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ABSTRACT

This paper "goes back to basics" in empirical analysis of the J-Curve. First, we document strong violations in the distributional assumptions that underlie nearly all previous work on this issue. Second, we employ distribution-free, non-parametric statistical tests to characterize the data and summarize the key relationships between real exchange rates, the current account, and real GDP. We find some (weak) evidence of a J-Curve in the data. Interestingly, however, we document that this evidence is not consistent with the standard theoretical explanation of the J-Curve. Consequently, our empirical results pose a strong challenge for international economic theory.

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1. Introduction

Financial and economic news reporters frequently include interviews with or quotations from economists that proclaim a connection between exchange rates and current accounts. Most economists assert that a J-Curve phenomena characterizes the data: that currency depreciation leads initially to current account deficits and subsequently to current account surpluses. Actual empirical studies on this issue, however, have shown a very mixed set of results.

Krugman and Baldwin (1987) find evidence of a J-Curve with an initial phase of current account deficits (following depreciation) that lasts about four quarters. Similarly, Foray and McMillan (1999) present evidence of a J-Curve. Their VAR results for the U.S. and a European aggregate, building on work by Eichenbaum and Evans (1995), indicate that a negative monetary shock reduces real GDP for about 1-1/2 years, generates currency appreciation for about half a year, and creates a trade balance surplus for about 1 1/2 years, followed by trade deficits after that. This gives a typical J-Curve.

On the other hand**,** Moffett (1989) finds *no* evidence for the J-Curve for the United States. Similarly, Rose and Yellin (1989) find no reliable evidence of a J-Curve in 25 years of American data; in fact they "robustly" reject the J-Curve hypothesis with U.S. data, finding "no convincing evidence that a currency depreciation causes a trade deficit in the short run either in bilateral or aggregate U.S. data," and "little evidence of a reliable long run relationship between the exchange rates and a trade balance."

Backus, Kehoe, and Kydland (1994) take a more general-equilibrium view of the problem, pointing out that the relation depends critically on the *source* of fluctuations. Their empirical results show that the trade balance is counter-cyclical and is generally *negatively* correlated with *current* and *future* changes in the terms of trade, but *positively* correlated with *past* changes in the terms of trade. Our statistical approach and empirical results complement theirs and add to the theoretical challenge of finding a model (including sources of distrubances) that can quantitatively reproduce the relations in the data.

A standard theoretical explanation has emerged for the (alleged) J-Curve in the data. A currency depreciation, in the presence of little or no offsetting changes in nominal price levels, raises the relative price of imports to home buyers and reduces the relative price of home exports to foreign buyers. In the short run, the quantity of goods imported and exported may be largely predetermined by previously-signed trade contracts, so the fall in the *value* of a given quantity of home exports creates a trade deficit (or smaller surplus). Once new trade contracts are signed, the fall in the relative price of home goods raises the quantity of home goods demanded, creating a tendency for a trade surplus. Domestic goods are cheaper, so foreigners buy more of them and, with sufficiently high elasticities of demand, spend more on them. With these elasticity conditions satisfied, changes in quantities traded overwhelm the changes in valuations. Consequently, the currency depreciation leads to an eventual trade surplus. This *fall* in the trade surplus, followed by a *rise*, naturally led to the J-Curve nomenclature.

The usual approach focuses on a single source of exogenous disturbance: an exogenous change in the exchange rate, given sluggish nominal prices, leads to changes in quantities demanded and (with demand-determined quantities), trade flows and GDP. The standard model also makes questionable assumptions about prices: it relies on an *absence* of pricing-to-market (international price discrimination with nominal prices set in buyers' currencies). Recent evidence has emphasized the importance of pricing to market in the data, and a large set of recent theoretical work on exchange rates embodies that assumption. In addition, the standard J-Curve model has implications for other variables, such as GDP. In that model, a currency depreciation reduces the relative price of home products, leading to an (eventual) increase in aggregate demand (by foreigners) for domestic products, eventually raising exports *and* raising real GDP. Little empirical work has focused on this additional set of predictions of the standard model.

A small literature has developed exploring nonlinearities in exchange-rate data.[1] Our earlier paper, Leonard and Stockman (2000), tests the predictions of a wide class of theoretical models by examining nonlinearities in the bivariate relationships between exchange rates and cross-country ratios of GDP. We show that when a country's real GDP rises (relative to another country) for a sustained period (at least 5 consecutive quarters), that country's currency initially *depreciates* in real terms, then *appreciates* significantly *above* its original level while GDP remains temporarily high. While the *initial* response is consistent with the main theoretical models, the subsequent response of the exchange rate contradicts those models.

