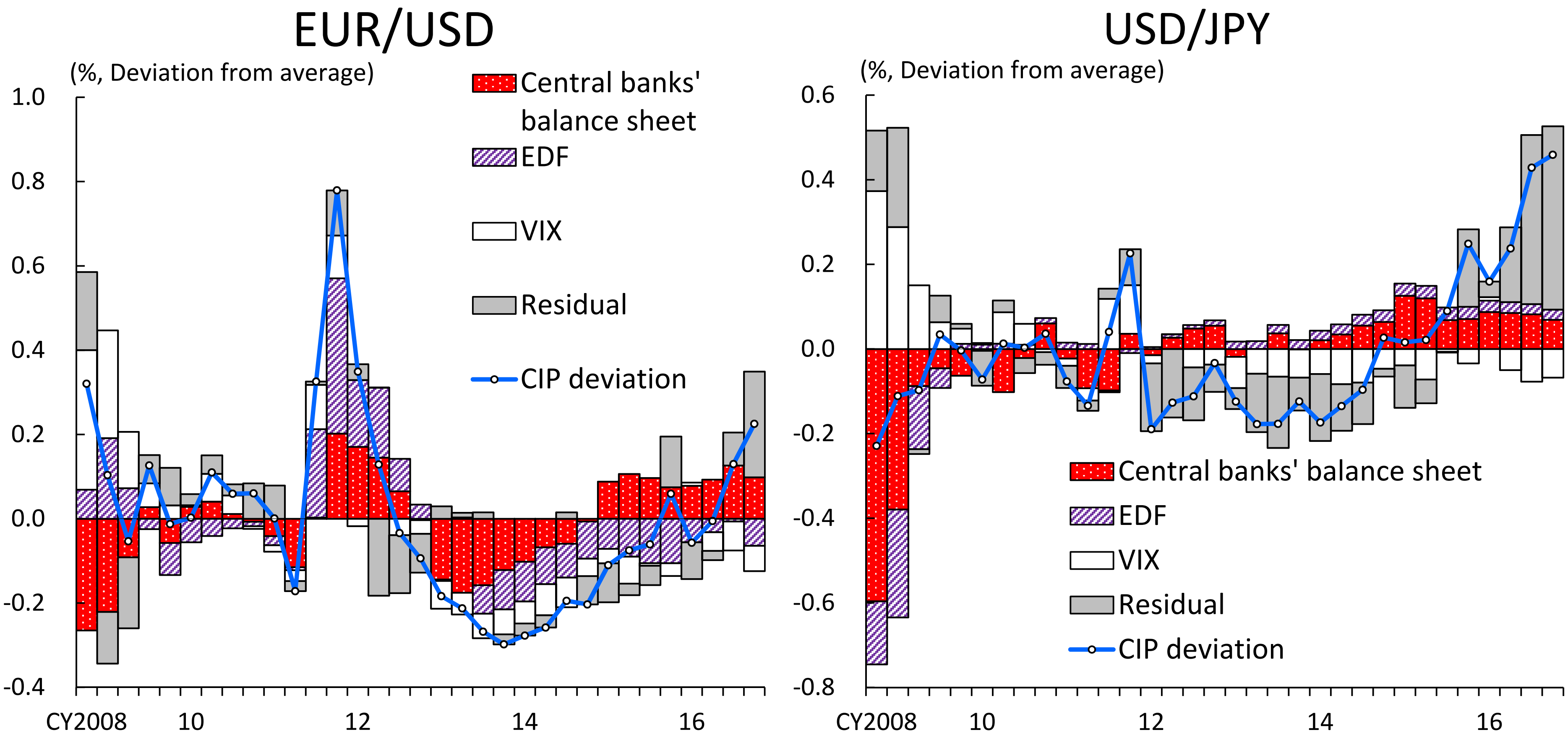
Notes: *1*. Sample period: 2007M1-2016M12.
2. ***, **, and * respectively indicate significance at the 1%, 5%, and 10% level.

