Validity of Absolute Purchasing Power Parity in G7 Countries

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Abstract. In popular studies, the theory of relative purchasing power parity (PPP) is tested for the real exchange rates (RERs) that are constructed by price indexes. In this paper, we construct the bilateral RERs by general price levels and study the absolute PPP theory in G7 countries. Coefficient restriction and RER misalignment distribution tests reveal that absolute PPP holds for the RERs of Canada, France, Germany, and Japan against the US in the whole samples. For the RERs of Italy and the UK against the US, we find the Balassa-Samuelson effect’s modification to the absolute PPP theory in the sub-samples.

1. Introduction

The theory of purchasing power parity (PPP) dominates the determination of exchange rate and is tested by extensive studies (Rogoff \cite{1}; Sarno and Taylor \cite{2}). In popular studies (e.g., Lothian and Taylor \cite{3}; Cheung et al. \cite{4}; Koedijk et al. \cite{5}; Bergin et al. \cite{6}; Huang and Yang \cite{7}), the real exchange rates (RERs) are constructed by consumer, producer, wholesale, and other price indexes, rather than actual price levels. Thus, such constructed RER in these studies is used in testing relative PPP rather than absolute PPP (Crownover et al. \cite{8}; Zhang and Zou \cite{9}).

Through a search of the literature, we find that the papers focusing on relative PPP are countless, but the papers focusing on absolute PPP are very few. Relative PPP has been thoroughly studied in terms of validity, convergence, and linearity or non-linearity. In contrast, absolute PPP has been scarcely studied. Concretely, the validity of absolute PPP in G7 countries has been scarcely known since Crownover \cite{8}. Zhang and Zou discuss absolute PPP of the 40 biggest countries against the US using panel data \cite{9}. However, the panel data dimension cannot tell us whether or not absolute PPP holds between a pair of countries. That is, the validity of absolute PPP in pairs of G7 countries is beyond their scope. Therefore, in this paper we construct the RER by price levels and use the time-series data to study the validity of absolute PPP in pairs of G7 countries.

The rest of the paper proceeds as below. Section 2 presents the definition, method and data. Section 3 and Section 4 present the econometric results. Section 5 concludes the paper.

2. Definition, Methodology and Data

2.1 Definition

In this paper, we follow Zhang and Zou to define the RER \cite{9}. Concretely, the RER is defined by Eq. 1, where \( P_i \) is the domestic (general) price level of country \( i \), \( P^* \) is the price level of the specific foreign country (in this paper, the United States), \( PPP_i \) rate is \( P_i \) divided by \( P^* \), and \( NER_i \) (nominal exchange rate) is expressed as the national currency units per US dollar. In this definition, a greater value of \( RER \) represents the local currency’s appreciation (against the US dollar).

Absolute PPP says that a bilateral nominal exchange rate should be equal to its PPP rate or two countries’ price levels should be equal when denominated in the same currency (Rogoff \cite{1}; Sarno and Taylor \cite{2}). Concretely, if the PPP rate is equal to the NER (or the RER is equal to one) in Eq. 1, APPP holds; if the PPP rate is not equal to the NER in Eq. 1, APPP does not hold.
\[
RER_t = \frac{PP_{t}}{NER_t} = \frac{P_t}{P^*} = \frac{P_t}{NER_t \times P^*}
\]

(1)

2.2 Methodology

Though the unit root and cointegration tests are used in relative PPP, they are not appropriate in testing absolute PPP. Crownover et al. said, “Testing for absolute PPP can only be accomplished by testing for the equality between the nominal exchange rate and the ratio of price levels” [8]. They empirically tested absolute PPP by estimating coefficients and examining coefficient restrictions. Further, Zhang and Zou discussed which econometric method should be used in testing absolute PPP [9]. They used empirical evidences and an example to prove that the unit root test is not sufficient in testing absolute PPP. Thus, in this paper, we use the coefficient restriction and the RER misalignment distribution tests proposed by Crownover et al., Zhang and Zou [8,9].

