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“Common Factors”, Cointegration, and Japan’s Aggregate Import Demand Function

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ABSTRACT

This study surveys the existing studies those examined a long-run (cointegration) aggregate import demand for Japan. Their empirical results are inconclusive on the “cointegratedness” of Japan’s aggregate demand for imports, and its determinants, namely activity variable, and relative price of imports. A set of determinants or so-called “common factors” is identified from the literature, and the empirical results provide some meaningful findings. An implication of this study is that the “common factors” have to consider when carrying out cointegration analysis, in particular, for the aggregate import demand function.

JEL Classification: F14, F41

Keywords: Aggregate import demand function, cointegration, Japan

INTRODUCTION

Using multivariate cointegration approach, Kurita (2010) revealed a *stable* economic linkage interpretable as a long-run import demand function for Japan that relates real import demand in Japan to real GDP, and relative price of imports (i.e. ratio of import

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price to domestic price level). The sample covers quarterly observations between 1993 and 2008. A usual observation is that the choice of empirical model, testing method, and sample is technically *random* (not justified) and ambiguous, in which the Kurita's positive finding of cointegration may be viewed cautiously. This study identifies the empirical importance of "common factors" in the research design and strategy of existing empirical work on Japan's import demand. It extends the comprehensive review by Sawyer and Sprinkle (1997), and Tang (2008a) of the vast literature on the cointegratedness of import demand behaviour for Japan.¹

Table 1 summarises the cointegration findings reported by existing studies with cointegration tests covering between an early work by Asseery and Peel (1991) and the late study by Bahmani-Oskooee and Kara (2005). With the increasing recognition of '*spurious regression*' problems and the introduction of the concept of cointegration (Engle and Granger, 1987), many macroeconomic models that had previously been estimated with the OLS estimator were being revisited. Japan's aggregate import demand function is no exception. In general, the existing studies of the long-run aggregate import demand function for Japan can be categorized into two distinct groups due to the nature of their interest. The first group (first panel of Table 1) investigates the cointegration or long-run properties of the aggregate demand for imports of Japan or for groups of countries that include Japan. They typically consider conventional determinants such as real income and the relative price of imports as well as additional variables such as exchange rates in a reduced form specification.

The second group of studies estimates the behaviour of trade flows for groups of countries by estimating export and import equations in order to clarify the empirical support for theoretical priors such as the Marshall-Lerner condition or the so called "45-degree rule"². Tests of both hypotheses are based on the estimated income elasticity and price elasticity of the export and the import demand functions. They employ the cointegration framework in order to identify the existence of long-run relations among

¹ Sawyer and Sprinkle (1997, p. 253, Table 1) covers 17 studies published between 1976 and 1996, while Tang (2008a, pp. 66-76, Appendix A) documented 40 articles available between 1975 and 2005. Both studies also included those early studies before the era of cointegration in 1990s.

² The "45-degree rule" (Krugman, 1989) depicts a systematic relationship between rates of economic growth and differences in the income elasticities of the demand for exports and imports. It explains the determination of equilibrium real exchange rates. The intuition, initially proposed by Houthakker & Magee (1969), is that the relationship between growth rates and income elasticities (of both exports and imports) helps to validate long-run PPP (Purchasing Power Parity). Countries with unfavourable income elasticities could find themselves running into balance of payments problems whenever they try to expand. If this forces them into stop-go economic cycles that inhibit growth, the result could be to limit growth to a level consistent with the initial real exchange rate. At the same time, differential growth rates affect trade flows in such a way as to create apparent differences in income elasticities (Krugman, 1989, pp. 1036-1037). Japan faced the highly favourable combination of a high income elasticity of exports and a low income elasticity of imports, in contrast to highly developed countries like the US and UK. But Japan was the fastest growing country in Krugman's (1989) study while the U.S. and U.K. were the slowest.

the variables in the export- and import- demand specifications. These studies do provide empirical information for analysing the joint effect of the “common factors” on the cointegration finding of Japan’s aggregate import demand function. But they employ a different research design compared to the first group of studies that directly investigate Japan’s aggregate import demand function. That observed that the cointegration results reported for Japan’s aggregate import demand vary systematically (or mixed) with the model specification and the estimation techniques employed. It motivates this study.

The study contributes to the existing literature in the field of aggregate import demand function. It reviews the empirical literature to identify the existing understanding of the equilibrium aggregate import demand function for Japan. This review enables us to identify those “common factors” that may have materially influenced the empirical findings of cointegration of Japan’s aggregate import demand relation. The most important “common factors” empirically identified are sample size, testing method and activity variable. The other component, examines empirically the influence of these “common factors” on the cointegration results of Japan’s aggregate import demand function. These findings constitute the foundation for a more systematic investigation and explanatory framework of the influence which the “common factors” may exert on the empirical results of cointegration studies. The usefulness of knowing these “common factors” is that researcher(s) have to seriously consider these potential determinants when implementing empirical testing in order to avoid *false* positive finding(s) since that the cointegratedness can be *sensitive (manipulated by)* to the choice of these “common factors”, in particular, aggregate import demand study for Japan. In order words, sensitivity check should conducted with these identified “common factors”.

