Measuring the Effect of Trade Barriers on Exchange Rates Using Data Envelopment Analysis

by
Richard Soteros

A THESIS

submitted to

Oregon State University

Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Economics and Political Science
(Honors Scholar)

Presented May 10, 2016
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AN ABSTRACT OF THE THESIS OF

Richard Soteros for the degree of Honors Baccalaureate of Science in Economics and Political Science presented on May 10, 2016. Title: Measuring the Effect of Trade Barriers on Exchange Rates Using Data Envelopment Analysis.

Abstract approved:

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This paper analyzes the implementation of the World Trade Organization's Uruguay Round policy package and its influence on the US Dollar to Chinese Yuan exchange rate parity. The Farrell Measure of Productive Efficiency associated with the change in the exchange rate parity between time periods before and after implementation provides a method with which to measure the effect. The resulting figures indicate a stabilization of the parity after implementation correlating with the policy change from a floating to a pegged exchange rate. This prompted the hypothesis that the Farrell Measure of Productive Efficiency could have a potential use as a measure of volatility. Further exploration through an additional parity case study offers supplementary support for its potential utilization.

Key Words: Data Envelopment Analysis (DEA), Farrell Measure of Productive Efficiency, volatility, floating exchange rate, pegged exchange rate

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I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

Richard Soteros, Author

Introduction

Changes in the exchange rate between nations are induced by many factors, but perhaps the most politically infused influence is trade policy. Barriers to trade are largely produced by politically driven factors, some of which may have large, unintended effects on exchange rates. By analyzing previous works, this paper explores the theoretical basis for trade policy having an effect on exchange rates. Depending on the policy objectives of a trade agreement, an exchange rate could incur a significant adjustment if the policy affects net exports of a country or opens new trade routes. Trade agreements, such as the Dominican Republic – Central America Free Trade Agreement, affect international trade to the level that global exchange rates could see an effect. It is predicted that the implementation of trade barriers will have an effect on exchange rates, since these barriers reduce export/import opportunities and therefore cut potential avenues for income. By analyzing various journal articles, previous works led to additional hypotheses on how this effect could be measured.

It is the purpose of this paper to explore the possible application of data envelopment analysis (DEA) methods in the research area of international trade and exchange. The methodology draws on Farrell Efficiency Measurement (Farrell) techniques and a linear program model to detect impacts of trade policy on exchange rates. This paper treats the implementation of a policy as a shock in the economy, potentially leading to adjustments in exchange rate parities.

It is hoped that this paper will provide an example of a case study in which DEA can be applied and effectively detect adjustments in exchange rates due to a change in policy. If the DEA application is able to accomplish this task, further research on its application is critical for the expansion of the technique for public use.

Literature Review

Several pieces of research have used economic theory to predict the effects of changes in trade policy on currency exchange rates, as well as the effects of large shocks to the system. Stockman (1980) uses theory to determine the shift in the exchange rate after trade policy was implemented. He used an equilibrium model to determine the pricing of goods and its effect on the exchange rate, which emphasized the role of relative price changes caused by real disturbances (for example, policy implementation) in determining the expected behavior of the currencies. What he found was that changes in the relative prices of goods, due to supply or demand shifts (including shifts in trade policy), would induce changes in the exchange rate. He claims that these changes can then be used to correlate the exchange rate and the terms of trade between two countries.

Baldwin (1989) also theorized what would happen when there was a large shock in the exchange rate. This can happen in a multitude of ways, but most relevant is a large influx of foreign investment bringing commerce to a country due to an initial rise in that country's business potential and an opening up of a new market for trade. This could be any rise in overall potential of an economy that is attracting foreign investment, including initial rises in the exchange rate itself. Baldwin uses a general case in his research to theorize the after effects of the new foreign investment if the currency valuation returns to its initial level after investments have already taken place. He theorized that a large capital inflow as such would initially lead to an appreciation in the exchange rate but would result in a reduction in the exchange rate past initial levels once the rate of capital inflow reverses. This means that shocks in capital inflows, perhaps caused by the implementation of new trade policy, cause the exchange rate to fluctuate around a mean that is lower than its level before the shock. These findings compliment those of Stockman, suggesting that trade barriers do have theoretical effects on exchange rate; whether those effects are positive or negative, however, depends on the case study.

Another set of research focuses on the "border effect". This is defined as the price change due to the additional import/export fees associated with trading the product. This border effect can be used as a proxy for the total effect of the trade policy package that a bilateral exchange rate has influencing the price of products. Parsley & Wei (2001) studied this effect, which was a combination of trade policy, shipping costs, and import/export costs. The calculation for import/export cost included the purchasing power provided by the exchange rate. They found that this border effect does influence product choice in a significant manner. For example, moving a product across the US-Japan "border" is equivalent to adding the value of 43,000 trillion miles of distance in shipping costs. They also found that distance, unit-shipping costs, and exchange rate variability collectively explain a large portion of the market separation. The adjusted-R^2 for nominal exchange rate alone is 0.49, and is significant at the 95% significance level.

