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Abstract

We discuss metrics of globalization for individual economies as distance measures between fully integrated and trade restricted equilibria in economies initially operating under less than full integration with the global economy. Such metrics can be used to construct country globalization metrics reflecting the distance of economies from full global integration due to trade barriers, barriers to factor flows, barriers to international financial intermediation, solved technological diffusion and other economy specific features yielding less than full integration into the global economy. Many distance metrics present themselves and none are wholly satisfactory since they each behave differently across various displacements from integration. Distance measures can, for instance, be small in goods space but large in price space. We present alternative measures constructed for eight OECD economies and comment in a concluding section on other measures used elsewhere in the literature such as trade / GDP ratios.

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1 Introduction

Globalization is simultaneously one of the most overused and ill defined terms in contemporary policy discussion, and conveys different things to different disciplinary researchers. Some of these meanings are discussed in Whalley (2004). Our point of departure relative to current literature is to focus on the measurement of globalization, asking how globalized are particular economies (or even the world economy), and how rapidly (or slowly) is globalization occuring?

Various indices of the extent of globalization appear in popular discussion. The Economist, for instance, publishes an annual index of globalization [1] in which Singapore typically appears as the most globalized of all national economies. [2] It is also commonly argued that the world economy today is as integrated as it was in 1913 (see Cable (1995) and Irwin (2001)). Are these positions able to be substantiated through constructed measures of globalization? These indices rely reliance on trade / GDP ratios and other variables which are larger for small entrepot economies.

Our approach here is to stay within the globalization discussion emphasized in analytically based economics literature which takes globalization to be ever deeper market based economic integration. The emphasis is on more trade and investment flows, increased international labour mobility, more rapid execution of cross border transactions rather than the governance and identity issues stressed by potential scientists and sociologists. We then ask how metrics of the degree to which individual economies are globalized may be developed and calculated.

Following classical general equilibrium trade literature, we discuss how close particular economies are to an equilibrium which would characterize full integration into the global economy (such as free trade in goods, full factor mobility, or both) assuming such equilibria are unique. There is little or no literature we are aware of which explicitly compares equilibria using distance metrics [3]; the main focus of prior general equilibrium literature being on comparative statics and issues of existence, uniqueness, and stability (see Arrow and Hahn (1971),

[1] Another such index is published annually in Foreign Policy, see the March - April 2004 issue.

[2] But on the basis of commodity price comparisons to neighbouring economies (particularly Malaysia) Singapore would appear as substantially less fully integrated into the global economy than many other economies.

[3] Measures of distance between equilibria are also critical in a number of other curremt subareas of economics. In the calibration area, for instance, inexact calibration (see Dawkins, Srinivasan, and Whalley (2001)) involves choosing parameter values for equilibrium structures so as to produce model generated equilibria as close as possible to observed data (pre-adjusted for compatibility with model equilibrium conditions), and closely related metrics of distance between equilibria are also needed here.

and Mas-Colell (1985)). Our analysis therefore forms part of a wider discussion of how far equilibrium observations for economies are from other hypothetical equilibria; in this case those that would be generated under complete openness (free trade and free factor flows).

In what follows, we first formalize alternative metrics of globalization as distance measures between equilibria, and then explore the behaviour of these metrics using data on simple forms of restricted equilibria for some sample economies. We use data for eight OECD countries (Australia, Germany, Italy, Japan, Korea, Mexico, UK, US) to make calculations of metrics of globalization using these measures. These are chosen as a sample of countries varying by size, level of income per capita, trade pattern, and size of trade barriers.

We calibrate a simple general equilibrium model to observed data reflecting less than full integration in the presence of existing trade barriers, and then use the model parametrizations generated in this way to compute counterfactual free trade equilibria. We then construct various globalization distance metrics between observed and counterfactual equilibria for each country. We first consider direct price and quantity measures of distance, calculating the sum of squares of differences in either prices or quantities (or both) between equilibria. We then construct a second set of distance measures reflecting the absolute value of excess demands when the equilibrium prices characterizing one equilibrium are introduced into the model generating the other equilibrium around to generate the excess demands associated with the model parameters supporting the other equilibrium. Measures can be constructed using either goods or factors excess demands, and there is an issue of which equilibrium is taken as the reference point. We finally construct endowment change metrics of distance following Debreu (1951), which also require explicit model structures and parameters for their implementation.

A limited prior related literature develops and discusses unidimensional metrics of distance between equilibria. Debreu (1951), for instance, compares distorted and undistorted equilibria in terms of the maximum proportional reduction possible in the endowments of a distorted economy which, when distortions are removed, implies unchanged utility to a single consumer (a scalar distance measure). To generate more generalized distance measures it is not clear how one proceeds since equilibria can be close in price space but far apart in quantity space. There may also be large relative price differences between equilibria but only small quantity differences.

Our conclusion from the calculations we report on is that these globalization distance metrics can behave in different ways and numerical measures of the degree of globalization can therefore be hard to interpret. No unambiguously preferred metric seems to offer itself, despite the growing importance attached to distance metrics in globalization debate. Parallels to the literature on inequality measures are also drawn.

2 The Analytics of Globalization Distance Measures

In this section we develop some analytics for distances measure which can be used to assess how close to or far away the equilibrium for a particular economy is from that which would characterize full integration into the global economy. We assume that we are to compare a trade (or factor flow) restricted equilibrium to a full integration equilibrium and only one of these equilibria will be observed (typically an equilibrium in the presence of trade and factor flow restrictions). We thus first calibrate models to data on actual economies in the presence of such restrictions, and then use the parametrizations generated for these models to compute unobservable free trade equilibrium. We make the strong assumption in what follows that both free trade and restricted equilibria are unique [4].

We begin with some simple measures of distance between two equilibria, calculated by summing the squares of differences across equilibria in endogenous variables (prices, quantities), noting that these are several issues which arise with such measures. One is that if price variables are involved they are not invariant to alternative price normalizations. Another is that the rationale for including all variables in such measures (such as both prices and quantities) is not clear, while neither is it clear that some variables should be excluded. If only a subset of variables are included in such distance measures one has to rationalize which they are and why they should be used. Such metrics could also be of the distance involved using exogenous variables such as endowments, although for simplicity these are not used here.

The second type of distance measure we develop involves computing excess demands at non-equilibrium prices. For these measures we take the prices from one equilibrium and use them in the model of the economy generating the other equilibrium and calculate the size of the implied excess demands. In the small open economy case, domestic prices are given by world prices gross of tariffs. If we calibrate a model using gross of tariff prices, we can then introduce net of tariff prices and recompute the excess demands (i.e. trade in the form of imports and exports). We take the absolute value of the change in excess demands relative to total demands as the distance measure between the two equilibria. These are model dependent measures in that the numerical value of the distance measure will vary as the underlying model parametrization used to calibrate to the equilibrium data changes (say, as elasticities of substitution and share parameters in CES functions change).

