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HETEROGENEOUS TRADE COSTS OF TRADE BARRIERS

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ABSTRACT

Economists have argued that rich and poor countries face asymmetric trade costs. In this short note, we propose a simple trade cost function to model trade cost asymmetry at the trade barrier level. Our trade cost function can better fit the data and shed light on the nature of some important parameters that have been used in applications on cross-country productivity and income differences.

INTRODUCTION

Economists have long noticed that rich countries trade more than the gravity model predicts, while the converse is true for poor countries. Some economists try to address this issue by refining the trade cost function in the gravity model. For example, Eaton and Kortum (2001) add a destination fixed effect to the trade cost function in their gravity model. A greater destination effect (in absolute value) in their model means that a country experiences higher friction to its imports, controlling for trade barriers.1 Waugh (2010) systematically discusses the significance of incorporating trade cost asymmetry by adding fixed effects to the trade cost function, but argues that the fixed effects should be interpreted as country-specific export costs.

Adding fixed effects to the trade cost function contributes greatly to our understanding of the trade pattern by incorporating the asymmetry in trade frictions. However, this approach still maintains the ad hoc assumption that a bilateral trade barrier incurs the same amount of trade costs in all country pairs, which is inconsistent with Limao and Venables' (2001) finding that the transportation costs for similar journeys are much higher for countries with poor infrastructure.2 Based on Limao and Venables' (2001) finding, in this short note we assume that the cost for a country to overcome a type of trade barrier depends on its general ability to overcome trade barriers, which we define as the (log) total cost for a country to overcome all types of trade barriers. Our results show that modeling trade cost heterogeneity at the trade barrier level can help the gravity model better fit the data and give more reasonable predictions.
The fixed effects in Eaton and others' trade cost functions serve as important parameters for applications concerning prices and productivity. These authors, however, have different opinions on the nature of these fixed effects, since some of them interpret the fixed effects as frictions to imports while other consider them as frictions to exports. This distinction does not matter for the purpose of explaining the trade pattern, but it makes a difference in applications concerning prices, productivity, or income levels. For example, Eaton and Kortum (2001) interpret the fixed effects as country-specific frictions to imports of capital goods. Since poor countries are subject to higher country-specific import frictions, it is more difficult for them to import capital goods, which helps explain the lower productivity of poor countries. Had these fixed effects in the trade cost function been explained as frictions to exports, however, the asymmetry in trade costs would be hurting the productivity of developed countries and it wouldn't help explain cross-country productivity differences. Waugh (2010) shows that how we interpret the fixed effects affects the predictions concerning the cross-country price levels. Therefore, it is important to revisit the whether trade frictions are export-specific or import-specific.

To discuss the nature of the fixed effects in Eaton and others' trade cost functions, in this work we assume that the border and bilateral trade barriers constrain both a country's imports and its exports. From the perspective of our setup, each country's fixed effect in Eaton and others' trade cost functions is the combination of the following trade costs for the country: country-specific import costs (i.e., border's friction to imports), country-specific expert costs (i.e., border's friction to exports), and the average extra import and export costs for bilateral barriers paid by the country. We use the trade volume data to estimate the cost that a barrier causes to a country's imports and exports, and find that these two costs are quite close. Therefore, attributing the fixed effects in Eaton and others' trade cost functions exclusively to imports or exports may be equally inaccurate. Eaton and Kortum (2001, 2002), and Waugh (2010) also restrict the sum of these country fixed effects to be zero, while our decomposition shows that the sum of these country fixed effects is the sum of border costs to trade flows for all countries, which should be positive. This restriction may also pose a problem to the applications based on the values of the country fixed effects.

Waugh (2010) uses patterns in the price data of the International Comparison Program (ICP) to argue that these fixed effects are country-specific export costs. Although great efforts have been exerted to ensure the ICP data incorporate the cross-country quality difference, the quality of the ICP data has frequently been discussed by economists. On the other hand, the trade volume data used by us are arguably more accurate and have substantially more observations. Therefore, it may be worthwhile to revisit this question with our approach.

Our approach of modeling trade cost heterogeneity has its own merit besides helping us address the above two issues. We model a country's general ability to overcome trade barriers as an unknown parameter to be estimated. This obviates the need of data on the determinants of a country's abilities to overcome trade barriers, such as the infrastructure data used by Limao and Venables (2001). Our approach is straightforward to implement and the empirical results are consistent over years. Therefore, we think that our work provides a convenient and reliable way to model heterogeneity in trade costs of trade barriers.

Our contribution to understanding of asymmetry in trade frictions is incremental compared with the works of above authors. However, Obstfeld and Rogoff (2000) argue
that all the major puzzles of international macroeconomics are related to trade costs, and Anderson and van Wincoop (2004) advocate careful modeling of trade costs. Therefore, the two issues mentioned above may be worth a formal discussion, and our modeling of heterogeneity in trade costs may lead to discovery of better trade cost functions that are essential to the understanding of international macroeconomics questions.

The rest of this work is structured as follows. In the next section, we introduce a normalized gravity equation that is suitable for our purposes. We also introduce our trade cost function in this section. Section 3 conducts the empirical analysis. The last section concludes.

**GRAVITY EQUATION AND TRADE COST FUNCTION**

**Gravity Equation**

We adopt the normalized gravity equation employed by Eaton and Kortum (2001, 2002) and Waugh (2010) for our empirical analysis. These authors derive the equation in a setting where trade costs act on the extensive margin. In what follows, we shall briefly show that the same equation can be generated by Anderson and van Wincoop’s (2003) setup where trade costs act on the intensive margin. It is also straightforward to derive the equation from Chaney’s (2008) model, where trade costs act on both the intensive margin and the extensive margin. Therefore, our results are robust to the choice of trade models.

Anderson and van Wincoop (2003) show that in an endowment-economy model where consumers share a CES utility function, the expenditure function and the market-clearance condition for each country’s output give the following gravity equation

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \frac{t_{ij}^{1-\sigma}}{\Pi_i^{1-\sigma} P_j^{1-\sigma}}$$

(1)

where $X_{ij}$ is the exports from $i$ to $j$ ($i \neq j$), $Y_i$ ($Y_j$ and $Y_w$) is the nominal output of country $i$ ($j$ and the world), $t_{ij}$ is the trade costs for exports from $i$ to reach consumers in $j$, $\sigma$ is the elasticity of substitution between goods, $\Pi_i = \left(\sum_{j=1}^{N} \frac{N_j^{1-\sigma}}{Y_{ij}^{1-\sigma}}\right)^{1/(1-\sigma)}$ and $P_j = \left(\sum_{i=1}^{N} \frac{Y_{ji}^{1-\sigma}}{Y_{iw}^{1-\sigma}}\right)^{1/(1-\sigma)}$ are referred to as outward and inward multilateral resistance terms, and $N$ is the total number of countries.

Following Eaton and Kortum (2002), and Head and Mayer (2004), we normalize $X_{ij}$ by the importer’s self-absorption, $X_{jj}$, which delivers

$$\ln \frac{X_{ij}}{X_{jj}} = \ln \frac{Y_i}{\Pi_i^{1-\sigma}} - \ln \frac{Y_j}{\Pi_j^{1-\sigma}} + (1 - \sigma) \ln t_{ij},$$

(2)

where $t_{jj}$ is set to 1. The benefit of normalizing the trade flow by $X_{jj}$ is that the inward multilateral resistance, $P_j = \left(\sum_{i=1}^{N} \frac{N_j^{1-\sigma}}{Y_{iw}^{1-\sigma}}\right)^{1/(1-\sigma)}$, is eliminated from the equation.
Now we can treat $\ln \frac{X_{i}}{X_{jj}}$ in Equation (2) as a fixed effect, $S_i$, and have the following equation:

$$\ln \frac{X_{ij}}{X_{jj}} = S_i - S_j - (\sigma - 1) \ln t_{ij}. \quad (3)$$

Equation (3) has the same structure as Equation (9) in Eaton and Kortum (2001), Equation (28) in Eaton and Kortum (2002), or Equation (7) in Waugh (2010). We denote the trade elasticity, $\sigma - 1$, with $\varepsilon$ and rewrite Equation (3) in the following form:

$$\ln \frac{X_{ij}}{X_{jj}} = S_i - S_j - \varepsilon \ln t_{ij}. \quad (4)$$

In this work, we take $\varepsilon$ as a known parameter and do not try to estimate it. Based on the various estimates in the literature, we set $\varepsilon = 5$ when we need it to interpret the economic meaning of our results.