More research has been done on the border effect, including that by Goldberg & Knetter (1996). They focused their research on the effects of the price of goods and the correlation of the change in price to the change in exchange rates. They discovered that the import prices of goods typically change by a smaller proportion than the exchange rate between the importing and exporting country. They allotted this observation to common-currency relative prices for similar goods exported to different markets as being highly correlated with exchange rates between those markets. This imperfect correlation is titled an "incomplete pass-through", and the researchers assert that it is due to price discrimination during the price adjustment. They also state that the border effect suggests that trade barriers do have an effect on pricing of goods, but the researchers found weak evidence that trade barriers alone are affecting market power. This compliments the Parsley & Wei (2001) paper, since that research suggests that nominal exchange rates explain 49% of the variation in the data.

A third classification of literature is concerned with the overall effect of trade restrictions on trade flows and the economic ramification of trade controls. Tamirisa (1999) studied these controls on trade, separating them into controls on capital and controls on payments and transfers. Her model was dependent on the distance between countries, the country's size and wealth, existing tariff barriers, and exchange and capital controls. Using cross-sectional data for country parities on bilateral exports of goods and services, population differences, GDP per capita differences, and measures of tariff barriers, she found that more liberal control and trade systems on current payments and transfers were only a minor impediment to trade, while controls on capital significantly reduced exports. She concluded that further capital account liberalization could significantly foster trade. Tamirisa's results were stated to be significant at the 95% significance level for the full sample. In terms of exchange rates, this is promising since the notion exists that increasing exports increases demand for currency. Since liberalization would foster exports, according to Tamirisa, an inverse relationship between a trade barrier variable and the exchange rate variable should exists.

A more concentrated study was conducted by Yeboah et al. (2007) concerning the effects of a specific trade agreement on a country previously barred from trade. The Dominican Republic – Central America Free Trade Agreement (DR-CAFTA) directly impacted the United States' exports to all six of the Agreement's involved countries. In this case, the trade agreement was opening up trade routes which were previously restricted. Yeboah et al. addressed the extent of advantage gained by the United States and the six other involved nations by the implementation of this Agreement. They theorized that the DR-CAFTA advantaged the U.S. specifically through the removal of tariffs, creating preference for U.S. goods over those of third country suppliers. Yeboah et al. used a gravity model to estimate and predict the bilateral trade flows between the U.S. and DR-CAFTA countries using panel data. This model assumes that volume of trade between nations is a positive function of national income and a negative function of distance, since distance increases transportation and other costs. Their findings were as expected: that the implementation of DR-CAFTA will benefit U.S. exports by a significant amount. DR-CAFTA caused all involved countries to be trade creators, except Costa Rica, ranging from 1% to 13% increase in trade. The model also revealed positive effects of differences in exchange rates on trade flows. Specifically, they found that a 1% appreciation in the U.S. Dollar increased imports by CAFTA nations from the U.S. by 0.34% ($p=0.0001$). These findings are consistent with those of Tamirisa's research, suggesting that there is a measurable effect of the implementation of trade barriers on the exchange rate.

Although trade policy and exchange rates have been highly influential in the global economy, limited research has been conducted estimating the effects of the latter on the former. Many studies, including Stockman (1980), focus on the theory of how trade barriers would affect exchange rate, but little empirical analysis exists that has measured the exact effects. Yeboah et al. (2007) finds a correlation between exchange rate and the implementation of the DR-CAFTA, but frames his findings as the exchange rate having an effect on US imports. This paper tries to expand on Yeboah et al., but applies an alternative methodology. This gathering of articles suggests that trade barriers do have an effect on exchange rates, but they do not include empirical evidence in direct support of that hypothesis. This paper attempts to provide an empirical case study of a policy implementation's effect on an exchange rate.

As for validity and bias in the included articles, none reported financial influence or association with conflicting interests. All results reported concerning exchange rates showed significant effects, some of which were significant to the 99% significance level (Yeboah et al.). The credibility of these results appears to be in good standing as well. The chosen pieces of literature were sourced from multiple economic journals – including the Journal of Economic Literature, the Journal of International Economics, and the Journal of Political Economy – and from published work done by the International Monetary Fund (Tamirisa 1999).

If exchange rate is conceptualized as a function of trade barriers, then the effects could be broken down to see what the individual effect of each barrier is estimated to be. Multiple techniques could be utilized to accomplish this estimation, including simple gravity models or a capacity utilization calculation. This paper aims to apply the methodology of Data Envelopment Analysis (DEA), as utilized in similar ways as Farrell, to provide a measurement of that effect. Whichever method is applied, however, the theory from the body of research that exists shows that there should be an observed effect of the trade barrier variable on the exchange rate. Moreover, Baldwin (1989) theorized that the effects could be quite large if certain events occur after the implementation of the trade policy. Finding true estimations of this effect could be useful in the creation of future international trade policy, especially to nations that are struggling to maintain manageable exchange rates to foster economic investment.