Section 2 reviews and identifies the potential “common factors” from the econometrics studies that potentially determining the empirical findings of cointegration. Some positive findings are obtained from the empirical results – Section 3. Section 4 concludes the study.

Table 1 Existing cointegration studies of Japan’s demand for imports – Summary of findings

Author(s)	Sample and data	Testing method	Activity variable	Finding	Remarks
Asseery and Peel (1991)	1972:1-1986:4 (Quarterly)	Engle-Granger Error-correction mechanism (ECM)	Real GNP	√	Canada, Japan, U.K., U.S., and West Germany. Referred to ECM because small sample consideration.
Arize and Walker (1992)	1973:1-1988:4 (Quarterly)	Engle-Granger (Jenkinson, 1986)	Real GNP	√	Japan. Included effective exchange rate as additional explanatory variable along with P ^d and P ^m .
Mah (1994)	1974:1-1990:2	Engle-Granger	Real GNP	×	Japan.

(Bi-annual)					
Urbain (1996)	1966:1-1994:1 (Quarterly)	Johansen	Real GDP	√	Revisited the work by (Mah, 1994). Accounted for small sample corrected version of test statistics. Included dummies to “filter” out outliers. Included a trend variable.
Senhadji (1998)	1960-1993 (Annual)	Engle-Granger (Phillips-Ouliaris residual test)	GDP –Exports	√	66 countries including Japan.
(Arize and Shwiff (1998)	1973:2-1995:1 (Quarterly)	Johansen	Real GDP	√	G7 member countries. Small sample bias correction was employed. Examined effects of exchange rate volatility.
Masih and Masih (2000)	1974:1-1990:2 (Bi-annual)	Johansen	Real GNP	√	Revisited the study (Mah, 1994) by applying Johansen’s multivariate cointegration tests instead of the Engle-Granger test.
Hamori and Matsubaya shi (2001)	1973:1-1998:1 (Quarterly)	Engle-Granger Johansen Gregory-Hansen	Real GDP	× √ ×	Japan.
Matsubaya shi and Hamori (2003)	1973:1-1999:4 (Quarterly)	Engle-Granger Gregory-Hansen	Real GDP	× ×	G7 member countries.
Tang (2003c)	1973-1997 (Annual)	Bounds test Engle-Granger ECM Johansen	Real GDP	√ × × √	Japan.
Tang (2003a)	1973:1-2000:2 (Quarterly)	Engle-Granger Johansen Bounds test	National cash flow (Xu, 2002)	× × ×	Japan. Included time trend.
Tang (2003b)	1973-1997 (Annual)	Bounds test	Components of GDP (i.e. C, G, X and I)	√	Japan.
Tang (2004)	1973:1-2000:2 (Quarterly)	Engle-Granger Johansen Bounds test	National cash flow (Xu, 2002)	× √ √	Japan. Extension of (Tang, 2003a). Includes time trend. Includes alternative financial variable(s): bank credit, lending rate, deposit rate, government bond yield, and share prices.
Tang (2006b)	1973-2000 (Annual; bi-annual; quarterly)	Engle-Granger Bounds test Johansen ECM	Real GDP	× √ √ ×	Japan. The cointegration findings are found to be consistent with the testing method regardless the data frequencies (i.e. annual, bi-annual and quarterly data).

Bahmani-Oskooee and Niroomand (1998)	1960-1992 (Annual)	Johansen	Real GNP (or GDP)	√	Employed export and import demand equations to test Marshall-Lerner condition for 30 countries.
Caporale and Chui (1999)	1960-1992 (Annual)	Johansen	Real GDP	√	Tested the “45-degree rule”.
Sinha (2001)	1952-1997 (Annual)	Johansen	Real GDP	√	Estimated trade flows for India, Japan, the Philippines, Sri Lanka, and Thailand.
Bahmani-Oskooee and Kara (2003)	1973:1-1998:2 (Quarterly)	Bounds test ECM	Real GDP	√ √	Estimated trade flows (exports and imports equations) for Australia, Austria, Canada, Denmark, France, Germany, Italy, Japan and the U.S. Included nominal effective exchange rate as additional explanatory variable.
Bahmani-Oskooee and Kara (2005)	1973:1-1998:4 (Quarterly)	Bounds test	Real GDP	√	Estimated trade flow equations for 28 countries. Extended their 2003 study. Included nominal effective exchange rate as additional explanatory variable.