[4]But see the discussion of the likelihood of multiplicity of equilibria in models similar to those we use in Kehoe (1991) and Whalley and Zhang (2004)

These are also issues with these types of measure. One is that they are only operational in the sense of producing a single valued measure where there are point-to-point mappings (a pure exchange economy), not correspondences (economies with production). Another is that one can have pairs of equilibria under this class of measures which yield sharp differences in distance measures (close, far) in prices and quantities as indicated above.

We finally use a third class of distance measures in parameter space. These are measures in the spirit of the Debreu (1951) coefficient of resource utilization which yield the maximum proportional uniform shrinkage in the endowments of an economy which is possible subject to the constraint that the utility of a representative consumer is preserved as distortions are removed, a measure of the degree of inefficiency of an economy. Using this type of globalization metric implies that, in a two consumer, two good, two factor model of an economy, one computes the maximal proportional shrinkage for each of the two factor endowments which preserves utility for a simple representative consumer as trade barriers are removed.

That there is seemingly no satisfactory way of choosing between these alternative measures since there is no single measure which dominates all other measures. Each will yield a numerical measure of distance, and these metrics will behave differently across alternative pairwise equilibrium comparisons. One measure may indicate a large distance between equilibria and another small. The interpretation of such measures thus becomes an issue. What can one conclude, for instance, if endowments change by, say, 10% in a Debreu type measure in comparsions across equilibria while an excess demand calculation implies say a 50% measure for the same tariff barrier. Our propose is thus to raise the issue of which distance measures to use in the globalization debate and why, rather than definitively resolve the issue of which measure to use in all circumstances.

To show more concretely how measures of distance can be constructed between globalized and non-globalized equilibria, we take the simple case of a small open price taking economy with 2 produced goods and 2 factors of production. For this economy, there will be various features which limit integration into the global economy, such as tariffs, domestic taxes, quotas and other policy interventions. We assume these are present in the observed restricted equilibrium, but absent in the hypothetical globally integrated equilibrium.

For this economy, we assume two input CES production functions for the two goods which are given by

$$Q_j = \phi_j \left\{ \sum_f \delta_{jf} T_{jf}^{\frac{\sigma_j - 1}{\sigma_j}} \right\}^{\frac{\sigma_j}{\sigma_j - 1}}, \qquad j = 1, 2 \tag{1}$$

where Q_j denotes output of the j-th industry, ϕ_j is the scale or units parameter, δ_{jf} is the distribution parameter ($\sum_f \delta_{jf} = 1$), T_{jf} is the labor and capital factor input ($f = L, K$), and σ_j is the elasticity of factor substitution.

The factor demand functions derived from cost minimization for these production functions (1) are:

$$T_{jf} = \frac{Q_j}{\phi_j} \left[\frac{B_f}{\delta_{jf}} \right]^{-\sigma_j} \left\{ \sum_{f'} \delta_{jf'} \left[\frac{B_{f'}}{\delta_{jf'}} \right]^{1-\sigma_j} \right\}^{\frac{\sigma_j}{1-\sigma_j}}, \qquad j = 1, 2 \qquad f = L, K \tag{2}$$

where B_f is the price of factor f (per-unit factor costs for the industry).

On the demand side of the economy we consider a representative consumer with a CES utility function given by

$$U = \left\{ \sum_j \alpha_j^{\frac{1}{\sigma}} X_j^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}} \tag{3}$$

where X_j is the quantity of good j demanded by the consumer, α_j is the share parameter ($\sum_j \alpha_j = 1$), and σ is the substitution elasticity in the consumer's CES utility function.

Consumer income has three parts, endowment income $\sum_f B_f W_f$, tariff revenue $\sum_j r_j^F P_j^0 Z_j$ and a foreign resource transfer R reflecting the financing of any trade imbalance [5]. We assume R to be exogenous and fixed in real terms (i.e. indexed to a measure of the price level).

$$I = \sum_f B_f W_f + \sum_j r_j P_j^0 Z_j + R \tag{4}$$

where W_f is the consumer's endowment of labor and capital, $Z_j = X_j - Q_j$ is the import and export of good j (excess demands for goods).

World prices for goods are P_j^0 and are taken as given exogenously, and the tariff rate on imports of goods j is r_j. $r_j > 0$ if good j is imported ($X_j > Q_j$), and $r_j = 0$ if good j is exported ($X_j \leq Q_j$). The domestic price of good j is $P_j = (1 + r_j)P_j^0$.

The consumer's budget constraint is

$$\sum_j P_j X_j = I \tag{5}$$

[5] We incorporate the trade imbalance in this way since typically for actual economy data to be used in model calibrateion will not bo consistent with zero trade balance

where P_j is the consumer price for good j.

Demand functions from utility maximizing behaviour are

$$X_j = \frac{\alpha_j I}{P_j^{\sigma} \sum_{j'} \alpha_{j'} P_{j'}^{1-\sigma}}, \qquad j = 1, 2 \tag{6}$$

The equilibrium conditions in this model are that market demand equals market supply for all factors, and that profits are zero in each industry. Goods markets will be characterized by domestic excess demands that meet the trade imbalance constraint. These equilibrium conditions are that

[1] Demands equal supply for factors

$$\sum_j T_{jf} = W_f, \qquad f = L, K \tag{7}$$

[2] Zero profit conditions hold in both industries

$$\sum_f B_f T_{jf} = P_j Q_j, \qquad j = 1, 2 \tag{8}$$

For this economy, an equilibrium is characterized by factor prices B_L and B_K, and domestic prices P_1 and P_2 (given world prices P_1^0 and P_2^0), such that equations (7) and (8) hold.

From equations (2) and (8) we have

$$\sum_f \delta_{jf} \left[\frac{B_f}{\delta_{jf}}\right]^{1-\sigma_j} = [\phi_j P_j]^{1-\sigma_j}, \qquad j = 1, 2 \tag{9}$$

Defining excess demands for factors as

$$Y_f = \sum_j T_{jf} - W_f, \qquad f = L, K \tag{10}$$

and excess demand of goods

$$Z_j = X_j - Q_j, \qquad j = 1, 2 \tag{11}$$

the equilibrium conditions can be rewritten as [1] excess demands for factors are zero, i.e. $Y_f = 0, f = L, K$; and [2] zero profit conditions hold in both industries (i.e. Equation (8)).

At such an equilibrium we can also show that the trade imbalance constraint is satisfied. Using full employment condition (7) and zero profit conditions (8), we have

$$I = \sum_j P_j Q_j + \sum_j r_j P_j^0 Z_j + R \tag{12}$$

from equation (4). Rewriting the budget constraint (5) as

$$\sum_j P_j X_j = \sum_j P_j Q_j + \sum_j r_j P_j^0 Z_j + R \tag{13}$$

that is,

$$\sum_j (1 + r_j) P_j^0 Z_j = \sum_j P_j Z_j = \sum_j r_j P_j^0 Z_j + R \tag{14}$$

from the excess demand of goods equation (11), and

$$\sum_j P_j^0 Z_j = R \tag{15}$$

which is trade balance.