Our current paper employs a similar approach to study bivariate statistical relationships between current accounts, exchange rates, and cross-country ratios of GDP. The paper differs from previous empirical work on these issues because we use nonparametric methods to allow for nonlinearities, employ a minimum of statistical assumptions, and focus on a fundamental characterization of the data. We present new evidence on the connections between exchange rates, the current account, and GDP. While the evidence we present loosely supports some common beliefs about the data, it conflicts with some common theoretical models. Consequently, our results pose new challenges for theory.

Specifically, our results show weak evidence of a J-Curve. When a home country

[1] This work inlucdes Taylor (2000), who discusses related problems with linear specifications in univariate analyses of exchange-rate mean reversion, and O'Connell and Wei (1997), Obstfeld sand Taylor (1997), and Michael, Nobay, and Peel (1997).

experiences real depreciation against a foreign country for a sustained period (at least 5 consecutive quarters), the home country may initially experience a larger current account deficit than "normal." After a lag, however, it tends to experience a current account surplus. The evidence of the subsequent surplus is stronger than the evidence of an initial deficit.

Perhaps most interestingly, we find that the evidence is *inconsistent* with the standard theoretical model of the J-Curve. Specifically, an increase in the relative current account tends to be associated with a *fall* in relative GDP, even after a lag – contradicting the implication of the standard theoretical model that an increase in the current account surplus results from a rise in foreign demand (due to home currency depreciation), which raises home GDP. Consequently, our evidence supports the J-Curve in the data but *not* its common explanation.

2. Data and Normality Tests

We examine quarterly data on current accounts, nominal exchange rates, consumer price indexes, and real GDP over the time period 1974:1 to 1997:4, for 18 countries. All data are taken from the International Financial Statistics CD-ROM and are seasonally adjusted.

For each pair of countries, we calculate the real exchange rate $\tilde{q} \equiv \ln(ep^*/p)$, the difference in the ratios of current accounts to GDP, $\tilde{c} \equiv \frac{CA}{y} - \frac{CA^*}{y^*}$, and the GDP ratio $\tilde{x} \equiv \ln(y/y^*)$. Then we remove means and linear trends in each series, resulting in series for the detrended real exchange rate, q, the detrended relative current account, ca, and detrended relative (real) GDP, x.

Nearly all previous empirical work involving the connections between these series relies upon statistical techniques that assume these series are normally distributed (Gaussian). Seldom, however, have researchers reported evidence on the appropriateness of that assumption. We begin by examining the results of three standard statistical tests.

First, the Shapiro-Wilk test for normality has good power and arguably provides the best omnibus test for normality. Suppose $y = (y_1, y_2, ..., y_n)$ ordered such that $y_1 < y_2 < ... < y_n$. Define $m' = (m_1, m_2, ..., m_n)$ to be the vector of expected values of the standard normal order statistics. Finally use an ordered random sample from a standard normal distribution $x_1 < x_2 < ... < x_n$ to calculate $V = (v_{ij})$ where $v_{ij} = \mathrm{cov}(x_i, x_j)$. The Shapiro-Wilk test statistic is then:

$$W = \frac{\left[\sum_{i=1}^{n} a_i y_i\right]^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$

where

$$a' = (a_1, a_2, ..., a_n) = m'V^{-1}\left[(m'V^{-1})(V^{-1}m)\right]^{-1/2}.$$

Tables of values for a' are readily available[2].

Second, we employ the Shapiro-Francia test, which is similar to the Shapiro-Wilk test and has the same asymptotic distribution. Third, we perform tests based on skewness and kurtosis, testing for normality based on the third and fourth moments of the empirical distribution function.[3]

Table 1 presents the results of the normality tests; the results cast strong doubt on the assumption of normality. The skewness-kurtosis tests reject normality at the 5% level more than 40% of the time for the real exchange rate, more than half the time for relative real GDP, and more than 20% of the time for the relative current account. The Shapiro-Wilk tests reject normality at the 5% level in more than half of the cases for the real exchange rate, almost two-thirds of the cases for relative real GDP, and more than one-fourth of the time for the relative current account. The Shapiro-Fancia tests reject normality at the 5% level in almost half of the

[2] See Royston (1982) for additional information on the Shapiro-Wilk test.
[3] Royston (1993) discusses these two tests in more detail.

cases for the real exchange rate, more than half of the cases for relative real GDP, and 30% of the time for the relative current account. Because this evidence casts considerable doubt on the normality assumptions that underlie most analyses of exchange-rate data, the remainder of the statistical tests in this paper are distribution-free.