**Trade Cost Function**

Consider country pair $ij$, in which country $i$ exports to country $j$. Let $t_{ij}^X$ denote the costs for the goods to cross country $i$'s border (e.g., transportation costs to the port). The goods then need to cross some bilateral barriers. We assume that the exporter and the importer collaborate to overcome each bilateral barrier $b$, each party being responsible for a fixed portion of the work. Suppose it takes $t_{bi}^X$ for a country $i$ exporter to do its part to overcome bilateral barrier $b$, and $t_{bj}^M$ for a country $j$ importer to do its part to overcome bilateral barrier $b$. Finally, the goods are subject to the border-related costs for entering country $j$, which we denote as $t_{bj}^M$ (e.g., import tariffs). Therefore we have

$$\ln t_{ij} = \ln t_{ij}^X + \sum_{b \in B_{ij}} \left( \ln t_{bi}^X + \ln t_{bj}^M \right) + \ln t_{bj}^M, \quad (5)$$

where $B_{ij}$ is the set of bilateral barriers between country $i$ and country $j$.

We must impose some structure on Equation (5) to reduce the number of parameters to be estimated. In light of the findings in Limao and Venables (2001), we assume that the cost incurred by a type of trade barrier is determined by a country's general ability to overcome trade barriers, $\tau_i$. We make the ad hoc assumption the trade cost is a log-linear function of the country's general ability to overcome trade barriers.

**Assumption**: The cost for country $i$ to overcome a trade barrier as an importer or exporter depends on its general ability to overcome trade barriers, $\tau_i$. The dependence takes the log-linear form, i.e., $\ln t_{bi}^X = \beta_i^X \tau_i$, $\ln t_{bj}^M = \beta_i^M \tau_i$, $\ln t_{bi}^X = \beta_j^X \tau_i$, and $\ln t_{bj}^M = \beta_j^M \tau_i$. 

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Given the log-linear form of the trade cost function, we can normalize a country’s general ability to overcome trade barriers, \( \tau_i \), as the log of the total cost for a country to overcome all types of trade barriers,

\[
\tau_i = \ln t_{\phi i}^X + \sum_{b \in B} (\ln t_{bi}^X + \ln t_{bi}^M) + \ln t_{\phi i}^M, \tag{6}
\]

where \( \mathcal{B} \) is the all-inclusive set of all possible bilateral trade barriers. Given this normalization, \( \beta_b^X, \beta_b^M, \beta_b^X, \) and \( \beta_b^M \) are the (log) shares of the cost of these trade barriers in a country’s total trade cost for all types of trade barriers. With the assumption on trade costs, we can write the trade cost function (5) as follows

\[
\ln t_{ij} = \beta_b^X \tau_i + \tau_i \sum_{b \in \mathcal{B}_{ij}} \beta_b^X + \tau_j \sum_{b \in \mathcal{B}_{ij}} \beta_b + \beta_b^M \tau_j. \tag{7}
\]

In Eaton and Kortum (2001, 2002), the trade cost function takes the following form:

\[
\ln t_{ij} = \sum_{b \in \mathcal{B}_{ij}} \tau_b + m_j, \tag{8}
\]

where \( m_j \) is the importer fixed effect. In Waugh (2010), the trade cost function takes the form of

\[
\ln t_{ij} = x_i + \sum_{b \in \mathcal{B}_{ij}} \tau_b, \tag{9}
\]

where \( x_i \) is the exporter fixed effect. We refer to a trade cost function that takes the form of Equations (8)(8) or (9)(9) as a trade cost function with fixed effects hereafter.

In contrast to Equation (7)(7), the trade cost functions with fixed effects assume that a bilateral trade barrier incurs the same costs for all country pairs, and that country-specific trade costs apply exclusively to either imports or exports. Since a bilateral trade barrier is assumed to incur the same costs for all country pairs, the fixed effects contain the average extra trade cost paid by each country. Given the estimation strategy used by Eaton and others, \( x_i \) and \( m_j \) are identified as a sum of the country-specific (log) costs to country \( i \)’s exports, \( t_{ji}^X \), and those to its imports, \( t_{\phi i}^M \).

If we eliminate the fixed effect from Equations (8)(8) or (9)(9), we have the traditional trade cost function

\[
\ln t_{ij} = c_0 + \sum_{b \in \mathcal{B}_{ij}} \tau_b, \tag{10}
\]

where \( c_0 \) is a border-related cost that is common to all countries and is usually combined with the intercept of the econometric models.
Econometric Models and Identification

Plugging our trade cost function (7) in Equation (4)(4) yields the following econometric model

$$\ln \frac{X_{ij}}{X_{jj}} = S_{i}^{X} - S_{j}^{M} + \epsilon_{ti} + \sum_{b \in B_{ij}} \beta_{b}^{X} + \epsilon_{tj} \sum_{b \in B_{ij}} \beta_{b}^{M} + \epsilon_{ni},$$  \hspace{1cm} (11)

where $S_{i}^{X} = S_{i} - \varepsilon(\ln t_{j}^{X} + \sum_{b \in B_{i}} \ln t_{b}^{X})$ can be explained as country $i$'s exporting competitiveness, $S_{j}^{M} = S_{j} + \varepsilon(\ln t_{i}^{M} + \sum_{b \in B_{j}} \ln t_{b}^{M})$ can be explained as country $i$'s competitiveness on its domestic market, and $B_{ij}$ is the set of trade barriers that country $i$ and $j$ do NOT need to overcome. The error term $\epsilon_{ni}$ captures variation in trade costs arising from trade barriers omitted by our data.

Now let us consider the identification of parameters. Following Eaton and Kortum (2001, 2002), we capture $S_{i}^{X}$ and $S_{j}^{M}$ as the coefficients of exporter and importer dummies. $\epsilon_{ti}$ is then pinned down as $\epsilon_{ti} = S_{i}^{M} - S_{i}^{X}$ (remember that we take $\varepsilon$ as a known parameter). Given $S_{i}^{X}, S_{j}^{M}, \epsilon_{ti},$ and $\epsilon_{tj}$, variations in geography can help us identify $\beta_{b}$'s in Equation (11)(44).

If we plug the trade cost function with fixed effect in Equation (4)(4), we get the following econometric model (c.f. Equation (30) in Eaton and Kortum 2002):

$$\ln \frac{X_{ij}}{X_{jj}} = S_{i}^{X} - S_{j}^{M} + \sum_{b \in B_{ij}} \tau_{b} + \epsilon_{ij},$$  \hspace{1cm} (12)

where $\sum_{b \in B_{ij}} \tau_{b}$ are referred to as independent geography terms. If we capture $S_{i}^{X}$ and $S_{j}^{M}$ as the coefficients of exporter and importer dummies, then $S_{i}^{M} - S_{i}^{X}$ gives us the country-specific trade costs. Though the country-specific trade costs have been recognized as either the destination fixed effect (e.g., Eaton and Kortum, 2001) or the source fixed effect (e.g., Waugh, 2010), the estimated value of $S_{i}^{M} - S_{i}^{X}$ contains both of these two effects. The estimated value of $S_{i}^{M} - S_{i}^{X}$ also contains extra trade costs that a country pays on top of the average cost assumed for all countries, $\tau_{b}$, for bilateral trade barriers.

Note that Equations (11)(44) and (12)(42) have roughly the same number of explanatory variables. Therefore, if our trade cost function improves the performance of the gravity model vis-à-vis the trade cost function with fixed effects, the number of explanatory variables is not the main reason.

With the traditional cost function (10)(40), we have the following econometric model

$$\ln \frac{X_{ij}}{X_{jj}} = S_{i} - S_{j} + \varepsilon \sum_{b \in B_{ij}} \tau_{b} + \epsilon_{ij}.$$  \hspace{1cm} (13)
EMPIRICAL ANALYSIS

We conduct empirical analysis using data from the manufacture sector for about 100
countries during 1995-2007. We choose the manufacture sector since it has good coverage
of output data, which are necessary for our empirical analysis. The data also show that
trade in manufacturing goods constitutes the majority of world trade, so the results based
on this sector should be representative. We focus on years 1995-2007 because it is the
period that we have sufficient observations in each year. Our bilateral trade data are from
COMTRADE. Our output data are from UNIDO. And our geography data are from CEPII.
In the appendix, we provide further details concerning the data.

We consider four types of variables related to trade barriers: distance (d), adjacency
(a), common language (I), and colonial ties (c). Following Eaton and Kortum (2002), we divide
bilateral distance into six intervals (in miles): \( [0, 375] \); \( (375, 750) \); \( (750, 1500) \); \( (1500,
3000) \); \( (3000, 6000) \); \( (6000, \text{maximum}) \). Being an importer or an exporter is perfectly
 correlated with being subject to a distance barrier, so we cannot include the full set of
distance dummies in the econometric model. We drop the dummy for the 6th distance
interval and define the coefficient of the \( k^{th} \) distance dummy as the cost incurred by
the distance between the \( k^{th} \) distance interval and the 6th distance interval. Eaton and Kortum
(2001, 2002), and Waugh (2010) identify the coefficients of all six distance dummies by
restricting the sum of country-specific trade costs to be zero, but we have argued that the
sum equals the sum of border costs to trade flows for all countries, which should be
positive. Therefore, we choose not to follow their approach to identify the coefficients of
the full set of distance dummies.

