A new REER index for RMB

How much competitiveness did China lose because of currency appreciation since 2010? The conventional effective exchange rate (EER) index for RMB shows a 31% appreciation against China’s trading partners. But we argue the conventional EER is misleading. A depreciation of Korean Won would help to lower costs of Chinese cell phone makers who import Korean memory chips. This “supply chain” effect is ignored in the conventional EER index.

We develop a new EER index for RMB. We utilize our proprietary processing trade model to correct for such supply-chain bias. The adjusted EER index suggests that China’s true price competitiveness loss between 2010 and 2015 was only some 19%, or 60% of what was indicated by the conventional EER.

We also develop the first set of sector EER indices in the market. The difference across sectors is huge: the automobile EER index appreciated by 32.5% since 2010, while the cell phone EER index only appreciated by 12.5%. This is in part because Chinese cell phone manufacturers heavily depend on imported parts from Korea, Taiwan, and Japan. Therefore, depreciation of these currencies actually helped Chinese cell phone exporters.

The appreciations of some sector EER indices (cell phone and computer) are in fact smaller than RMB’s bilateral appreciation against any of China’s major trade partners. This highlights that, due to the existence of global supply chains, it is indeed possible for a country like China to benefit, on a net basis, from bilateral depreciations of its trade partners’ currencies.

We believe our EER indices provide better—more accurate, more complete and more update-to-date—measures for China’s competitiveness. They have important market and policy implications:

- We believe there is a large chance that the RMB will depreciate 5 to 10 percent versus the US dollar in 2016. Such seemingly large bilateral depreciations would indeed imply a fairly stable RMB in EER terms in 2016, with a range of approximately ±1.5%.

- Some argue that RMB is significantly overvalued, based on the 31% appreciation of the conventional EER index. Our index shows a much smaller competitiveness loss, consistent with China’s robust market share in trade. This implies lower likelihood of RMB depreciation in EER terms.

- When PBoC released a RMB basket in Dec 2015, many were surprised to find out that Korea and Taiwan, two of China’s biggest trade partners, were not included in the basket. Our index shows that, because of processing trade, their impact on China’s overall competitiveness is indeed much smaller than indicated by their gross trade with China.

We aim to publish and regularly update our DB EER indices.
A new REER index for RMB

Introduction

Effective exchange rate (EER) is an important competitiveness indicator. The conventional way of compiling an EER index assumes that countries are competitors; hence a devaluation of one country’s currency hurts the competitiveness of its trading partners. It does not, however, take into consideration the supply-chain effect – the imports of IC chips from Korea to China may help China’s exports, and therefore a depreciation of the Korean Won may not be a bad thing for Chinese cell phone exporters.

Such supply-chain bias in EER is particularly serious for China. Nearly 30% of China’s imports in 2015 are parts and components to be assembled into exports (for detailed discussions, please see our report: The Gravity of China, Part I, 11/24/2015). These imports actually work as complements to Chinese exports. The conventional way to calculate EER does not consider this effect.

As a result, the conventional EER indices have led to some puzzling observations. According to the BIS, China’s real EER has appreciated over 30% since 2010 (Figure 1). Yet its global export market share has increased steadily during this period (Figure 2). Making the puzzle more striking is the contrast with Japan, whose currency has depreciated by about 30%, yet its global export market share has kept declining.

The first task of this report is to help reconcile those puzzles by correcting the supply-chain bias in China’s EER indices. We show that the BIS real EER index overstates the price competitiveness loss for China’s exports. Our adjusted real EER index suggests that China’s true price competitiveness loss between 2010 and 2015 was only about 60 percent of what was indicated by the BIS index.

Another drawback of conventional EER indices is that they are so “composite” that the large cross-sector differences are ignored. To fill in the gap, we first develop a few sector EER indices for China. Then we take one step further and correct the supply-chain bias for those sector EER indices.
There are some very interesting findings. For instance, China’s cell phone EER index appreciated much less than the automobile EER index between 2010 and 2015. In addition, after the correction of supply-chain bias, the cell phone EER index appreciated only some 13 percent, smaller than any bilateral appreciation of the RMB against China’s major trade partners.

