DEUTSCHE BUNDESBANK
EUROSYSTEM

Exchange Rate Effects in the IIP

Methods, Tools and Applications for Germany

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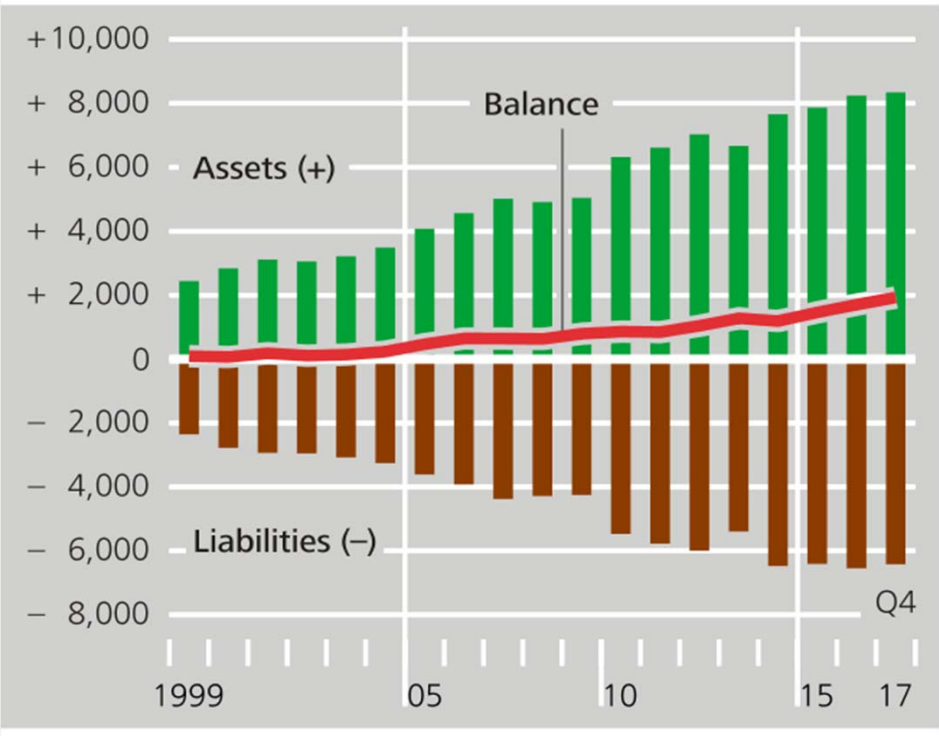
Outline

- Introduction: The significance of exchange rate fluctuations on the IIP for wealth and financial stability
- Basic concepts: the matrix of currency compositions
- An index of IIP weighted exchange-rate effects
- Sensitivity analysis
- Outlook: taking hedging into account

Introduction

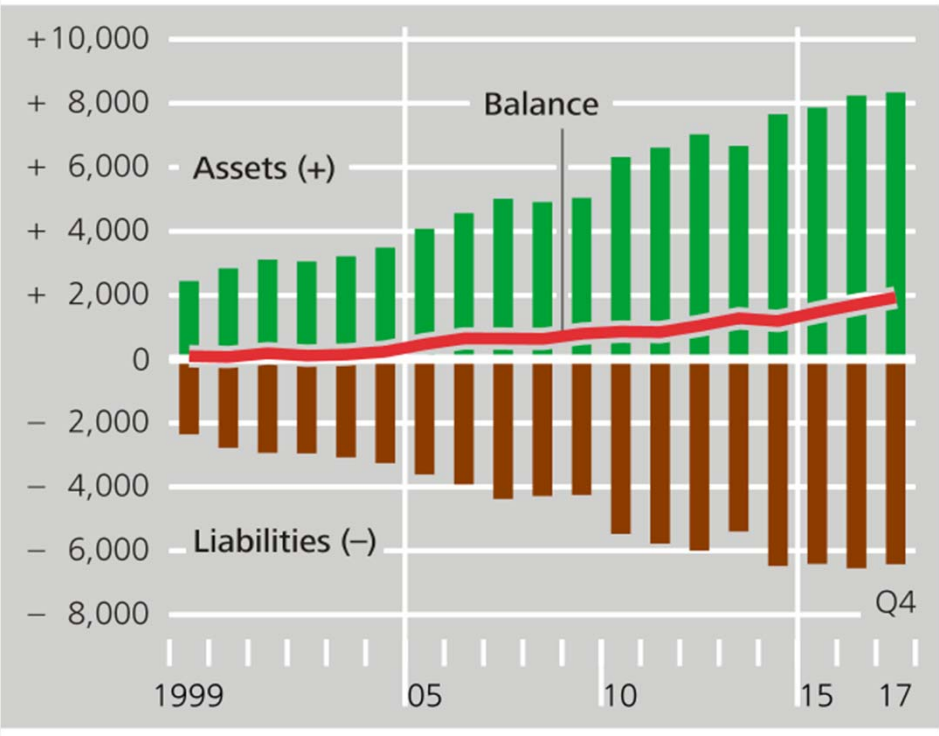
German IIP, all sectors, 1999 to end of 2017