Concretely, we use the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test to examine whether the NER and PPP rate series are stationary or not. If both the NERs and PPP rates are stationary, we use OLS with Newey-West robust standard error to estimate Eq. 2. If they are not stationary, we apply the Engle-Granger method to Eq. 2 to test for a cointegration relationship between them. If the Engle-Granger test indicates that they are cointegrated, FMOLS with Bartlett kernel and Newey-West fixed bandwidth is used. For the coefficient restriction test in Eq. 2, we follow Zhang and Zou [9] and use the Wald test. If the \( p \)-value for the \( \chi^2 \) statistic in the Wald test is greater than a usual significant level (1%, 5%, or 10%), we accept the null hypothesis \( \beta_0 = 0 \) and \( \beta_1 = 1 \) and accept the absolute PPP theory. Second, we test whether the RER misalignment (= \( RER - 1 \)) is a normal distribution with zero mean. According to Zhang and Zou [9], for the PPP theory to hold, the RER misalignment should be near a normal distribution with a mean of zero, which means that the NER fluctuates around the PPP rate. In the norm distribution test, if the \( p \)-value for the Jarque-Bera (JB) statistic is greater than a usual significant level, we accept the null hypothesis that the misalignment is a normal distribution.

\[
NER_t = \beta_0 + \beta_1 PPP_t + u_t
\]

(2)

2.3 Data

We follow Zhang and Zou [7] in collecting the data. That is, all data are from the World Bank’s World Development Indicators (WDI) online database and University of Pennsylvania’s Penn World Table (PWT) 7.1 online database. The bilateral RERs are of the six countries (Canada, France, Germany, Italy, Japan, and United Kingdom) against the United States. The WDI supplies the RER (the variable “PPP conversion factor to official exchange rate ratio” in the database) in 1980-2012. The PWT supplies the RER (the variable “p” divided by 100 in the database) in 1950-2010. But the concrete values of the RERs in the two databases are not completely the same. Thus, we combine a RER’s value in 2010 in the PWT and its growth ratio in 2011-2012 in the WDI to obtain the consistent values in 2011-2012. Such obtained values of a RER in 2011-2012 and those in 1950-2010 in the PWT constitute the total values in the whole period 1950-2012. For Euro countries, the NERs before 1998 have been adjusted to be consistent with those after 1999 (when changed to Euros) in the PWT 7.1, so the consistent RERs can also be obtained. The available whole sample for Germany is 1970-2012, and those for the other countries are all 1950-2012.

3. Econometric Analysis in the Whole Samples

As a preliminary, we first test the stationarity of the series. For Canada, Italy, and Japan, both the NERs and PPP rates are I(0), so cointegration tests are skipped and OLS regressions are used. For France, Germany, and the UK, both the NERs and PPP rates are I(1), but they are cointegrated, so FMOLS regressions are used. The relevant results are given in Table 1, where the unit root and cointegration tests are trivial and are omitted.
Table 1. Test the absolute PPP theory in the whole samples.

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample</th>
<th>Coefficient estimation</th>
<th>Wald test for $\beta_0 = 0$ and $\beta_1 = 1$:</th>
<th>Descriptive statistic test for the RER misalignment:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\beta_0$</td>
<td>$\beta_1$</td>
<td>Chi-square statistic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
</tr>
<tr>
<td>Canada</td>
<td>1950–2012</td>
<td>-0.214</td>
<td>1.247</td>
<td>6.138</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.346)</td>
<td>(0.000)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>France</td>
<td>1950–2012</td>
<td>0.232</td>
<td>0.739</td>
<td>5.777</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.034)</td>
<td>(0.000)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Germany</td>
<td>1970–2012</td>
<td>-0.314</td>
<td>1.356</td>
<td>2.798</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.234)</td>
<td>(0.000)</td>
<td>(0.247)</td>
</tr>
<tr>
<td>Italy</td>
<td>1950–2012</td>
<td>0.176</td>
<td>0.847</td>
<td>161.277</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Japan</td>
<td>1950–2012</td>
<td>17.443</td>
<td>1.238</td>
<td>7.559</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.850)</td>
<td>(0.010)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>UK</td>
<td>1950–2012</td>
<td>0.197</td>
<td>0.694</td>
<td>49.410</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

Notes: The values in parentheses are the p-values.

Sources: The PWT 7.1, the WDI, and the authors' calculations.

For Canada, $\beta_0 = -0.214$, $\beta_1 = 1.247$, the Wald test cannot reject the null hypothesis of $\beta_0 = 0$ and $\beta_1 = 1$ at the 1% level, and the RER misalignment is a norm distribution with a mean of near zero (-0.041). Therefore, for Canada, both the Wald test and the RER misalignment distribution test give the same conclusion that absolute PPP holds. Similarly, for France, Germany, and Japan, the Wald test and the RER misalignment distribution test also indicate that absolute PPP holds.