Into this economy, we can introduce a wide range of trade distorting instruments beyond tariffs, such as domestic taxes and quotas. All of these policy interventions will limit the degree of integration of the economy into the wider global economy. Assuming for now that equilibria in this economy are unique, this economy has two equilibria for case with and without policy interventions. We label these restricted and unrestricted economies as $E^{(1)}$ and $E^{(2)}$. Typically we will use an observed equilibrium $E^{(1)}$ and a model parametrization will be calibrated from the equilibrium data as consistent with it. The other equilibrium $E^{(2)}$ will be computed as a counterfactual equilibrium. We can also construct various distance measures between equilibria for different barriers applying to the imported good. These equilibria we also characterize by the variables $(B_f^{(1)}, P_j^{(1)}, Q_j^{(1)}, X_j^{(1)}, T_{jf}^{(1)})$ and $(B_f^{(2)}, P_j^{(2)}, Q_j^{(2)}, X_j^{(2)}, T_{jf}^{(2)})$.

We first consider simple normalized **Euclidean distance measures** between restricted and unrestricted equilibria in prices and quantities as

$$M_B = \frac{\sqrt{\sum_{f=L,K} \left[B_f^{(1)} - B_f^{(2)}\right]^2}}{\frac{1}{4}\sum_{m=1}^{2} \sum_{f=L,K} B_f^{(m)}} \tag{16}$$

$$M_P = \frac{\sqrt{\sum_{j=1,2} \left[P_j^{(1)} - P_j^{(2)}\right]^2}}{\frac{1}{4}\sum_{m=1}^{2} \sum_{j=1}^{2} P_j^{(m)}} \tag{17}$$

$$M_Q = \frac{\sqrt{\sum_{j=1,2} \left[Q_j^{(1)} - Q_j^{(2)}\right]^2}}{\frac{1}{4}\sum_{m=1}^{2} \sum_{j=1}^{2} Q_j^{(m)}} \tag{18}$$

$$M_T = \frac{\sqrt{\sum_{j=1,2} \sum_{f=L,K} \left[T_{jf}^{(1)} - T_{jf}^{(2)}\right]^2}}{\frac{1}{8}\sum_{m=1}^{2} \sum_{j=1}^{2} \sum_{f=L,K} T_{jf}^{(m)}} \tag{19}$$

$$M_X = \frac{\sqrt{\sum_{j=1,2}\left[X_j^{(1)} - X_j^{(2)}\right]^2}}{\frac{1}{4}\sum_{m=1}^{2}\sum_{j=1}^{2} X_j^{(m)}} \tag{20}$$

Constructing these measures requires data on the two equilibrium outcomes. The measures M_B and M_P are dependent on the choice of price normalization.

We can also construct **excess demand measures** between the two economies: $E^{(1)}$ and $E^{(2)}$ and their equilibria: $(B_f^{(1)}, P_j^{(1)}, Q_j^{(1)}, X_j^{(1)}, T_{jf}^{(1)})$ and $(B_f^{(2)}, P_j^{(2)}, Q_j^{(2)}, X_j^{(2)}, T_{jf}^{(2)})$ are the associated variable values. We assume $E^{(1)}$ in the presence of barriers is observed, and we then eliminate the tariff in the case where this is the trade barrier and introduce the net of tariff prices into the model parametrization supporting $E^{(2)}$ and compute excess demands. This procedure does not yield an equilibrium solution to the model, but does suggest locally how large the change in excess demands for goods (trade) world be were trade barriers to be eliminated.

We construct excess demand measures in factor space by introducing the production values $Q_j^{(2)}$ into model supporting Economy $E^{(1)}$, and evaluating excess demand functions for factors $Y_f^{(1')}$ given by equation (10). Given $Q_j^{(2)}$, we solve for $T_{jf}^{(1')}$ from Equation (2), for $j = 1, 2$ and $f = L, K$,

$$T_{jf}^{(1')} = \frac{Q_j^{(2)}}{\phi_j}\left[\frac{B_f^{(1)}}{\delta_{jf}}\right]^{-\sigma_j}\left\{\sum_{f'}\delta_{jf'}\left[\frac{B_{f'}^{(1)}}{\delta_{jf'}}\right]^{1-\sigma_j}\right\}^{\frac{\sigma_j}{1-\sigma_j}} = \frac{Q_j^{(2)}}{Q_j^{(1)}}T_{jf}^{(1)} \tag{21}$$

and generate the excess demands for factors $Y_f^{(1')} = \sum_j T_{jf}^{(1')} - W_f$ $(f = L, K)$ as in equation (10). This yields a factor excess demand measure between $E^{(1)}$ and $E^{(2)}$ as

$$R_F^{(1)} = \frac{\sum_f B_f^{(1)}|Y_f^{(1')}|}{\sum_j\sum_f B_f^{(1)}T_{jf}^{(1')}} \tag{22}$$

In this evaluation of factor excess demands full employment conditions do not hold, and so consumer' income is given

$$I^{(1')} = \sum_f B_f^{(1)}W_f + \sum_j r_j^{(1)}P_j^0 Z_j^{(1')} + R \tag{23}$$

where $Z_j^{(1')} = X_j^{(1')} - Q_j^{(2)}$. Solving for consumption $X_j^{(1')}$ from Equation (6), for $j = 1, 2$,

$$X_j^{(1')} = \frac{\alpha_j\left\{\sum_f B_f^{(1)}W_f + \sum_j r_j^{(1)}P_j^0[X_j^{(1')} - Q_j^{(2)}] + R\right\}}{[P_j^{(1)}]^{\sigma}\sum_{j'}\alpha_{j'}[P_{j'}^{(1)}]^{1-\sigma}} \tag{24}$$

we can also generate an excess demand distance measure between $E^{(1)}$ and $E^{(2)}$ in terms of goods excess demands $Z_j^{(1')}$ using Equation (11). This yields a goods excess demand measure of distance between $E^{(1)}$ and $E^{(2)}$ as

$$R_G^{(1)} = \frac{\sum_j P_j^{(1)} |Z_j^{(1')}|}{\sum_j P_j^{(1)} X_j^{(1')}} \tag{25}$$

We can finally construct **Debreu type shrinkage measures** of distance between the two Economies: $E^{(1)}$ and $E^{(2)}$ and their equilibria: $(B_f^{(1)}, P_j^{(1)}, Q_j^{(1)}, X_j^{(1)}, T_{jf}^{(1)})$ and $(B_f^{(2)}, P_j^{(2)}, Q_j^{(2)}, X_j^{(2)}, T_{jf}^{(2)})$ are the associated variable values. To do this we use $P_j^{(2)}$ in the model specification supporting Economy $E^{(1)}$, and compute an equilibrium for the case where tariffs are eliminated and there is a supporting endowment of factors $W_f^{(1')} = [1 - R_D^{(1)}]W_f^{(1)}$ which yields unchanged utility for the representative consumer. $R_D^{(1)}$ yields the Debreu type shrinkage measure of distance between the two equilibria $E^{(1)}$ and $E^{(2)}$.