The net external position of Germany has **increased from almost 20% to around 60% of GDP** in the years between 2007 and 2017. At the end of 2017, **external assets have reached a volume of € 8,346 bn** € and **external liabilities amount to € 6,417 bn €.**

Introduction

German IIP, all sectors, 1999 to end of 2017



A large share of IIP is denominated in foreign currencies: 34% of all assets and 20% of all liabilities – **net exposure is equivalent to € 1.5 trillion**, around 50% of GDP. For such a portfolio, even small exchange rate changes may have a high impact.

Introduction

- **National wealth** is **sum of real capital** plus **net foreign position**
- For wealth effects of exchange rate changes, IIP is the point of departure.
- Wealth effects on countries, sectors and individuals **depend on the currency composition of their portfolio**
- For investors holding **unhedged net positions** in a foreign currency, **exchange rate changes will directly affect net wealth.**
- **BPM6** asks for **breakdown** of changes of IIP positions into **transactions, revaluations** – exchange rate changes among them – and **other changes.**

- To identify effects of exchange rate changes, a **system of bookkeeping for currency denominations is needed** -- for each position, each instrument of each entity!

→ **Matrix of currency compositions needed!**

Basic concepts

Euro value of *N* currency positions in IIP stock *k*, the first being €

Exchange rate change for home currency, identically = 0

$$\mathrm{a}_t = \begin{pmatrix} a_t^1 \\ \vdots \\ a_t^K \end{pmatrix} \qquad \mathrm{A}_t = \begin{pmatrix} a_t^{11} & \cdots & a_t^{1N} \\ \vdots & \ddots & \vdots \\ a_t^{K1} & \cdots & a_t^{KN} \end{pmatrix} \qquad \hat{\mathrm{E}}_t = \begin{pmatrix} 0 \\ \Delta E_t^2 \,/\, E_{t-1}^2 \\ \vdots \\ \Delta E_t^N \,/\, E_{t-1}^N \end{pmatrix}$$

Vector of *K* different IIP stocks, in €

Matrix of currency compositions of stocks in a_t

Vector of exchange rate changes w.r. to €, for currencies 1 to *N*

Basic concepts

The **vector of exchange rate effects** is given by:

$$EE_t = \mathrm{A}_{t-1} \cdot \hat{\mathrm{E}}_t$$

Share of currency *N* in the Euro value of item 1

Consider the matrix of weights

$$\mathrm{G}_t = \begin{pmatrix} a_t^{11} / a_t^1 & \cdots & a_t^{1N} / a_t^1 \\ \vdots & \ddots & \vdots \\ a_t^{K1} / a_t^K & \cdots & a_t^{KN} / a_t^K \end{pmatrix}$$

and accordingly a **vector of IIP weighted exchange rate changes:**

$$\eta_t = \mathrm{G}_{t-1} \cdot \hat{\mathrm{E}}_t$$

Basic concepts

Formally, η_t is a **vector of growth rates.** One can look at it in two ways:

- By **weighting the exchange rate changes on the basis of IIP positions**, η_t "translates" these changes into effects on wealth stocks.
- Regarding the stocks, the elements of η_t denote the **relative changes of IIP positions** induced by exchange rate variations.

Absolute value of exchange rate effects can be **recovered** by simply **multiplying the weighted changes back into the stocks.**

An index of IIP weighted exchange rate effects

Chain-linking the growth factors associated with asset *k* while setting some base period equal to 100 yields an index for the capital gains and losses due to exchange rate changes in the respective IIP positions.