TABLE 1
NORMALITY TESTS:
Number of series ***rejected*** as Gaussian:

Test	**Variable**	**Total Number of Series**	**Rejected as Gaussian at Significance Levels:**		
			1%	**5%**	**10%**
Skewness/Kurtosis	Real exchange rate	306	70	126	170
	Relative GDP	306	90	160	186
	Relative Current Account	272	14	58	78
Shapiro-Wilk	Real exchange rate	306	108	172	196
	Relative GDP	306	150	194	212
	Relative Current Account	272	32	74	118
Shapiro-Francia	Real exchange rate	306	88	146	178
	Relative GDP	306	110	178	196
	Relative Current Account	272	36	82	122

3. Evidence *Supports* a "J-Curve"

Non-normal distributions are not the only factors complicating the statistical connection between exchange rates and current accounts. In addition, transitory fluctuations can mask longer-run statistical connections. Consequently, we study episodes in which a bilateral (two-country) variable of interest exceeds its unconditional mean for at least five consecutive quarters. This has three benefits. First, it involves time periods that are sufficiently long to display J-Curves. Second, the time periods are long enough to capture any relevant business-cycle phenomena. Third, it helps to avoid results based on small, transitory changes.

Specifically, we define a **real depreciation episode** between nations A and B as a sequence of at least five consecutive quarters $\{t_1, t_2, \ldots, t_T\}$ for which $q_{AB,s} > 0 \; \forall \; s \in \{t_1, t_2, \ldots, t_T\}$ with $T \geq 5$. For each bilateral pair of countries in our data set, we test the null hypothesis that the probability distribution of the detrended relative current account, ca, during a real-depreciation episode is the same as the probability distribution at other times.

The J-Curve refers to a *change* in the current account over the duration of a depreciation episode. Consequently, we test the null hypotheses that the probability distributions of ca in various *sub-periods* of real-depreciation episodes are the same as at other times. We define quarter $\tilde{t}$ as belonging to the ***beginning*** of a real-depreciation episode if (i) that episode started at $\tilde{t}-2, \tilde{t}-1, or\ \tilde{t}$, *and* (ii) $\tilde{t}+4$ is in the same run. Similarly, we define quarter $\tilde{t}$ as belonging to the ***middle*** of a real-depreciation episode if $\tilde{t}-2$ and $\tilde{t}+2$ are in the same episode. Similarly, we define quarter $\tilde{t}$ as belonging to the ***end*** of a real-depreciation episode if (i) the last quarter of the episode is $\tilde{t}, \tilde{t}+1, or\ \tilde{t}+2$, *and* (ii) $\tilde{t}-4$ is in the same episode.[4] Finally, for additional detail on sub-periods, we define quarter $\tilde{t}$ as belonging to the ***beginning of the middle*** of an episode if it is in the middle but either $\tilde{t}-3$ or $\tilde{t}-4$ (or both) is *not* in the middle of the episode. Similarly, we define quarter $\tilde{t}$ as belonging to the ***end of the middle*** of an episode if it is in the middle but either $\tilde{t}+3$ or $\tilde{t}+4$ (or both) is *not* in the middle of the episode. We apply two standard non-parametric tests, Wilcoxon rank-sum tests and Komolgorov-Smirnov tests, to examine the behavior of current accounts over the course of real-depreciation

[4] When T=7, for example, the first two quarters of the episode are in its *beginning*, the final two quarters are in its *end*, and the middle three quarters are in its *middle*.

episodes.