Research Foundation

Research conducted in 1957 by M.J. Farrell produced a method by which to measure productive efficiency that would avoid standard issues with other methods. Alternative methods each held the index number problem, and finding a method that did not hold this in its calculation was desired. Farrell created a method, known as the Farrell Input-Oriented Measure of Efficiency. This method uses data envelopment analysis to calculate relative efficiency scores. These scores tell how efficient a certain decision-making unit (DMU) is in comparison to a relative benchmark. This method is meant to be flexible to avoid inappropriate assumptions when applying it to differing datasets. It is important to note that this method uses relative measures when calculating efficiency scores. This means that the benchmark that is used by the data and the comparison of observations to that benchmark are all relative to the dataset being utilized. The method builds what is called a "Best Practice Frontier", which it then compares with all other observations in the dataset. What is obtained from this process is a distribution of scores that then can be compared to each other for relative efficiency purposes. This paper utilizes Farrell's work and applies it in conjunction with international policy and exchange rate theory.

Methodology Walkthrough

The methodology utilized by this paper relies on Data Envelopment Analysis (DEA) to organize data. To create the model, it is best to think of the data in terms of inputs and outputs. Diagram 1 is an example of a dataset that could be used with the DEA method.

Diagram 1.

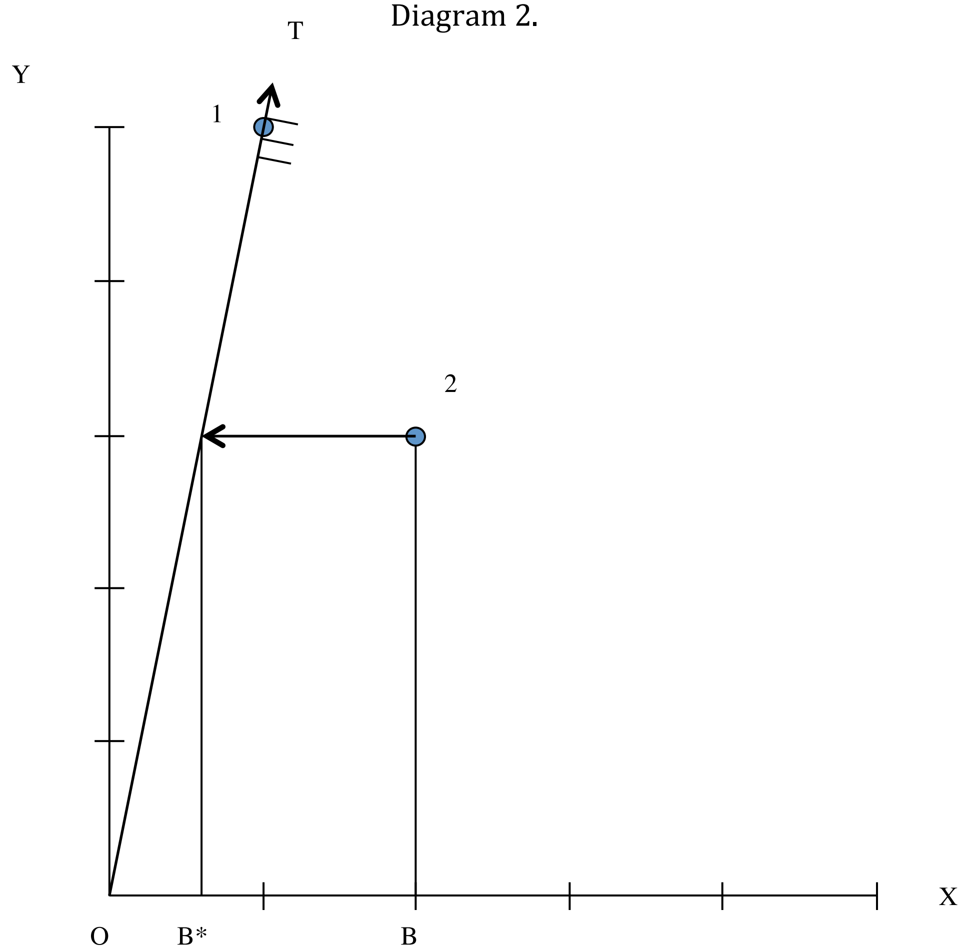
Obs.	Input (X)	Output (Y)
1	1	5
2	2	3

Using the values in Diagram 1, a graph of the observations can be created. This uses a standard x-y plane, where the X-values represent input observations and the Y-values represent output observations. Diagram 2 is the graphical interpretation of the values in Diagram 1. The objective necessary to compare the efficiency of these observations is to first find the observation with the greatest ratio of inputs to outputs. There can be more than one observation with the greatest ratio, however in this example there is only one. This is done using a Linear Program Model, shown in Figure 1. The observation found to have the greatest ratio creates the "Technology Frontier", as indicated by the "T" in Diagram 2. All other observations are contained within the cone-shaped technology frontier. These observations all have ratios ≤ T. This is due to the assumption of free disposability of inputs and outputs, meaning that extra inputs can be wasted to achieve the same level of outputs and/or fewer outputs can be created using the same level of inputs. The z-variable in the model is the assigned weight for each observation within the comparison calculation.