Before closing the report with some concluding remarks, we present a few examples to illustrate the application of our results, including understanding why Korea and Taiwan are missing from the currency basket of the newly launched CFETS RMB index, and interpretation of our 2016 RMB forecast.

Effective exchange rate indices and adjustments for supply-chain bias

In this section, using a simplified example, we first illustrate how an effective exchange rate (EER) index is usually calculated. We then explain why processing trade, or the existence of global and regional supply chains, would make such EER index a biased price competitiveness measure. Finally we show how we correct such supply-chain bias and make the EER index a better price competitiveness measure for China.

Conventional effective exchange rate indices

Effective exchange rate (EER) is a composite measure of price competitiveness for a country versus its trade partners. It is a weighted average of the country’s bilateral exchange rates. If the bilateral exchange rates used to compute EER are not adjusted for countries’ price levels, the calculated is called a nominal effective exchange rate (NEER). If they are adjusted for price levels, the calculated is then called a real effective exchange rate (REER).

To illustrate how an EER index is calculated, let’s assume China has only two trade partners: Korea and the US. It imports 200 and 300 units of goods from the two partners, respectively; and it exports 150 and 450 units of goods to these partners, respectively (Figure 3).

<table>
<thead>
<tr>
<th>China’s gross imports from:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>200</td>
</tr>
<tr>
<td>US</td>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>China’s gross exports to:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>150</td>
</tr>
<tr>
<td>US</td>
<td>450</td>
</tr>
</tbody>
</table>

The key to EER calculation is to compute the weight for each trade partner in the basket (Figure 4). In this example, Korea’s weight is 0.32, which itself is a weighted average of Korea’s import weight (or its share in China’s total imports, 0.4) and its export weight (or its share in China’s total exports, 0.25).
The two shares are weighted using China’s aggregate import and export shares in total trade (500/1100 and 600/1100), respectively. Similarly, the US’s weight in this example is 0.68. They together constitute the EER basket.

Figure 5: EER example, calculation of EER change

IF: bilateral exchange rate change in $t$
- vs. Korean won $+30\%$
- vs. US dollar $+15\%$

THEN: change of RMB EER index in $t$

$+19.8\%$
$= 30\% \times 0.32 + 15\% \times 0.68$

Source: Deutsche Bank

Figure 5 illustrates how the change in an EER index is computed based on bilateral exchange rates. Suppose in period $t$, the RMB appreciates 30% and 15% versus the Korean won and the US dollar, respectively. With the trade structure assumed in Figure 3 and the weights shown in Figure 4, the RMB EER index in this example appreciates 19.8% during period $t$.

Explained by Figures 3 to 5 is, in essence, how most conventional EER indices are computed, including the most widely used ones compiled by the BIS. Figure 6 presents two RMB REER indices: the BIS series and one compiled by us following the BIS methodology. Our index includes the same currencies as the BIS basket, but the currency weights are computed by ourselves and more frequently updated based on annual trade data. It tracks the original BIS index very well and is the starting point of our adjustments for supply-chain bias later.

Impact of supply chain, and correction of the supply-chain bias

For countries well integrated into a global or regional supply chain, such as China, a conventional EER index could be a biased measure of exchange-rate-related price competitiveness.

We illustrate this using the same example as above, but with more detailed assumptions on the trade structure. Based on the same example, we also show how we correct the supply-chain bias and make the EER index a better measure of price competitiveness.

Figure 7 extends the trade structure assumptions in Figure 3. Note that the gross trade flows are identical as before, but there are more detailed decompositions of these flows. Among China’s total imports from Korea, only 40 units, or 20 percent, are consumed domestically. The rest 80 percent, after being processed in China, are re-exported to their final markets, 40 units back to Korea (returning re-exports) and 120 units to the US. China’s imports from the US are also consumed domestically or re-exported. The shares of two are 80 percent and 20 percent, respectively.