Notes: The column of Finding, √ stands for “cointegration”, while X denotes “non-cointegration”.

LITERATURE REVIEW

THE INFLUENCE OF “COMMON FACTORS” ON COINTEGRATION

The differentiated incidence of the “common factors” in the various studies may indeed help to understand the mixed evidence on the cointegration of Japan’s import demand relation. Theory provides little guidance to selecting the appropriate empirical implementation of the conventional import demand model Thursby and Thursby (1984, p. 120) - proxies for variables, functional form and dynamic structure. In a sample of nine models examining Canada, Germany, Japan, the U.K. and the U.S., Thursby and Thursby found that “dynamic” models that include lagged values of imports tend to yield elasticity estimates consistent with theory. Also, log specifications are widely accepted by the data except for Canada. However, they could not comment on the influence of empirical implementation on cointegration findings. The cointegration approach and its application to long-run aggregate import demand function Engle and Granger (1987) gained popularity only several years after their work. Different studies draw different cointegration conclusions but no specific study looks at the implications for cointegration results of different empirical implementations involving particularly

differences in sample period and data frequency, testing method and proxies for domestic activity, domestic prices and import prices. As demonstrated in the preceding section, a set of “common factors” can potentially exert a significant influence on empirical cointegration findings. This section reviews briefly the conceptual background of the “common factors”, and examines through formal testing by econometric methods their statistical significance for the findings obtained in previous studies.

Since the findings reported in the existing empirical literature on the import demand of Japan are ambiguous, it has been difficult to identify the important forces that determine the presence of cointegration. This ambiguity calls for a systematic examination of the role of the “common factors” that may affect the test findings of cointegration of Japan’s aggregate import demand. Potentially important “common factors” identified in the preceding review include the particular testing method, sample size (including data frequency), and the measure of domestic activity.

TESTING METHODS

Harberger (1953) noted many years ago that the most critical (and also most neglected) aspect of the problem of estimating import demand functions (for the U.S) is the choice of an appropriate estimating technique. In the case of Japan’s aggregate import demand existing studies have largely been driven by the development of cointegration testing procedures. These procedures have progressed from the residuals based approach of Engle and Granger (1987) to the system based approach of Johansen and Juselius (1990), to other new testing methods that examine specific issues such as small sample size, unit roots, and structural breaks. Conceptually, Banerjee, *et al.*’s (1998) study illustrates that the error correction mechanism (ECM) tests perform better than other cointegration tests - Engle and Granger (1987), and Hansen (1990). The ECM test statistic is based on the coefficient of the lagged dependent variable in an autoregressive distributed lag (ADL) model.

Using a battery of cointegration tests³, Pesavento (2004) finds that different tests give different answers. Based on a comparison of their power properties, the study finds that the Johansen maximum eigenvalue tests and tests of the ECM significantly outperform single equation tests. Summer (2004) has examined the sensitivity of the Johansen procedure to variations in the treatment of deterministic terms (intercept and/or trend) and lag length in a study of the consumption function for the UK and US. He compared the results of the Johansen tests with the results of alternative tests⁴ and found

³ The tests include the ADF test on the residuals of the cointegration regression, Johansen's maximum eigenvalue test, the t-test on the Error Correction (EC) term, and Boswijk’s (1994) Wald test

⁴ The tests include the *t*-test on the lagged residuals in error correction models; an unrestricted error-correction model with *F*-test on the lags of the ‘level’ variables set at the highest-order significant term in the unrestricted *i*-order VAR; unrestricted error-correction model suggested by the selection criteria.

that the unrestricted ECM yields unambiguous inferences and performs better in a range of tests. Kanioura and Turner (2005) have found that the F -test has higher power than the Engle-Granger test but lower power than the t -form of the error correction test. It is based on the observation that the F -test rejects the null of no cointegration between UK and US interest rates although the Engle-Granger test fails to do so. Similarly, Cook (2006) has revealed that the F -test possesses greater power than both the Engle-Granger and the Generalized Least Squares (GLS) based cointegration tests. The simulation evidence is supported by an empirical examination of the relationship between UK non-durable consumer expenditure and disposable income, in with the F -test alone was able to reject the null of no cointegration between the series.

These studies clearly demonstrate that different testing methods do affect assessments of the presence of cointegration among time series data. In general, the ECM (in an unrestricted ECM - ADL model) seems strictly superior to the Engle-Granger tests as their results support cointegration. Specifically, the ECM tests are robust for small samples, while the unrestricted version of ECM tests (based on the ADL model) allows $I(0)$ and $I(1)$ regressors because the pre-testing for unit roots can be exempted. Meanwhile, the system based Johansen multivariate tests are more appropriate than the Engle-Granger residual based tests to identify more than one cointegrating relation when there are more than two endogenous variables. The pervasive ambiguity about the existence of cointegration relations can be resolved by running at least one residuals based tests and one system based test. However, this strategy does not provide an unequivocal resolution of the ambiguity problem since the cointegration findings are also affected by data frequency and activity variable as well as by other potential factors.