Figure 1.

$$
\begin{aligned}
&T = \{(x, y): \\
&\sum_{k=1}^{k} z_k y_k \geq Y, \\
&\sum_{k=1}^{k} z_k x_k \leq X, \\
&z_k \geq 0, k = 1, \ldots, 12\}
\end{aligned}
$$

Diagram 2.



Once the technology frontier is created, the objective becomes to find the ratio of all other observations in relation to the frontier. This paper uses the computer program OnFront to calculate the ratios otherwise derived by the linear program model in Figure 1. Graphically, this is done by comparing all observations to the frontier and measuring their ratios on the input (x) axis keeping a constant level of output (y). Maintaining a constant level of output during the comparison process is what makes the method an input-oriented measure of efficiency.

Referring to the example of Diagram 2, Observation 1 forms the frontier. If where Observation 2 crosses the x-axis is labeled as point B, where the frontier crosses the x-axis given the same level of outputs that Observation 2 produces is labeled as point B*, and where the point the frontier crosses the x-axis is labeled as point O, then the resulting contraction ratio for Observation 2 is: $\frac{OB^*}{OB}$. This ratio is called the Input-Oriented Farrell Efficiency Score (F_i). Due to the way the ratio is set up, the frontier – and all observations on the frontier – will have a ratio equal to 1. This makes sense since the ratio for any observation on the frontier is: $\frac{OB^*}{OB^*}$. Therefore, any observation that is not on the frontier will have a ratio < 1, as previously defined by the cone-shaped technology frontier. Once the F_i Scores have been calculated, they can be used for comparison of relative efficiency given the amount of inputs each utilizes to receive their observed level of outputs.

Application of Methodology

This paper aims to apply the Farrell Input-Oriented Measure of Efficiency methodology to changes in exchange rates correlating with policy shocks. Using a case study of a chosen shock, an exchange rate is analyzed during the period in which the shock occurred. The shock in this case study is the implementation of the Uruguay Round policy package put forth by the World Trade Organization. This policy package was scheduled for implementation on January 1st, 1994. The United States Dollar to Chinese Yuan exchange rate was chosen as the dataset for the case study. This decision was made due to the volume of exchange between the two nations, and the influence the two currencies hold in the global marketplace. The dataset includes yearly data surrounding the year of implementation, ranging from

1989 to 1998. This data was collected from the Federal Reserve Economic Data historical data site, sponsored by the St. Louis Federal Reserve Branch. This data is then put into OnFront's linear program model, outlined in Figure 1.

To begin, a single year of data is put in the calculation. Using 1992 as an example, the exchange rate data is put in terms of inputs and outputs. In this application, outputs (Y) are the exchange rates at the beginning of each month. These are referred to as the current price (P_C) on the first day of the month. The inputs (X) in this model are the exchange rates at the beginning of the prior month. These are referred to as the last month's price (P_L) on the first day of that month. The dataset for each year includes 12 (monthly) exchange rates. These are the pairings of the P_L and P_C for each of the 12 months during that specific year. The data table for the 1992 dataset is shown as Figure 2.

Figure 2.

Obs.	X (PL)	Y (PC)
1	Dec	Jan
…	…	…
12	Nov	Dec

Month	Last	Current
1/1/92	5.42	5.46
2/1/92	5.46	5.48
3/1/92	5.48	5.49
4/1/92	5.49	5.51
5/1/92	5.51	5.52
6/1/92	5.52	5.49
7/1/92	5.49	5.46
8/1/92	5.46	5.44
9/1/92	5.44	5.5
10/1/92	5.5	5.55
11/1/92	5.55	5.61
12/1/92	5.61	5.81

These exchange rates can then be graphed on the input-output plane to generate a technology frontier for that yearly dataset, as shown by Diagram 3. The prices are then put into the model, calculated by OnFront, to generate a F_i score for each change between the monthly rates. For 1992, these scores are shown in Figure 3. For this example, the month of December is forming the frontier for the dataset – as depicted by the F_i score of 1. All other observations fall within the cone-shaped frontier and receive scores less than 1 relative to that observation and the benchmark set by the frontier. Plotting these scores on a graph with the year on the x-axis and the F_i score on the y-axis, the distribution of scores for the year can show the overall variability for that year. An example of this is shown in Diagram 4, using 1992 data distributions.

Diagram 3.