3a. Wilcoxon Rank-Sum Tests

One method of evaluating whether two samples X and Y are drawn from the same distribution is the Wilcoxon Rank-Sum test. The test is based on the idea that if the distributions from which the samples are drawn differ in their location parameters, then combining and ordering the samples will yield ranks from one sample above the ranks from the other. Formally, suppose the two populations have the same form, but the X sample may be drawn from a distribution with a different central tendency or location than the distribution producing the Y sample. Thus, we wish to test:

$$H_0 : F_Y(x) = F_X(x) \qquad \text{for all x}$$
$$H_A : F_Y(x) = F_X(x-\theta) \qquad \text{for all x and some } \theta$$

Using the Wilcoxon rank-sum test, we will accept the one-sided location alternative H_A: $\theta<0$ if the sum of the ranks of the X's is larger than some critical value. Thus, for an X sample of size *m* and a Y sample of size *n*, the test statistic is:

$$W_N = \sum_{i=1}^{N} iD_i$$

where $m+n=N$ and $D_i=1$ if the i^{th} variable in the combined ordered arrangement is an X and $D_i=0$ if the i^{th} variable is a Y.

If the distribution is continuous so that there are no ties among the values in X and Y, then under H_0 the mean and variance and variance of W_N are

$$E[W_N] = \frac{m(N+1)}{2} \qquad \operatorname{var}(W_N) = \frac{mn(N+1)}{12}$$

For samples larger than 12, a normal approximation has been shown to be a practical alternative to generating the exact small sample probability distribution of W_N.

One advantage of our bilateral approach over the standard VAR approach is that we take account of changes in *both* countries in every bilateral pair. One disadvantage, perhaps, is that our approach does not identify sources of shocks, or condition on such shocks as an impulse-response function does. However, one can also regard this as an *advantage* of our approach. We do not employ assumptions required for identification of shocks. Given the questionable identifying assumptions often employed in time-series analysis of data that presumably must be described by a general-equilibrium model, our approach provides evidence on *unconditional* moments that pose challenges for theoretical models to explain.[5]

3b. Komolgorov-Smirnov Tests

While the Wilcoxon rank-sum test evaluates differences in the *location* of probability distributions from which the two samples are drawn, other techniques can investigate whether the *forms* of the probability distributions also differ. The Komolgorov-Smirnov two-sample test determines whether two distribution functions associated with two samples are identical. Specifically, we wish to test:

$$H_0 : F_Y(x) = F_X(x) \qquad \text{for all x}$$
$$H_A : F_Y(x) \neq F_X(x) \qquad \text{for some x}$$

To calculate the test statistic for two samples X and Y of sizes m and n drawn from distributions $F_X(x)$ and $F_Y(x)$, order the variables in each sample as

$$X_1, X_2, ..., X_m \ \text{ and } Y_1, Y_2, ..., Y_n$$

[5] For example, results that condition on monetary shocks are highly questionable, given the difficulty of identifying such shocks. Much VAR evidence, as in Sims (1995), suggests that monetary shocks do *not* play a major role in explaining movements in real GDP. Consequently, there is room for suspicion that they are a major force explaining changes in exchange rates and the current account. However, using different identifying assumptions, other work such as Gali (1998) finds considerably larger roles for monetary shocks.

and define the empirical analogs of the distribution functions as:

$$S_X(x) = \begin{cases} 0 & \text{if } x < X_1 \\ \dfrac{k}{m} & \text{if } X_k \le x \le X_{k+1} \qquad \text{for } k = 1,2,\ldots m-1 \\ 1 & \text{if } x \ge X_m \end{cases}$$

$$S_Y(x) = \begin{cases} 0 & \text{if x} < Y_1 \\ \dfrac{k}{m} & \text{if } Y_k \le x \le Y_{k+1} \qquad \text{for } k = 1,2,\ldots n-1 \\ 1 & \text{if } x \ge Y_m \end{cases}$$

The test statistic then becomes

$$T_{m,n} = \sup_x \left| S_x(x) - S_Y(x) \right|$$

The small sample distribution of $T_{m,n}$ can be looked up in available tables. For larger samples, the asymptotic distribution of $\left(\sqrt{mn/(m+n)}\right)T_{m,n}$ is given by

$$L(t) = 1 - 2\sum_{i=2}^{\infty}(-1)^{i-1}e^{-2i^2t^2}$$

The Komolgorov-Smirnov can also be utilized to test the null hypothesis against the one one-sided alternative:

$$H_A : F_Y(x) \leq F_X(x) \qquad \text{for all x}$$
$$H_A : F_Y(x) < F_X(x) \qquad \text{for some x}$$