3 Applying Globalization Distance Metrics to Actual Economies

To investigate how the distance measures set out above behave in practice, and what numerical measures of globalization distance are implied for particular economies, we have used the simple 2 good, 2 factor trade model set out above to construct globalization distance measures for a sample of OECD economies. We use the OECD STAN database for 2000 which provides consistent data on consumption, production, and trade for all OECD economics. Into this we also introduce measures of average tariff rates on imports taken from OECD sources. We find this OECD data simpler to use and in some ways more applicable to our needs than the GTAP data base currently widely used by trade equilibrium modellers.

The procedures set out in Section 2 are relatively simple to implement, but there are a number of issues of detail which arise. One is that in a model in which factors are fully mobile the production frontier will be close to linear for conventional fractional forms such as Cobb Douglas and CES unless share and substitution parameters differ sharply across sectors. This means that for even a small barrier change specialization will occur and so globalization distance measures may only be able to be computed for this model for barrier reductions rather than barrier eliminations.

Also, calculating globalization distance measure in practice requires a number of prior judgment calls in the use and interpretation of data, as is typical in most subjective numerical modelling in economics. In our empirical implementation of distance metrics, we first need to select our sample of countries. We have chosen Australia, Germany, Italy, Japan, Korea, Mexico, UK, US as our sample of OECD economies since these differ in size, their trade patterns, their levels of development, and their degree of openness. We take data for the year 2000 for each of these economies and consider each of them in isolation from each other, modelling each country as a small open price taking economy (clearly a strong assumption in the US case).

We construct an initial base case data set reflecting an equilibrium for each of these economies in the presence of domestic trade restrictions, which for simplicity we limit to tariffs. The equilibrium data involve terms we use for each economy are set out in Table 1. To generate this we take information from the STAN database in value terms in domestic currency from which we assemble consumption, production, factor by sector, and net trade for each country for the year 2000.

Table 1 Value Data Reflecting Assumed 2000 Benchmark Equilibria for a Sample of OECD Economies[1]

(Country Data in Domestic Currency[2])

	Australia	Germany	Italy	Japan	Korea	Mexico	UK	US
Value of Output								
NM[3]	55,593	27,750	35,534	7,772	26,320	272,188	34,109	267,362
M[3]	73,354	423,220	220,604	112,114	163,283	1,013,597	153,671	1,520,263
Value of Factor Use								
L[3] - NM	10,505	15,870	8,314	2,382	3,115	51,105	6,163	89,190
L[3] - M	40,296	310,640	122,207	59,506	59,670	311,239	110,483	981,781
K - NM	45,088	11,880	27,220	5,390	23,205	221,083	27,946	178,172
K - M	33,058	112,580	98,397	52,608	103,613	702,358	43,188	538,482
Value of Net Trade (Imports - Exports)								
NM	-23,421	48,333	26,554	9,604	42,072	-131,025	-0,325	89,103
M	49,096	-120,091	-37,996	-19,178	-57,401	145,532	36,799	321,348
Value of Consumption								
NM	32,172	76,083	62,088	17,376	68,392	141,163	33,784	356,465
M	122,450	303,129	182,608	92,936	105,882	1,159,129	190,470	1,841,611
Initial Tariff Rate on Imports[4]								
NM	0.000000	0.208675	0.208675	0.158008	0.368725	0.000000	0.000000	0.109535
M	0.105931	0.000000	0.000000	0.000000	0.000000	0.348223	0.041334	0.033641

1 Sources: OECD STAN database plus Table 2

2 These value units in domestic currency are AUD 10^6, EUR 10^6, EUR 10^6, JPY 10^9, KRW 10^9, MXP 10^6, GBP 10^6, and USD 10^6.

3 In this table, M and NM denote Total Manufacturing and Non Manufacturing (Agriculture, Hunting, Forestry and Fishing; Mining and Quarrying); L and K denote Labour and Capital.

4 See Table 2 for the underlying data used to generate tariff averages reputed here.

We use a two sector classification for each economy in which we first ignore all service related and non-tradable transactions such as utilities, government activity, retailing, wholesaling, distribution, banking, and financial services. We only consider two aggregate traded goods sectors which we take to reflect manufacturing and non-manufacturing activity. From the STANs data, "total manufacturing" is taken as manufacturing and "agriculture, fishing, forestry, and mining / quarrying" are taken as non-manufacturing. Since the 2×2 case requires as many factors as goods in the model, this is a relatively easy case to implement. Subsequent applications of this approaching can easily (but more tediously) be applied to multisector multifactor models and the change of level aggregation in data will clearly affect the dumenical value of globalization measures generated.

STAN data give value added according to our sectoral classification, and also provide data on the compensation of employees. The return to capital is constructed by residual for each sector as the difference between the two. We make the strong assumption that the output of each sector is given only by the value added originating in the sector, and we ignore all intermediate transactions. This yields data on output and factor use by sector in value terms for each country for our benchmark year. This data is in value terms, and to produce equilibrium data on both prices and quantities we need to adopt a units convention for the measurement of both goods and factors. We follow the convention attributed to Harberger (1962) and discussed in Shoven and Whalley (1992) of assuming unitary prices for factors, and unitary world prices for goods in the trade distorted equilibrium. This yields domestic prices for imports as one plus the tariff rate.

We use the trade data in STANs on a net trade basis which nets out imports and exports (again in value terms) by good (for our 2 good classification) for each country. This yields consumption as production plus net trade. This substantially reduces trade volumes as they appear in each country model relative to published trade data. Most of the OECD economies we consider are net exporters of manufactured goods. Trade balance does not hold for this net trade data by country since some countries have trade surpluses and other (notably the US) have trade deficits. One procedure is to modify the data to force trade balance; another is to use a model which incorporates a fixed trade imbalance (which is non-zero). We choose the latter procedure. For the US, this yields the feature that both goods are imported, and financed by foreign resource transfers supporting the observed trade imbalance.

We use tariff rate data from OECD sources as our trade barrier representative in the restricted equilibrium. This data is presented in Table 2 which reports the tariff data we have relied on for our barrier estimates. This data is from OECD Sources on bound tariff rates by Harmonized Nomenclature section headings, and this gives the fraction of line items in specified tariff lines falling in numerical ranges of tariff rates. We have aggregated this data using simple means for in sample ranges. We do not employ trade weighted average, nor use applied rather than bound tariff rates. There is a considerable literature on constructing tariff averages, which for simplicity we ignore. We use statutory rather than effective tariff rates.

In the data in Table 1, the relative size of economies differs, as do trade patterns and factor use by sector, and initial tariff rates. This provides the benchmark equilibrium taken as observed for each of our sample OECD economies. We then calibrate each of our country models to this data which we assume for now to be generated in the presence of a tariff as the only trade barrier which creates distance from full integration. We then apply the procedures set out in the previous section to construct our globalization metrics.