SAMPLE SIZE AND DATA FREQUENCY

Another differentiating factor of the empirical studies of the cointegration properties of Japan's aggregate import demand is the choice of sample period (or time span), and of data frequency (quarterly, biannual, or annual). These choices, typically dictated by data availability, determine the sample size which, in turn, affects the results of cointegration tests. Their importance has been documented and examined in a number of studies.⁵ In a seminal paper Shiller and Perron (1985) have concluded, on the basis of a Monte Carlo experiments, that the power of unit root tests depends more on the span of data than on the number of observations. Their methodology is based on a fixed span of data (time period) while varying the number of observations by changing the data frequency. A cointegration relation is established among a set of macroeconomic variables if the residual which is obtained from the regression equation is stationary Engle and Granger (1987). In the same vein, Hakkio and Rush (1991) have documented that for a given period of observation, "data frequency has no important influence on the cointegration

⁵ Data frequency or time span: Shiller and Perron (1985), Hakkio and Rush (1991), Charemza and Deadman (1992), Horvath and Watson (1995), Marcellino (1999) and Haug (2002). Sample size: Toda (1994) and Zhou (2000).

findings.” Since “cointegration is a long-run property ... we often need long spans of data to properly test it” (p. 579). From another perspective, Charemza and Deadman (1992, p. 153) recommend the use of annual data on the grounds that they “could be used to estimate these long-run parameters thereby avoiding the need to model the seasonality, and the standard tests for cointegration applied”. In contrast to Shiller and Perron (1985), and Hakkio and Rush (1991) who emphasised the span of data (length of period of observation), Charemza and Deadman (1992) establish the importance of data frequency for cointegration findings.

Toda (1994) investigated the sampling properties of the tests for cointegrating rank, namely the Johansen (1992) and Perron and Campbell (1992) tests. His simulation results suggest that these asymptotic test procedures to detect “stochastic cointegration” but that they are not very reliable for the small sample sizes that are typical of economic time series. The performance of any test is not quite satisfactory even for a sample of 100, and Toda (*loc. cit.*, p78) concludes that “... 300 or more observations are needed to ensure good performance of the tests.” This conclusion is inconsistent with the previous studies supporting the importance of data span in cointegration findings. Toda’s (1994) study does not explore the crucial issue of the perfect correlation between sample length and size, i.e. that the number of observations is proportional to sample length for a given frequency. Shiller and Perron (1985) address this concern with three different settings which allows them to examine how power depends on the number of observations for a fixed span, on the span for a fixed number of observations, and on the number of observations when, as is usually the case, the span is proportional to observations. Toda (1994) confirms the significance of sample size as a “common factor” in cointegration findings, while the previous works such as Shiller and Perron (1985) and Charemza and Deadman (1992) suggest the data span or the data frequency.

On the other hand, Marcellino (1999) has demonstrated theoretically that time aggregation (reducing data frequency) may increase the local power of cointegration tests. But this effect may be offset by the associated decrease in the number of observations when one deals with finite samples. However, based on the results of Monte Carlo experiments, Haug (2002) shows that an increase in the frequency of observations for a given span of data can substantially improve the performance of cointegration tests in finite samples and, therefore, compensate to some degree for the loss of power attributable to the short duration of the span. This finding seems to contradict other studies (Shiller and Perron, 1985; Hakkio and Rush, 1991) which found that the frequency of observation is less important than the span of time in cointegration findings. Marcellino (1999), and Charemza and Deadman (1992) suggest that lower frequency (annual) data avoid the estimation bias associated with seasonality.

Zhou (2000) has used Monte Carlo experiments to study the finite sample bias of Johansen likelihood ratio tests for structural hypotheses about cointegration relations among economic variables. Again, the study shows that for small samples the Johansen tests are biased toward rejecting the null hypotheses more often than suggested by asymptotic theory. This bias persists even after the test statistics are adjusted by Sims’s (1980) finite-sample correction of standard likelihood ratio tests. Similarly, Zhou (2001)

has investigated how the power of cointegration tests of Engle and Granger (1987), Johansen (1992), and Horvath and Watson (1995) is affected by data frequency and time spans as well as by the small sample size distortions of the tests. The Monte Carlo experiments support the potential benefits of using high frequency data series for cointegration analysis. When the data are restricted by relatively short time spans of 30 to 50 years, increasing data frequency may yield considerable power gain and reduce size distortion.

