TRADE BALANCES AND THE TERMS OF TRADE IN G-7 COUNTRIES: PENAL COINTEGRATION APPROACH

HAMORI, Shigeyuki*

Abstract

This paper empirically analyzes the long-run equilibrium between trade balances and the terms of trade using the nonstationary panel data analysis. Empirical results indicate that trade balances and the terms of trade do not have cointegrating relation for G-7 countries. This implies that the deterioration in the terms of trade will not necessarily improve a country's trade balance in the long-run.

Key words: panel unit root, panel cointegration, Marshall Lerner condition

JEL classification number: F41, C32

1. Introduction

Changes in the exchange rate impact the trade balance by changing the terms of trade. The relationship between terms of trade and the trade balance is ordinarily analyzed using the Marshall-Lerner condition (ML condition). The ML condition holds that deterioration in the terms of trade is to improve a country's trade balance, provided that the sum of the country's price elasticity of demand for exports and imports must be greater than one in absolute value. The principle is named after the economists Alfred Marshall and Abba Lerner. As a devaluation of the exchange rate reduces the price of exports, the demand for exports will increase. The price of imports, meanwhile, will rise, and the demand for imports will decrease. The net effect on the trade balance will depend on price elasticities. If exported goods are elastic to price, their demand will increase proportionately more than the decrease in price, and the total export revenue will increase. If imported goods are elastic, the total import expenditure will decrease. The trade balance will improve in both cases.

To examine the ML condition using actual data, it is necessary to estimate both the import function and the export function. Such an approach has been taken in past research, i.e., Arize (1990), Goldstein and Khan (1978), Houthakker and Magee (1969), and Warner and Kreinin (1983). In such research, it was reported that the ML condition was fulfilled. However, there is a problem with this approach. In order to estimate the export function and the import function, it is necessary to collect data such as world income, world export prices and effective exchange rates, and to specify trading partners. For many countries, however, it is difficult to collect such data.

Haynes and Stone (1982) attempt to address this issue by directly analyzing the relationship between the trade balance and terms of trade – an alternative approach. They analyze the impact of terms of trade on the trade balance by looking at the estimated coefficients of terms of trade using a distributed lag model. Haynes and Stone (1982), on the other hand, conduct their analysis within the framework of regression analysis and are thus unable to avoid the spurious regression of Granger and Newbold (1974).

With the recent development of time series analysis, cointegration analysis is now used for analyzing long-run relationships among variables. Arize (1996) uses cointegration

* Shigeyuki Hamori, Faculty of Economics, Kobe University, Rokkodai, Nada-Ku, Kobe 657-8501, JAPAN, e-mail: hamori@econ.kobe-u.ac.jp

analysis to empirically analyze the long-run equilibrium between the trade balance and the terms of trade using quarterly data on sixteen countries from 1973 to 1992, i.e., the G-7 members (Canada, France, Germany, Italy, Japan, the United Kingdom, the United States), Denmark, Finland, the Netherlands, Switzerland, and five newly industrializing economies (NIES: India, Korea, Malaysia, Mexico, Sri Lanka). His empirical results indicate that, for a majority of the countries, there exists a positive and significant long-run statistical equilibrium between the trade balance and the terms of trade. Thus his approach adopted is found to be an acceptable substitute for testing the Marshall-Lerner condition of stability.

This paper extends the Arize (1996) approach by empirically analyzing the relationship between the trade balance and the terms of trade in G-7 countries. A distinctive feature of our research is the use of panel unit root and panel cointegration analysis, an approach not attempted by Arize (1996). The individual nonstationary time series analysis is known to have low power for short span of the data. We pool the data of G-7 countries in the hopes of adding cross-sectional variation to the data that will increase the power of panel unit root or panel cointegration tests.

