



# Testing purchasing power parity for Japan and the US: A structural-break approach



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## ABSTRACT

In this work we empirically assess the weak and strong forms of purchasing power parity (PPP) hypothesis for the economies of Japan and US. Monthly data for the, traded-goods price indices and the JPY/USD exchange rate are employed for the, period from January 2000 to October 2012. This period includes large shocks, such as, the US subprime crisis and the 2011 Tsunami in Japan. We take into account possible, structural shifts and breaks by employing the class of Lee and Strazicich (2003, 2004) unit, root tests. Empirical analysis suggests that a break corresponding to the start of the US subprime crisis is not rejected. Furthermore, utilizing the Gregory and Hansen (1996) and, Hatemi (2008) cointegration methodologies, the weak form of PPP is not rejected. We, also test the strong PPP hypothesis by using Dynamic Ordinary Least Squares, (DOLS). The empirical evidence rejects the strong form of PPP for the period, preceding the US subprime crisis in contrast to the period after.

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## 1. Introduction

During the last two decades, considerable effort has been put into testing the validity of purchasing power parity (PPP) hypothesis. In principle, PPP is considered to be a long-term phenomenon, while various types of rigidities can distort the PPP relationship in the short run. The long-run relationship or weak form of PPP can be investigated using unit root and cointegration tests, as well as nonlinear methods. Studies focusing on the weak form of PPP include those of Chang et al. (2012), Wallace and Shelley (2006), Taylor and Taylor (2004) and Lothian and Taylor (2000, 2008) among others. Although there may be a tendency for exchange rates and price ratios to move in equilibrium over long periods of time, this relationship does not necessarily hold in the short-run. The seminal paper of Pedroni (2001) tests the short-run relationship or strong form of PPP using fully modified and dynamic OLS techniques for twenty countries and produces an overwhelming rejection of the strong PPP hypothesis.

Another important issue on which many previous studies focused is the validity of PPP after taking into consideration major

economic, financial and currency shocks. For example, Zumaquero and Urea (2002) employed bivariate systems for European countries and located three different breaks corresponding to the oil shock, the beginning of the European Monetary System (EMS) and the general crisis of EMS in 1992. This evidence suggests that strong depreciations or appreciations of the exchange rate lead to international relative price adjustment. Papell (2000) models the appreciation/depreciation of the dollar in the 80s as shifts in the deterministic components of the series.

However, to our knowledge, so far no study has examined empirically the weak and strong PPP hypotheses among US and Japan taking into account both the US subprime crisis and the 2011 Tsunami in Japan. Studies that tested the PPP hypothesis between these two markets have produced mixed and contradictory results. Chang et al. (2010) apply a panel SURKSS to test the PPP hypothesis using monthly data for G7 countries over the period from January 1980 to September 2008. Wallace and Shelley (2006) employ the Fisher and Seater (1993) methodology and finally reject the weak PPP hypothesis for Japan and the US. Their dataset includes one hundred years of annual observations through 1996. Pedroni (2001) empirically investigates the PPP theory in twenty countries using cointegrated panels of post Bretton Woods data. Applying the DOLS and the FMOLS methodology he rejects the strong PPP theory for the US and Japan. On the contrary, Chang et al. (2012) testing the long-run PPP via a nonlinear KSS test for G7 countries do not reject the strong PPP.

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In the present work we focus on the last turmoil decade taking into account shocks such as the US subprime crisis, Bank of Japan currency interventions and Japan's 2011 Tsunami. The economies of US and Japan pair exert a significant impact on the rest of the world. Together they account for over 30% of world domestic product, while their bilateral economic relationship, via trade and capital flows, can influence economic conditions in other countries (see e.g. Dimitriou and Simos, 2013).

We empirically investigate the above issues, for the period January 2000–October 2012 by employing the Lee and Strazicich (2003, 2004), Gregory and Hansen (1996) and Hatemi (2008) econometric techniques to endogenously identify the structural breaks in unit roots and cointegration structure. The results suggest that the weak PPP hypothesis is not rejected for the US and the Japanese economies. We proceed our analysis by testing the strong PPP hypothesis through dynamic OLS (DOLS), taking into account the US subprime crisis which seems to be empirically dominant.

The rest of the paper is organized as follows. Section 2 presents an overview of the two markets. Section 3 describes the dataset and the dynamic relationship between exchange rates and prices, while Section 4 presents the econometric methodology. In Section 5, we interpret the empirical results whereas Section 6 concludes.