Data frequency is an important “common factor” in cointegration analysis. Higher data frequency provides larger numbers of observation to guarantee the degree of freedom. However, “excessive” observations can destroy the power of cointegration tests Shiller and Perron (1985), while Toda (1994) maintains that a large sample size of 300 observations or more is needed to guarantee the robustness of cointegration findings. Eventually, the sample size is determined jointly by data frequency and the sample period. An opposite argument is that the span of data is more important than data frequency (and sample size). This inconclusive finding can be explained by the core argument that data frequency, sample size, and sample span are not independent.

DOMESTIC ACTIVITY VARIABLE

The last obvious feature observed from the existing literature summarised in the previous section concerns the choice of proxy variable(s) for measuring income or economic activity. These have ranged from real income, real GNP, real GDP, GDP adjusted for exports, the components of final expenditures to national cash flow. These alternative proxies have been used in empirical studies of aggregate import demand behaviour without recourse to rigorous selection criteria. To test the sensitivity of cointegration findings to the choice of activity variable, Harb (2005) conducted an empirical study of aggregate import demand functions for 40 countries, including Japan, using the two alternative activity variables GDP and GDP minus exports. He found that the empirical estimates of the long-run income elasticities obtained with GDP, compared to GDP minus exports, correspond better to the theoretical prior of a unitary income elasticity of imports. Some less conventional proxies for the income variable have also been used in the literature. For example, Xu (2002) has proposed a national cash flow variable which is obtained by subtracting the sum of investment (I), government spending (G), and exports (X) from GDP. Amano and Wirjanto (1997, p. 467) consider the sum of total private real consumption (C) and aggregate real investment (I) as proxy for domestic activity in estimating the Canadian and the U.S. import demand function. They exclude government expenditure because it generally consists of labour services and non-imported defence spending. They found a cointegration relation between imports, their activity variable and the relative price of imports.

An empirical work by Tang (2003d) studied the existence of cointegration for China’s aggregate import demand by using a set of domestic activity variables that includes national cash flow and the components of GDP. The study covers annual observations between 1970 and 1999. The results of the ARDL bounds testing approach

confirm cointegration between imports, the alternative activity proxies and the relative price of imports. Similar findings are also obtained from the ECM tests and the Johansen multivariate tests. The study shows that the choice of activity variable has no effect on the cointegration finding of China's import demand during the observation period. Tang (2005a) has also applied this framework to South Korea, using quarterly data for 1970-2002. The ARDL bounds tests, Engle-Granger tests, ECM tests and Johansen multivariate tests yield no indication that the choice of activity variable affects the cointegration findings. All the tests provide empirical support for the presence of cointegration for South Korea's aggregate import demand with the different activity variables – real GDP, GDP minus exports, national cash flow variable and the components of final expenditure. However, the cointegration tests with structural breaks (Gregory and Hansen, 1996) demonstrate that the choice of activity variable may have an effect on the cointegration finding. Using GDP minus exports as activity variable returns a finding of no cointegration while the other activity variables show the presence of cointegration. Harb (2005) considers real GDP and GDP minus exports in studying import demand for 40 countries. The panel cointegration tests for all countries, developed and developing, show that the choice of activity variable does affect cointegration findings. GDP out-performs GDP minus exports in rejecting the null of no cointegration.

These studies document that the choice of activity variable exerts a potential influence on empirical cointegration findings. While this influence does not seem to be as powerful as data frequency and testing method it may well help to contribute to the unravelling of the ambiguous cointegration findings of Japan's import demand.

EMPIRICAL TESTING OF THE IMPORTANCE OF THE “COMMON FACTORS”

The empirical findings about the existence of cointegrating relations in import demand behaviour for Japan remain ambiguous. One finding from the literature survey is that the identified “common factors” seem to affect the existing cointegration findings individually or jointly. Hence, the aim of this section is to examine empirically the influence of these “common factors” on the cointegration findings that have been obtained in studies of Japan's demand for imports. It seeks to identify those factors that determine the probability that Japan's aggregate demand for imports and its determinants are cointegrated.

The formal method for the systematic examination of the influence of the “common factors” involves the application of binary regression methodology. This method involves regressing a zero-one dummy variable denoting the absence or presence, respectively, of cointegration against the “common factors”, namely:-

- (1) Testing methods for cointegration - Engle and Granger (1987), Johansen and Juselius (1990), and Pesaran *et al.* (2001).
- (2) Data frequency - yearly, biannual, and quarterly data; and

- (3) Proxy for income variable - real GDP, real GDP minus exports, and national cash flow.

The theoretical descriptions of the Probit estimator are not documented here since it has been widely applied in empirical studies. A comprehensive survey of the literature on binary response models is provided in Amemiya (1981, pp. 1486-1510) .