2. Basic model

Following Haynes and Stone (1982) and Arize (1996), we can write the long-run relationship between the trade balance and the terms of trade as follows:

$$TB_t = \alpha + \beta TOT_t + u_t , \qquad (1)$$

where TB_t is the trade balance at time t, TOT_t is the terms of trade at time t, and u_t is a disturbance at time t. If trade balance and terms of trade are cointegrated, they have a long-run equilibrium relationship. If the ML condition is satisfied in the long-run, then an increase in the terms of trade can be expected to increase the trade balance, and thus $\beta > 0$.

3. Data

This paper analyzes G-7 countries using annual data for the period between 1971 and 2003: Canada; France; Germany; Italy; Japan; the United Kingdom; the United States. The data were obtained from the World Development Indicators (The World Bank). The real trade balance and terms of trade are used for the empirical analysis. The real trade balance is obtained as follows: exports of goods and services (in constant local currency unit) minus imports of goods and services (in constant local currency unit). Note that the real trade balance is measured as a share of real GDP for empirical analysis. The terms of trade are obtained as a ratio of export prices to import prices in the local currency unit. The data are balanced panel data without any missing observations.

Tables 1 and 2 present data for some selected years. Tables A1 and A2 in the Annex present yearly data for 1971-2003.

Table 1. Terms of trade and trade balance/Gdp in Canada, France, Germany and Italy.

Country	Canada		France		Germany		Italy
Series	tot	tb/gdp	tot	tb/gdp	tot	tb/gdp	tot
1971	0.9305	0.03243678	1.2501	-0.021195158	1.0379	-0.021099562	1.1175
1975	1.0654	-0.030481738	1.1171	-0.009219239	0.9925	-0.01365184	0.9231
1980	1.0553	0.002459327	1.0109	-0.016245042	0.9143	-0.023434917	0.8535
1985	0.9772	0.025317854	0.9648	0.000540335	0.8759	0.008302514	0.8923
1990	1.0092	-0.001880776	1.0524	-0.020332838	0.9943	-0.000627395	1.0693
1995	0.9773	0.039232459	1.0288	0.004568623	1.0585	-0.009075291	1.0223
2000	1	0.057731904	1	0.009029585	1	0.003515145	1
2001	0.9839	0.063514739	1.0063	0.009977287	0.9989	0.020468698	1.0058
2002	0.9593	0.060939805	1.0327	0.009362304	1.0192	0.03973327	1.0210

Table 2. Terms of trade and trade balance/Gdp in Japan, the UK and the USA

Country	Japan		UK		USA	
Series	tot	tb/gdp	tot	tb/gdp	tot	tb/gdp
1971	1.3536	-0.002165885	0.987061749	0.011057722	1.384672287	-0.015738218
1975	1.0014	-1.68877E-05	0.847524099	0.015581488	1.142462274	-0.000561153
1980	0.7305	0.016624474	0.944639598	0.024358341	0.918526629	0.002457102
1985	0.8230	0.033400907	0.954036359	0.014718084	1.035868836	-0.023540174
1990	1.0379	0.004573434	0.953946835	-0.011210381	0.963017775	-0.007739193
1995	1.1307	0.003778246	0.940565193	0.01024476	0.980741038	-0.008892734
2000	1	0.014303106	1	-0.020566814	1	-0.03886408
2002	0.9779	0.014648414	1.021599376	-0.038240165	1.030628408	-0.047099312

4. Empirical analysis

4.1 Panel Unit Root Tests. To begin with, we need to perform unit root tests on the trade balance and the terms of trade. Levin et al. (2002) suggest that individual unit root tests have limited power against alternative hypotheses, especially in small samples. Panel unit root tests help us to overcome the problem.

We use two types of panel unit root tests for empirical analysis. One is the LLC test proposed by Levin et al. (2002) and the other is the Breitung test developed by Breitung (2000). Breitung (2000) finds that the LLC test suffers from a substantial loss of power if individual-specific trends are included, and proposes a test statistic whose power is

substantially higher than that of LLC.