In implementing these procedures, we have restricted ourselves to cases where the only barrier limiting full integration into the global economy is a tariff. In reality there are many barriers which limit integration into the global economy including other trade measures (quotas, dumping and countervailing daties), national standards, differential regulation of financial institutions, transportation regulation, agricultural policies, and many others. Each of these would need an explicit model representation which sharply differ from a representation by an advaloren equivalent tariff if they were to be sensibly incorporated into such analyses. Extensions of this approach can be used to analyze these barriers also; we have not done so since our purpose is to illustrate a general approach to constructing globalization metrics.

Table 2 OECD Data on Tariff Intervals by HS Section (Post-Uruguay Round Bound Rates) by Country Used to Calculate Country Tariff Rates in Table 1[1 2]

(% of Tariff Nomenclature Section Headings in Specified Rate Ranges by Country)

Tariff Binding Ranges	Australia	Germany	Italy	Japan	Korea	Mexico	UK	US
Non Manufacturing								
Duty Free	32.6	26.5	26.5	31.0	2.2	0.1	26.5	27.9
0 – 5%	16.2	16.1	16.1	19.1	8.4	3.3	16.1	16.7
5 – 10%	1.6	9.3	9.3	6.7	16.6	3.0	9.3	2.0
10 – 15%	0.0	7.7	7.7	1.2	19.1	8.4	7.7	0.1
15 – 20%	44.0	12.2	12.2	22.0	7.2	0.0	12.2	48.1
20 – 50%	4.2	11.2	11.2	10.3	8.1	0.3	11.2	4.7
> 50%	1.4	17.0	17.0	9.6	38.6	84.8	17.0	0.4
Manufacturing								
Duty Free	18.7	22.2	22.2	53.8	13.5	0.2	22.2	37.2
0 – 5%	19.6	43.0	43.0	28.4	7.1	0.0	43.0	39.6
5 – 10%	28.1	27.3	27.3	14.5	23.8	0.2	27.3	15.6
10 – 15%	17.7	7.0	7.0	2.7	36.8	0.0	7.0	5.6
15 – 20%	2.5	0.4	0.4	0.2	8.2	0.3	0.4	1.3
20 – 50%	11.6	0.2	0.2	0.4	10.5	99.2	0.2	0.8
> 50%	1.7	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Calculated Country Average Tariff Rates (Percentage)								
NM	10.7450	20.8675	20.8675	15.8008	36.8725	65.1276	20.8675	10.9535
M	10.5931	4.1334	4.1334	2.3100	11.8107	34.8223	4.1334	3.3641

1 Note: Calculations are report 6 - digit HS section headings.

2 Sources: Tariffs and Trade: OECD query and reporting system, OECD 2000.

We calibrate the model set out in the previous section, for cases where the trade imbalance for each economy is non-zero. The calibration procedures we use are set out in Dawkins, Srinivasan and Whalley (2001). To implement calibration we rely on a simple nunded literature search to generate substitution elasticities by sector by country, and we use values roughly consistent with those reported in Piggott and Whalley (1985) and Hammermesh (1993) of 2.0 in non manufacturing and 0.5 in manufacturing.

Table 3 presents the calibrated model parameter values for the model we use for each country, along with model data on endowments and tariff rates. We use each country model to compute free trade equilibrium by eliminating country tariff. For each economy we are able to then construct sum of squares distance measures between these equilibria, as set out in previous section. We are also able to use the model parameterizations supporting each equilibrium to construct excess demand distance measures, and Debreu type shrinkage measures of distance of economies from full integration (globalization).

Table 3 Calibrated and Other Model Parameter by Country

Reproducing the Equilibrium Data in Table 1

	Australia	Germany	Italy	Japan	Korea	Mexico	UK	US
Scale Parameters in Production								
NM	1.782958	1.646108	1.527880	1.659805	1.202613	1.781035	1.769515	1.751178
M	1.790994	1.640678	1.976970	1.992457	1.864930	1.291180	1.611564	1.783280
Share Parameters in Production								
L - NM	0.325550	0.536134	0.355946	0.399319	0.268142	0.324684	0.319547	0.414355
L - M	0.597721	0.883905	0.606688	0.561295	0.249053	0.164137	0.867450	0.768743
K - NM	0.674450	0.463866	0.644054	0.600681	0.731858	0.675316	0.680453	0.585645
K - M	0.402279	0.116095	0.393312	0.438705	0.750947	0.835863	0.132550	0.231257
Share Parameters in Preferences								
NM	0.203951	0.208341	0.262811	0.162445	0.411299	0.101542	0.149360	0.164593
M	0.796049	0.791659	0.737189	0.837555	0.588701	0.898458	0.850640	0.835407
Initial Endowment								
L	50,801	326,510	130,521	61,888	62,785	362,344	116,646	1070,971
K	78,146	124,460	125,617	57,998	126,818	923,441	71,134	716,654
Substitution Elasticities in Production (All Countries)								
NM	2.0							
M	0.5							
Substitution Elasticities in Consumption (All Countries)								
	1.25							
Initial Tariff Rate on Imports[1] (Percentage)								
NM	0.0000	20.8675	20.8675	15.8008	36.8725	0.0000	0.0000	10.9535
M	10.5931	0.0000	0.0000	0.0000	0.0000	34.8223	4.1334	3.3641
Foreign Resource Transfers in Domestic Currency[2]								
	20,972.4	-80,102.6	-16,026.5	-10,884.5	-26,662.9	-23,081.5	35,013.3	352,576.6

1 Model tariff rates on exports are set equal to zero, the US imports both goods, with the trade imbalance financed by a resource transfer from abroad.

2 Footnote from Table 1.

4 Some Calculations of Distance Measures for a Sample of OECD Economies

We have implemented calculations of globalization distance measures for the eight OECD countries chosen in our sample for the year 2000 (Australia, Germany, Italy, Japan, Korea, Mexico, the UK, and the US). To make these calculations we first calibrate each country model as described above and then proceed to compute a barrier change equilibrium as our counterfactual in each case. We then compare initial and barrier change equilibria.

As we note above, due to the near linearity of the production frontier in the 2×2 case (see Johnson (1966), and Abrego and Whalley (2001)) specialization occurs as the equilibrium outcome with most country models in the tariff elimination case (the US, the UK, and Australia) are the exceptions. We therefore compute two different sets of globalization metrics for the country models. One is with an 8% common reduction in tariff rates in all country cases since this is the maximal common reduction comparationally possible. This allows for comparability across country analyses. The second considers the largest possible reduction in the national tariff such that specialization does not occur. Table 4 presents the first set of results, and Table 5 presents the second.

Several features of these results are work highlighting. The first is that for any country these are large differences in globalization measures for the same tariff change. Taking Column 1 for Australia as illustrative, an 8% reduction in a tariff rate reveals a 49% distance measure under measure MG_1, but only a less then 1% measure occur MD_1, or MD_2. Within the Euclidean measure group measures differ by a factor of nearly 10. Similar features occur in every country case (i.e. in results down each column of Table 4). Whether an 8% tariff reduction moves countries considerably closer to or only little closer to global integration we are therefore not easily able to say. How to choose between these measures is also not clear.

In addition, for a similar distance measure there may or may not be very large differences across countries in globalization measures. By way of illustration, for the measure M_X distance measures of 2.64 and 0.006 are obtained for Mexico and the UK for the same 8% tariff reduction. Large differences also occur for the measure MG_1.