Several *ad hoc* control variables are also taken into account, including sample size, ‘non-traditional’ variables (like the real exchange rate), time trend and small sample correction.⁶ The data consist of the findings reported in the cointegration studies of Japan’s aggregate demand for imports summarised in Table 1, yielding 39 observations.

In principle, the influence of “common factors” (x) on the cointegration findings of Japan’s aggregate import demand behaviour (y) could be examined with a simple or multiple linear regression using the OLS estimator. However, the standard OLS linear regression is not appropriate econometrically in the present setting for at least two reasons. The implied model of the conditional mean places inappropriate restrictions on the residuals of the model, and the estimated value of y is not defined continuously over the 0-1 space. Rather, y is restricted to take on either of the polar values of 0 or 1. In such situations a binary dependent variable model such as a Probit is more appropriate for yielding empirical insight into the potential factors responsible for the cointegration findings.

The testing equation is $\hat{y}_i = a + bx_i$, where the y and x variables can be described as follows. Let $y = 1$ if there is cointegration and $y = 0$ if there is not. x_i is a vector of variables (“common factors”) that may affect the cointegration result. That vector includes the sample size N ; the data frequency FRQ where 1 represents quarterly data and 0 otherwise (semi or annual data)⁷; $M1$ and $M2$ are testing methods with $M1$ assuming the value of 1 for single equation based approaches (Engle-Granger, ECM, bounds testing, and so on) and 0 otherwise (mainly for system based-approaches such as Johansen’s multivariate test), and $M2$ assuming the value of 1 for bounds test⁸, and 0

⁶ The selection of these variables is based on their theoretical relevant and widely being included in past studies. In theory, traditional model relates real imports positively to real GDP, but negatively to relative price of imports (i.e. ratio of import price to domestic price level). The import price (proxied by import unit value index) can be decomposed in foreign price, and exchange rate (see Sawyer and Sprinkle, 1997, p. 249). A time trend is included to capture time effect, changes in importers’ taste over time, as well as technical progress. Some studies such as Arize and Shwiff (1998) adjusted the cointegration tests for small sample – its inclusion will capture this ‘correction factor’ in finding cointegration.

⁷ Most of the studies of Japan’s aggregate import demand use quarterly data because they generate more observations for a given time span than semi or annual data. More practically, quarterly data are readily available from official sources. For the dummy variable FRQ , 1 represents quarterly data, and 0 refers to semi or annual data to capture the influence of high frequency quarterly data. The analysis becomes more complex if a second and a third dummy variable for FRQ were included, namely 1 for semi and 0 for others (quarterly and annual).

⁸ The bounds test for the $M2$ variable is partially captured by $M1$ as a single equation based approach cointegration test. The bounds test procedure does not require a pre-testing for unit roots, and the test is applicable whether the regressors are stationary, $I(0)$, or nonstationary, $I(1)$, while other testing methods require all variables to be $I(1)$ by the unit root (or stationary) tests. Due to the popularity of the test in

otherwise; the activity variable *INC* where 1 represents real GDP or real GNP⁹ and 0 otherwise; *Time* represents time trend (*Time* = 1 if there is a time trend, and 0 otherwise); *SC* is a sample size dummy equal to 1 if the cointegration tests were adjusted (or designed) for small sample and 0 otherwise; and *AV* represents explanatory variables additional to income and the relative price of imports.

Two groups of Probit equations are estimated to provide empirical identification of the importance of the “common factors” for the cointegration result. As shown in Table 2, equations (1) – (9) are specified to capture the importance of each individual factor by assuming that all other factors are constant. The second group of Probit estimates covers multiple regression equations (equations 11 – 20 in Table 3) that examine the joint role of the “common factors”, i.e. *N*, *FRQ*, *M1* or *M2*, *INC*, *AV*, and *SC*.

Table 2 reports the Probit regression estimates for equations (1)-(9) with the estimated parameters and *p*-values in a simple regression framework that tests one potential explanatory variable – “common factor” - at a time. With the exception of equations (3) and (7) which examine the influence of *M1* and *AV*, the *p*-values are highly insignificant (larger than 0.10). This indicates that the various “common factors,” taken in isolation, do seem to possess explanatory power of the divergent cointegration findings reported in the existing literature. Specifically, these estimates corroborate the hypothesis that the empirical identification of cointegration of Japan’s aggregate demand for imports and its determinants is affected by the testing method used and by the choice of additional variable(s) included in the demand equation. Even though the estimated coefficient in equations (3) and (4) is significant, these regressions yield low McFadden R-squared value (15.4% and 7%, respectively).