The asymptotic distribution of the test statistic $T_{m,n}$ now becomes

$$L(t) = 1 - e^{-2t^2}$$

3c. Results: The Data Show a J Curve

Table 2 summarizes the results, for all bilateral pairs in our sample, of the Wilcoxon rank-sum tests and Komolgorov-Smirnov tests. It also presents summary statistics on the magnitudes of relative current accounts over the course of real-depreciation episodes. The first two rows of the table show the number of cases in our sample in which the relative current account between two countries shows a surplus (first row) or deficit (second row) during various sub-periods of real-depreciation episodes. At the beginning of a real-depreciation episode, 117 cases show relative current-account surpluses, while 148 show relative current-account deficits, indicating that there is a slight tendency for current-account deficits when a country's currency initially depreciates. However, only slightly more than 10% of these cases show statistically significant differences, at the 5% level, in the probability distributions of the relative current account. Restricting attention to those statistically significant cases, a current account surplus appears in 12 cases, and a current account deficit appears in 16 cases. The slight predominance of current account deficits at the beginnings of real-depreciation episodes is (weakly) consistent with the first part of the J Curve.

INSERT TABLE 2 ABOUT HERE

In contrast, countries tend to have current account surpluses around the *ends* of depreciation episodes (shown in the last columns). At the end of a depreciation episode, surpluses appear in 182 cases while deficits appear in only 78 cases. Restricting attention to cases with statistically-significant differences at the 5% level, surpluses appear in 44 cases while deficits appear in only 8 cases. This transition from an initial current account deficit at the beginning of a depreciation episode, to a current account surplus later in the episode has been recognized many times in the past, and has been labeled the "J Curve."

The other columns in the table show the transition from the slight tendency for deficits at the beginnings of depreciation episodes to the stronger tendency for surpluses at the ends of those episodes. The initial tendency for deficits vanishes quickly: by the beginning of the middle of an episode, current account surpluses are more frequent than deficits. In fact, by that time, statistically-significant cases of surpluses (15) outnumber statistically-significant cases of deficits (8) by nearly two-to-one. Overall, during the middle of the episode, one-third of the cases (94 of 271 bilateral country pairs) show statistically significant current account surpluses at the 5% level.

The Komolgorov-Smirnov tests, in the middle rows of Table 2, show similar results. At the beginning of a real-depreciation episode, 26 cases show relative current-account surpluses that are statistically significant at the 10% level in one-sided tests, while slightly more, 29 cases, show current-account deficits that are statistically significant at the 10% level in one-sided tests. However, only about 13% of all cases (34 of 267 cases) show statistically significant differences, at the 10% level, in the probability distributions of current accounts between depreciation episodes and other times (without depreciation episodes). Consequently, the evidence that current account deficits accompany the beginnings of depreciation episodes is fairly weak.

The Komolgorov-Smirnov tests (like the Wilcoxon tests) show evidence of current account surpluses at the ends of depreciation episodes. The last column in Table 2 shows 63 cases (about one-fourth of the 262 total) with statistically-significant surpluses (in one-tailed tests, at the 10% level) at the ends of depreciation episodes, and only 19 cases of statistically-significant deficits (7 percent of the total). Overall, the evidence shows a tendency for a J Curve, in the sense of a (slight) statistical tendency for current account deficits when currencies initially depreciate, followed later by a (somewhat stronger) tendency for current account surpluses.

How large are these changes in current accounts? The bottom rows of Table 2 summarize the magnitudes. Recall that the relative current account equals the detrended difference, between two countries, in the ratios of their (overall) current accounts to their GDPs. The table shows that the median relative current account is -.0002, or minus 2/100 of one percent of GDP at the beginning of a depreciation episode, and rises to 4/100 of one percent of GDP by the middle of the episode and to 5/100 by the end of the episode. The last two rows of the table show that the 10^{th} and 90^{th} percentiles of the distribution are both rising along with the median. Clearly, the magnitudes of changes in current accounts (as fractions of GDP) accounted for by depreciation episodes are small. In summary, while the data show evidence of a J Curve, currency depreciation appears to explain only a small fraction of the variation of current accounts.

4. Evidence *Rejects* the Standard Explanation of the J-Curve

3a. Real GDP and Current Accounts

While the bilateral data on exchange rates and current accounts show a J-Curve pattern, other data contradict the standard theoretical explanations of the J Curve. The standard theoretical explanation of the J-Curve predicts that currency depreciation raises real GDP along with the current account. By reducing the relative price of home products (to foreign products), depreciation raising aggregate demand (by foreigners) for domestic products, thereby increasing exports and GDP together. This relative-price change also leads the home country to substitute away from imports toward domestically-produced goods, further raising the current-account surplus, domestic aggregate demand, and domestic GDP. (Previously-signed international-trade contracts may delay the responses of both GDP and the current account.) In contrast, Table 3 presents evidence that current account surpluses are associated with unusually *low* real GDP.