We assume that disturbances \( \epsilon_{n} \) in the econometric model are independent draws
from a normal distribution and they are not correlated with explanatory variables. We
estimate the econometric model by maximum likelihood. It would be tempting to estimate
the model with full sample to exploit the benefits of panel data. The large number of
parameters, however, makes this approach very difficult with maximum likelihood. Instead,
we estimate econometric models independently for each year between 1995-2007, which
makes the computation manageable. Since the results of these years exhibit similar
patterns, most of the time we only report results for the 2007 sample to save space.

In Section 0, we discuss the first issue mentioned in the introduction, i.e., whether we
should model trade cost asymmetry at the trade barrier level or the country level. In Section
0, we discuss the second issue mentioned in the introduction, i.e., the nature of the fixed
effects in Eaton and others' trade cost function.

Heterogeneity at Barrier Level vs. Heterogeneity at Country Level

In this section, we discuss the advantage of modeling trade cost asymmetry at the
trade barrier level over modeling it at the country level. We first show that modeling trade
cost asymmetry at the trade barrier level can greatly improve the fit of the gravity model at
little extra cost. Then we use the predicted trade costs to help us have a better perspective
about the advantage of our trade cost function.
Fit of the Model

Column (1) in Table 1 reports the estimated parameters for the traditional trade cost function. The results show that the distance increases from the first interval, [0, 375] miles, to the sixth interval, [6000, Max] miles, the trade cost increases by a factor of \(\exp(4.31/\varepsilon) \approx 2.37\) (we set \(\varepsilon = 5\)). If two countries do not share a border, the trade cost between them is higher by a factor of \(\exp(0.9/\varepsilon) \approx 1.2\) than otherwise. Other cost coefficients in this column can be explained similarly.

Column (2) in Table 1 reports the estimated parameters for the trade cost function with fixed effects. These estimates are smaller than those in Column (1), and are largely consistent with estimates of similar parameters in Eaton and Kortum (2001, 2002) and Waugh (2010). Consistent with Waugh (2010), the results in Table 1 show that adding fixed effects (for 70 countries) to the trade cost function can greatly improve the fit of gravity model to the trade data.

Column (3) in Table 1 reports the estimated parameters for our trade cost function. The \(\beta\) coefficients, i.e., the coefficients of interactions terms in Equation (11)-(14), are the share of trade cost incurred by a barrier in a country's total trade restrictiveness, e.g., \(\beta_i^M = \ln t_i / (\ln t_i^{M} + \sum_k \ln t_k^{M} + \ln t_k^{X})\). Most of these estimated coefficients fall between 0 and 1 as our assumption implies, and most coefficients related to distance exhibit an expected order. By assuming that a trade barrier incurs different costs in different country pairs, our trade cost function help the gravity model fit the trade data much better since the log likelihood increases from -8813 to -8655. The improvement in fit is comparable to the one obtained by adding country fixed effects, though our trade cost function have roughly the same number of parameters as the trade cost function in column (2). In column (4), we restrict \(\beta_i^M\) and \(\beta_i^X\) in our trade cost function to be equalized (now the gravity model has the same number of parameters as the one underlying column (2)). We can see that the results are largely similar to those in column (3). All coefficients are highly significant, fall strictly between 0 and 1, and the coefficients related to distance strictly conform to the expected order.

In column (5), we introduce the independent geography terms in our trade cost function. The estimated \(\beta\) coefficients are similar to those in columns (3) and (4), while the independent geography terms are quite different from those in columns (1) and (2) and do not have sensible economical interpretations. This observation favors the interpretation that the trade cost of a barrier depends on the trading countries instead of depending on the barrier itself.

The patterns discussed above are true for all years between 1995-2007. We also checked various model selection criteria and experiment with other specifications (e.g., trade cost function with only import side interactions) for all years (results not reported here). All the results are consistent with what we discussed above.

To summarize, as argued by Waugh (2010), modeling trade cost asymmetry at the country level can greatly improve the fit of gravity models. Modeling the trade cost heterogeneity at the barrier level, however, can further improve the performance of the gravity model at little extra cost.
Predicted Trade Costs

The previous section shows that modeling trade cost heterogeneity at the barrier level can improve the fit of the model, but it is hard to interpret the economical meaning of the improvement of the fit. In this section, we show that given the same geography, trade cost functions with fixed effects could result in trade costs that are very different from true trade costs for many observations, while it is very unlikely for our trade cost function to cause such large inaccuracy.

We do not observe the true trade costs in the real world, but we are sure that they must be positive. We can use this knowledge to gauge inaccuracy in the fitted trade costs. We calculate the predicted trade cost in each pair assuming that two countries are contiguous and within 375 miles, share a common language and have colonial ties. If we obtain a negative predicted trade costs, then the residual in the trade cost is at least greater than the border-related costs plus the cost incurred by a distance of 375 miles. The combined share of these costs in a country’s total trade restrictiveness is $1 - \beta_2^s - \beta_2^m - \beta_s^M - \beta_s^M - \beta_2^s - \beta_s^M - \beta_2^s$, whose estimated value is about 23% according to the results in Table 2. So it implies a significant amount of trade costs. Consequently, a negative sign indicates that the predicted trade cost must be very different from the true trade cost.

Table 2 shows that the model based on the trade cost function with fixed effects predict negative trade costs for 538 observations out of the 4481 observations in 2007, and roughly 10% of observations in all years. Table 2 also shows that our trade cost function only has 2 negative predicted trade costs. Therefore, even when the trade cost function with fixed effects causes large inaccuracy to many observations, it is very unlikely for our trade cost function to cause comparable inaccuracy in the trade costs.

We would like to briefly discuss why the trade cost function with fixed effects tends to predict negative trade costs. The common coefficients for trade barrier in this type of trade cost function measure the average trade costs of each bilateral trade barrier, so they overstate the trade cost paid by rich countries. To match the actual trade cost facing the rich countries, the estimator has to assign a small value for the country’s border-related trade costs (country fixed effect). The downward bias in the border-related costs tends to cause negative predicted trade costs for rich countries.

Exporter-Specific Costs or Importer-Specific Costs

The fixed effects in Eaton and others’ trade cost function can effectively model the trade cost asymmetric at the country level and help gravity models fit trade data. These fixed effects, however, have different interpretations in different works. Some economists explain them as frictions to imports while others argue that they are frictions to exports. In this section, we discuss the nature of these fixed effects.

We have shown that these fixed effects are the combination of the following trade costs for each country: country-specific import costs (i.e., border’s friction to imports), country-specific export costs (i.e., border’s friction to exports), and the average extra import and export costs paid by the country. Therefore, whether we should ascribe the fixed effect to the imports or the exports depend on whether the border and other trade barriers mainly restrict imports or exports.
According the results in column (3) in Table 1, the distance between the first interval and the sixth internal incurs a (log) cost of $0.31T_i$ to country $i$'s imports, while it causes a (log) cost of $0.22T_i$ to the country's exports. The costs are not equal to each other, but no one dominates the other. We can make the same conclusion for other bilateral trade barriers, or at least we should refrain from making the conclusion that bilateral trade barriers only affect imports or exports.

We cannot separately identify border's friction to imports and border's friction to exports, but the above discussion implies that it is doubtful to claim that a country's border would only constrain its imports or exports. In fact, based on the trade volume data, maybe it is reasonable to assume that that a country's border causes similar amounts of trade costs to its imports and exports.

To summarize, based on the evidence from trade data, perhaps the fixed effects in Eaton and Kortum (2001, 2002) and Waugh's (2010) trade cost function should not be explained exclusively as frictions to imports or exports. A fifty-fifty division may bring us closer to the truth.

**CONCLUSION**

Economists have long noticed the asymmetry in trade costs. Some economists address this issue by adding country fixed effects to the trade cost function to model the asymmetry at the country level. In this work, we propose a simple micro-found trade cost function to model trade cost asymmetry at the trade barrier level. Our trade cost function greatly improves the performance of the gravity model and sheds light on the nature of some important parameters that have been used in applications on cross-country productivity and income differences.
REFERENCES


Table 1: Estimation Results for Year 2007

<table>
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<tr>
<th>(1) Traditional trade cost function</th>
<th>(2) Trade cost function with fixed effects</th>
<th>(3) Our trade cost function</th>
<th>(4) Our trade cost function with restriction $\beta_1^N = \beta_2^N$</th>
<th>(5) Our trade cost function with independent geography terms</th>
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<tr>
<td>$\beta_{21}^N$ (dist. between $d_{1i}$ &amp; $d_{2i}$)</td>
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Country Fixed Effect in Cost Function: Yes

Country Openness Index

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Note: 1. Standard errors are reported in parentheses. 2. ***, **, * indicate significance levels of 1%, 5%, and 10% respectively. 3. The $\beta$ coefficients in the first 16 rows are the share of trade cost incurred by a barrier in a country's total trade restrictiveness. For example, $\beta_1^N = \ln t_i / (\ln t_{d1}^N + \sum_{n \neq i} (\ln t_{d1}^N + \ln t_{d1}^N + \ln t_{d1}^N))$. 