The specification of each of equations (1) – (9) assumes the absence of any of the other potentially relevant “common factors”. In contrast, the Probit estimates of equations (11)-(20) examine the *simultaneous* influence of some or all of the eight factors identified above (*N*, *FRQ*, *M1*, *M2*, *INC*, *AV*, and *SC*). These results, reported in the lower panel of Table 3, suggest several empirical findings. One prominent finding of this exercise is the strong explanatory power of the testing approach used (*M1*). This is robust across all specifications which include this variable. Secondly, controlling for all other factors except for *M2* (equation 11) and *FRQ* and *M2* (equation 13), these two equations consistently show that both sample size (*N*) and testing approach (*M1*) (either single equation or multivariate) are statistically significant at the 10% level. The

applied research, this is an attempt to investigate its specific influence on cointegration. Hence *M2* is proposed as a separate variable to capture the bounds test. These two variables *M1* and *M2* are not jointly tested in order to avoid multicollinearity problems.

⁹ Both the real GDP and the real GNP have been used interchangeably by researchers as domestic activity variable. GNP is the sum of GDP and net income from assets abroad. The early studies such as Asseery and Peel (1991), Arize and Walker (1992), Mah (1994), and Masih and Masih (2000) used real GNP rather than real GDP due to unavailability of comprehensive real GDP data series. The aim of the dummy variable, *INC*, is to distinguish between the effect of the conventional activity variable (real GDP or real GNP) and other proxy variables such as GDP minus exports or ‘national cash flow’ on the cointegration finding.

‘restricted’ specifications of equations (12), (14), and (16) all show that the particular proxy for the income variable (*INC*), non-traditional determinants of imports (*AV*) and adjusted tests for small sample (*SC*) affect the cointegration findings for Japan’s aggregate demand for imports function while other factors are statistically insignificant (*FRQ* and *M2*). In general, the other “common factors” (*FRQ* and *M2*) are not statistically insignificant if the set of explanatory variables is examined *simultaneously*. The inclusion of variable(s) additional to real income and the relative price of imports (*AV*) is found to be statistically significant in all equations (11)-(20). Surprisingly, the estimates of equations (18) and (20) show none of the candidate variables (*N* or *FRQ*, *M2*, and *INC*) to be statistically significant at the 10% level, except for *AV*. This would seem to reinforce the importance of *MI* because neither of these equations includes this variable.

In general, the testing method (*MI*) and additional non-conventional import demand variables (*AV*) are individually significant. Other variables seem to come into play only through their joint influence when more than one “common factor” are included. In particular, sample size (*N*) and proxies for domestic activity (*INC*) are significant. The implication of these findings is that sample size (*N*), testing approach (*MI*), proxy for activity variable (*INC*), other additional explanatory variable(s) (*AV*), and adjusted cointegration tests for small sample (*SC*) do influence the empirical cointegration findings of the aggregate demand for imports in Japan. The role of other ‘statistically insignificant’ variables such as data frequency (*FRQ*) and bounds testing method (*M2*) are ambiguous. Since the econometrics literature has documented the influence of these factors for cointegration tests in general, further clarification, at least from the empirical perspective, is recommended for the case of Japan.

CONCLUSIONS

This study reviewed empirical studies of the cointegration properties of the aggregate import demand function for Japan. Those studies have yielded conflicting findings without any evident basis for a viable consensus. A potential explanation of this lack of consensus may be found in differences in the research design and strategy employed. A set of possible “common factors” was identified as a potential source of the different findings. They include most prominently data frequency, testing approach and activity proxy, as well as sample size, small sample correction and range of explanatory variables.

Preliminary examination suggested that the different implementations of the “common factors” could affect the cointegration finding. This tentative result was tested by subjecting the “common factors” to a set of elementary econometric tests to ascertain whether they do carry explanatory power of the divergence in cointegration findings. Empirical Probit models were estimated that explore the separate and joint influences of these factors on the results of cointegration tests of Japan’s aggregate import demand function. It turns out that sample size, testing approach, and activity variable systematically influence the cointegration findings in models that include more than one

“common factor”. This preliminary investigation attests to the potential importance that the joint influence of the “common factors” may exert on empirical tests of cointegration.

Implication of the study is empiric. It alerts researchers the biasness of favouring a cointegration finding, in particular study on Japan’s import demand function. Mostly, it is the case when researchers *simply* employ newer method(s), longer sample periods or bigger observations, and so on because of their *convenient*. An unfavourable finding (non-cointegration) can be altered to a positive finding when changes are made in sample period, data frequency, testing method, proxies for activity variables, and so on. If the former is true, bias will be occurred in policy formulation and its implementation. Hence, a careful selection of “common factors” is a *necessary* but not sufficient condition – it suggests a sensitivity check which, at least with the suggested “common factors”.

This initial result provides a strong rationale for more comprehensive future empirical work that systematically examines the nature of this influence and interaction among the various “common factors”. This comprehensiveness involves larger samples of past empirical studies (covering other countries); inclusion of others “common factors” (i.e. income groups, trading blocs, disaggregated imports, and so on); and development of a “common factors” matrix that *inform* cointegratedness. It helps to generate this study.