For LLC and Breitung tests, we use the following specification:

$$\Delta y_{i,t} = \alpha y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{i,j} \Delta y_{i,t-j} + \delta_{0,i} + \delta_{1,i} t + \varepsilon_{i,t}, \qquad (2)$$

where $i = 1, 2, \cdots, N$ are the cross-section series observed over periods $t = 1, 2, \cdots T_i$; $\delta_{0,i}$ are fixed effects, $\delta_{1,i} t$ are individual time trends; Δ is the difference operator, i.e., $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$; and the errors ε_{it} are assumed to be mutually independent disturbances.

The null and alternative hypotheses for the tests can be written as:

$$H_0 : \alpha = 0, \text{ and } H_A : \alpha < 0$$

The null hypothesis holds that each individual time series has a unit root. The alternative hypothesis holds that each time series is stationary.

Table 1 shows the results of panel unit root tests. The LLC test statistics, the Breitung test statistics, and their respective *p*-values are included. The SBIC was used as the criterion for selecting the number of lags (p_i) in Eq. (2). Individual constant and time trend are used for the deterministic component. From the results in Table 1, we find that the LLC test statistic and its p-value are -0.620 and 0.268 for the level of trade balance, and -9.184 and 0.000 for the first difference of trade balance. We obtain the similar results when we use the Breitung test. Thus, the trade balance has a unit root.

Table 1 Results of Panel Unit Root Tests

Variable	Method	Test Statistic	*p*-value
TB_t	LLC test	-0.620	0.268
	Breitung test	-1.365	0.086
TOT_t	LLC test	-0.392	0.347
	Breitung test	-1.066	0.143
ΔTB_t	LLC test	-9.184	0.000
	Breitung test	-5.127	0.000
ΔTOT_t	LLC test	-9.450	0.000
	Breitung test	-8.562	0.000

Note: Null hypothesis is no unit root. LLC test indicates the Levin, Lin and Chu (2002) test. Breitung test indicates the Breitung (2000) test. Δ is the difference operator, i.e., $\Delta y_t = y_t - y_{t-1}$.

Table 1 also shows the results of panel unit root tests performed on the terms of trade. The results indicate that the LLC test statistic and its p-value are -0.392 and 0.347 for the level of the terms of trade, and -9.450 and 0.000 for the first difference of the terms of trade.

Here too, we obtain the similar results for the Breitung test. Thus, the terms of trade has a unit root as well. We can say that the trade balance and the terms of trade are nonstationary variables with a unit root.

4.2 Panel Cointegration Tests. The two series were unable to reject the null of the unit root. Our next step, therefore, is to perform the cointegration test. We start with the following equation:

$$TB_{i,t} = \alpha_i + \beta_i TOT_{i,t} + u_{i,t},\ i = 1, 2, \cdots, N,\ t = 1, 2, \cdots, T. \quad (3)$$

In a bivariate context, Pedroni (1999) develops asymptotic and finite-sample properties of the test statistic to test the null hypothesis of no-cointegration in the panel. While both the homogeneous and heterogeneous panel models are possible, the heterogeneous model such as Eq. (3) is consistent with the class of model when parameters α and β are allowed to vary across countries. Having no reason to believe that all of the parameters are the same across countries, as is assumed in the homogeneous model, we employ the heterogeneous model in our analysis.

Pedroni (1999) derives the asymptotic distribution and explores the small sample performances of seven different statistics. Of these seven statistics, four are based on pooling along what is commonly referred to as the "within-dimension" and three are based on pooling along what is commonly referred to as the "between-dimension." Pedroni (1999) describes the former and latter as "panel cointegration statistics" and "group mean panel cointegration statistics."

The first of the simple panel cointegration statistics, the "panel v-statistic", is a non-parametric variance ratio statistic. The second, the "panel ρ-statistic", is a panel version of a non-parametric statistic analogous to the familiar Phillips and Perron ρ-statistic. The third, the "panel t-statistic (parametric)", is a non-parametric statistic analogous to the Phillips and Perron t-statistic. The fourth of these simple panel cointegration statistics, the "panel $t-$statistic (non-parametric)", is a parametric statistic analogous to the familiar augmented Dickey-Fuller t-statistic.[1]

The other three panel cointegration statistics are based on a group mean approach. The first, the "group ρ-statistic", is analogous to the Phillips and Perron ρ-statistic. The last two, the "group t-statistic (non-parametric)" and the "group t-statistic (parametric)", are analogous to the Phillips and Perron t-statistic and the augmented Dickey-Fuller t-statistic, respectively.