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Count of negative predicted trade cost by trade cost function with fixed effects: 278 282 332 587 403 517 637 492 582 730 652 672 538

Observations: 4663 5270 4749 5745 4625 5359 5962 5853 5826 5847 5578 5908 4481

Countries: 77 80 76 83 74 79 83 82 81 81 78 80 70

Note: 1. The first 16 rows report the estimates of \(\beta\) coefficients in our trade cost function. 2. When calculating predicted trade costs, we assume that the border causes the same amount of trade cost to a country's imports and exports.
APPENDIX

DATA

Our empirical analysis requires information on manufacture output, bilateral trade flows, and bilateral trade barriers.

The output data is from UNIDO’s Industrial Statistics Database. We conduct our empirical analysis for years between 1995 and 2007 because we have information on aggregate output in manufactures for a decent number of countries in these years.

We obtain the bilateral trade data from COMTRADE and concord the data into the ISIC 2 classification with the concordance table provided Muendler (2009). When the data on imports (exports) is missing, we replace it with the exports (imports) of the partner if applicable.

We calculate country’s self-supply $X_{jj}$ in a year as follows:

$$X_{jj} = \text{Output}_j - (\text{Export}_j - \text{Reexport}_j - \text{Reimport}_j).$$

(14)

The total exports of a country include re-exports and the exports that eventually come back to the domestic market (i.e., reimports). These two export flows do not represent the amount of home-produced goods that are eventually sold abroad, so they should be subtracted from the exports to calculate $X_{jj}$. This correction procedure matters for economies that have a large share of re-exports or re-imports in its trade flows. The self-supply $X_{jj}$ is negative for some country-years. The theory does not provide guide for this situation, so we simply drop the observations when this occurs.

Our geography data comes from the CEPII dataset (Mayor and Zignago, 2006).
FOOTNOTES

1 In another paper, Eaton and Kortum (2002) adopt the same approach.

2 Hummels (2001) also reports that the all-commodities trade-weighted average freight cost ranges from 3.8% of the FOB price for the U.S. to 13.3% for Paraguay.

3 For example, Eaton and Kortum (2001), Waugh (2010), Levchenko and Zhang (2011) all make use of these fixed effects to analyze price levels and productivity in different countries.

4 The average extra costs paid for bilateral barriers by each country sum to zero.

5 This restriction is used to identify the effects of physical distance, so the levels of the effects of physical distance are also affected.

6 Anderson and Yotov (2012) argue that econometric problems of endogeneity and omitted variables are demolished when fixed effects replace the theoretically indicated size and multilateral resistance variables.


8 It does not cause any substantive changes when we write the econometric model in terms of the absence of trade barriers. This unorthodox representation, however, makes it easier to interpret the parameters and how they are identified.

9 Historically, heteroskedasticity has been an important topic in the estimation of gravity models. However, the dependent variable in this work is size adjusted, and Anderson (2011) argues that this normalization is likely to attenuate the heteroskedasticity problem. Silva Santos and Tenreyro (2006) develop a pseudo Poisson maximum likelihood estimator to address the heteroskedasticity problem. Waugh (2010) finds that the estimates of the size-adjusted gravity model based on this new estimator are similar to the OLS results.

Zero trade flows are another concern for estimating gravity models. Fortunately, Anderson and Yotov (2012) report that when they include country fixed effect instead of structural terms in the gravity model, OLS and Helpman, Melitz and Rubinstein (2008) sample selection estimator give similar results. Based on these findings, we believe that heteroskedasticity and zero trade flows are not likely to be serious problems in our exercise. To focus on the topic of this short note, we decide not to discuss these issues.

10 The increase in the magnitude of the β coefficients and the negative signs of the independent geography terms in column (4) indicate that our trade cost function understates the trade cost heterogeneity at the barrier level.
In our econometric model, the border-related costs for exports, $t^X_i$, are included in the coefficient of the exporter dummy, $S^X_i = S_i - e(\ln t^X_i + \sum_{n \neq i} \ln t^X_n)$. We can identify $S^X_i$, but cannot isolate $t^X_i$ from it given the data that we have (being a country-$i$ exporter is perfectly correlated with being subject to country-$i$ specific export cost). Likewise, we cannot identify $\beta^N_i$.

The three databases that we use are INDSTAT4 2007 ISIC Rev.2, INDSTAT4 2007 ISIC Rev.3, and INDSTAT4 2011 ISIC Rev.3.
OPTIMAL DEBT COMPOSITION: AN EMPIRICAL MODEL FOR NIGERIA

Soloman Kone
City University of New York

ABSTRACT

This paper develops a debt composition hedging strategy that minimizes a developing country’s budget exposure to external price shocks and applies the technique to Nigeria. The survey should be useful to other less developed countries interested in hedging tools to limit the impact of volatility in global markets. There are several principle results that emerge from this study. The empirical results establish that Nigeria faces large exposures to oil price and exchange rate uncertainty and, to a lesser extent, to interest rate movement. The analysis also reveals that Nigeria’s external debt composition is far from optimal. The actual debt portfolio contains an excess of liabilities denominated in US dollars, British pounds, German marks and French francs. Swiss francs and Japanese yen, by contrast, are substantially underrepresented in the portfolio. Dollar denominated debts become more attractive for Nigeria as oil becomes a more important component of export earnings.

INTRODUCTION

At the end of 1997, Sub Saharan Africa’s debt was about $215 billion, roughly 10 percent of all developing countries (World Bank, Global Development Finance, 1999). This debt was at the center of the crisis in international lending that preoccupied economic policymakers throughout the world. A recent survey by the World Bank revealed that most borrowers in developing countries do not hedge their interest rate or exchange rate exposures. Effective risk management activities require a good knowledge of recently-developed financial products and techniques. Considerable expertise is required in understanding the risk structure of the economy, identifying which instruments are appropriate and making or supervising the transactions. Setting up an appropriate institutional structure to undertake these tasks also requires a thorough understanding of the nature of risks and risk management instruments. Unfortunately, many developing countries lack the expertise for these operations. However, an alternative to these financing techniques and macroeconomic policies to minimize a country’s exposure to exchange rate and commodity price movement is the use of foreign currency composition of the optimal debt portfolio as a hedging instrument first developed by Claessens (1988) then improved by Kroner and Claessens (1991). The principles that should govern these countries' debt
management strategies should be the goals of improving their credit ratings, limiting the impact of volatility in global markets by maintaining an optimal currency composition of the debt. The currency composition of the external debt can be used to minimize exposure to external price risk and thus to diminish the exposure of their budget to external price shocks such as fluctuating exchange rate, interest rate and commodity price.

This paper develops a debt composition strategy that minimizes the effect of exchange rate, commodity price and interest rate fluctuations on the balance of payments of Nigeria. The empirical work (pre-euro era) is based on historical data aimed at extracting useful relationships between the balance of payments and the relevant financial risks of Nigeria. This technique is also applicable to other developing countries since they share a number of common characteristics: heavy dependence on primary commodities exports earnings, significant reliance on outside aid, large debt burdens, poor infrastructure, and low level of education (Husain and Underwood 1991). During most of the 1990s, Nigeria faced fiscal and balance of payments crises because of a serious deterioration in public sector management, especially among public enterprises, inadequate macroeconomic policies and declining domestic savings and crude oil prices. The Nigerian government continued to borrow abroad in order to close the financing gap. Servicing external liabilities became a large drain on Nigeria's resources (See Table 3). The total external debt grew from $9 billion to $33 billion (≈ 4 times increase) between 1980 and 1990.