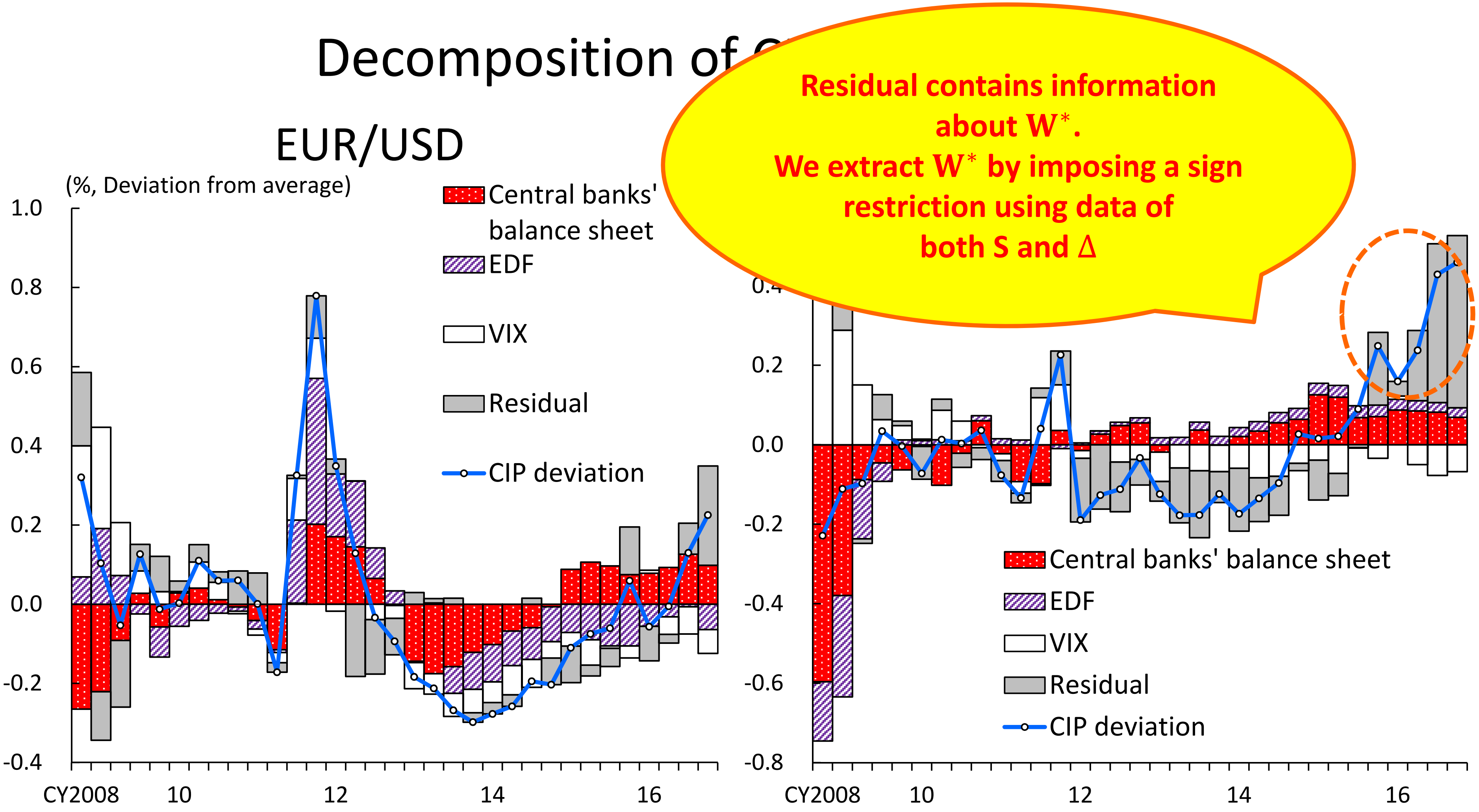
Determinants of CIP deviations: Role of MP divergence

Decomposition of CIP deviation (3M)



(Note) "Central banks' balance sheet" in each panel is the contribution of the difference in growth rates of the central banks' balance sheets. "EDF" in each panel is the sum of the contribution of EDF in the non-U.S. jurisdiction and EDF in the U.S., indicating the net effect of banks' default probabilities. Residuals in each panel include the contribution of control variables.