Table 2 shows the results of panel unit cointegration tests on the trade balance and the terms of trade. The test statistics are as follows: 1.547 for the panel v-statistic, -0.476 for the panel ρ-statistic, -0.033 for the non-parametric panel t-statistic, -0.529 for the parametric panel t-statistic, 0.605 for the group ρ-statistic, 0.688 for the non-parametric

[1] See Table 1 of Pedroni (1999, p.660).

group t -statistic, and 0.198 for the parametric group t -statistic. This table clearly indicates that the null hypothesis of no cointegration is accepted for every case considered. Thus, the trade balance and the terms of trade are not cointegrated in G-7 countries.

Table 2 Results of Panel Cointegration Tests

Method	Test Statistic
Panel v -Statistic	1.547
Panel ρ -Statistic	-0.476
Panel t -Statistic (non-parametric)	-0.033
Panel t -Statistic (parametric)	-0.529
Group ρ -Statistic	0.605
Group t -Statistic (non-parametric)	0.688
Group t -Statistic (parametric)	0.198

Note: All reported value are distributed N(0,1) under null of no cointegration. Panel statistics are weighted by long-run variance.

4.3 Sub-Sample analysis. In this section we carry out a sub-sample analysis to check the robustness of our empirical analysis. The whole sample is split into two sub-samples: the period between 1971 and 1986, and the period between 1987 and 2003. We just split the whole sample period at the midpoint. Through this approach we can check for any shift in the cointegration structure over time.

Table 3a shows the results of panel cointegration test for the first sub-sample. The test statistics are as follows: 0.793 for the panel v -statistic, -0.496 for the panel ρ -statistic, -0.572 for the non-parametric panel t -statistic, -0.949 for the parametric panel t -statistic, 0.731 for the group ρ -statistic, 0.091 for the non-parametric group t -statistic, and -0.215 for the parametric group t -statistic. The table indicates that the null hypothesis of no cointegration is accepted for all cases at the conventional significance level. Thus, trade balances and the terms of trade are not cointegrated for G-7 countries over the sample between 1971 and 1986.

Table 3b shows the results of the panel cointegration test for the second sub-sample. The test statistics are as follows: 0.319 for the panel v -statistic, 0.495 for the panel ρ -statistic, 0.427 for the non-parametric panel t -statistic, -1.040 for the parametric panel t -statistic, 1.353 for the group ρ -statistic, 1.023 for the non-parametric group t -statistic, and -0.688 for the parametric group t -statistic. The table indicates that the null hypothesis of no cointegration is accepted for every case considered at the conventional significance level. Thus, the cointegrating relation between trade balances and the terms of trade does not exist over the sample between 1987 and 2003.

The evidence indicates that the rejection of cointegrating relation between trade balances and the terms of trade is robust even if we split the whole sample into sub-samples.

Table 3a Results of Panel Cointegration Tests (1971-1986)

Method	Test Statistic
Panel v -Statistic	0.793
Panel ρ -Statistic	-0.496
Panel t -Statistic (non-parametric)	-0.572
Panel t -Statistic (parametric)	-0.949
Group ρ -Statistic	0.731
Group t -Statistic (non-parametric)	0.091
Group t -Statistic (parametric)	-0.215

Note: All reported value are distributed N(0,1) under null of no cointegration.
Panel statistics are weighted by long-run variance.

Table 3b Results of Panel Cointegration Tests (1987-2003)

Method	Test Statistic
Panel v -Statistic	0.319
Panel ρ -Statistic	0.495
Panel t -Statistic (non-parametric)	0.427
Panel t -Statistic (parametric)	-1.040
Group ρ -Statistic	1.353
Group t -Statistic (non-parametric)	1.023
Group t -Statistic (parametric)	-0.688

Note: All reported value are distributed N(0,1) under null of no cointegration.
Panel statistics are weighted by long-run variance.