China’s gross exports to each partner are now decomposed into four components. Again, take Korea as an example. The total exports of 150 units of goods to Korea include: (i) those not related to processing trade, 40 units; (ii) returning re-exports, 40 units; (iii) re-exports of inputs imported from the US,
15 units; and (iv) value-added by China to the re-exports, 55 units (= 40 + 15, assuming China adds 1 unit of value-added to every unit of re-export).

The conventional way of compiling and interpreting EER indices implies that trading partners are only competitors. Therefore, if China imports more from or exports more to a partner, then bilateral depreciation of this partner’s currency against the RMB would hurt China’s price competitiveness more.

This is not always the case, however. In Figure 7, if the Korean won depreciates against the RMB, China’s re-exports to the US that are originally imported from Korea (120 units), along with the associated value-added by China (also 120 units), would actually become more competitive on the US market. The competitiveness impact associated with the 40 units returning re-exports to Korea is basically a wash, because their costs in Korean won remain unchanged. In other words, when the won depreciates, among the 200 units of imports from Korea, the amount that might hurt China’s competitiveness (40 units consumed by China domestically) is much smaller than the amount that brings price competitiveness gains to China (120 units re-exports to the US).

To reflect such supply-chain effect, we would adjust how the import and export weights are calculated for the trade partners (Figure 8). Take Korea as an example. For the import weight, the numerator in the calculation is no longer China’s gross imports from Korea. Rather, it is the difference between: (i) imports from Korea that are consumed domestically by China; and (ii) imports from Korea that are re-exported to other countries (that is, excluding the returning re-exports).

Computed this way, Korea has a negative import weight in the example, reflecting the fact that depreciation of its currency indeed helps China’s price competitiveness. After the adjustment, the import weight for the US also drops, but the change is smaller relative to Korea, because processing trade makes up a smaller part in its total exports to China.

For export weights, the numerators in the calculation now only include domestic value-added by China. In the case of Korea, it is equal to 40 (China’s exports to Korea that are not related to processing trade) plus 55 (China’s domestic value-added exports to Korea associated with re-exports). The exclusion of the returning re-exports is easy to understand, because their costs in won remain unchanged. The non-returning re-exports (that is, re-exports to Korea that are originally imported from the US) are also excluded. This is because, although following a won depreciation they would become less competitive on the Korean market, the actual producer that is being affected is not China, but the original source country (in this case, the US).
The adjustments in Figure 8 would reduce the appreciation of China’s EER in period t from 19.8% (Figure 5) to 7.4%. Note that we do not rescale the total weights for Korea and the US back to 1. This is equivalent to applying a dampening factor to the EER movements, to correct the supply-chain bias.

Aside from this overall dampening factor, the exact difference between the unadjusted and adjusted EER indices also depends on the currency composition. In this example, Korea is the partner with higher processing trade share. The fact that it is also the partner with larger bilateral depreciation against the RMB is another reason why we see a big difference between the adjusted (7.4%) and unadjusted (19.8%) EER appreciations.

The DB-REER series in Figure 9 is an RMB REER index that corrects for the supply-chain bias, following the adjustments illustrated in Figure 8. It shows an appreciation of 18.7% since 2010, which is only 60 percent of the appreciation (31%) indicated by the BIS RMB REER index.

What has led to the difference between the two REER series? Comparing the currency baskets of the two indices, Korea and Taiwan stand out as two major partners with biggest drop in their adjusted weights. In our unadjusted basket, the weights for the Korea won and Taiwan dollar are 8.7 and 6.1, respectively. In the basket for DB-REER, however, their weights are only 1.7 and 0.8, respectively, less than 20 percent of the unadjusted weights. The DB-REER weights for other trade partners, such as Japan, the US and the euro area, also become smaller. The size of the change varies, depending on how important processing trade is in their total trade activities with China.

**Sector effective exchange rates**

**Sector effective exchange rates**

Aside from neglecting the complexity arising from global and regional supply chains, another major drawback of conventional EER indices as price competitiveness measures is that cross-sector differences are overlooked.