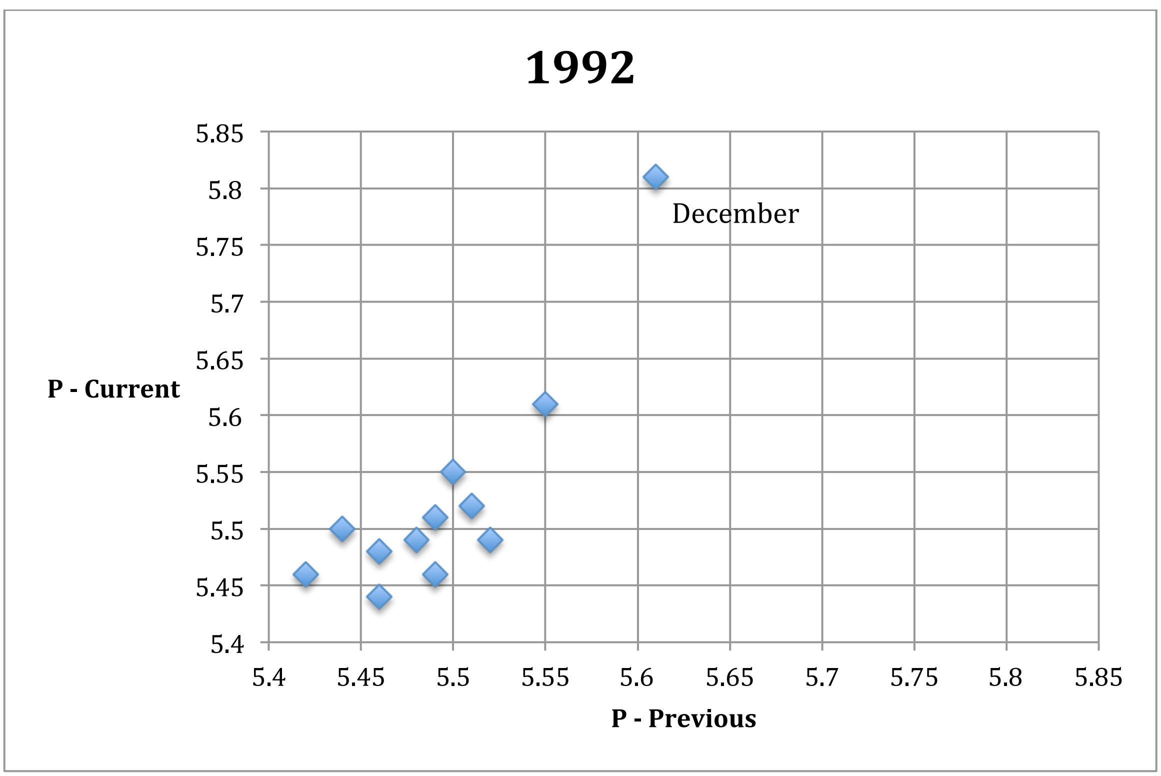
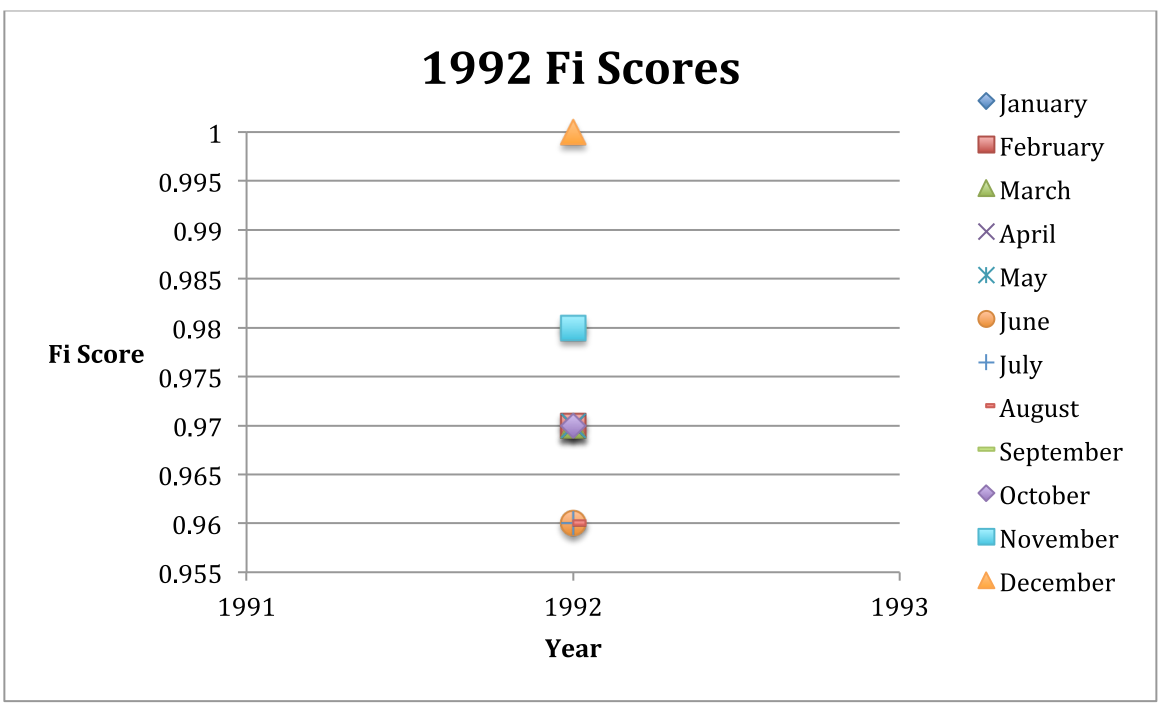


Figure 3.