Define a **relative current-account surplus episode** between nations A and B, in analogy to the real depreciation episodes defined earlier, as a sequence of at least five consecutive quarters for which the relative current account as a fraction of GDP, ca_{AB}, is positive. Table 3 presents results, like those in Table 2, showing the behavior of relative real GDP during relative current-account surplus episodes.

The Wilcoxon rank-sum tests in Table 3 show that nations tend to have unusually *low* GDP at the beginning of a current-account surplus episode; that the tendency for low real GDP continues into the middle of the current-account surplus episode; and that GDP tends to return to normal only near the end of the episode. At the beginning of a surplus episode, 201 cases (out of 260 bilateral nation-pairs studied) show lower-than-normal GDP, while only 59 cases show higher-than-normal GDP. Restricting attention to cases that show statistically-significant differences at the 5% level, 60 cases (nearly one-fourth of the total) show low GDP, while only 8 show high GDP. By the middle of the current-account surplus episode, real GDP is statistically-significantly below normal (at the 5% level) in 38% of all cases (99 of 262 cases), and significantly above normal in only 10% of the cases. [6] Only late in the surplus episode does real GDP return to normal (with a slight tendency for above-normal GDP).

INSERT TABLE 3 ABOUT HERE

The Komolgorov-Smirnov tests, in the middle rows of Table 3, show similar results. The table reports the number of cases of high GDP and low GDP that are statistically significant at the 10% level in one-sided tests. At the beginning of a surplus episode, 93 cases (more than1/3 of all cases) show significantly *low* GDP, while only 22 such cases show *high* GDP. These tests also show that GDP tends to recover only near the *end* of a surplus episode. The bottom rows of the table show that the magnitudes involved are sizable: median relative GDP is 1.3% below trend at the beginning of a current-account surplus episode, 2.1% below trend by the beginning of the middle of the episode, and finally rises above trend (by 0.4%) only at the ends of the episodes. This tendency for low GDP to accompany current-account surpluses contrasts with the standard J-Curve model in which changes in exchange rates drive a positive relation between GDP and the current account.[7]

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[6] "Normal" refers to time-periods *outside* episodes of current-account-surpluses (for each bilateral pair of nations).

[7] The standard explanation of J Curve involves the *conditional* responses of real GDP and the current account to a change in the exchange rate. In contrast, our evidence refers to the *unconditional* relation between real GDP and the current account. Consequently, our evidence does not rule out the possibility that the standard explanation of the J Curve correctly describes that conditional response, but that this mechanism is only a minor factor affecting the overall relation between the current account and GDP.

INSERT TABLE 4 ABOUT HERE

Table 4 presents additional evidence on the usual interpretation of the J Curve. It reverses the roles of the variables in the previous table, and shows relative current accounts during *high relative GDP episodes*. These episodes are defined (in analogy to the other episodes studied above) as sequences of at least 5 consecutive quarters in which x, the log of the ratio of detrended (and mean-adjusted) GDPs between two countries, exceeds zero. Table 4 shows that there is a slight tendency for current-account surpluses at the *beginnings* of high-GDP episodes, but that current-account deficits begin emerging as the high-GDP episode persists. The Wilcoxon tests show statistically-significant deficits, at the 5% level, in more than 40% of the cases (114 of 271 bilateral nation-pairs) by the middles of the high-GDP episodes. The Komolgorov-Smirnov tests show statistically-significant deficits, at the 10% level, in almost one-third of the cases (82 of 268 cases) by the ends of the high-GDP episodes.

Tables 3 and 4 show that the (unconditional) relationship between the current and account and real GDP differs substantially from the (conditional) prediction of standard J-Curve models. High-GDP episodes tend to have current account surpluses *initially*, which then become deficits; current-account surplus episodes tend to have low GDP both initially and throughout the episodes, until those episodes are about to end. Notice that the relationship between the current account and GDP is more subtle than implied by the common assertion that the current account is countercyclical.