For any asset or liability position *k*, we obtain the **I**ndex of **I**IP-weighted **E**xchange rate effects:

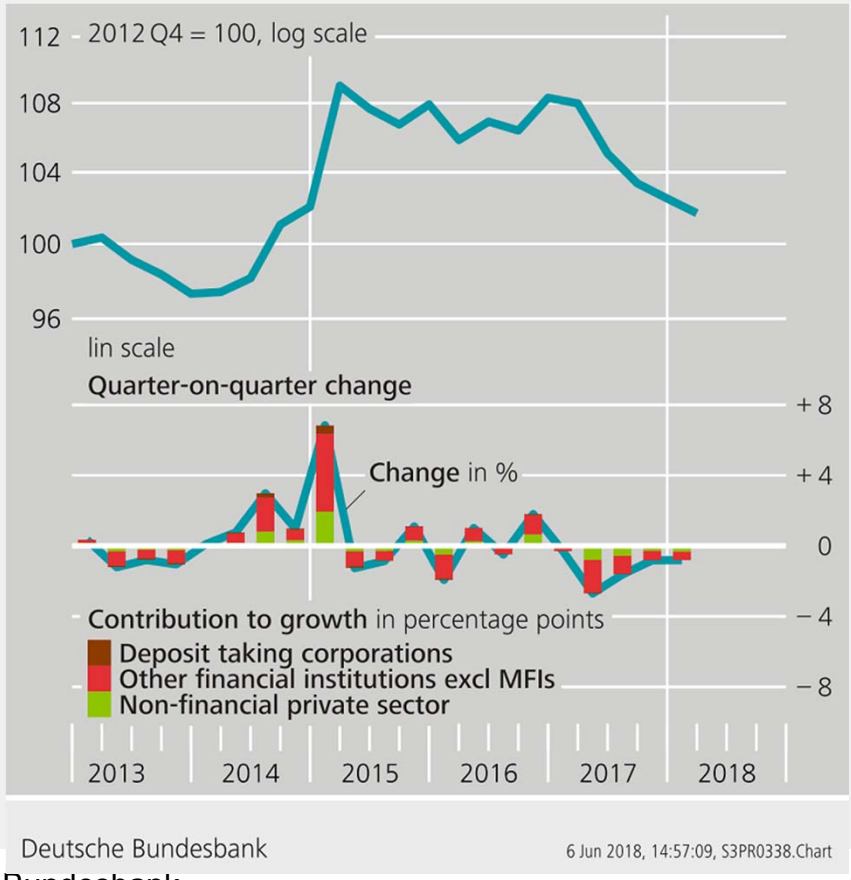
$$IIE_t^k = 100 \cdot \left(1+\mathfrak{n}_1^k\right) \cdot \left(1+\mathfrak{n}_2^k\right) \cdot \ldots \cdot \left(1+\mathfrak{n}_t^k\right) = IIE_{t-1}^k \cdot \left(1+\mathfrak{n}_t^k\right)$$

See Lane and Shambough (2010), Bénétrix, Lane and Shambough (2015) and Kearns and Patel (2016) for similarly constructed aggregate indices!

At the Bundesbank, as a service to analysts, the *IIE* are being computed and stored **for the baseline combinations of sectors, instruments and currency denominations, as well as for many meaningful aggregates!**

