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

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.
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 €

$\begin{bmatrix}
a_t^1 \\
\vdots \\
a_t^K
\end{bmatrix}$

Matrix of currency compositions of stocks in $a_t$

$\begin{bmatrix}
a_{t1}^{11} & \cdots & a_{t1}^{1N} \\
\vdots & \ddots & \vdots \\
a_{tK}^{K1} & \cdots & a_{tK}^{KN}
\end{bmatrix}$

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

$\hat{E}_t = \begin{bmatrix}
0 \\
\Delta E_t^2 / E_{t-1}^2 \\
\Delta E_t^N / E_{t-1}^N
\end{bmatrix}$

Exchange rate change for home currency, identically = 0
The **vector of exchange rate effects** is given by:

\[ EE_t = A_{t-1} \cdot \hat{E}_t \]

Consider the matrix of weights

\[
G_t = \begin{pmatrix}
\frac{a_t^{11}}{a_t^1} & \cdots & \frac{a_t^{1N}}{a_t^1} \\
\vdots & \ddots & \vdots \\
\frac{a_t^{K1}}{a_t^K} & \cdots & \frac{a_t^{KN}}{a_t^K}
\end{pmatrix}
\]

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

\[ \eta_t = G_{t-1} \cdot \hat{E}_t \]

Share of currency \( N \) in the Euro value of item 1.
Basic concepts

Formally, $\eta_t$ 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**, $\eta_t$ "translates" these changes into effects on wealth stocks.

- Regarding the stocks, the elements of $\eta_t$ 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 Index of IIP-weighted Exchange rate effects:

$$\text{IIE}_t^k = 100 \cdot \left(1 + \eta_1^k\right) \cdot \left(1 + \eta_2^k\right) \cdot \ldots \cdot \left(1 + \eta_t^k\right) = \text{IIE}_{t-1}^k \cdot \left(1 + \eta_t^k\right)$$

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)

[Graph showing quarterly changes and contributions to growth in percentage points for different sectors from 2013 to 2018]
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

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

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 $n$...

\[
\frac{da}{d\hat{E}_t^n} = \begin{pmatrix}
a^1_{t-1} \cdot g^1_{t-1} \\
\vdots \\
a^K_{t-1} \cdot g^K_{t-1}
\end{pmatrix}
= \begin{pmatrix}
a^{1n}_{t-1} \\
\vdots \\
a^{Kn}_{t-1}
\end{pmatrix}
= a^n_{t-1}
\]

... 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:

\[
\Omega = \text{cov} \hat{E}_t = \begin{pmatrix}
0 & 0 & \ldots & 0 \\
0 & \text{var} \hat{E}^2_t & \ldots & \text{cov}(\hat{E}^2_t, \hat{E}^K_t) \\
\vdots & \vdots & \ddots & \vdots \\
0 & \text{cov}(\hat{E}^2_t, \hat{E}^K_t) & \ldots & \text{var} \hat{E}^K_t \\
\end{pmatrix}
\]

Exchange rate change for home currency identically 0

We obtain

\[
\frac{\text{da}}{d\hat{E}^n_t} \bigg|_\Omega = \sqrt{\bar{a}_{i-1}^n \cdot \Omega \cdot 1(n)}
\]

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:**

$$\text{std}(\eta^k_t) = \sqrt{\text{var}(g^k_t \cdot \hat{E}_t)} = \sqrt{g^k_t \cdot \Omega \cdot g^k_t}$$

- 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...

IIP weighted STD of exchange rate changes
Germany: total assets and total liabilities compared

STD exchange rate effects

<table>
<thead>
<tr>
<th>Date</th>
<th>STD eta total liabilities</th>
<th>STD eta total assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1/2014</td>
<td></td>
<td></td>
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<tr>
<td>7/1/2015</td>
<td></td>
<td></td>
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<tr>
<td>1/1/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/1/2018</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sensitivity: standard deviation for rates of change

... due to rising share of US Dollar

Germany: Exchange rate weights in total assets

The largest three: USD, GBP and CHF

 Shares in IIP total assets

Date

0 0.05 0.1 0.15

7/1/2012 1/1/2014 7/1/2015 1/1/2017 7/1/2018

asset share USD asset share GBP asset share CHF

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30 August 2018
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Looking at absolute values

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

\[
\text{std}\left(a_t^k \eta_t^k\right) = a_t^k \text{ std}\left(\eta_t^k\right) = a_t^k \sqrt{g_t^k \cdot \Omega \cdot g_t^k}
\]

This is a **measure for potential currency risk** in position \( k \)
Sensitivity: standard deviation for absolute changes

Strongly increasing volatility of total assets

Exchange rate related STDs for totals
Germany: total assets and total liabilities compared

STD assets and liabilities

STD total liab., bn EUR
STD total assets, bn EUR

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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 $g$:

$$WR\left(a^k_t\right)_{FX} = a^k_t \sqrt{g^{*k}_t \cdot \Omega \cdot g^{*k}_t}$$

- 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!