3b. Real Exchange Rates during Surplus Episodes

Table 5 shows the behavior of real exchange rates during episodes of relative-current-account surpluses. Currencies tend to be depreciated at the beginning of a surplus episode. In Wilcoxon tests at the 5% level, one-fifth of cases (54 of 259) show statistically-significant depreciation at the beginnings, and one-third of cases (79 of 253) show statistically-significant depreciation by the middles of the surplus episodes. However, a slight tendency for appreciated currency emerges by the ends of the middles of the surplus episodes, with 15% of cases showing significant appreciation in one-sided Wilcoxon tests at the 5% level, and 25% of cases showing significant appreciation in one-sided Komolgorov-Smirnov tests at the 10% level. The magnitudes of these changes in exchange rates are not trivial: the median real exchange rate shows 2.8% depreciation (relative to normal) at the beginnings of current-account surplus episodes. The tendency for subsequent appreciation results, by the end of current-account surplus episodes, in a 5% change in the median real exchange rate, to a level that shows 2.2% appreciation relative to normal.

INSERT TABLE 5 ABOUT HERE

4. Conclusions

This paper "goes back to basics" in empirical analysis of the J-Curve. First, we document strong violations in the distributional assumptions that underlie nearly all previous work on this issue. Second, we employ distribution-free, non-parametric statistical tests to characterize the data and summarize the key relationships between real exchange rates, the current account, and real GDP. We find some (weak) evidence of a J-Curve in the data. Interestingly, however, we document that this evidence is *not* consistent with the standard theoretical explanation of the J-Curve. Consequently, our empirical results pose a strong challenge for international economic theory.

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TABLE 2

RELATIVE CURRENT ACCOUNTS DURING REAL-DEPRECIATION EPISODES

		Beginning of Depreciation Episode		*Beginning of Middle*		*Middle of Depreciation Episode*		*End of Middle*		*End of Depreciation Episode*	
Wilcoxon Rank-Sum Tests	**CA surplus**	117	12*	145	15*	174	94*	170	35*	182	44*
Tests for differences in central locations of probability distributions of relative current accounts between real-depreciation episodes and other periods.	**CA deficit**	148	16*	121	8*	97	39*	90	6*	78	8*
	Number of bilateral country-pairs tested	265		266		271		260		260	
	* Number of cases statistically significant at the 5% level										

		Beginning	*Beginning of Middle*	*Middle*	*End of Middle*	*End*
Komolgorov-Smirnov Tests	**CA surplus**	26**	32**	38**	47**	63**
Tests for differences in probability distributions of relative current accounts between depreciation episodes and other periods.	**CA deficit**	29**	35**	32**	21**	19**
	# Significant at 10% (2-tailed tests)	34	28	46	37	61
	Number of bilateral country-pairs tested	267	268	265	262	262
	** Number of cases statistically significant at the 10% level in one-sided tests					

Magnitudes of Differences	*First Quarter of Episode*	*Beginning of Middle*	*Mean of Data during Middle*	*End of Middle*	*Last Quarter of Episode*
Median Difference in Relative Current Account (compared to times *without* depreciation episodes)	-.0002	-.0000	.0004	.0002	.0005
10th Percentile of Distribution of Difference	-.0052	-.0043	-.0034	-.0048	-.0037
90th Percentile of Distribution of Difference	.0043	.0054	.0044	.0064	.0060

TABLE 3

RELATIVE REAL GDP DURING RELATIVE-CURRENT-ACCOUNT-SURPLUS EPISODES

		Beginning of Current-Account Surplus Episode		*Beginning of Middle*		*Middle of Current-Account Surplus Episode*		*End of Middle*		*End of Current-Account Surplus Episode*	
Wilcoxon Rank-Sum Tests	**High GDP**	59	8*	53	2*	72	26*	99	16*	124	37*
Tests for differences in central locations of probability distributions of relative real GDP between CA-surplus episodes and other periods.	**Low GDP**	201	60*	205	46*	190	99*	157	17*	135	24*
	Number of bilateral country-pairs tested	260		258		262		256		259	
	* Number of cases statistically significant at the 5% level										

		Beginning	*Beginning of Middle*	*Middle*	*End of Middle*	*End*
Komolgorov-Smirnov Tests	**High GDP**	22**	3**	39**	30**	51**
Tests for differences in probability distributions of relative real GDP between CA-surplus episodes and other periods.	**Low GDP**	93**	74**	54**	43**	48**
	# Significant at 10%, 2-tailed tests	78	53	56	37	71
	Number of bilateral country-pairs tested	260	260	249	259	259
	** Number of cases statistically significant at the 10% level in one-sided tests					