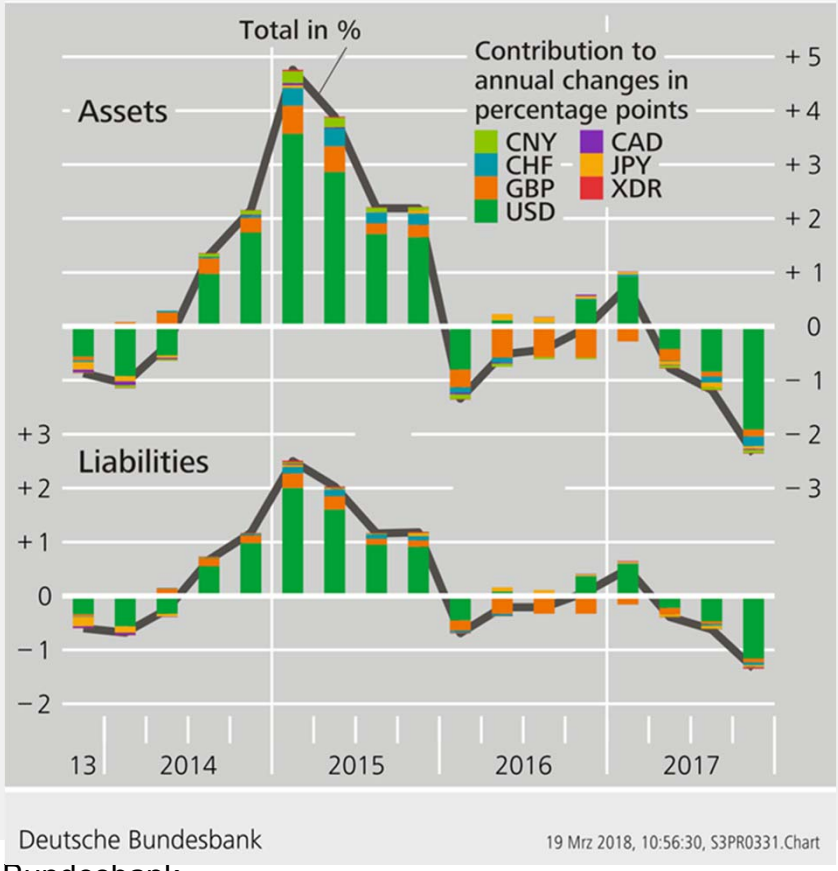
An index of IIP weighted exchange rate effects

IIE for shares in portfolio investment (asset side)



An index of IIP weighted exchange rate effects

Currency decomposition of IIE changes in percentage points
Total assets and liabilities



Sensitivity: ex post analysis

We may start by looking at time series **variability of IIP weighted exchange rate changes**, for certain asset positions or an aggregate portfolio, using historic currency compositions and ER-changes.

Std dev of portfolio inv. assets: q-on-q changes of IIE

	All sectors	Banks	MM funds	Fin. corp. w/o MFIs	Gov	Others*
All instruments	0.6	0.9	0.1	0.8	1.7	0.4
Long term debt securities	0.6	0.3	0.0	0.6	1.5	0.3
Short term debt securities	0.8	1.2	3.3	0.8	0.0	0.6
Shares	2.0	1.5	0.0	2.0	0.0	2.4
Investment fund shares	0.6	0.9	0.1	0.8	1.7	0.4

However, the currency compositions of asset or liability positions evolve over time, as does the covariance structure of exchange rate volatility.

Sensitivity: the effect of a 1 pp exchange-rate change

More informative to study **current IIP and currency composition.**

The effect of an isolated 1 percentage point change in currency *n*…

$$\frac{\mathrm{da}}{\mathrm{d}\hat{E}_t^n} = \begin{pmatrix} a_{t-1}^1 \cdot g_{t-1}^{1n} \\ \vdots \\ a_{t-1}^K \cdot g_{t-1}^{Kn} \end{pmatrix} = \begin{pmatrix} a_{t-1}^{1n} \\ \vdots \\ a_{t-1}^{Kn} \end{pmatrix} = \mathrm{a}_{t-1}^n$$

… is given by the respective **column of the currency composition matrix**

Sensitivity: considering correlation

However, exchange rate changes **do not happen in isolation.**

Covariance matrix of exchange-rate fluctuations:

Exchange rate change for home currency identically 0

$$\Omega = \operatorname{cov} \hat{\mathrm{E}}_t = \begin{pmatrix} 0 & 0 & \dots & 0 \\ 0 & \operatorname{var} \hat{E}_t^2 & \dots & \operatorname{cov}\left(\hat{E}_t^2, \hat{E}_t^K\right) \\ \vdots & \vdots & \ddots & \vdots \\ 0 & \operatorname{cov}\left(\hat{E}_t^2, \hat{E}_t^K\right) & \dots & \operatorname{var} \hat{E}_t^K \end{pmatrix}$$

We obtain

$$\left.\frac{\mathrm{da}}{\mathrm{d}\hat{E}_t^n}\right|_{\Omega} = \sqrt{\mathrm{a}_{t-1}^n \cdot \Omega \cdot 1(\mathrm{n})}$$

as the effect of a one standard deviations shock to currency n on the asset positions in absolute values, taking into account the correlation structure.