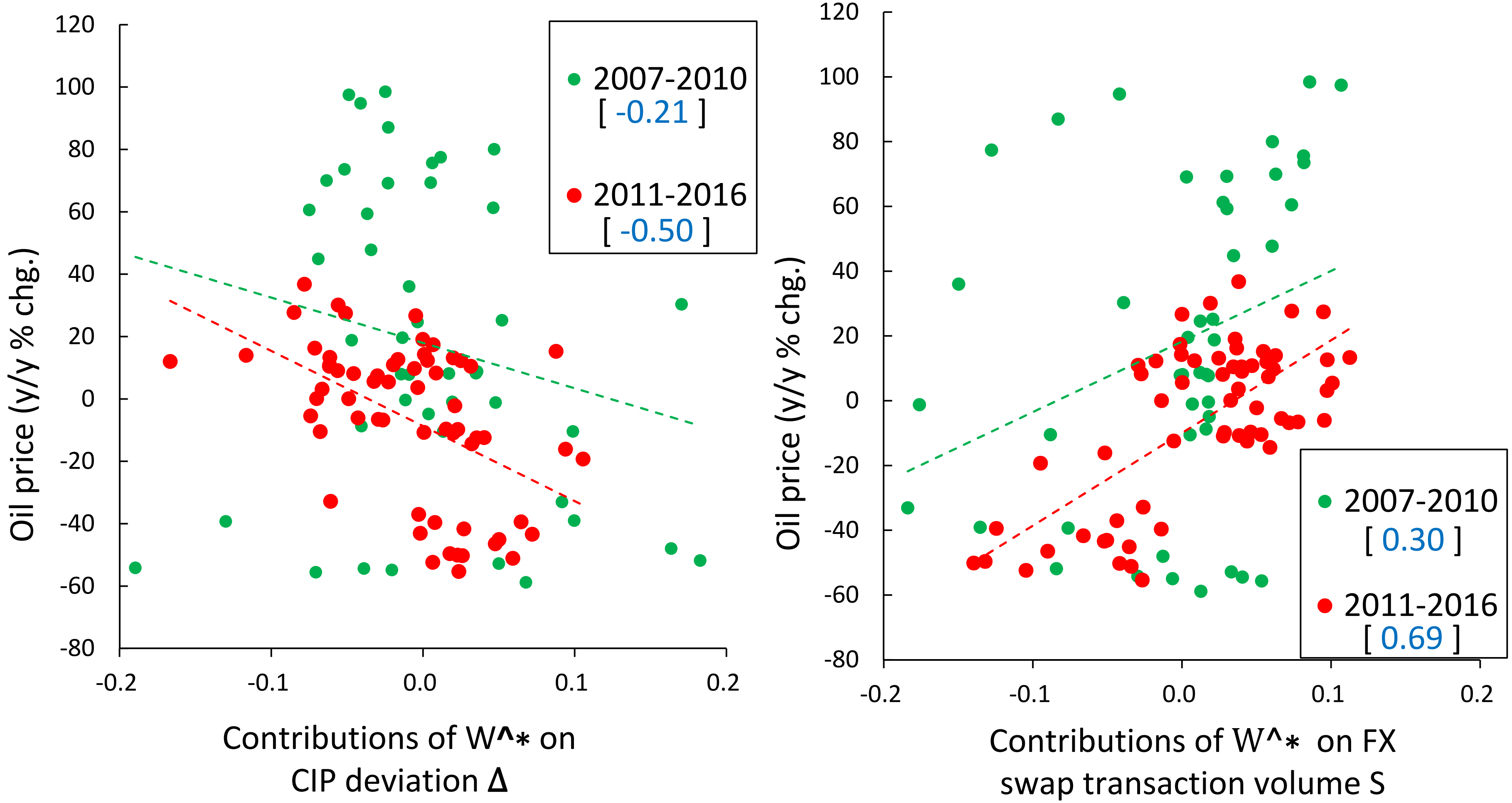
Determinants of CIP deviations: Further decomposing CIP deviations to extract W^*



(Note) "Central banks' balance sheet" in each panel is the contribution of the difference in growth rates of the central banks' balance sheets. "EDF" in each panel is the sum of the contribution of EDF in the non-U.S. jurisdiction and EDF in the U.S., indicating the net effect of banks' default probabilities. Residuals in each panel include the contribution of control variables.

