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Purchasing Power Parity and aggregation bias for a developing country: The case of Mexico[☆]

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ABSTRACT

This paper investigates long-run Purchasing Power Parity (PPP) between the US and Mexico. We use a panel of disaggregated price data between the US and Mexico with a long time series to look at two types of aggregation bias. The first is examined in Imbs et al. — which we refer to as estimator aggregation bias — and the second is put forth by Broda and Weinstein — hereafter, data aggregation bias. The findings indicate substantial estimator aggregation bias and data aggregation bias. Although estimates using aggregate data and imposing homogeneous coefficients provide little evidence of PPP, findings with disaggregated data and heterogeneous coefficient estimators offer strong support. The results also suggest the presence of small-sample bias as examined in Chen and Engel, but with little effect on the qualitative results. Tradable goods and non-tradable goods show little distinction in convergence rates. Estimated half-lives are lower under flexible than fixed exchange rates and indicate rapid convergence during the Mexican peso crisis.

1. Introduction

Expanding trade agreements, availability of new data, and advancements in econometric techniques have led to renewed interest in the long-standing debate surrounding Purchasing Power Parity (PPP). Reviews by Froot and Rogoff (1995), Rogoff (1996), and Goldberg and Knetter (1997) highlight the interest and remaining puzzles in this literature. In particular, Taylor and Taylor (2004) identify aggregation bias as a critical, although not necessarily new, issue in the PPP debate. Isard (1977) and Parsley and Wei (2003) suggest that aggregation bias plays a significant role in explaining the relatively weak empirical support for PPP.[1]

In the context of empirical investigations of PPP, several sources of bias have emerged. Imbs et al. (2005a) emphasize aggregation bias due to failing to take into account parameter heterogeneity in estimation, resulting in inflated estimated half-lives. We refer to this bias as "estimator aggregation bias".[2] Broda and Weinstein (2007) examine the existence of aggregation bias in PPP, also reflected in overly high estimated half-lives, from using aggregated price level data. We designate this type of bias as "data aggregation bias". A third type of bias, which we call "small sample bias", comes from Chen and Engel (2005). They contend that failing to account for small-sample properties leads to downward bias in estimated half-lives.

This paper examines long-run PPP between the US and Mexico. Our study contributes to the debate over the role of the relative importance of the different types of bias in estimates of PPP convergence. The issue remains contentious. Imbs et al. (2005a), based upon estimates from two panels of real exchange rates across a sample of countries in the European Union, find evidence of substantial estimator bias. However, Chen and Engel (2005), in addressing Imbs et al. (2005a), contend that other factors such as small-sample bias carry more importance. Imbs et al. (2005b) counter these claims. The authors reiterate the importance of estimator aggregation bias in the PPP puzzle and point to the importance of accounting for common effects in the residuals. Broda and Weinstein (2007) examine PPP using several datasets with the US and Canada, including one with highly disaggregated barcode

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[1] Empirical evidence on the importance of aggregation bias, though, is not uniform. For example, Richardson (1978) uses disaggregated goods categories (e.g. fruits and vegetables) but finds little role for aggregation.

[2] Imbs et al. (2005a,b) refer to this behavior as "sectoral aggregation bias". We use the term "estimator aggregation bias" instead. We feel that the latter term more directly distinguishes this type of bias from the one that results from using aggregated data as studied in Broda and Weinstein (2007).

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data. Their evidence indicates modest estimator aggregation bias in estimated half-lives, but more substantial data aggregation bias. Our study investigates the importance of all three sources of bias as applied to the Mexican case.

We do so using an uncommonly comprehensive panel dataset with a large time span. The data consist of seasonally-adjusted Mexican and US price levels at five different levels of aggregation, all at a monthly frequency, and cover a 13-year period. The most disaggregated level is made up of specific goods (e.g. taxi cab rides, eggs, rum, children's clothes). The levels of disaggregation are comparable to those of Parsley and Wei (2003), Crucini and Shintani (2006), and Broda and Weinstein (2007), while the time series frequency correspond to Imbs et al. (2005a). Parsley and Wei (2003) and Crucini and Shintani (2006) use detailed product-level data from the Economist Intelligence Unit. These data, however, are only available annually and may suffer from problems related to temporal aggregation (e.g. Pesaran and Smith 1995). The datasets in Broda and Weinstein (2007) each have a large cross-sectional dimension but small time span. Imbs et al. (2005a,b) employ monthly data but at a relatively aggregated (2-digit) level. As a result, their cross-sectional dimension includes observations across countries.

Our data allow us to employ several panel estimation techniques for estimating half-lives. This enables us to carefully investigate the importance of estimator aggregation bias and data aggregation bias, especially as it pertains to PPP between the US and Mexico. The estimations contain findings from a homogeneous coefficient estimator, two heterogeneous coefficient estimators, and a heterogeneous coefficient estimator that allows for common correlated effects in the residuals. Our study performs a systematic review of the importance of each type of aggregation bias. We also examine the importance of small-sample bias, following Chen and Engel (2005). As suggested in Imbs et al. (2005b), we present bias-corrected estimates of half-lives using a direct nonparametric bootstrap approach.