Sensitivity: standard deviation for rates of change

Total volatility given **current currency composition** and **current covariance structure** of exchange rate changes

Std. dev. of asset or liability position *k* resulting from ER volatility:

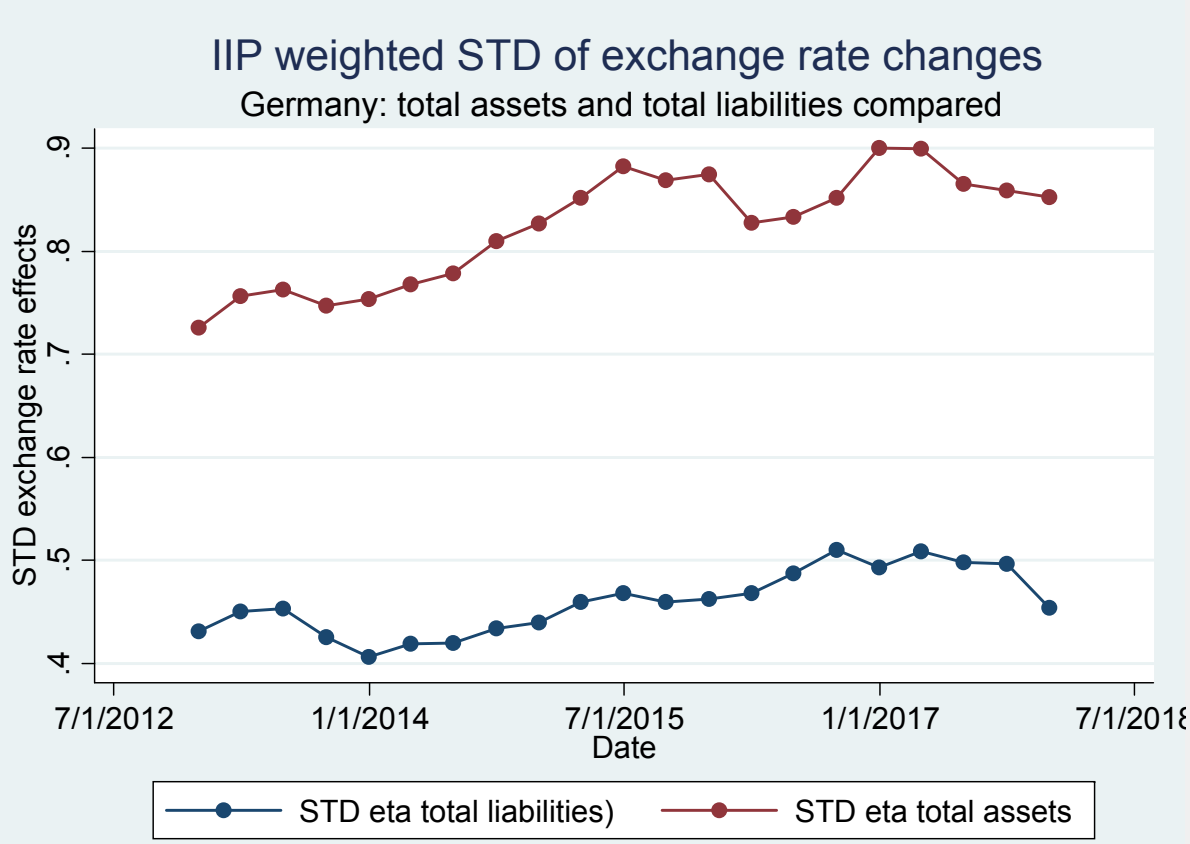
$$\operatorname{std}\left(\eta_t^k\right) = \sqrt{\operatorname{var}\left(g_t^{k\,\prime} \cdot \hat{E}_t\right)} = \sqrt{g_t^{k\,\prime} \cdot \Omega \cdot g_t^k}$$