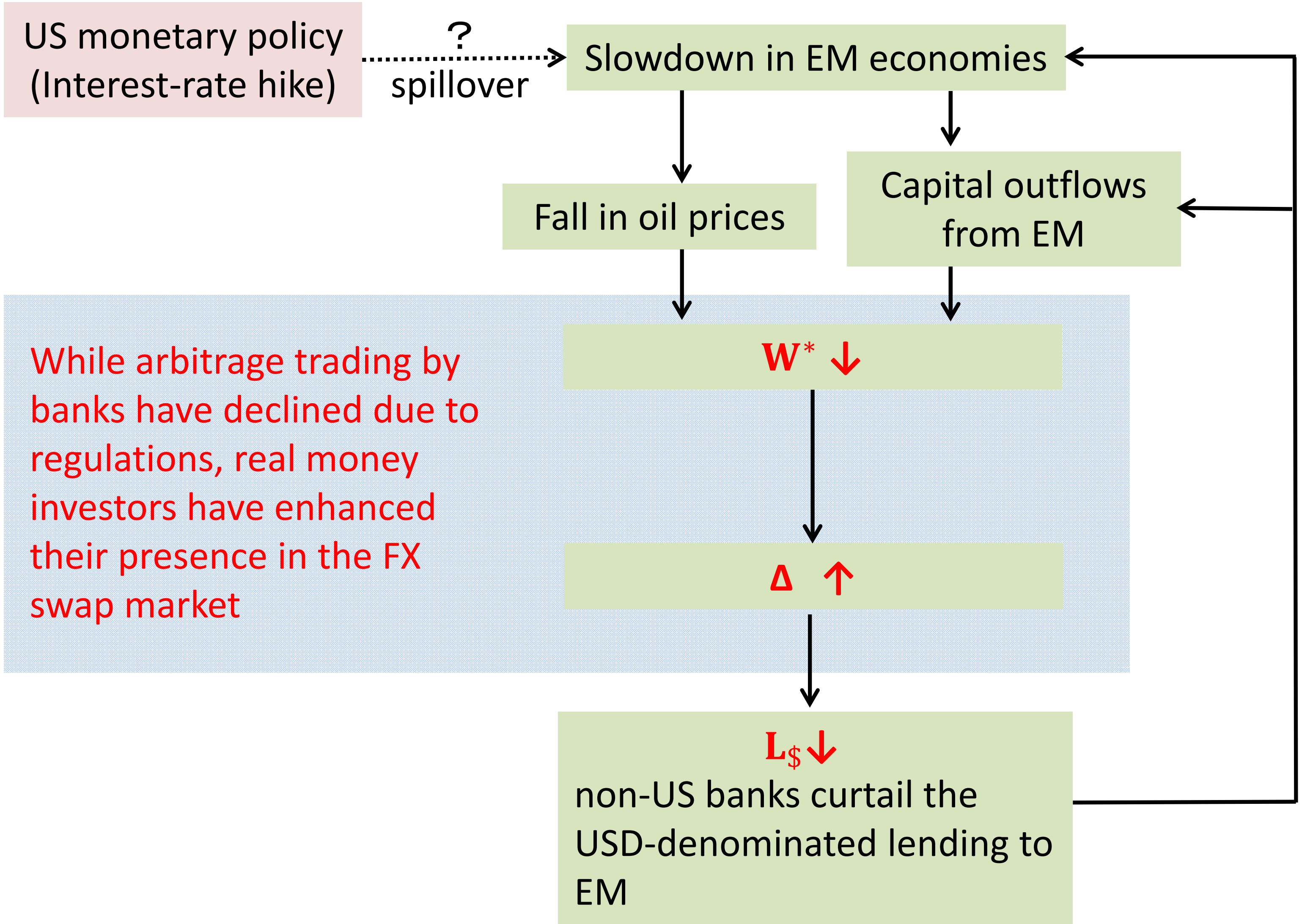
Determinants of CIP deviations: Nature of W* and oil price

Relationship between oil price and identified W*



Note: Figures in parentheses indicate correlation coefficients.