Table 2 Binary Probit regression results

Variable:-	Measures:-	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sample size (<i>N</i>)	Number of observations	-0.006 (0.302)								
Data frequency (<i>FRQ</i>)	1 = quarterly data; 0 = otherwise (i.e. yearly or bi-annual)		-0.312 (0.457)							
Method 1 (<i>M1</i>)	1= Single equation based approach; 0 = otherwise (i.e. system based)			-1.426** (0.012)						
Method 2 (<i>M2</i>)	1 = bounds test; 0 = otherwise				0.698 (0.281)					
Income variable (<i>INC</i>)	1 = real GDP or real GNP; 0 = otherwise					0.460 (0.358)				
Time trend (<i>Time</i>)	1 = trend; 0 = no trend						-0.669 (0.207)			
Additional variable(s) (<i>AV</i>)	1 = additional variable(s); 0 = otherwise							1.053* (0.079)		
Interaction <i>Time*AV (TAV)</i>	1 = T and AV; 0 = otherwise (i.e. no T and AV)								0.010 (0.824)	
Small sample correction (<i>SC</i>)	1 = small sample correction; 0 = otherwise									-0.461 (0.358)
Constant		0.815* (0.096)	0.541* (0.091)	1.426*** (0.005)	0.269 (0.224)	0.000 (1.000)	0.489** (0.035)	0.168 (0.465)	0.331 (0.179)	0.460** (0.049)
McFadden R-squared		0.021	0.011	0.154	0.025	0.017	0.032	0.070	0.001	0.017

Notes: The definitions of the variables are: Dependent variable (*CI*) measures the cointegration finding, i.e. 1 = cointegration, and 0 = no cointegration. The sample size is 39 observations. The reported values are coefficients, and the values in parentheses are *p*-values. ***, **, and * denote significance difference from zero at the 1%, 5%, and 10% levels, respectively.

Table 3 Binary Probit regression results

Variable:-	Measure:-	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Sample size (<i>N</i>)	Number of observations	-0.034* (0.055)	-0.014 (0.306)	-0.019** (0.033)	-0.014* (0.065)			-0.017** (0.044)	-0.011 (0.107)		
Data frequency (<i>FRQ</i>)	1 = quarterly data; 0 = otherwise (i.e. yearly or bi-annual)	1.129 (0.315)	0.01 (0.994)			-0.806 (0.140)	-0.804 (0.113)			-0.751 (0.158)	-0.746 (0.126)
Method 1 (<i>M1</i>)	1 = Single equation based approach; 0 = otherwise (i.e. system based)	-2.091** (0.020)		-1.810** (0.026)		-1.480** (0.039)		-1.925** (0.0138)		-1.623** (0.020)	
Method 2 (<i>M2</i>)	1 = bounds test; 0 = otherwise		1.110 (0.321)		1.111 (0.320)		1.150 (0.280)		1.051 (0.282)		1.107 (0.254)
Income variable (<i>INC</i>)	1 = real GDP or real GNP; 0 = otherwise	0.954 (0.166)	1.503* (0.065)	0.925 (0.171)	1.503* (0.065)	0.928 (0.141)	1.492* (0.056)	0.637 (0.309)	1.024 (0.155)	0.700 (0.241)	1.086 (0.127)
Additional variable(s) (<i>AV</i>)	1 = additional variable(s); 0 = otherwise	2.312** (0.0122)	2.279** (0.010)	2.259** (0.010)	2.279** (0.010)	1.899** (0.015)	2.120** (0.012)	2.106** (0.013)	1.740** (0.035)	1.843** (0.019)	1.754** (0.031)
Small sample correction (<i>SC</i>)	1 = small sample correction; 0 = otherwise	-1.159 (0.127)	-1.253* (0.063)	-1.004 (0.149)	-1.252* (0.057)	-0.819 (0.208)	-1.08** (0.083)				
Constant		2.880** (0.036)	-0.055 (0.955)	2.202* (0.054)	-0.057 (0.949)	1.052 (0.212)	-0.626 (0.410)	2.165** (0.046)	-0.058 (0.946)	1.151 (0.159)	-0.514 (0.483)
McFadden R-squared		0.422	0.276	0.401	0.276	0.341	0.256	0.358	0.199	0.309	0.194

Notes: The definitions of the variables are: Dependent variable (*CI*) measure the cointegration finding, i.e. 1 = cointegration, and 0 = no cointegration. The sample size is 39 observations. The reported values are coefficient, and the values in parentheses are *p*-values. ***, **, and * denote significance difference from zero at the 1%, 5%, and 10% levels, respectively.

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