Why would cross-sector differences matter? Suppose China has two equally important trade partners, Korea and Germany (Figure 10). Both partners export 100 units of goods to China, but with different compositions: while 80 percent of Germany’s exports to China are cars and 20 percent are electronic products, it is the opposite for Korea.
Imagine a scenario where the Korea won depreciates 30% against the RMB, while the euro appreciates 30% against the RMB. A conventional EER index would suggest that such changes have no impact on China’s price competitiveness. Nonetheless, the real situation is that both the auto and electronics industries in China are facing drastic price competitiveness changes.

Figure 10: Example, why sector EERs are important

<table>
<thead>
<tr>
<th>Exports to China</th>
<th>Automobiles</th>
<th>Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Germany</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

We try to fill in this gap by compiling sector EER indices. Figure 11 explains how the sector EER indices relate to other more traditional exchange rate measures. In this example, if one wants to look at China’s price competitiveness versus an individual partner, bilateral exchange rate is the best measure. If one is concerned with China’s overall price competitiveness against all partners, then a traditional composite EER index should be used. If instead one is more interested in the price competitiveness of a certain sector in China, then a sector EER index would be the best measure to look at.

Sector EER is conceptually similar to the traditional composite EER, except that, in calculating partners’ basket weights, bilateral imports and exports of a certain product are used, instead of bilateral aggregate imports and exports.

Figure 12 presents five sector REER indices for China: automobile, textile, footwear, computer, and cell phone. There are clear differences among these sector EER indices. The automobile index shows the biggest appreciation since 2010, around 35%. The appreciations of the textile and footwear EER indices are smaller, around 32% and 30.5%, respectively. Computer and cell phone seem to be another group. Their EER appreciations are only 27% and 25%, respectively. Relative the automobile EER, their appreciations are about 25 to 30 percent smaller.
To give an idea on what makes the sector EERs different from each other, Figure 13 reports the currency weights for selected partners in the automobile and cell phone baskets. There is a clear contrast between two groups. The first group is the euro area and Japan. They both had very large bilateral depreciations against the RMB, and they both have much bigger shares in the automobile than in the cell phone basket. The US, Korea and Taiwan, on the other hand, all had much smaller bilateral depreciations against the RMB, and they all have much bigger shares in the cell phone than in the automobile basket. The difference between the two groups to a large extent explains the divergence between the automobile and cell phone REERs.

Correction of the supply-chain bias for sector EERs

Sector EER indices are not immune to the supply-chain bias discussed in the previous section. For some sectors, the problem is less acute. For instance, processing trade makes up only a small part of China’s automobile imports and exports. However, processing trade could be a much more serious issue for some other sectors. For example, according to our estimates, for both computer and cell phone, processing trade related imports and exports account for around 70 percent of China’s total trade of these products.

Correcting the supply-chain bias in sector EERs is a much more challenging task than the correction for the composite EER index. In addition to the obvious pain from huge amount of data work, one major conceptual obstacle is that processing trade at sector level does not necessarily follow the “same in, same out” rule. That is, for instance, metal products imported by China for processing trade purpose could leave China as part of a machine. This makes the decomposition of trade flows, as shown in Figures 8, less accurate.

Bearing this caveat in mind, and mainly for illustration purpose, we present the sector REER indices corrected for the supply-chain bias in Figure 14. Considering the varying importance of processing trade to each sector (Figure 15), it is not surprising that the adjustments make the cross-sector differences even bigger. For the auto industry, its adjusted EER index is not much different from the unadjusted one. Their appreciations between 2010 and 2015 are 35% and 32.5%, respectively. It is a quite different story for computer products, whose adjusted EER index appreciated only 10% during this period, or some 35 percent of the 27% appreciation of its unadjusted EER index.
It is also worth pointing out that, the appreciations of the adjusted computer and cell phone REERs are actually smaller than the RMB’s bilateral appreciation against any currency of China’s top trade partners. Among China’s major trade partners, the RMB appreciated the least in real terms against the Korea won (14%), but the appreciations of the adjusted computer and cell phone REERs are only 10% and 12.5%, respectively.