Determinants of CIP deviations: EM economy-CIP deviation linkages through W^*



Effects of Regulatory reforms

$$\boldsymbol{CIP\ deviation_t} = \left(\boldsymbol{\delta_T} + \boldsymbol{\delta_T^D} \times \boldsymbol{Dum_t^T}\right)\left[\left(\boldsymbol{q_t^*} - \boldsymbol{r_t^*}\right) - \left(\boldsymbol{q_t} - \boldsymbol{r_t}\right)\right] + \cdots.$$

Sample period: Jan. 2007- Dec. 2016

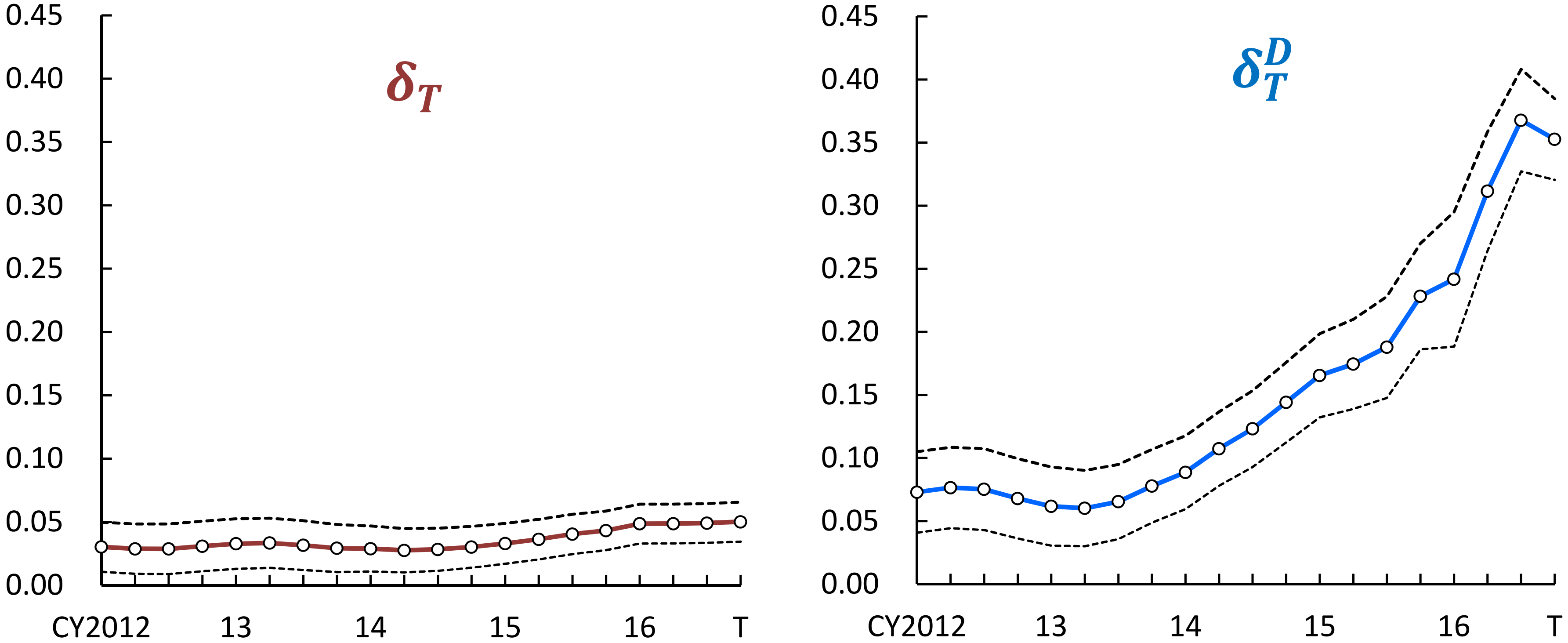
$$\boldsymbol{Dum_t^T} = \begin{cases} \mathbf{0}, & \boldsymbol{t < T} \\ \mathbf{1}, & \boldsymbol{T \leq t} \end{cases}$$

Effects of Regulatory reforms

$$CIP\ deviation_t = \left(\delta_T + \delta_T^D \times Dum_t^T\right)\left[\left(q_t^* - r_t^*\right) - \left(q_t - r_t\right)\right] + \cdots .$$