The empirical results can be summarized as follows. We find the magnitude of both estimator aggregation bias and data aggregation bias to be substantial. In general, the movement from the homogeneous coefficient estimator to the heterogeneous coefficient estimator brings about non-trivial decreases in estimated half-lives. Especially noticeable decreases in turn are obtained from accounting for common correlated effects. These results generally hold for any level of data aggregation. Similarly, each successive movement to more disaggregated data tends to produce more supportive results in testing PPP. Evidence on the importance of data aggregation bias occurs for each estimator.

In this regard, the results present a striking contrast regarding the evaluation of whether PPP holds for the US and Mexico. Although estimations with homogeneous coefficients and relatively aggregated data provide little support for PPP, results with heterogeneous coefficient estimators, common correlated effects, and disaggregated data provide evidence favoring PPP. For example, moving from the pooled fixed effect estimator with the most aggregated data to the mean group estimator with common correlated effects and the most disaggregated data results in a change in the estimated half-life from 140 months to 7 months. These results are robust to the existence of outliers and possible measurement error in the data. We also find that the magnitude of small-sample bias bears some importance but has little effect on the overall results. Small-sample bias generally results in increases of estimated half-lives of less than two years. In addition, the qualitative evidence regarding the existence of PPP between the US and Mexico is robust to estimations considering small-sample bias.

We also investigate the estimated half-lives that result from splitting the sample. Our findings indicate little difference in estimated half-lives between tradable and non-tradable goods. This result corresponds to Imbs et al. (2005a) but differs from several other studies such as Crucini and Shintani (2006). Dividing the sample along the time dimension generates much more noticeable deviation. Our evidence points to lower long-run convergence rates in moving from a fixed exchange rate to a flexible exchange rate regime and considerably smaller half-lives during the Mexican peso crisis. Overall our study calls for the importance of testing PPP with the most disaggregated data possible, preferably goods-level data, and making the necessary econometric adjustments. It also presents strong support for US-Mexican market integration.

The paper proceeds as follows. Section 2 describes the problems of aggregation bias and small-sample bias in testing for PPP. A discussion of the data appears in Section 3. Section 4 reports empirical results. The paper ends with a conclusion in Section 5.

2. Purchasing Power Parity (PPP) and aggregation bias

Our discussion of estimator aggregation bias uses the framework in Imbs et al. (2005a). Suppose that the Mexican and US economies each have M goods. Each good is assigned to one of N sectors (e.g. lettuce and food), with the jth sector containing M_j goods. For the ith good in the jth sector at date t, the stationary logarithm of the real exchange rate (q) behaves according to

$$q_{i,j,t} = \theta_{i,j} + \lambda_{i,j} q_{i,j,t-1} + \varepsilon_{i,j,t}, \tag{1}$$

where $\varepsilon_{i,j,t}$ are non-serially correlated residuals with variance σ_j^2, for $i=1,2,\ldots,M_j$, $j=1,2,\ldots,N$, and $t=1,2,\ldots,T$. As in Imbs et al. (2005a), we use a first order autoregressive (AR) process for expositional purposes although their results readily apply to higher order AR specifications. Suppose also that the $\lambda_{i,j}$ vary across goods within their sector according to

$$\lambda_{i,j} = \lambda_j + \eta_{i,j}, \tag{2}$$

where the goods-specific component $\eta_{i,j}$ has mean zero and finite variance.

Substituting (2) into (1) for $\lambda_{i,j}$, the resulting equation can be expressed in terms of sectoral level real exchange rates as:

$$\bar{q}_{j,t} = \bar{\theta}_j + \lambda_j \bar{q}_{j,t-1} + \bar{v}_{jt}, \tag{3}$$

where

$$\bar{v}_{j,t} = \bar{\varepsilon}_{j,t} + \left(1/M_j\right) \sum_{i=1}^{M_j} \eta_{i,j} q_{i,j,t-1}, \tag{4}$$

$\bar{q}j,t = (1/M_j) \sum_{i=1}^{M_j} q_{i,j,t}$, with $\bar{\theta}_j$ and $\bar{\varepsilon}_{j,t}$ defined analogous to $\bar{q}_{j,t}$.

Eqs. (3) and (4) reveal how estimator aggregation bias occurs. Under unaccounted-for heterogeneity across parameters within a sector, the residual in (3) includes the lagged dependent variable. Therefore, estimation using panel data methods that impose parameter homogeneity results in inconsistency. Imbs et al. (2005a) demonstrate that under plausible assumptions this bias leads to inflated estimates of half-lives.

Broda and Weinstein (2007) argue that bias in estimated half-lives can occur due to aggregation in the data. This arises from the presence of nonlinearities in response to shocks. In particular, they report that the rate of convergence tends to be slower for goods that experience small shocks but considerably more rapid for those that incur large shocks. On intuitive grounds the authors argue that if price differentials are small, gains from arbitrage are likely to be minimal and these differentials can persist for a long time. On the other hand, producers may find it more difficult to maintain substantial price differentials for extended periods of time. The presence of both types of goods within a sector leads to data aggregation bias.

To illustrate this source of bias, we present the following example. Suppose that the jth sector, which has M_j goods, can be partitioned into two subsectors. One subsector consists of m_j goods that have fast convergence rates and large shocks with m_j being close in magnitude to M_j. The (M_j-m_j) goods in the other subsector each have slow convergence rates and small shocks. Letting q^F and q^S denote respectively the