On the whole, given that the common 8% reduction in tariff rates yields a larger absolute tariff change in countries with higher initial tariffs, such as Mexico, results for such countries show higher measures than for low initial tariff rate countries, such as the UK. There are exceptions, however, such as the MF measure between Mexico and the UK.

From these results we thus conclude that both constructing and interpreting measures of globalization distance is at best a difficult and treacherous matter given all these differences in the behaviour of measures. Similar themes emerge from the results in Table 5, although these cases have less comparability across countries since the depth of tariff reduction varies across the individual country cases.

We have performed further calculations with the country calibrated models which also allow us to also investigate the sensitivity of distance measures first with respect to critical model parameters, such as elasticities of substitution, and secondly with respect to the depth of tariff cut in particular cases. For simplity these sensitivity analyses are presented for only one country, the US. These are displaced graphically in Figures 1 and 2.

What is striking about the results in Figure 1 is the near independence of some measures to elasticities and extreme sensitivity in other cases. Euclidean distance measures (which themselves are sharply different one from another) vary little, but excess demand measures vary more (especially for MF_2). Debreu shrinkage measures vary proportionally but little in absolute value across elasticity values.

Figure 2 reports the variation of distance measures with the size of the tariff reduction, since the US is a country case where tariff elimination is possible without specialization occuring. Here, Euclidean distance measures behave similarly in proportional terms across different depth of tariff cuts, being roughly linear in the depth of cut. Excess factor demand measures are also nearly linear and behave equiproportionally. Debreu shrinkage measures behave in a non linear way.

Our conclusion from these calculations is just as the many measures of inequality in the income inequality literature yield different and non comparable partial orderings, so with globalization measures (and equilibrium metrics in general) there are many available measures whose numerical behavior will differ. Which to use, and how to interpret such metrics when calculated, even if reported in popular press, is not clear. Seemingly measures will also vary with the degree of disaggregation in models, the structural form of models, and the treatment of factor flows and barriers. Making sense out of the numbers which currently circulate thus seems to be a hazardous occupation, as it is in general of one is to say how far equilibria are apart. This also presumes that equilibrium rather than disequilibrium adequately characterizes the state which individual economies find themselves in.

Table 4 Globalization Metrics for a Common 8% Reduction in Tariff Rate for a Sample of OECD Countries[1]

Metrics	Australia	Germany	Italy	Japan	Korea	Mexico	UK	US
Tariff Rate Change								
NM	0.000000	0.208675	0.208675	0.158008	0.368725	0.000000	0.000000	0.109535
M	0.105931	0.000000	0.000000	0.000000	0.000000	0.348223	0.041334	0.033641
	↓	↓	↓	↓	↓	↓	↓	↓
NM	0.000000	0.191981	0.191981	0.145367	0.339227	0.000000	0.000000	0.100772
M	0.097456	0.000000	0.000000	0.000000	0.000000	0.320365	0.038027	0.030950
Euclidean Distance Measures								
M_B	0.017811	0.061041	0.030250	0.033446	0.062720	0.184693	0.004956	0.013891
M_P	0.008064	0.015174	0.015174	0.011750	0.025062	0.023868	0.003242	0.008577
M_Q	0.035139	0.130947	0.053118	0.075660	0.107683	1.741749	0.004313	0.023990
M_X	0.049851	0.203774	0.085114	0.120297	0.205375	2.648417	0.006152	0.034914
M_T	0.005717	0.014704	0.007603	0.005880	0.021365	0.312117	0.001528	0.002088
Excess Demand Measures								
MF_1	0.008876	0.016166	0.012843	0.012785	0.021072	0.142613	0.001620	0.005427
MF_2	0.008757	0.018976	0.013228	0.013567	0.021974	0.070413	0.001618	0.005514
MG_1	0.498664	0.551121	0.302689	0.318401	0.650488	1.312605	0.168093	0.187149
MG_2	0.472607	0.448203	0.269251	0.263651	0.581470	0.222766	0.166499	0.186741
Debreu Shrinkage Measures								
MD_1	-0.001384	-0.008777	-0.013937	-0.003981	-0.012864	-0.159362	-0.000083	-0.000652
MD_2	0.001386	0.008856	0.003953	0.003997	0.013035	0.189577	0.000083	0.000652

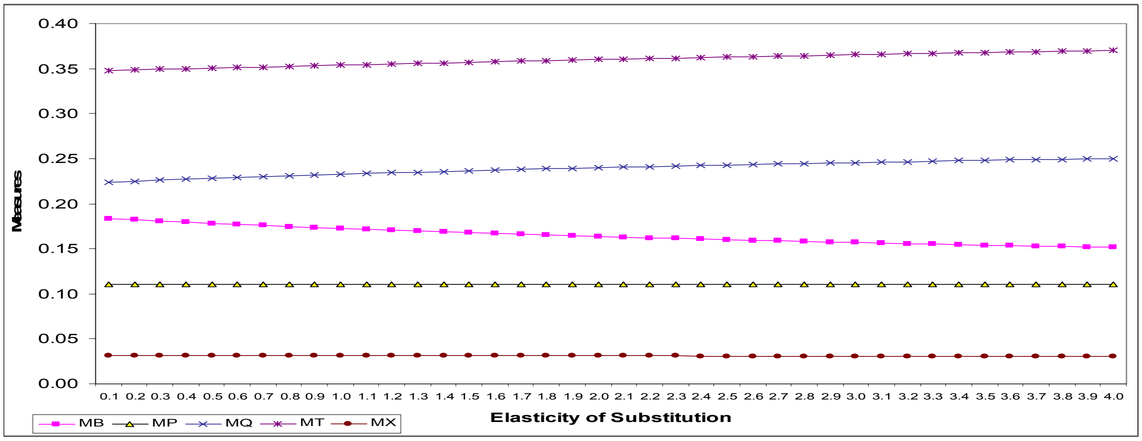
1 Due to the near like early of the production frontier in a model with goods and fully mobile factors, elimination of the tariff leads to specialization. We therefore consider a case where there is a common 8% reduction in the tariff rate.