Months	Last	Current	Fi
1/1/92	5.42	5.46	0.97
2/1/92	5.46	5.48	0.97
3/1/92	5.48	5.49	0.97
4/1/92	5.49	5.51	0.97
5/1/92	5.51	5.52	0.97
6/1/92	5.52	5.49	0.96
7/1/92	5.49	5.46	0.96
8/1/92	5.46	5.44	0.96
9/1/92	5.44	5.5	0.98
10/1/92	5.5	5.55	0.97
11/1/92	5.55	5.61	0.98
12/1/92	5.61	5.81	1

Diagram 4.



Once the scores are calculated for any individual year, calculations for the other years can be done as well. This paper repeats the methodology explained above for each year in the time period of 1989-1998; the scores for which are included in Figure 4. Again, the frontier creators are indicated by a score of 1 in the data table. In this data, there are multiple observations with scores that form the frontier, meaning that they are all considered equally efficient. These nine years of data surrounding the year of implementation can show a trend in the exchange rates before and after the policy change. The calculated F_i scores for each year can then also be plotted on the time-score plane, giving a visual distribution of the score trends over time. This distribution can be seen in Diagram 5. A detection of any effect could then be seen visually through a spike or drop in the average distribution. Additionally, calculating the geometric mean for each year's scores can provide a single observation for each year. When plotting these geometric means on the time-score plane, a trend line can easily be seen. This distribution of geometric means is shown in Diagram 6.

Figure 4.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
January	0.89	1	0.99	0.97	0.99	1	0.99	1	1	1
February	0.89	0.88	0.99	0.97	1	0.67	1	1	1	1
March	0.89	0.88	0.99	0.97	0.99	0.67	1	1	1	1
April	0.89	0.88	1	0.97	0.99	0.67	1	1	1	1
May	0.89	0.88	1	0.97	1	0.66	0.99	1	1	1
June	0.89	0.88	1	0.96	1	0.67	1	1	1	1
July	0.89	0.88	0.99	0.96	1	0.67	1	1	1	1
August	0.89	0.88	0.99	0.96	1	0.66	1	1	1	1
September	0.89	0.88	0.99	0.98	1	0.66	1	1	1	1
October	0.89	0.88	0.99	0.97	1	0.67	1	1	1	1
November	0.89	0.93	0.99	0.98	1	0.67	1	1	1	1
December	1	0.93	1	1	1	0.66	1	1	1	1

Diagram 5.