LITERATURE OVERVIEW

This section reviews the relevant literature on financial risk management and the current approaches to currency denomination of external debt in developing countries. Claessens (2005) reviews the current state of affairs and thinking on external risk management for developing countries. He tries to identify the reasons behind the limited risk management by sovereigns. He argues that limited access to international financial markets arising from low creditworthiness (see also the literature on "original sin", Eichengreen et al. (2003), Hausmann and Panizza (2003) and Chamon and Hausmann (2005)), a limited supply of financial risk management tools, and a poor supply of skills have inhibited risk management in developing countries. The work of Caballero and Cowan (2006), Claessens (2006), and Bordo and Meissner (2006) indicates that although the foreign exchange risk in developing countries is high, the use of derivatives for hedging is limited and other types of hedging are costly (accumulation of foreign exchange reserves; foreign trade diversification). Lessard and Williamson (1985) present a number of financial mechanisms, several of which would represent innovations in the debt literature and have improved the structure of the external borrowing of developing countries. The characteristics of alternative international financial instruments, including commodity-linked bonds extensively discussed by Lessard and Williamson (1985) provide the financial literature with a framework for choosing an optimal external debt portfolio consisting of commodity-linked bonds and conventional debt. Svensson (1987) and Claessens (1988) examines the optimal foreign currency composition of a developing country's portfolio, which includes private net assets, central bank exchange reserves and government foreign debt. Malekpour (1987) and Glaessner (1988) suggest that the decision rules proposed for the currency denomination of external debt of developing countries have been ad-hoc and not related to a specific goal or objective and because "risk" has not been explicitly defined and measured. Both authors conclude that a more integrated approach is necessary.
Many articles report the results of optimal international asset allocation using portfolio choice models similar to the one outlined by Claessens (1988). Examples are the articles by Macedo (1982, 1983, 1984), Adler and Dumas (1983), Jorion (1985), Cholerton, Pieraert and Solnick (1986), Brown, Papell and Rush (1986), Dumas and Jacquier (1987), and Eun and Rosnick (1987). Regression based methods have been in deriving portfolios which minimize the variance of domestic currency export earnings net of external debt service payments. Coleman and Qian (1991) show that Papua New Guinea's debt servicing could benefit substantially from an active assets-liabilities risk management. The authors present a model and estimate of an optimal debt portfolio that allows for the use of commodity-linked bonds and conventional debt denominated in different currencies. They judge the hedging effectiveness of this portfolio by how much the variance of expected real import is reduced. The results indicate that commodity-linked bonds could play an important role in the country's risk management strategy. Claessens (1992) uses percentage change in the six-month LIBOR rates expressed in the local currency as the cost of borrowing in the different currencies. The ordinary least square regression estimates are found to be optimal portfolio weights. The findings of Claessens (1992) do not support the usefulness of currency composition as a perfect hedging instrument and are subject to criticism of the assumptions of ordinary least square regression. Similar technique was also used by Powell (1993) to derive the optimal currency composition for Columbia. Kroner and Claessens (1991) have calculated a sequence of optimal dynamic hedging portfolios for Turkey and Indonesia using a Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) model. Mateus and van Wijnbergen (1996) have developed an integrated approach and given special emphasis to the hedging strategies of monetary authorities to decrease the risk of external trade fluctuations. The model is then applied to the case of Portugal and simulations show that a significant improvement in the net external position of the monetary authorities can be achieved.

Another approach in the finance literature to develop an optimal portfolio is the method of surplus optimization (SO), which is similar to an asset-liability management technique, extensively used in asset allocation decisions of pension's funds. The surplus optimization is a technique that optimizes the net surplus: assets minus liabilities instead of just assets or liabilities only. Leibowitz and Henrikson (1988), Leibowitz (1987), Ezra (1991) and Sharpe and Tint (1990) uses the concept of SO in deriving optimal portfolios for managing a pension fund. Analogous to asset allocation, the application of surplus optimization in external debt management is a relatively new concept in solving sovereign debt problems. Surplus optimization uses the mean variance criterion in optimal allocation of external debt in different currencies. The main focus of the surplus framework is on the net foreign liabilities (liabilities-assets), where the assets could consist of exports and foreign exchange reserves, and the liabilities could be external borrowings and imports. Pradeep (1957) applied the surplus optimization technique to derive the optimal currency composition of external debt for Mexico and Venezuela.

Mellick (2007) reviews current approaches for choosing the currency structure of sovereign debt. Most of the methods dealing with currency allocation of foreign debt are focused on (i) the minimum variance portfolio, (ii) matching the currency structure of foreign exchange reserves, foreign trade or capital flows, or (iii) relying on the promise of the national central bank to maintain a peg against chosen currency. Mellick (2007) also surveys the approaches proposed by Licandro and Masoller (2000) and Giavazzi and Missale (2004) for choosing optimal weights of domestic inflation indexed debt, domestic
nominal debt and foreign currency debt in a sovereign debt portfolio (the benchmark portfolio). These two approaches were recently applied in the cases of Uruguay and Brazil, respectively. The approaches of Licandro and Masoller (2000) and Giavazzi and Missale (2004) differ in several aspects. Licandro and Masoller consider tax smoothing as the government's (debt manager's) objective while Giavazzi and Missale employ stabilization of the debt-to-GDP ratio as the objective function in their setup. However, both approaches emphasize the importance of co-movements of the exchange rate with determinants of government revenues, negative correlation of an exchange rate with government expenditure, and the overall riskiness of a given foreign currency - the exchange rate's variance. Recent empirical examination on foreign currency denominated debt includes the work of Stijn Claessens, Daniela Klingebiel, and Sergio L. Schmukler (2007). Claessens et al. (2007) study the determinants of the size and currency composition of government bond markets for a panel of developed and developing countries. They find that countries with larger economies, greater domestic investor bases and more flexible exchange rate regimes have larger domestic currency bond markets, while smaller economies rely more on foreign currency bonds. Better institutional frameworks and macroeconomic fundamentals enhance both domestic currency bond markets and increase countries' ability to issue foreign currency bonds, while they raise the share of foreign exchange bonds.

Our study complements and enriches previous research both in terms of methodology and data on the currency composition of external debt. The model used here is an extension of past empirical work. We develop a debt composition strategy that minimizes the effect of exchange rate, commodity price and interest rate fluctuations on the balance of payments of Nigeria. The application here differs from previous studies in the sense that, in addition to exchange rate and commodity price risks, the interest rate risk is included in the investigation. Three types of debt composition portfolios are derived (exchange rate portfolio, interest rate portfolio and an average exchange rate and interest rate portfolio). We then compare the estimated portfolios and determine which one is more appropriate for Nigeria in light of the elasticities of its imports, exports and trade balance functions.

MODEL AND FRAMEWORK OF ANALYSIS

Assumptions

These assumptions are drawn on previous work of Krugman and Obstfeld (1994).

1. The government can borrow externally by taking out a conventional loan at a rate of interest i* and/or the government can borrow by issuing bonds at an interest rate r* that mature in one period and require a payment at the beginning of the next period [t+1].

2. The country can improve the risk characteristics of its balance of payments by holding an adequate level of foreign exchange reserves and borrowing in appropriate currency denominations. The currency composition of its external debt is a policy tool (debt composition is endogenous, i.e. derived from the ad hoc model).

3. The agent's problem is to choose a portfolio of bonds b_t, and/or conventional debt d_t, in different currencies such that the balance of payment is stabilized, optimized (in equilibrium) in each period t, that is:

21
\[ \text{BOP} = (\text{Current Account} + \text{Capital Account}) + \Delta \text{International Reserves}, \]
\[ \text{BOP} = 0 \]  

(1)

Furthermore, we assume that Nigeria is only limited to conventional debt therefore no bond financing will be carried out in the statistical implementation e.g. \( b_i = 0 \). (See Table 1)

We also assume that Nigeria holds an adequate level of international reserves.

4. The regressions will be based on historical data (time series) aimed at extracting useful relationships between the balance of payments and risk factors (commodity price risk, exchange rate risk, interest rate risk). The shortcoming with this method is that it doesn't take into account future changes in the country's economic structure that may alter the country's risk exposure profile. The other method proposed in the finance literature is the measurement based on projections or simulation, (Masuoka, 1992).

**Calculating the Optimal Composition of Debt**

The model used in this study to estimate the optimal composition of debt for Nigeria is based on the work of Powell (1993), Kroner and Claessens (1991), and Claessens (1988). One main difference that has to be taken into account is the presence of the three risk characteristics in our model: commodity price, exchange rate risk, and interest rate risk. Furthermore, we allow all the interest rates to be variable over time. The general framework for defining the optimal composition of debt is to use the trade balance or resource balance. The framework allows for different variables to be considered as exogenous or endogenous. [See Claessens (1988)] In this study, commodity sensitivities are exogenous and debt composition is endogenous. [See Powell (1993)]

Consider the trade balance as related to a set of commodity prices and interest rates as follows:

\[ \text{TB} = \lambda_0 + \sum_{i=1}^{e} \lambda_i P_i + \sum_{j=r+1}^{e} \lambda_j P_j \]  

(2)

In natural log:

\[ \log(\text{TB}) = \lambda_0 + \lambda_{oil} \log P_{oil} + \lambda_{com} \log P_{com} + \sum_{j=r+1}^{e} \lambda_j P_j \]  

(3)

In equation (2), TB is the trade balance, \( P_i \) represents the set of commodity prices (\( P_{oil} \) \( P_{com} \)) in the case of Nigeria and, \( P_j \) represents the set of interest rates or exchange rates. The sensitivities of the trade balance to these prices are thus represented by \( \lambda_i \). Although a number of these sensitivities may be exogenous, a number are endogenous. Claessens (1988) considers the case in which commodity quantities (and thus sensitivities) are exogenous, whereas the amount of debt denominated in a particular currency (and hence the sensitivity of the resource to that currency interest rate is endogenous.