Table 5 Globalization Tariff Metrics for a Sample of OECD Countries where Maximium Possible Reductions in Tariff Rates Occur

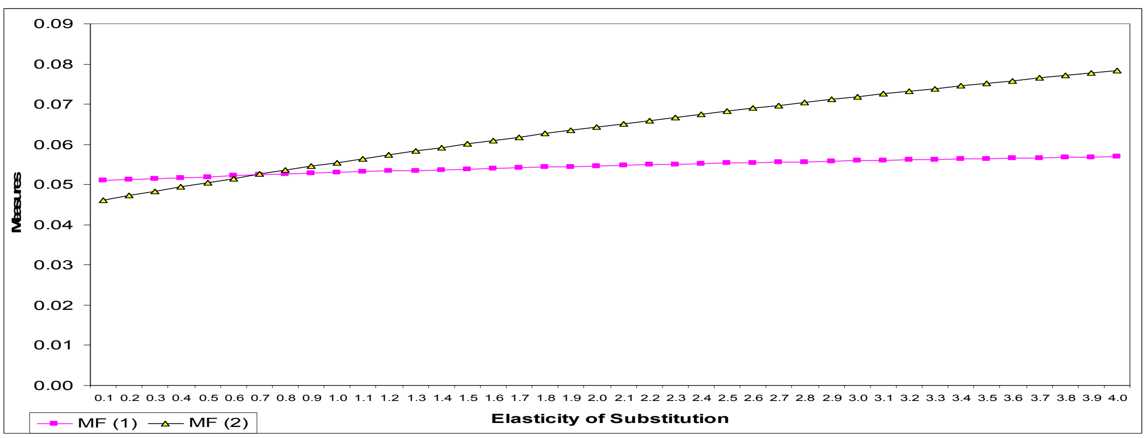
Metrics	Australia	Germany	Italy	Japan	Korea	Mexico	UK	US
Tariff Rate Change								
NM	0.000000	0.208675	0.208675	0.158008	0.368725	0.000000	0.000000	0.109535
M	0.105931	0.000000	0.000000	0.000000	0.000000	0.348223	0.041334	0.033641
	↓	↓	↓	↓	↓	↓	↓	↓
NM	0.000000	0.189550	0.082779	0.125721	0.260000	0.000000	0.000000	0.000000
M	0.000000	0.000000	0.000000	0.000000	0.000000	0.318750	0.000000	0.000000
Euclidean Distance Measures								
M_B	0.233503	0.068459	0.210283	0.081843	0.227912	0.194858	0.062120	0.158944
M_P	0.105931	0.019125	0.125897	0.032287	0.108725	0.029473	0.041334	0.114584
M_Q	0.717596	0.145425	0.309497	0.170203	0.337117	2.115240	0.058251	0.239993
M_X	1.036370	0.226255	0.539441	0.276936	0.686069	3.272022	0.082343	0.360016
M_T	0.068532	0.016205	0.061315	0.012864	0.071136	0.376297	0.018861	0.031064
Excess Demand Measures								
MF_1	0.181606	0.017950	0.077043	0.028939	0.069163	0.176719	0.021860	0.054615
MF_2	0.138559	0.021491	0.090467	0.033142	0.077544	0.077322	0.021414	0.064296
MG_1	0.885209	0.562865	0.488009	0.389845	0.816065	1.522364	0.199955	0.193069
MG_2	0.517654	0.448735	0.302928	0.267422	0.608150	0.223772	0.177853	0.188212
Debreu Shrinkage Measures								
MD_1	-0.011845	-0.009712	-0.018332	-0.008516	-0.037212	-0.189353	-0.000565	-0.003818
MD_2	0.011985	0.009808	0.018679	0.008589	0.038688	0.233587	0.000566	0.003832

Figure 1 Sensitivity of US Globalization Measures to Substitution Elasticity Parameter Value (in Sector Non Manufacturing)

1.1 Euclidean Distance Measures



1.2 Excess Demand Measures



1.3 Debreu Shrinkage Measures

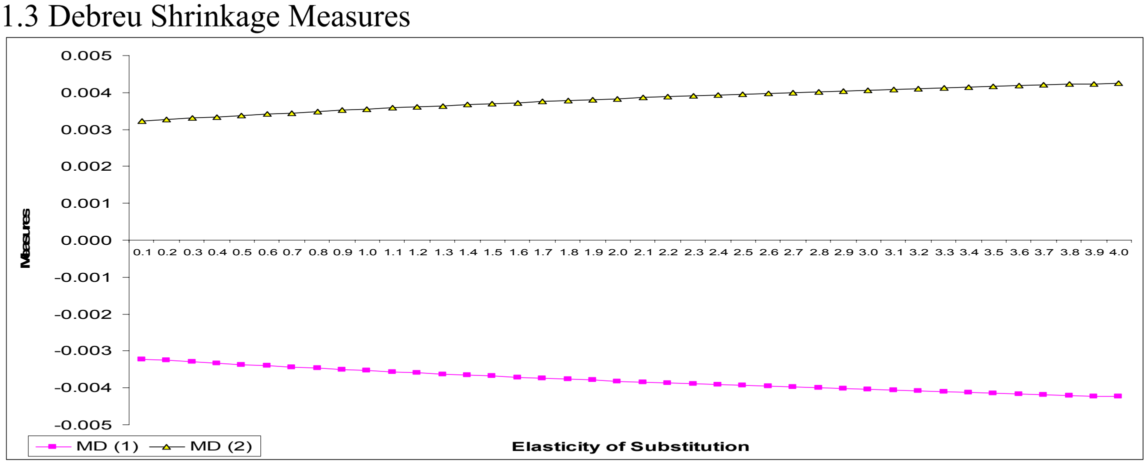
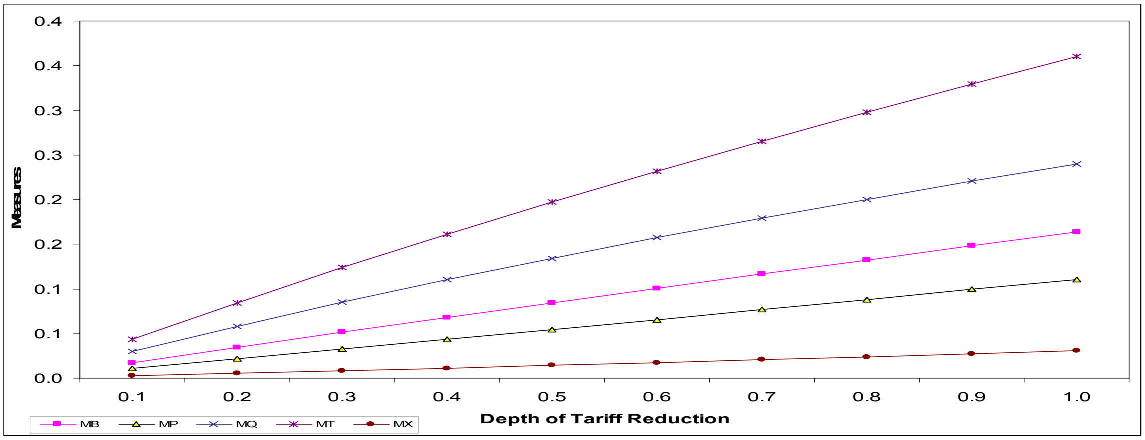
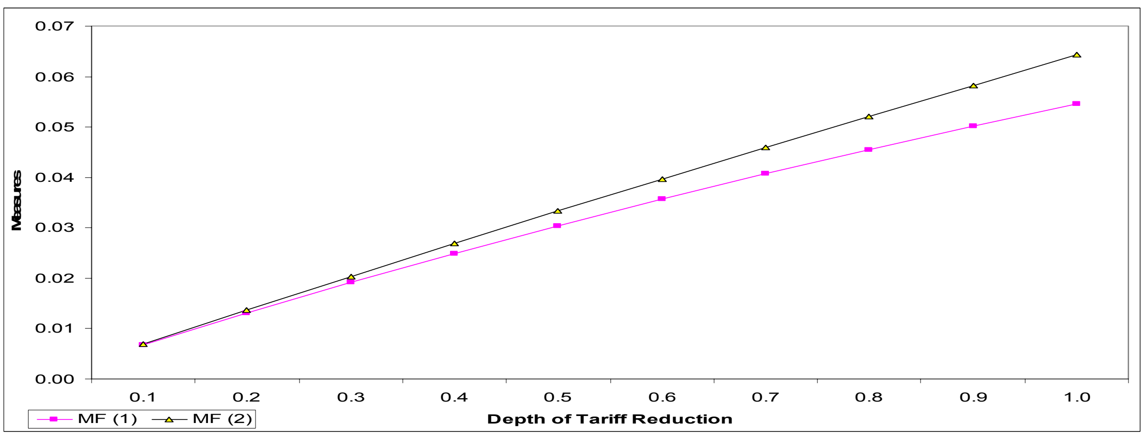