For Italy, however, the Wald test rejects the null hypothesis of $\beta_0 = 0$ and $\beta_1 = 1$; and the RER misalignment is a norm distribution but with a mean of -0.24 (much smaller than zero). Therefore, the coefficient restriction and RER misalignment distribution tests reject absolute PPP. The conclusion about the UK is similar to that on Italy.

In summary, in the whole samples, absolute PPP holds for Canada, France, Germany, and Japan, but not for Italy and the UK.

4. Econometric Analysis in the Sub-samples

It is well known that the Balassa-Samuelson effect (BS effect hereafter) would cause absolute PPP to be invalid, which can be seen from Table 3 and Figure 3 in Rogoff [1]. Thus we wonder in the cases of the two countries (Italy and the UK) where absolute PPP does not hold in the whole samples, whether absolute PPP holds in the sub-samples (whether the BS effect influences the validity of absolute PPP).

To examine this issue we divide each whole sample by two sub-samples according to each country’s GDP per capita relative to the US (the US = 1). Before performing the Wald coefficient restriction test, we still need to test the stationarity of the NER and PPP rate series. If both the NER and PPP rate are I(0), OLS is used. If the NER and PPP rate are I(1) and cointegrated, FMOLS is used. The results are listed in Table 2.
Table 2. Test the BS effect’s modification to the absolute PPP theory in the sub-samples.

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample</th>
<th>Wald test for $\beta_0 = 0$ and $\beta_1 = 1$: Chi-square statistic ($p$-value)</th>
<th>Descriptive statistic test for the RER misalignment:</th>
<th>Relative GDP per capita (the US = 1):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean JB statistic ($p$-value)</td>
<td>Mean (Rang (Min., Max.))</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>1950-1970</td>
<td>14028264 (0.00)</td>
<td>-0.458 (2.406 (0.300))</td>
<td>0.54 (0.40, 0.70)</td>
</tr>
<tr>
<td>Italy</td>
<td>1971-2012</td>
<td>5.375 (0.068)</td>
<td>-0.128 (2.490 (0.288))</td>
<td>0.74 (0.65, 0.82)</td>
</tr>
<tr>
<td>UK</td>
<td>1950-1980</td>
<td>203.111 (0.000)</td>
<td>-0.270 (49.035 (0.000))</td>
<td>0.68 (0.64, 0.73)</td>
</tr>
<tr>
<td>UK</td>
<td>1981-2012</td>
<td>5.591 (0.061)</td>
<td>-0.025 (2.414 (0.299))</td>
<td>0.75 (0.65, 0.83)</td>
</tr>
</tbody>
</table>

Notes: The values in parentheses are the $p$-values.
Sources: The PWT 7.1, the WDI, and the authors’ calculations.

From Table 2, we can see an interesting phenomenon. For Italy, from 1950-1970 to 1971-2012, as the relative GDP per capita increases (both in the mean, from 0.54 to 0.74, and in the range, from 0.40 to 0.65 in the minimum and from 0.70 to 0.82 in the maximum respectively), the Wald test changes from rejecting the null hypothesis to accepting it, and the RER misalignment changes from being a normal distribution with a mean of -0.46 to being a normal distribution with a mean of -0.13 (which is more near a normal distribution with zero mean). A similar phenomenon appears in the UK. That is, for the two countries, when the GDP per capita is lower (in the period 1950-1970 for Italy and in the period 1950-1980 for the UK), absolute PPP does not hold. However, when the GDP per capita is higher (in the period 1971-2012 for Italy and in the period 1981-2012 for the UK), absolute PPP is more valid or holds. This gives an indication of the BS effect’s modification to the absolute PPP theory.

5. Conclusion

Zhang and Zou (2014) investigate a panel including 40 main bilateral RERs against the US dollar, absolute PPP does not hold according to coefficient constriction and RER misalignment distribution tests. In this paper, when the theory is investigated country by country and in a time-series dimension, we find more concrete conclusions. That is, absolute PPP holds for four countries (Canada, France, Germany, and Japan) and it does not hold for the other two countries (Italy and the UK) in the whole sample. In addition, for the two countries (Italy and the UK) where absolute PPP does not hold in the whole sample, when the BS effect is considered, it does hold in their higher income level sub-samples, which indicates the BS effect’s modification to this theory.

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