This approach can be generalized as follows: Allow the sensitivity of the trade balance or resource balance to parameters (for example, a set of interest rates or exchange rates) to be thought of as endogenous. Let \( P_n \) be the \((1 \times p)\) vector of such parameters and let \( n \) be the \((1 \times p)\) vector of endogenous sensitivities. Further, let there be \( q \) parameters (for example, a set of commodity prices) that can be thought of as exogenous, and let \( P_x \) be the
(1 × q) vector of such parameters and let x be the (1 × q) vector of exogenous sensitivities. Then the trade balance or resource balance may be reformulated as follows:

\[ TB = P_n n' + P_x x' \]  

(4)

The optimal value for n can be obtained by differentiating the expression for the variance of the trade balance or resource balance with respect to the p endogenous variables. This results in p equations in p unknowns, which may be written in matrix form as \( B n = A x \), where \( B \) is the (p × p) variance-covariance matrix of the endogenous variables [that is, \( B = \text{var}(n) \)] and \( A \) is the (p × q) matrix of covariances between n and x [that is, \( A = \text{cov}(n, x) \)]. We can then solve for the optimal set of variables n (e.g., portfolio weight of each currency) as follows:

\[ n = B^{-1} A x \]  

(5)

In the model, commodity sensitivities are exogenous and debt composition is endogenous. Hence, the first problem is to put values on the exogenous sensitivities (λ). The estimates in equation (6), λk (for Nigeria, they are λoil, λcocoa) will become natural candidates for the commodity sensitivities in equation (5) since the oil and the cocoa are the main determinants of Nigeria’s external account.

The ad hoc model of this study consists of two equations given below:

\[
\ln TB_t = \lambda_0 + \lambda_1 \ln cocoa_t + \lambda_2 \ln oil_t + \lambda_3 \ln iUS + \lambda_4 \ln iUK + \lambda_5 \ln iGer + \\
\lambda_6 \ln iFranc + \lambda_7 \ln iJapan + \lambda_8 \ln Swissf + \lambda_9 \ln Xfranc + \lambda_{10} \ln Xpound + \\
\lambda_{11} \ln Xmark + \lambda_{12} \ln Xyen + \lambda_{13} \ln Xdollar + \lambda_{14} \ln XSwissfr + \lambda_{15} D1 + \lambda_{16} D2 + \epsilon_t
\]

\[ n = B^{-1} A x \]  

(6)

DATA AND ESTIMATION TECHNIQUE

The relevant data used in this investigation are primarily from the IMF database (International Financial Statistics, Balance of Payments Statistics), World Bank publication (World Debt Tables), Bank of America (World Information Services Country Risk Monitor). The following data were collected: Nigeria export and import values, cocoa bean price, crude oil price, exchange rates and interest rates for US dollar, German mark, French franc, Japanese yen, Swiss franc, and British pound. All these variables were transformed in natural log or first difference before the estimations were carried out. Data from Nigeria main industrial trading partners (see Table 2), when needed were converted into US dollar or Nigeria naira at the prevailing nominal exchange rates. Quarterly data are used for the countries considered covering the period from the first quarter of 1976 to the last quarter of 2000. The choice of the period of the study from 1976 to 2000 could be explained by two main reasons. First, some of the series in the study were not available before 1976. The second reason is that Nigeria's main European trading partners dissolved their domestic
currency systems in 2000 to join the euro. The trade balance variable is the difference between the exports and imports series. To avoid the negative sign in the log transformation of the trade balance, the export series is divided by the import series (terms of trade) before taking the natural log. Two dummies were created to capture unusual periods in the sample. The dummy variable D1 is used to capture economic, political, and institutional factors that shape Nigeria’s trade balance function after 1980. The dummy variable D2 is used to capture any shift in Nigeria’s trade balance function due to the reform of the exchange rate system and the elimination of prices control as part of the structural adjustment program (SAP) supported by the IMF and the World Bank in 1986. The models were estimated by way of three methods: (1) Ordinary Least Squares (OLS), (2) Generalized Least-Squares Estimation (GLS), and (3) Autoregression (AR).

**Stationarity Diagnostics**

A review of the stationarity tests performed on the trade balance function (Table 4) reveals the presence of unit root (non stationary) in most of the variables tested. An analysis of the cointegration is undertaken to confirm the presence of a long-run equilibrium relationship between the dependent variables and explanatory variables. According to Granger [see Engle and Granger (1987)] and others, the trade balance function can be estimated using standard OLS estimation techniques, if a cointegrating relationship exists between the nonstationary [I(1)]. In the absence of such a relationship Granger found that OLS estimation is inappropriate and could lead to spurious results, given the presence of nonstationary series. Further, first differencing the I(1) time series to achieve stationarity could lose important information. In practical terms, a long-run relationship can be confirmed if the residual term of the undifferenced I(1) process is stationary. After confirming that all the estimated residuals in Table 4 are stationary (presence of no unit root), the estimation is carried out at the level (log form).

**Autocorrelation Diagnostics**

A Durbin Watson value of 1.986 (d ≈2) from the OLS estimation in Table 5 indicates the absence of a serial correlation at the 5 percent level (dL=1.956) in the residuals of the trade balance function.

**Multicollinearity Diagnostics**

Several approaches were used to detect multicollinearity in the regressions such as bivariate correlations, partial correlations, tolerance index, variance inflation factor (VIF), and condition indices (See Table 6). The analysis revealed that the industrial countries currencies form a block with high correlations. Currency composite indexes for Nigeria’s leading trading partners were used in order to correct the multicollinearity problem in the estimation of the trade balance function.
ESTIMATION RESULTS

Summary of Empirical Findings for Nigeria Trade Balance

It was found that the world price of crude is a significant determinant for Nigeria’s trade balance function (see Table 7). More importantly, the oil price has the highest impact on the trade balance function with a magnitude of 1.597 (elastic). This result is consistent with other empirical findings that higher price of oil tends to improve the current account balance for oil exporters due to the inelastic demand for oil, that has a few substitutes (Asheghian, 1995). It was also found that the effect of the price of cocoa was marginally significant but negative. By contrast, the price of cocoa bean, the U.S interest rate, the German interest rate, and the export and import currency composites have no significant effect on Nigeria’s trade balance. The empirical findings also show evidence that the economic policies implemented by the Shagari’s government have caused a significant drop in Nigeria’s trade balance after 1980. The coefficient of the dummy DI used to capture the shift is negative and significant at the one percent level. AR process was found not to be significant, implying that Nigeria trade balance does not depend on the previous period.

CALCULATION OF THE OPTIMAL DEBT COMPOSITION

Determination of Exogenous and Endogenous’ Sensitivities

We consider the trade balance also known as resource balance as related to a set of commodity prices, exchange rates, and interest rates. In our model, commodity sensitivities are exogenous and debt composition is endogenous (for more details, see section on framework of analysis):

Debt Portfolio Weights Calculation

In this section, we compute three types of Debt Portfolio weights, and then we recommend the one that is the most appropriate one for Nigeria given its balance of payments’ risks structure.

DISCUSSION AND EVALUATION OF THE PORTFOLIOS

In this section the portfolios are compared and analyzed. The feasible portfolios in Tables 19, 20, and Table 21 are compared with the actual currency composition in Table 22. We refer to the actual portfolio of Nigeria as the benchmark portfolio. There are several key factors, which define the composition of the portfolio: cost of borrowing and its variance, the correlation between asset and liability, and correlation among liabilities. The hedging portfolios are sensitive to the assumption of the stability of the covariance.
Consequently, the estimates of optimal portfolio shares may change from period to period, if covariance changes over time.