5. Conclusion

This paper has applied the recent development of non-stationary panel data analysis to examine the long-run relationship between the trade balance and the terms of trade for G-7 countries. Using the methodologies of Haynes and Stone (1982) and Arize (1996), we directly analyze the long-run relationship between the two variables. This is an attractive and practical approach which requires no estimations of the import and export demand function.

Arize (1996) found that, for a majority of the countries, there exists a positive and significant long-run statistical equilibrium between the trade balance and the terms of trade. The major finding, based on Pedroni (1999)'s panel cointegration test, however, suggests that the trade balance and the terms of trade are not cointegrated. This result holds even if we split the total sample into two sub-samples. This implies that there is no long-run equilibrium relation implied by the Marshall-Lerner condition for G-7 countries. Thus, the deterioration in the terms of trade will not necessarily improve a country's trade balance.

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Annex

Table A1. Terms of trade and trade balance/Gdp in Ca, Fr, De, It: yearly series

Country	Canada		France		Germany		Italy
Series	tot	tb/gdp	tot	tb/gdp	tot	tb/gdp	tot
1971	0.9305	0.03243678	1.2501	-0.021195158	1.0379	-0.021099562	1.1175
1972	0.9443	0.022446358	1.2583	-0.024236715	1.0563	-0.023230189	1.1340
1973	1.0029	0.014046084	1.2808	-0.030099792	1.0422	-0.015440799	0.9984
1974	1.0929	-0.019660605	1.0871	-0.021569832	0.9672	0.000787715	0.8885
1975	1.0654	-0.030481738	1.1171	-0.009219239	0.9925	-0.01365184	0.9231
1976	1.0980	-0.028028338	1.0956	-0.021641108	0.9740	-0.015083479	0.8637
1977	1.0541	-0.013672141	1.0663	-0.011746543	0.9776	-0.015240221	0.8803
1978	1.0101	0.000587376	1.1025	-0.007834213	1.0113	-0.019421316	0.8916
1979	1.0493	-0.006727434	1.0921	-0.012723871	0.9737	-0.027101466	0.8759

1980	1.0553	0.002459327	1.0109	-0.016245042	0.9143	-0.023434917	0.8535
1981	1.0212	0.000588372	0.9461	-0.006589838	0.8675	-0.006927053	0.8262
1982	0.9982	0.032939495	0.9470	-0.013204493	0.8832	0.000180472	0.8628
1983	1.0067	0.026816451	0.9658	-0.002104876	0.8935	-0.00514481	0.8810
1984	0.9898	0.032808024	0.9581	0.004165085	0.8745	0.001731017	0.8823
1985	0.9772	0.025317854	0.9648	0.000540335	0.8759	0.008302514	0.8923
1986	0.9548	0.019394255	1.0524	-0.010439546	0.9769	-5.79976E-05	1.0092
1987	0.9863	0.013940779	1.0590	-0.018009618	1.0158	-0.007643976	1.0368
1988	1.0109	0.004080048	1.0747	-0.01925196	1.0149	-0.008050744	1.0226
1989	1.0313	-0.008917847	1.0513	-0.017410258	0.9880	-0.005193657	1.0195
1990	1.0092	-0.001880776	1.0524	-0.020332838	0.9943	-0.000627395	1.0693
1991	0.9880	-0.003883801	1.0323	-0.01481696	0.9812	0.000843829	1.1050
1992	0.9737	0.003133905	1.0519	-0.007845563	1.0127	-0.007254	1.1025
1993	0.9560	0.013751966	1.0311	0.002585827	1.0327	-0.007430846	1.0598
1994	0.9498	0.028995242	1.0287	0.002287025	1.0428	-0.008322512	1.0442
1995	0.9773	0.039232459	1.0288	0.004568623	1.0585	-0.009075291	1.0223
1996	0.9938	0.042730095	1.0239	0.009168453	1.0512	-0.0033451	1.0632
1997	0.9872	0.024498482	1.0172	0.023934585	1.0283	0.005071973	1.0516
1998	0.9492	0.040175901	1.0268	0.018918426	1.0449	0.001407997	1.0761
1999	0.9613	0.053032644	1.0299	0.013905262	1.0506	-0.005973371	1.0745
2000	1	0.057731904	1	0.009029585	1	0.003515145	1
2001	0.9839	0.063514739	1.0063	0.009977287	0.9989	0.020468698	1.0058
2002	0.9593	0.060939805	1.0327	0.009362304	1.0192	0.03973327	1.0210
2003	1.0173	0.035905685	1.0359	0.002448099			