The fact that, after correction for the supply-chain bias, appreciation of an EER could be smaller than any bilateral appreciation shows that, due to the existence of global and regional supply chains, it is indeed possible for a country like China to benefit, on a net basis, from bilateral depreciations of its trade partners’ currencies.

Making puzzles less puzzling

EER indices adjusted for the supply-chain bias and sector EER indices provide better price competitiveness measures for China. This section shows a couple of examples of how they can make some puzzles less puzzling, if not solving them completely.

Korea and Taiwan’s missing from the CFETS RMB index

When the China Foreign Exchange Trade System (CFETS) RMB index was launched in December 2015, many were surprised to find out that Korea and Taiwan, two of China’s largest trade partners, were not included in the currency basket (Figure 16). The CFETS has not provided an explanation.

We do not know exactly why Korea and Taiwan are not in the basket, but our findings in this note show maybe their weights should be close to zero anyway. Before correction for the supply-chain bias, Korea and Taiwan are the fourth and fifth largest trade partners of China, respectively. Their combined weight for 2015 is around 14.8, putting them only after the US, but ahead of the euro area and Japan, as the second largest trade partner(s) of China.

After correcting for the supply-chain bias, however, the weights for Korea and Taiwan drop to 1.7 and 0.8, respectively, ranking no. 10 and no.19 among the basket of 41 currencies. This shows that, due to processing trade, the impact of the Korean won and Taiwan dollar on China’s overall competitiveness is much smaller than indicated by their gross trade with China.
China: rising REER with rising market share

As mentioned in the introduction, conventional measures suggest that China’s REER has appreciated over 30 percent since 2010, yet its exports still gained significant market share worldwide (Figures 1 and 2). Making it more striking is the contrast with Japan, whose REER has depreciated around 30%, yet its exports still kept losing market share.

One might argue that it was driven by China’s non-price competitiveness gains. Although this could be true to some extent, it is hard to think of it as the entire story, because the size of the implied non-price competitiveness gains by China would be huge, which is inconsistent with the general perception that China’s productivity growth has decelerated in recent years.

The adjustment for the supply-chain bias and a more careful look into sector development can help to give a more plausible story. At the aggregate level, DB-REER (Figure 9, our supply-chain bias adjusted index) shows that China’s true price competitiveness loss due to exchange rate appreciation was only about 60 percent of what was indicated by the conventional REER measure. The non-price competitiveness gains needed to offset the price competitiveness loss is therefore much smaller.

At a sector level, the telecommunication industry is one of the most relevant sectors. While accounting for only about 12% of China’s total exports, cell phone and other telecom products contributed more than 20% of China’s global market share gain in 2014. Although quick catch-up by domestic manufacturers such as Huawei certainly played a role, processing trade is perhaps still the most important factor. The impact of processing trade is two-fold. First, as shown in Figure 14, because of high share of processing trade, the cell phone industry suffered a much smaller price competitiveness loss relative to other sectors, such as automobile and textile. Second, which is also a point highlighted by our previous report (see: The Gravity of China, Part I, 11/24/2015), processing trade tends to overstate the market shares of the “processors”.

Together, the three factors — non-price competitiveness gains, less price competitiveness loss than appeared, and exaggerated global export market share — provide a much better explanation to China’s rising-REER-and-rising-market-share puzzle than non-price competitiveness does alone.

Diverging REERs since late 2011… Why?

Curious readers might wonder why the DB-REER index stayed very close with the BIS index until mid 2011 and only started to diverge from it since then (Figure 17).