Figure 2 Sensitivity of US Globalization Measures to the Depth of Tariff Reduction

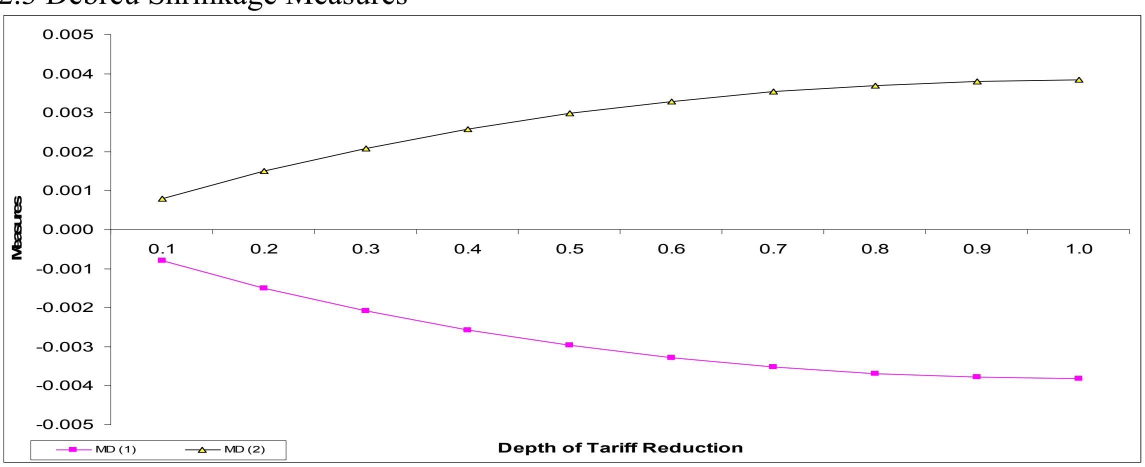
2.1 Euclidean Distance Measures



2.2 Excess Demand Measures



2.3 Debreu Shrinkage Measures



5 Concluding Remarks

In this paper we have discussed possible metrics of globalizations for countries constructed as distance measures between barrier restricted and globally integrated country equilibriua. In the process we also emphasize that literature on equilibrium metrics in general is limited, and so our paper is part of a wider discussion of possible metrics of distance across equilibria.

Our results which we report for a sample of 8 OECD countries using 2000 data applied to simple 2×2 country models suggest both substantial differences in measures for a single country and differences across country in measures for the same barrier reduction. As such our results are on the whole negative, but they do illustrate the many pitfalls involved with measures currently reported in populist magazines such as the Economist and Foreign Policy.

Our findings may appear to those outside the area to be too negative, and our tone overly pessimistic on the measurement front so far as quantifying globalization is concerned. But little literature exists on these issues and our hope is that our paper might spark further work in the area that will advance on what we have to offer. Our belief is that we are indeed moving to an increasingly integrated global economy in terms of goods flows and capital markets, but with more segmentation in labour markets, where the global costs of restrictions are large [6]. Adding in the concerns of political scientists over global governance and sociologists over global identity, to say nothing of the anti globalization protestors, may well leaves globalization as an inherently unquantifiable metric; but hope springs eternal, and with fortitude and perseverance the challenge is for a new cottage industry of globalization quantifiers to emerge to fill the gap.

[6] See Hamilton and Whalley (1984)

References

[1] Arrow, K.J. and F. Hahn. (1971) **General Competitive Equilibrium**. Mathematical Economics Texts 6, San Francisco: Holden-Day, Inc.

[2] Cable, V. (1995) **The Diminished Nation-State: A Study in the Loss of Economic Power**. Daedalus (Spring 1995).

[3] Cable, V. and A. Bressand. (2000) **Globalization: Rules and Standards for the World Economy**. Chatham House Papers, Thomson Learning.

[4] Debreu, G. (1951) *The Coefficient of Resource Utilization.* Econometrica 19 (3), 273 - 292.

[5] Dawkins, C., T.N. Srinivasan, and J. Whalley. (2001) *Calibration.* in J.Heckman and E. Leamer (Eds) **Handbook of Econometrics**, Volume 5, 3653 - 3703. New York, N.Y.: Elsevier Science Publishing. Co.

[6] Foreign Policy, *Measuring Global.* March - April 2004, Page 54 - 69.

[7] Hamilton, R.W. and J. Whalley. (1984) *Efficiency and Distributional Implications of Global Restrictions on Labour Mobility: Calculations and Policy Implications.* Journal of Development Economics 14 (1-2), 61-75.

[8] Hammermesh, D. (1993) *Labour Demand Elasticities.* The World Economy 24 (1), 15 - 30.

[9] Harberger, A.C. (1962) *The Incidence of the Corporate Tax.* Journal of Political Economy 70 (3), 215 - 240.

[10] Irwin, D.A. (2001) *Tariffs and Growth in Late Nineteenth Century America.* The World Economy 24 (1), 15 - 30.

[11] Kehoe, T. (1991) *Computation and Multiplicity of Equilibria.* in W. Hildenbrand and H. Sonnenschein (Eds) **Handbook of Mathematical Economics**, volume 4, 2049-2143. North Holland.

[12] Mas-Colell, A. (1985) **The Theory of General Economic Equilibrium - A Differentiable Approach**. Econometric Society Monographs 9, Cambridge University Press.

[13] Piggott, J.R. and J. Whalley. (1985) *UK Tax Policy and Applied General Equilibrium Analysis.* Cambridge: Cambridge University Press.

[14] Shoven, J.B. and J. Whalley. (1992) **Applying General Equilibrium**. Cambridge University Press.

[15] Whalley, J. (2004) *Globalization and Values.* Paper Prepared for CES-ifo Conference "Dissecting Globalization", Vince, July 21 - 23, 2004.

[16] Whalley, J. and S. Zhang. (2004) *Surfing the Manifolds of An Economy with Five Equilibria.* Research Paper, Department of Economics, The University of Western Ontario.