Sample period: Jan. 2007- Dec. 2016

$$Dum_t^T = \begin{cases} 0, & t < T \\ 1, & T \le t \end{cases}$$



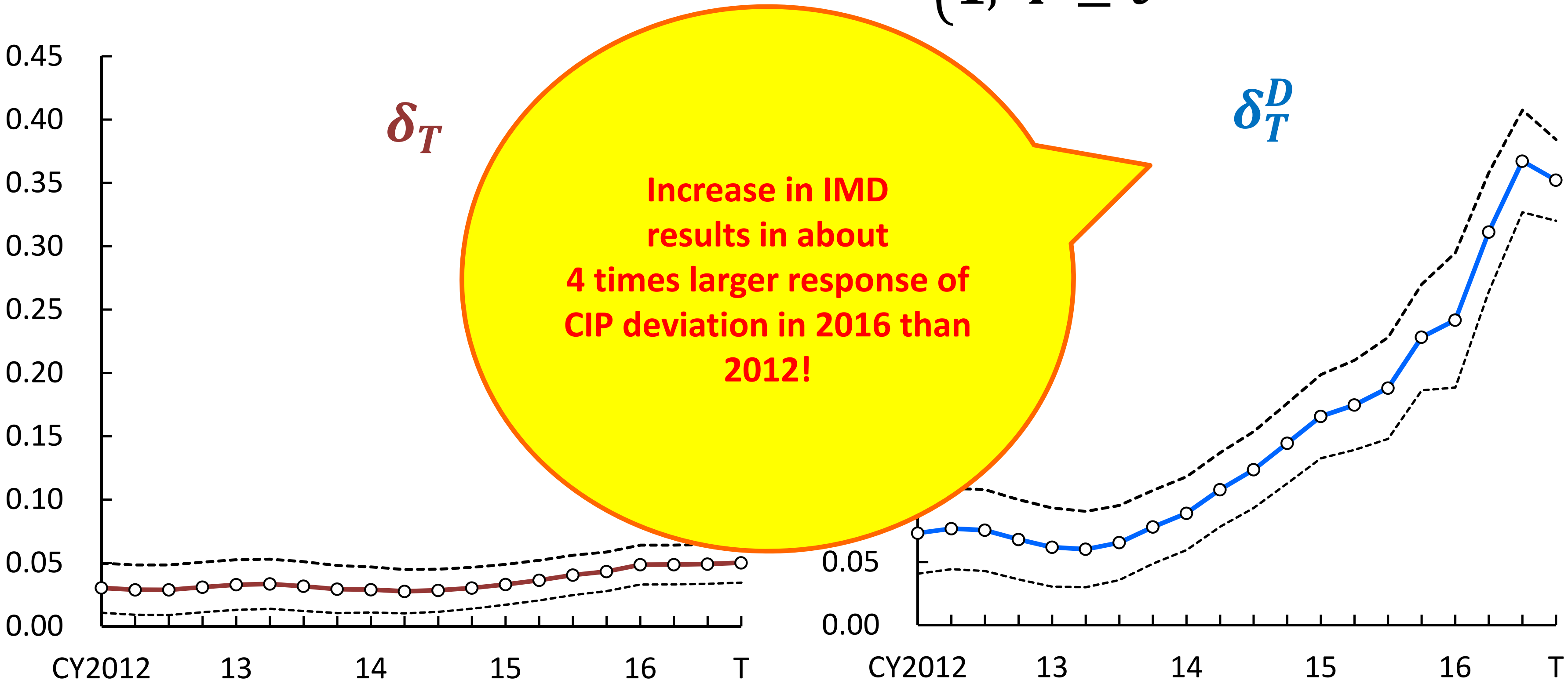
Note: The X-axis denotes the starting period from which the dummy variable takes unity. Dotted lines indicate 95 percent confidence intervals.

Effects of Regulatory reforms

$$CIP\ deviation_t = \left(\delta_T + \delta_T^D \times Dum_t^T\right)\left[\left(q_t^* - r_t^*\right) - \left(q_t - r_t\right)\right] + \cdots.$$

Sample period: Jan. 2007- Dec. 2016

$$Dum_t^T = \begin{cases} 0, & t < T \\ 1, & T \leq t \end{cases}$$



Note: The X-axis denotes the starting period from which the dummy variable takes unity. Dotted lines indicate 95 percent confidence intervals.

Summary

- Banks' creditworthiness is being replaced by other factors as the driving force of CIP deviations, though it is hasty to conclude CIP deviations should be dropped from watch list.

- New characters in the play: disagreement of monetary policy stance and real money investors.

- Volatile CIP deviations as byproduct of safeguarding financial system?

Thank you