The key difference between a conventional EER and one that is adjusted for the supply-chain bias is how they treat trading countries on a supply chain. To a conventional EER, they are only competitors; while the supply-chain bias

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**Figure 16: Currency basket of the CFETS RMB index**

<table>
<thead>
<tr>
<th>Currency Pair</th>
<th>USD/CNY</th>
<th>EUR/CNY</th>
<th>JPY/CNY</th>
<th>HKD/CNY</th>
<th>GBP/CNY</th>
<th>AUD/CNY</th>
<th>NZD/CNY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (%)</td>
<td>26.4</td>
<td>21.39</td>
<td>14.68</td>
<td>6.55</td>
<td>3.86</td>
<td>6.27</td>
<td>0.65</td>
</tr>
<tr>
<td>Currency Pair</td>
<td>SGD/CNY</td>
<td>CHF/CNY</td>
<td>CAD/CNY</td>
<td>CNY/MYR</td>
<td>CNY/RUB</td>
<td>CNY/THB</td>
<td></td>
</tr>
<tr>
<td>Weight (%)</td>
<td>3.82</td>
<td>1.51</td>
<td>2.53</td>
<td>4.67</td>
<td>4.36</td>
<td>3.33</td>
<td></td>
</tr>
</tbody>
</table>

Source: CFETS
adjusted EERs consider not only the competing relationship, but also the partnership among them.

This implies that, only when currencies of China’s major supply-chain partners start to show splitting trends from the RMB, we would see divergence between China’s adjusted EER and its conventional EER. That is exactly what happened since September 2011 (Figure 18). It was initially the Korean won and Taiwan dollar that showed relative weakening to the RMB. But since early 2012, the Yen has been the major driver of the divergence between the BIS index and our supply-chain bias adjusted DB-REER series.

Interpreting 2016 outlook of the RMB
There is a large chance that the RMB will depreciate 5% to 10% vs. the US dollar in 2016, and our baseline forecast of USDCNY at end-2016 is 7.0 (for more details, please see: How to think about tail risks in China, 01/05/2016). Does this mean that China is going to engage in a competitive devaluation?

Figure 19 presents an assessment using several different EER measures. Based on the DB EER basket, a 5% bilateral depreciation versus the US dollar would in fact lead to a 1.6% appreciation in the RMB NEER. Our baseline forecast implies a virtually unchanged RMB NEER in 2016. Only when the RMB depreciates 10% versus the dollar, it would “achieve” an effective depreciation of some 1.3%. In other words, the seemingly large bilateral depreciations vs. the US dollar actually imply a fairly stable RMB (approximately ±1.5% in real EER terms, considering the slightly higher projected CPI for China).
Concluding remarks

We are not the first ones trying to disentangle the supply chain and refine the EER indices to better measure price competitiveness. In fact, there has been a large academic literature on this topic, for instance, see Bayoumi et al. (2013), Patel, Wang and Wei (2014), and Bems and Johnson (2015).

Nonetheless, what we did in this report is a step forward. First, our EER basket is the only one in the market that controls for the supply-chain bias explicitly. Investors in the market usually refer to the BIS REER which does not control for such bias. The difference between the two indices is significant.

Second, our REER index can be maintained and regularly updated based on the latest trade data. Most academic studies on this topic are based on the World Input-Output Database (WIOD). While fascinating theoretically, the WIOD also ties the hands of those using it, because the world input-output table depends on a lot of assumptions, and more importantly, the information comes with significant time lag: the latest available world input-output table is for 2011, which is already five or six iPhone generations old.

The adjustments for the supply-chain effect in this report depend on our proprietary processing trade model for China. While forcing us to narrowly focus on China, it allows us to produce more accurate and up-to-date estimates.

Lastly, we provide the first set of REERs on sector level. To our knowledge this has not been done in academia or in the market. While this may not be a big innovation in methodology, it matters in practice. For investors and policy makers who care about industry specific competitiveness, the sector level REERs are much more informative.

This is not to say that our EER measures are perfect though. For instance, as acknowledged earlier, we do not have a perfect solution yet for the product mismatch problem when correcting the supply-chain bias for sector EER indices. There are also many interesting but unanswered questions, for example, how competitive a regional supply chain (the East Asia one) is relative to another (the German supply chain). Our aim is to maintain and regularly update the EER indices we developed here while keep refining them.

Reference


Appendix 1

Important Disclosures

Additional information available upon request

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<tr>
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