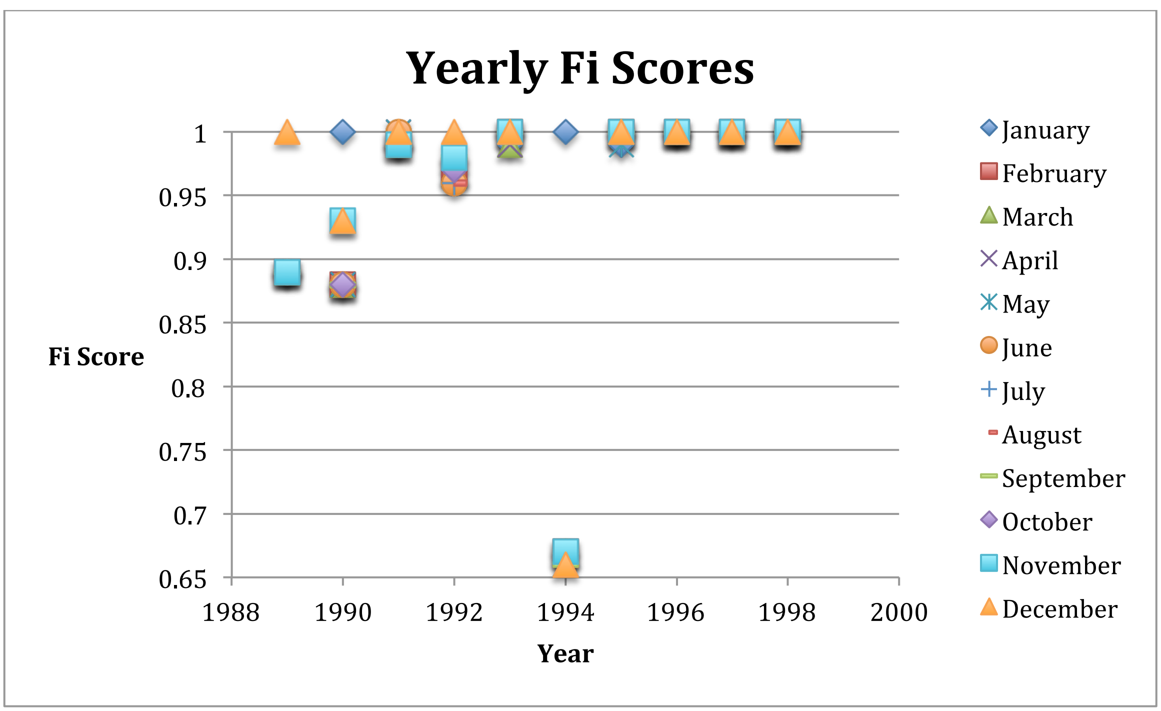
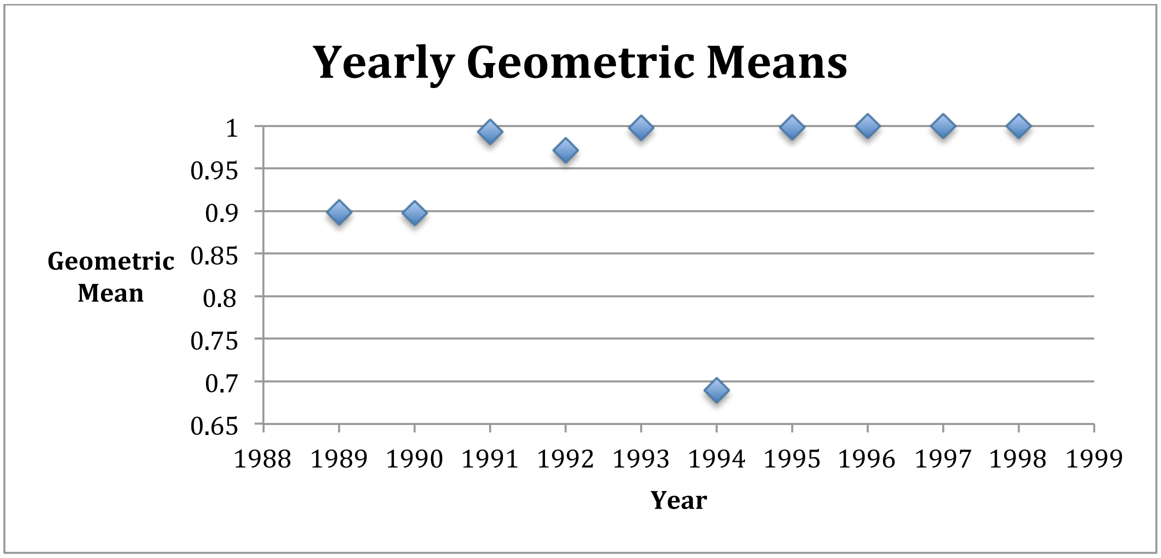


Diagram 6.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
GM	0.89869	0.89765	0.99332	0.97161	0.99749	0.68927	0.99833	1	1	1



Analysis of Results

The way by which the observations are graphed and create the frontier leads to an interesting interpretation of what possible observations could have occurred had nothing differed in efficiency from the frontier. Observations with OB ratios – being any observation that is not equal to OB* – are receiving differing levels of output relative to their inputs that are deemed inefficient by the standard interpretation of the Farrell measure. In the realm of exchange rates, however, the observations are not necessarily "inefficient" but simply represent a differing level of change than the observations on the frontier experienced. For this reason, observations on the frontier – with ratios equal to 1 – are not necessarily staying the same (although they could be), but they are changing by an equal amount relative to the other changes in the dataset. In a case when a large shift occurs during one period, it can be expected that a single observation will differ greatly from the other observations. In Diagram 5, it can be seen that the January 1994 observation is drastically different than the other 11 observations in the dataset. The grouping of observations at the 0.66-0.67 levels could all be varying (as they are), but they are varying by such similar amounts relative to the January variation that they receive very similar scores to each other. Additionally, the same variation in those 11 months without the inclusion of the January 1994 observation could be more on the 0.99-1 levels, as seen in 1995. The changes between the last 11 months in 1994 and the entire dataset of 1995 is about the same, but since the 1994 set includes the large January shift it causes the grouping of the following 11 months in the set to be shifted down to the 0.66-0.67 levels.

This large shifting of the scores due to a single observation could indicate the presence of a shock. The implementation of the Uruguay Round policy package took place January 1st, 1994. This correlates perfectly with the observed shift in exchange rates that took place between December 1st, 1993 and January 1st, 1994, being the first observation in the 1994 dataset. As discussed above, this is the lone observation forming the frontier for the year 1994. When viewed all together in Diagram 5 and Diagram 6, the presence of a major shift (a shock) seems evident.