Table A2. Terms of trade and trade balance/Gdp in Japan, UK and the USA: yearly series

Country	Japan		UK		USA	
Series	tot	tb/gdp	tot	tb/gdp	tot	tb/gdp
1971	1.3536	-0.002165885	0.987061749	0.011057722	1.384672287	-0.015738218
1972	1.4103	-0.005309002	1.001836501	-0.001033548	1.35152678	-0.018077623
1973	1.3061	-0.015054409	0.903262516	0.000471491	1.303579168	-0.012056311
1974	1.0448	-0.006415933	0.796074011	0.010085175	1.122826346	-0.006862102

1975	1.0014	-1.68877E-05	0.847524099	0.015581488	1.142462274	-0.000561153
1976	0.9705	0.005619551	0.838143045	0.022215371	1.145389758	-0.008209453
1977	0.9723	0.010450683	0.851674517	0.030427082	1.09541938	-0.012953147
1978	1.0808	0.005790338	0.888953235	0.027220451	1.085966167	-0.012424981
1979	0.9155	0.000718147	0.907301992	0.018885474	1.038419311	-0.007976035
1980	0.7305	0.016624474	0.944639598	0.024358341	0.918526629	0.002457102
1981	0.7456	0.023953366	0.950578129	0.027765839	0.936006324	0.001578728
1982	0.7495	0.022796407	0.949837192	0.021230062	0.972955048	-0.00244489
1983	0.7673	0.026545492	0.954512614	0.013407213	1.015226784	-0.011176502
1984	0.7993	0.030463409	0.944139242	0.008638502	1.033176616	-0.021198478
1985	0.8230	0.033400907	0.954036359	0.014718084	1.035868836	-0.023540174
1986	1.0415	0.026218616	0.915593544	0.010367837	1.01976532	-0.025156017
1987	1.0958	0.017445246	0.919646338	0.007401494	0.985528372	-0.023096918
1988	1.1198	0.009724844	0.93011136	-0.01449769	0.989058894	-0.015964124
1989	1.0953	0.005287047	0.944296873	-0.020533985	0.983859641	-0.011434671
1990	1.0379	0.004573434	0.953946835	-0.011210381	0.963017775	-0.007739193
1991	1.0691	0.008459197	0.966172419	-0.001950964	0.979642466	-0.002073478
1992	1.0981	0.012019131	0.982099387	-0.007070345	0.974187051	-0.002185209
1993	1.1181	0.012940426	0.983868701	-0.004894655	0.982611887	-0.006972699
1994	1.1342	0.010190237	0.96510511	0.002130631	0.984552897	-0.010211563
1995	1.1307	0.003778246	0.940565193	0.01024476	0.980741038	-0.008892734
1996	1.0720	-0.001537691	0.951771777	0.008436044	0.985259429	-0.009623517
1997	1.0247	0.00791151	0.982954306	0.005694283	1.004055057	-0.012095847
1998	1.0606	0.011771109	1.003213296	-0.010584639	1.037247755	-0.022613028
1999	1.0608	0.010146001	1.009041923	-0.020340325	1.0245311	-0.031453419
2000	1	0.014303106	1	-0.020566814	1	-0.03886408
2001	0.9753	0.008463189	0.99427194	-0.026662791	1.021859302	-0.040563481
2002	0.9779	0.014648414	1.021599376	-0.038240165	1.030628408	-0.047099312