## 2. Overview of the two markets

An overview of some key macroeconomic characteristics is displayed in Table 1. As is shown, the US – Japanese bilateral trade in goods and services has increased over time, is declined significantly in 2009, however, because of the subprime crisis. The pace of US – Japan trade picked up in 2010. US imports from Japan consist mainly of technological parts and machinery. However, US exports to Japan are much more diverse. A major portion of these exports are computers and agricultural products, such as wheat and meat. Moreover, as Table 2 indicates, the services trade turnover is modest relatively to trade in goods turnover. The US has realized surpluses in its bilateral trade in services with Japan. Along with trade in goods and services, Foreign Direct Investment (FDI) in manufacturing facilities, real estate etc., as well as portfolio investments (i.e., investments in government securities, corporate stocks and bonds and bank deposits) between residents of the US and Japan also define the strong economic relationship for these economies (see Table 3). The value of portfolio and direct investments between the US and Japan exceeds the value of trade in goods and services. In addition, investments, particularly FDI, signify a long-term financial commitment on the part of the investor.

Because of the growth in the US federal budget deficit, Japan has consistently been among the largest sources of FDI in the US. From 2000 to 2009, the Japanese FDI in the US has more than doubled.

**Table 1**  
Japan merchandise trade with US, 2000–2010 (billions of \$US).

Year	Japan imports	Japan exports	Trade turnover	Japan balances
2000	64.9	146.5	211.4	81.6
2001	57.5	126.5	184.0	69.0
2002	51.4	121.4	172.8	70.0
2003	52.1	118.0	170.1	66.0
2004	54.4	129.6	184.0	75.2
2005	55.4	138.1	193.5	82.7
2006	59.6	148.2	207.8	88.6
2007	62.7	145.5	208.2	82.8
2008	66.6	139.2	205.8	72.3
2009	51.2	95.9	147.1	44.8
2010	60.5	120.3	180.8	59.8

Source: US Department of Commerce, Bureau of the Census.

**Table 2**  
Japan trade in services with US, 2001–2010 (billions of \$US).

Year	Japan imports	Japan exports	Trade turnover	Japan balances
2001	30.5	18.0	48.5	–12.5
2002	30.4	18.9	49.3	–11.5
2003	30.1	20.0	50.1	–10.2
2004	36.0	21.3	57.3	–14.8
2005	42.5	23.8	66.3	–18.7
2006	42.0	25.5	67.5	–16.5
2007	41.2	26.2	67.4	–15.0
2008	42.3	25.7	68.0	–16.6
2009	41.4	22.9	64.3	–18.5
2010	46.6	26.6	73.2	–20.0

Source: US Department of Commerce, Bureau of the Census.

These macroeconomic key characteristics support the strong bidirectional financial, trade and economic relationship and motivate us to further investigate the PPP issue.

## 3. Data and the dynamic relationship between exchange rates and prices

The following data are used in the analysis: traded-goods price indexes (TPI) and Japanese yen to US dollar (JPY/USD) exchange rate. We prefer a traded-goods price index to the commonly used consumer price index (CPI), because the latter might have caused distortions to our analysis, since it takes into account nontradables, such as housing and local services. All indexes are obtained from DataStream. Following the approach of Xu (2003), the traded-goods price indexes are constructed as follows:

$$P_t = \left( \frac{EX_t}{IM_t + EX_t} \right) EXP_t + \left( \frac{IM_t}{IM_t + EX_t} \right) IMP_t \quad (1)$$

where  $EX_t$  and  $IM_t$  are the level of exports and imports at time  $t$ , and  $EXP_t$  and  $IMP_t$  are the export and import prices at time  $t$ . All data are monthly and cover the current floating rate period from January 2000 to October 2012, a total of 154 observations. Following Hakkio's (1992) methodology, we obtain spot exchange rate deviations as the difference between the actual exchange rate and an implied relative PPP equilibrium exchange rate. According to relative PPP, the spot exchange rate between two countries' currencies should be proportional to the ratio of price levels in the two countries:

$$S_t = \Phi \frac{P_t^{\text{Japan}}}{P_t^{\text{US}}} \quad (2)$$

where  $P_t^{\text{Japan}}$  is the price level in Japan at time  $t$ ,  $P_t^{\text{US}}$  is the price level in the US at time  $t$ ,  $S_t$  is the JPY per USD exchange rate at time  $t$ , and  $\Phi$  is a constant that represents all forces that prevent absolute

**Table 3**  
Japanese – US Foreign Direct Investments (FDI) Positions, 2000–2009 (billions of \$US – historical cost basis).

Year	Japanese FDI in US	US FDI in Japan
2000	159.7	57.1
2001	149.9	55.7
2002	147.4	66.5
2003	157.2	57.8
2004	175.7	68.1
2005	190.3	75.5
2006	204.0	84.4
2007	229.4	85.2
2008	259.8	101.9
2009	264.2	103.6

Source: US Department of Commerce, Bureau of the Census.

Note. FDI indices are cumulative.

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