Referring to Table 19, where the hedging interest rate debt portfolio is determined by the covariance matrix of interest rates (endogenous) and prices of oil and cocoa (exogenous) multiplied by the inverse of the covariance matrix among interest rates (endogenous) then multiplied by the vector of elasticities (sensitivities) of prices of oil and cocoa with respect to the trade balance. For Nigeria, the interest rate portfolio consists of 12.4% French franc, 14.4% pound sterling, 11.8% Swiss franc, 27.0% deutsche mark, 4.4% Japanese yen, and 30.0% US dollar as compared to the benchmark portfolio (5.5% French franc, 22.0% pound, 0.0% Swiss franc, 21.5% mark, 6.0% yen, and 45.0% dollar). Interestingly, for Nigeria, dollar denominated debt is more desirable compared to non-dollar liabilities. The actual debt portfolio contains an excess of liabilities denominated in US dollar, pound sterling, and Japanese yen. French francs, Deutsche mark, and Swiss francs, by contrast, are substantially underrepresented in the benchmark portfolio.

Referring to Table 20, where the hedging exchange rate debt portfolio is determined by the covariance matrix of exchange rates (endogenous) and prices of oil and cocoa (exogenous) multiplied by the inverse of the covariance matrix among exchange rates (endogenous) then multiplied by the vector of prices elasticities (sensitivities) of oil and cocoa with respect to the trade balance. For Nigeria, the exchange rate portfolio consists of -6.9% French franc (asset share), 21.8% pound sterling, 31.8% Swiss franc, -9.9% deutsche mark (asset share), 30.2% Japanese yen, and 33.4% US dollar as compared to the benchmark portfolio (5.5% French franc, 22.0% pound, 0.0% Swiss franc, 21.5% mark, 6.0% yen, and 45.0% dollar). The actual debt portfolio contains an excess of liabilities denominated in US dollar, Japanese yen and pound sterling (almost close to optimal). The Swiss franc, by contrast, is substantially underrepresented or non-existent in the benchmark portfolio. On the contrary, the French franc and the Deutsche mark emerge asset shares for Nigeria in the exchange rate portfolio. It is, however, unlikely that a small country like Nigeria will be a lender in financial markets, given its recurrent foreign exchange shortages. The dollar debt is fairly the same in both types of calculated portfolios (interest rate portfolio and exchange rate portfolio). As Table 20 shows, the total proportion of European currencies (French franc and mark) decreases as we move from interest rate debt portfolio to exchange rate debt portfolio. The decrease can largely be explained by the fact that an appreciation of the French franc and German mark against the Nigerian naira implies a higher servicing cost, thus reducing the demand to borrow in these currencies.

Referring to Table 21, where the average hedging of interest rate and exchange rate debt portfolio is determined by the average of the weights of each currency in both the interest rate portfolio and the exchange rate portfolio. The empirical results established that Nigeria faces large exposures to oil price and exchange rate uncertainty and, to a lesser extent, to interest rate movement. Since the hedging portfolio is based on risk minimization, it makes sense to have a balanced debt portfolio that takes into account both the exchange rate risk and interest rate risk. In this regard, the average optimal interest rate and interest rate portfolio is more appropriate in designing a risk hedging portfolio. For Nigeria, the average hedging of interest rate and exchange rate portfolio consists of 2.7% French franc and 8.5% deutsche mark, 8.1% pound sterling, 21.8% Swiss franc, 17.2% Japanese yen, 31.7% US dollar as compared to the benchmark portfolio of 5.5% French franc and 21.5% deutsche mark, 22.0% pound sterling, 0.0% Swiss franc, 6.0% yen, and
45.0% US dollar, respectively. The most striking feature of this portfolio is the heavy weight in the US dollar. This is not surprising because Nigeria’s exports are largely made up of crude oil and primary commodities whose prices are closely related to the US dollar. Therefore, borrowing a large fraction in US dollars should provide a hedge for changes in terms of trade against currency fluctuations. The actual debt portfolio contains an excess of liabilities denominated in US dollar, pound sterling, French francs, Deutsch mark. Swiss franc and Japanese yen by contrast, are substantially underrepresented in the benchmark portfolio.

Referring to Table 22, last column, where the average debt portfolio of public and publicly guaranteed debt portfolio for each currency is determined by the actual weight average for each currency over the period of the study from 1976 to 2000. The data is obtained from the World Bank World Debt Table. As the table shows, the actual debt composition of Nigeria is heavily skewed toward the dollar. The share of the dollar debt has averaged 45.0 percent over the period of the study. The dollar debts have come to be more attractive as oil became a more important component of Nigeria’s export earnings. The sums of the shares of the European currencies (DM, SWF, and FF) for the same period are 27.0 percent. Nigeria began to borrow heavily in European commercial markets, with its total commitments approaching $3 billion during 1978 and 1979. The share of the pound sterling has averaged 22.0 percent. Traditionally, the UK was the main financial provider for Nigeria. In 1970, Britain was Nigeria’s biggest creditor with 61.0 percent of its external debt portfolio. Evidently, the movement in Nigeria’s borrowing portfolio away from British pound to US dollar results in the increased macroeconomic links between Nigeria and the US. Over the same period, only 6.0 percent of Nigeria’s external debt was contracted in Japanese yen. It is worth noting that, after the dollar, the DM and the yen play the most important roles in the foreign exchange market. For instance, in 1992, 38.0% of all foreign exchange transactions have involved the DM. The pound sterling, once second only to the dollar as a key international vehicle currency, has declined in importance. Over the same period, its share in world foreign exchange trading was just 14.0%.

CONCLUSION AND POLICY IMPLICATIONS

The empirical results establish that Nigeria faces large exposures to oil price and exchange rate uncertainty and, to a lesser extent, to interest rate movement. Since the hedging portfolio is based on risk minimization, it makes sense to have a balanced debt portfolio that takes into account of both the exchange rate risk and interest rate risk. In this regard, the hedging based on average interest rate and interest rate portfolio (Table 21) is more appropriate for Nigeria in designing a risk hedging portfolio. Nigeria’s optimal average interest rate and exchange rate portfolio consists of 2.7% French franc and 8.5% deutsche mark, 18.1% pound sterling, 21.8% Swiss franc, 17.2% Japanese yen, and 31.7% US dollar as compared to the actual benchmark portfolio (5.5% French franc, 22.0% pound, 0.0% Swiss franc, 21.50% mark, 6.0% yen, and 45.0% dollar). The most striking feature of this portfolio is the heavy weight in the US dollar. This is not surprising because Nigeria’s exports are largely made up of crude oil and primary commodities whose prices are closely related to the US dollar. Therefore, borrowing a large fraction in US dollars should provide a hedge for changes in terms of trade against currency fluctuations.
Given the substantial difference between the hedging portfolio (calculated in Table 21) and the actual (benchmark) portfolio (Table 22), it would seem that the actual portfolio should result in a dramatic improvement in Nigeria's ability to hedge themselves against price risks. The analysis indicates that Nigeria's external debt composition is far from efficient or optimal. The model (Table 21) shows that Nigeria's external debt structure is not well balanced to hedge the foreign exchange and interest rate risks effectively. The actual debt portfolio (Table 22) contains an excess of liabilities denominated in US dollars, British pounds, German marks and French francs. The Japanese yen, by contrast, is substantially underrepresented in the portfolio. In addition, Nigeria needs to significantly improve the weight of the Swiss franc in its debt composition for effective hedging. The actual pound sterling share does not differ much from the optimal composition.

In the case of Nigeria and other oil producer developing countries, a risk adverse economic agent, dollar liabilities do appear to have good risk-sharing characteristics. Dollar denominated debts become more attractive and desirable only as petroleum becomes a more important component of export earnings. However, all these results should be treated with caution. In particular, the covariances that are estimated may be unstable over time. Also, conducting the analysis over different time period might give different results. In addition, the costs of rebalancing and the stability of the portfolio will determine an optimal “average” portfolio. The initial level of total external debt is not derived from the model. The model determines only the amounts or share of currencies to be borrowed in each period. Similar analyses can be conducted to find portfolios that hedge against changes in export prices, export values, import prices, and import values covering the period after the introduction of the euro. The strong policy implication of this finding is that Nigeria and other sub Saharan Africa oil producers should attempt to link their debt-servicing payments to the outcome of oil prices in order to stabilize their balances of payments. In addition to currency diversification, these countries should also try to broaden the base of their exports as well as their trading partners.
REFERENCES


Table 1 Debt stock and its components

By Debt
- Private Non Guaranteed Debt
- Public and Publicly Guaranteed Debt

By Creditor
- Official Creditors
  - Multilateral
  - Bilateral
- Private Creditors
  - Commercial Banks
  - Bonds
  - Other