Another interesting result seems to be the stabilization of scores after the year 1994. Prior to the year of implementation, the scores varied between the 0.89 and 0.99 levels. Yet after the year of implementation, the scores varied only between the 0.99 and 1 levels. This sparked further research into what may have caused such a pattern of variation before and stabilization after. The findings returned that a separate policy change occurred on January 1st, 1994 that fixed the Yuan/USD exchange rate. As previously discussed, a dataset with similar variations between the observations would lead all Fi scores to equal 1. However, if that similar variation were equal to zero then the Fi scores would also be all equal to 1. This second case seems to be what is occurring between the years of 1996 and 1998. The geometric mean for 1995 is 0.998, being almost completely stable. The reason for the discrepancy could be a result of lag in the market, as the data seems to suggest.

When comparing the pre- and post-1994 datasets, it seems that the Farrell measure is detecting variations in the bilateral rate differently during periods of floating and fixed exchange rates. The pre-1994 period clearly shows variation in the efficiency level, indicating that variation in the dataset exists. Whereas the post-1994 period shows practically zero variation in F_i scores, indicating that variation in the exchange rate did not exist. This leads to the hypothesis that perhaps the technique could be utilized as a general volatility measure.

Application as a General Volatility Measure

In addition to Data Envelopment Analysis being able to detect shocks in the exchange rate, it seems that the method may be able to be used to measure variability in general. The way the F_i scores adjust as the exchange rates change seems to be a measure the variability between months on a relative scale of $0 \leq V \leq 1$. If this holds true, what a period of floating exchange rates might look like could be hypothesized based on the previous case study of the Yuan/USD exchange rate.

To test this hypothesis, this paper compares a period of exchange rate data from two notoriously floating currencies during a time when no known shocks occurred. Applying an identical methodology from the prior case study, this paper looks at the 2011-2015 data on the Canadian Dollar to Euro exchange rate. This data was sourced from the historical records of the Bank of Canada and put into the Linear Program Model in OnFront. From there, a comparison can be made between the results of the methodology during a fixed rate period and floating rate period. Figure 5 shows the F_i scores calculated by OnFront for the CAD/Euro exchange rate and the F_i scores of the Yuan/USD exchange rate during its fixed rate period.

Figure 5.

CAD/Euro	2011	2012	2013	2014	2015
January	1	0.94	0.95	1	0.9
February	0.99	0.95	0.96	0.97	1
March	0.95	0.93	0.92	0.98	1
April	0.97	0.93	0.96	1	0.96
May	0.93	0.95	0.95	1	0.94
June	0.99	1	0.96	1	0.94
July	0.96	0.94	0.95	1	0.96
August	0.97	0.98	0.95	1	0.96
September	0.94	0.96	0.94	0.98	0.98
October	0.95	0.94	1	1	1
November	0.98	0.95	0.97	0.97	0.98
December	0.93	0.95	0.92	0.96	0.96
GM	0.96306	0.95147	0.95228	0.98822	0.96458

Yuan/USD	1996	1997	1998
January	1	1	1
February	1	1	1
March	1	1	1
April	1	1	1
May	1	1	1
June	1	1	1
July	1	1	1
August	1	1	1
September	1	1	1
October	1	1	1
November	1	1	1
December	1	1	1
GM	1	1	1

As seen previously, the F_i scores and geometric means during the period when the Yuan/USD was fixed are all equal to 1. This means that all the scores are creating the frontier and grouped along the frontier. The variability between the months is so small that it does not register a change in F_i. During a fixed rate period, this is expected because the rate should not be able to vary by any amount. During a floating rate period, however, the scores are allowed to vary and a different result is seen. In Figure 5, scores range down to the 0.92 level and the geometric means are different in each year. This means that the exchange rate is changing between months and the currencies are not fixed to one another, as should be expected since the period used is known to have had a floating rate. This provides support that the methodology can generally measure variability in exchange rates.

Since the ratios in the calculation of the scores are based on a relative measure of each observation to the frontier within the dataset, the scores alone can provide information on how the changes in rate compare to changes in other months within the same set. In datasets where both upward and downward shifts occur, the largest upward shift receives a $F_i = 1$. From there, the other observations are ordered by their scores from largest upward change between months to largest downward change between months. In other words, F_i is organized by largest increase in the exchange rate to largest decrease in the exchange rate. This is only true for a set that has upward and downward shifts, however. In a set with only upward shifts, the scores are simply organized by largest increase to smallest increase. In a set with only downward changes in the rate, the smallest decrease in price would receive a $F_i = 1$. Larger decreases would receive scores ranging down from there relative to the size of the downward change in the rate. This makes sense with the assumption of free disposability in the model, suggesting that freely disposing of fewer inputs is more efficient than freely disposing of more inputs.

Conclusion

It seems, through a case study of the Yuan/USD exchange rate, that Data Envelopment Analysis can be used to detect shocks in the economy. These shocks do not necessarily need to be caused by the implementation of trade policy for the method to be able to detect them, although the one in the presented case study seems to correlate with the implementation of a particular policy package. It also seems that the method can be applied as a general measure of variability in exchange rates. As seen in the CAD/Euro data, the method was able to show differences when the rate was floating and show a perfect grouping of scores when the rate was fixed. These successes in measurement ability show potential for further use of this methodology in the future.

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