Magnitudes of Differences	*First Quarter of Episode*	*Beginning of Middle*	*Mean of Data during Middle*	*End of Middle*	*Last Quarter of Episode*
Median Difference in Relative Real GDP (compared to times *without* current-account-surplus episodes)	-1.3%	-2.1	-1.4%	-0.6%	0.4%
10th Percentile of Distribution of Difference	-7.0%	-7.6%	-6.2%	-5.8%	-4.4%
90th Percentile of Distribution of Difference	3.7%	3.3%	3.8%	5.2%	6.1%

TABLE 4

RELATIVE CURRENT ACCOUNTS DURING HIGH-RELATIVE-GDP EPISODES

		Beginning of High-GDP Episode		*Beginning of Middle*		*Middle of High-GDP Episode*		*End of Middle*		*End of High-GDP Episode*	
Wilcoxon Rank-Sum Tests	**CA surplus**	152	33*	132	14*	78	22*	72	1*	63	4*
Tests for differences in central locations of probability distributions of current accounts between high-relative-GDP episodes and other periods.	**CA deficit**	112	11*	131	13*	193	114*	196	44*	203	50*
	Number of bilateral country-pairs tested	264		263		271		268		266	
	* Number of cases statistically significant at the 5% level										
		Beginning		*Beginning of Middle*		*Middle*		*End of Middle*		*End*	
Komolgorov-Smirnov Tests	**CA surplus**	49**		33**		23**		7**		19**	
Tests for differences in probability distributions of current accounts between high-relative-GDP episodes and other periods.	**CA deficit**	23**		31**		67**		65**		82**	
	# Significant at 10%, 2-tailed tests	45		31		57		39		61	
	Number of bilateral country-pairs tested	266		266		267		268		268	
	** Number of cases statistically significant at the 10% level in one-sided tests										
Magnitudes of Differences		*First Quarter of Episode*		*Beginning of Middle*		*Mean of Data during Middle*		*End of Middle*		*Last Quarter of Episode*	
Median Difference in Relative Current Account (compared to times *without* high-GDP episodes)		.0004		.0000		-.0048		-.0011		-.0008	
10th Percentile of Distribution of Difference		-.0032		-.0051		-.0011		-.0082		-.0071	
90th Percentile of Distribution of Difference		.0066		.0054		.0018		.0022		.0029	

TABLE 5

RELATIVE REAL EXCHANGE RATES DURING CURRENT-ACCOUNT-SURPLUS EPISODES

		Beginning of Current-Account Surplus Episode		*Beginning of Middle*		*Middle of Current-Account Surplus Episode*		*End of Middle*		*End of Current-Account Surplus Episode*	
Wilcoxon Rank-Sum Tests	**Depreciation**	169	54*	162	36*	148	79*	121	13*	108	14*
Tests for differences in central locations of probability distributions of relative real exchange rates between CA-surplus episodes and other periods.	**Appreciation**	90	16*	97	10*	105	34*	137	29*	149	36*
	Number of bilateral country-pairs tested	259		259		253		258		257	
	* Number of cases statistically significant at the 5% level										
		Beginning		*Beginning of Middle*		*Middle*		*End of Middle*		*End*	
Komolgorov-Smirnov Tests	**Depreciation**	84**		62**		43**		31**		34**	
Tests for differences in probability distributions of relative real exchange rates between CA-surplus episodes and other periods.	**Appreciation**	35**		24**		59**		42**		66**	
	# Significant at 10%, 2-tailed tests	84		52		66		39		63	
	Number of bilateral country-pairs tested	260		260		259		259		259	
	** Number of cases statistically significant at the 10% level in one-sided tests										
Magnitudes of Differences		*First Quarter of Episode*		*Beginning of Middle*		*Mean of Data during Middle*		*End of Middle*		*Last Quarter of Episode*	
Median Difference in Relative Real Exchange Rate (compared to times *without* surplus episodes)		2.8%		2.2%		1.5%		-0.9%		-2.2%	
10^{th} Percentile of Distribution of Difference		-10.5%		-11.5%		-11.7%		-14.9%		-16.9%	
90^{th} Percentile of Distribution of Difference		17.4%		17.4%		14.6%		13.1%		11.5%	