Exchange-rate induced r.o.c. in IIP position *k*

Currency weights for IIP position *k*

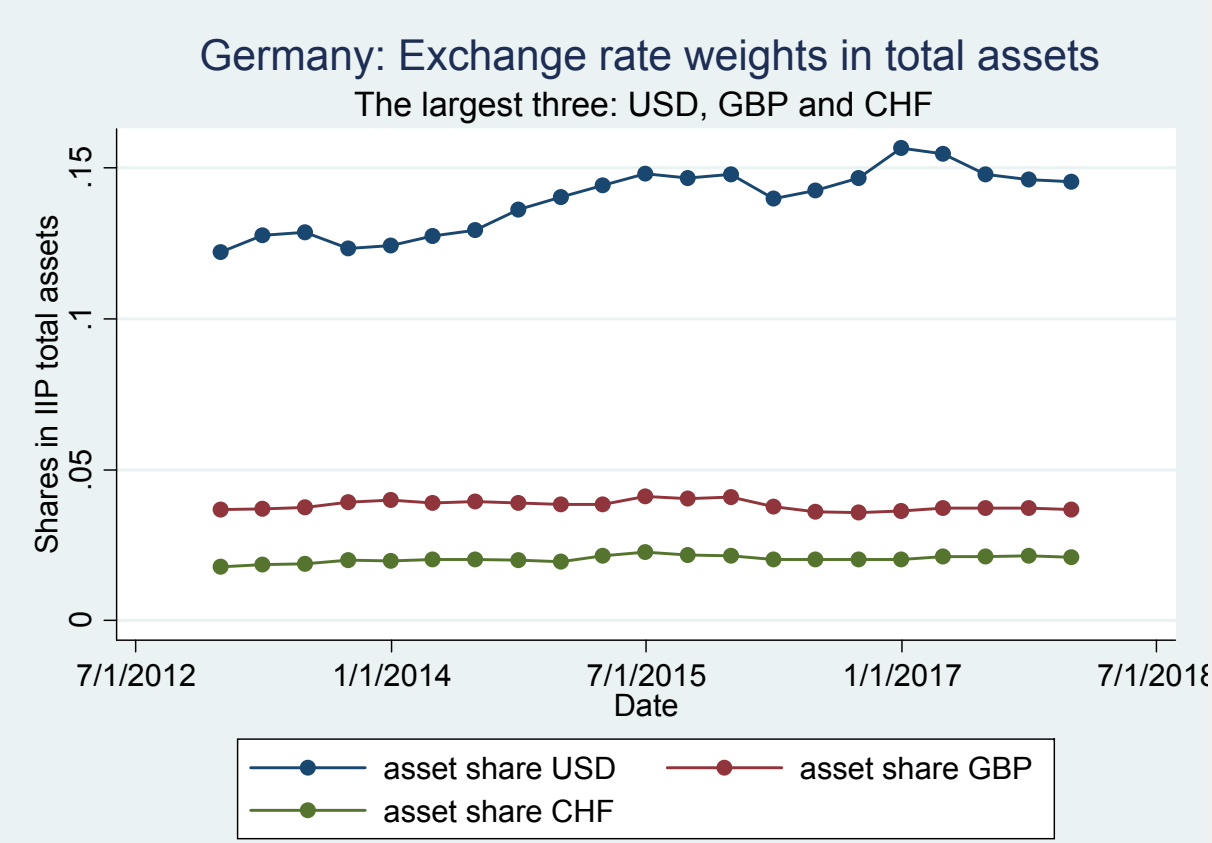
Sensitivity: standard deviation for rates of change

Growing exchange rate sensitivity of total assets…



Sensitivity: standard deviation for rates of change

… due to rising share of US Dollar



Sensitivity: standard deviation for absolute changes

Looking at absolute values

The **absolute value** of position *k* may be changing quite strongly over time.
→ look at the **scaled standard deviation:**

$$\mathrm{std}\left(a_t^k \eta_t^k\right) = a_t^k \,\mathrm{std}\left(\eta_t^k\right) = a_t^k \sqrt{\mathrm{g}_t^{k\,\prime} \cdot \Omega \cdot \mathrm{g}_t^k}$$

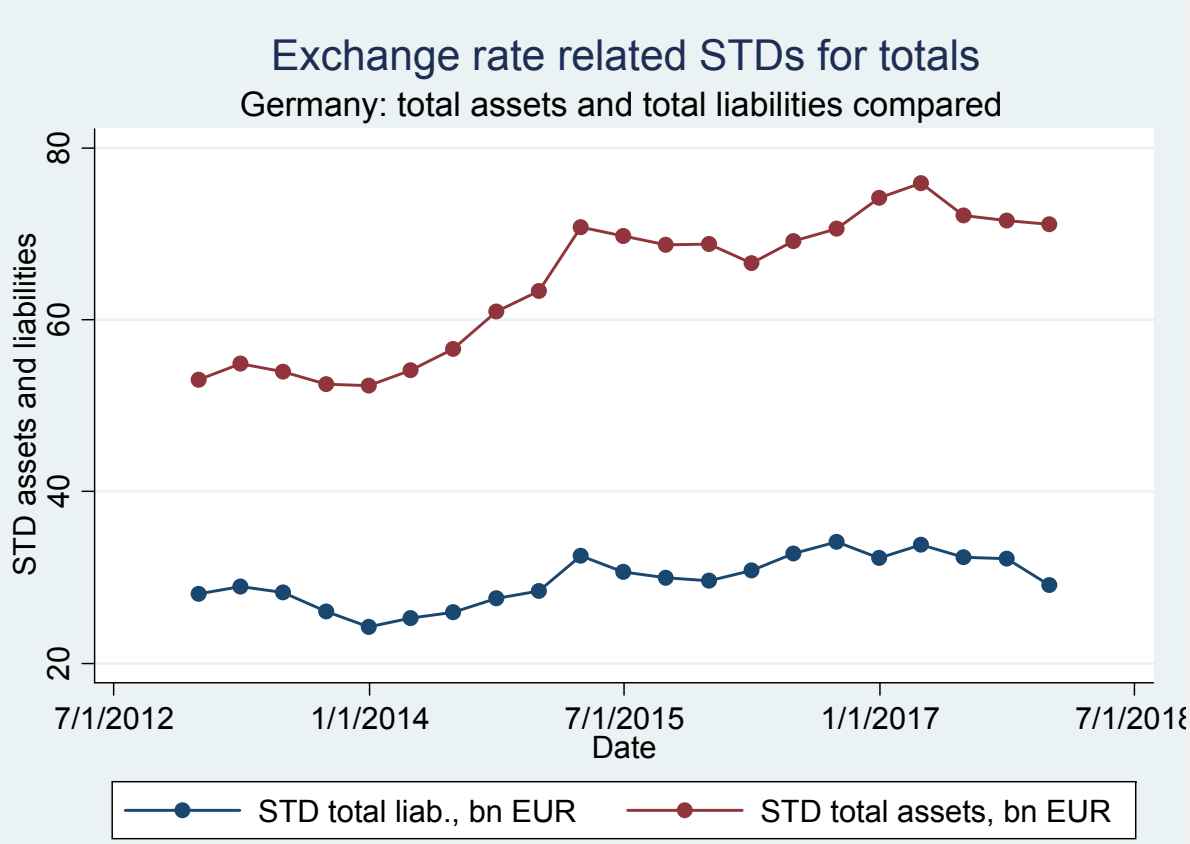
Absolute value of change in IIP position *k*

Currency weights for IIP position *k*

This is a **measure for potential currency risk** in position *k*

Sensitivity: standard deviation for absolute changes

Strongly increasing volatility of total assets



Outlook: taking hedging into account

Taking hedging into account – a way towards useful macro-statistical risk measures?

Part of IIP positions are hedged (forward contracts, derivatives or holding counter positions within the group). No direct information in IIP!

If there is exogenous information on hedging, we may construct **modified weights g*** to be used instead of g**:**

$$WR\left(a_t^k\right)\Big|_{FX} = a_t^k \sqrt{g^{*k\prime}_t \cdot \Omega \cdot g^{*k}_t}$$

Std dev of exchange rate induced changes in unhedged part of IIP position *k*

Currency weights of **unhedged assets or liabilities** in IIP position *k*

Outlook: taking hedging into account

This may **delineate the path** towards **operational macro-statistical risk measures** of foreign currency exposure associated with IIP.

But:

- Empirical values for g* are not to be had without estimates and approximations.
- Derivative contracts between agents that are both domestic residents will not reduce the aggregate exposure of the country – although it can still reduce systemic risk if currency risk in different positions is annihilated or ultimately rests with agents that are able to deal with it.
- Trading in derivatives with non-residents may increase or reduce aggregate open positions, thereby affecting aggregate exposure outside the IIP.

A better understanding of sectoral hedging activities is needed.

This is the end…

Thank you!