Source: World Debt Table (The World Bank)
<table>
<thead>
<tr>
<th>Destination</th>
<th>1995</th>
<th>2000</th>
<th>2001</th>
</tr>
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<tbody>
<tr>
<td>Spain</td>
<td>1,035</td>
<td>2,189</td>
<td>1,747</td>
</tr>
<tr>
<td>France</td>
<td>734</td>
<td>1,055</td>
<td>1,073</td>
</tr>
<tr>
<td>Germany</td>
<td>626</td>
<td>463</td>
<td>627</td>
</tr>
<tr>
<td>Portugal</td>
<td>418</td>
<td>727</td>
<td>657</td>
</tr>
<tr>
<td>Subtotal (EMS Countries)</td>
<td>2,813 (38%)</td>
<td>4,434 (32%)</td>
<td>4,104 (33%)</td>
</tr>
<tr>
<td>United States</td>
<td>4,595 (62%)</td>
<td>9,409 (68%)</td>
<td>8,345 (67%)</td>
</tr>
<tr>
<td>Total (US &amp; EMS countries)</td>
<td>7,408 (100%)</td>
<td>13,843 (100%)</td>
<td>12,449 (100%)</td>
</tr>
</tbody>
</table>

Nigeria Imports (in millions of US $)

<table>
<thead>
<tr>
<th>Origin</th>
<th>1995</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>631</td>
<td>635</td>
<td>971</td>
</tr>
<tr>
<td>France</td>
<td>461</td>
<td>746</td>
<td>832</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>749</td>
<td>881</td>
<td>1,082</td>
</tr>
<tr>
<td>Subtotal (EMS Countries)</td>
<td>1,841 (68%)</td>
<td>2,262 (67%)</td>
<td>2,885 (65%)</td>
</tr>
<tr>
<td>United States</td>
<td>662 (25%)</td>
<td>789 (23%)</td>
<td>1,053 (24%)</td>
</tr>
<tr>
<td>Japan</td>
<td>193 (7%)</td>
<td>318 (10%)</td>
<td>487 (11%)</td>
</tr>
<tr>
<td>Total (US &amp; Japan &amp; EMS countries)</td>
<td>2,696 (100%)</td>
<td>3,369 (100%)</td>
<td>4,425 (100%)</td>
</tr>
</tbody>
</table>

Data Source: IMF, Direction of Trade Statistics
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</tr>
</thead>
<tbody>
<tr>
<td>Debt Service to Export Ratio</td>
<td>75.3</td>
<td>71.8</td>
<td>74.3</td>
<td>49.5</td>
<td>57.2</td>
<td>61.6</td>
<td>70.4</td>
<td>76.1</td>
<td>81.9</td>
<td>58.7</td>
<td>77.6</td>
</tr>
<tr>
<td>External Debt to Export Ratio</td>
<td>258.4</td>
<td>244.6</td>
<td>263.9</td>
<td>381.1</td>
<td>409.6</td>
<td>474.0</td>
<td>541.5</td>
<td>585.8</td>
<td>629.8</td>
<td>402.3</td>
<td>282.3</td>
</tr>
<tr>
<td>External Debt to GDP Ratio</td>
<td>118.5</td>
<td>120.8</td>
<td>98.8</td>
<td>75.2</td>
<td>77.6</td>
<td>88.9</td>
<td>101.3</td>
<td>114.7</td>
<td>128.5</td>
<td>103.1</td>
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<tr>
<td>External Debt to International Reserves Assets (with gold) Ratio</td>
<td>734.6</td>
<td>2,650</td>
<td>2,056</td>
<td>2,600</td>
<td>2,770</td>
<td>2,366</td>
<td>1,807</td>
<td>1,607</td>
<td>1,449</td>
<td>1,888</td>
<td>2,283</td>
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<tr>
<td>International Reserve Assets (with gold) to Import Ratio</td>
<td>36.5</td>
<td>10.4</td>
<td>13.3</td>
<td>9.9</td>
<td>9.4</td>
<td>12.0</td>
<td>17.1</td>
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<td>23.8</td>
<td>19.4</td>
<td>29.6</td>
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<td>Months of Imports covered by existing International Reserve assets (with gold)</td>
<td>4.4</td>
<td>1.3</td>
<td>1.6</td>
<td>1.2</td>
<td>1.1</td>
<td>1.4</td>
<td>2.0</td>
<td>2.4</td>
<td>2.9</td>
<td>2.3</td>
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<td>Exports to GDP Ratio</td>
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<td>49.4</td>
<td>37.5</td>
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<td>18.9</td>
<td>18.8</td>
<td>18.7</td>
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<td>20.4</td>
<td>29.4</td>
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<td>Current Account Balance to GDP Ratio</td>
<td>4.1</td>
<td>8.6</td>
<td>0.9</td>
<td>-10.2</td>
<td>-11.4</td>
<td>-12.5</td>
<td>-14.0</td>
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<td>-5.1</td>
<td>-2.1</td>
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<tr>
<td>Government Budget Balance to GDP Ratio</td>
<td>-3.0</td>
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<td>-11.5</td>
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<td>-10.5</td>
<td>-8.5</td>
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<td>-6.0</td>
<td>-5.0</td>
<td>-7.8</td>
<td>-4.2</td>
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<tr>
<td>Country Per Capita GDP to G7 per Capita GDP Ratio</td>
<td>1.2</td>
<td>1.0</td>
<td>1.3</td>
<td>1.8</td>
<td>2.0</td>
<td>1.9</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
<td>1.6</td>
<td>37.1</td>
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Source of Data: Bank of America
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<th>Variables</th>
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<th>Unit Root I(1)</th>
<th>First Difference</th>
<th>Unit Root I(0)</th>
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<td>Trade Balance: InTB</td>
<td>-3.913***</td>
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<td>Price of Cocoa: Incocoa</td>
<td>-1.8851</td>
<td>YES</td>
<td>-5.196*</td>
<td>NO</td>
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<tr>
<td>Price of Crude Oil: Inpoil</td>
<td>-3.156**</td>
<td>NO</td>
<td>-7.604*</td>
<td>NO</td>
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<tr>
<td>US Lending Rate: IniUS</td>
<td>-2.089</td>
<td>YES</td>
<td>-2.593***</td>
<td>NO</td>
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<td>UK Lending Rate: IniUK</td>
<td>-0.031</td>
<td>YES</td>
<td>-4.841*</td>
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<td>German Lending Rate: IniGer</td>
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<td>YES</td>
<td>-4.845*</td>
<td>NO</td>
</tr>
<tr>
<td>France Lending Rate: IniFranc</td>
<td>-0.743</td>
<td>YES</td>
<td>-4.406*</td>
<td>NO</td>
</tr>
<tr>
<td>Japan Lending Rate: IniJapan</td>
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<td>-3.156**</td>
<td>NO</td>
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<tr>
<td>Japan Lending Rate: IniSwissf</td>
<td>-0.694</td>
<td>YES</td>
<td>-3.765*</td>
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<td>Naira per French Franc: Inenaira_frc</td>
<td>-0.563</td>
<td>YES</td>
<td>-7.083*</td>
<td>NO</td>
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<tr>
<td>Naira per Pound:</td>
<td>-0.348</td>
<td>YES</td>
<td>-8.898*</td>
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<tr>
<td>Naira per Deutschmark:</td>
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<td>YES</td>
<td>-7.571*</td>
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<tr>
<td>Naira per Yen: Inenaira_yen</td>
<td>-0.192</td>
<td>YES</td>
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<td>NO</td>
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<tr>
<td>Naira per Dollar:</td>
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<td>YES</td>
<td>-9.982*</td>
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<tr>
<td>Naira per Dollar:</td>
<td>-0.802</td>
<td>YES</td>
<td>-6.837*</td>
<td>NO</td>
</tr>
<tr>
<td>Trade Balance Residuals</td>
<td>7.319***</td>
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<td></td>
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</table>

Critical values: ***significant at the 1% level = -3.497, ** at the 5% level = -2.891, * at the 10% level = -2.582

Incococa (Natural log of cocoa price), Inpoil (Natural log of oil price), IniUS (Natural log of US interest rate), IniUK (Natural log of UK interest rate), IniGer (Natural log of German interest rate), IniFranc (Natural log of French interest rate), IniJapan (Natural log of Japan interest rate), IniSwissfr (Natural log of Swiss interest rate), InXFranc (Natural log of French franc exchange rate), InXPound (Natural log of pound exchange rate), InXMark (Natural log of mark exchange rate), InXyen (Natural log of yen exchange rate), InXdollar (Natural log of dollar exchange rate), InXSwissfr (Natural log of Swiss franc exchange rate)

$Y_t = \beta Y_{t-1};$  $\text{Ho: } \beta = 1$ or $\text{Ha: } \beta \neq 1$

I(1) $\rightarrow$ integrated One;  I(0) $\rightarrow$ integrated Zero

If T-test statistic < Critical value $\rightarrow$ accept Ho ($\beta = 1$) $\rightarrow$ Unit Roots; I (1) $\rightarrow$ there is a trend

If T-test statistic > Critical value $\rightarrow$ reject Ho ($\beta \neq 1$) $\rightarrow$ No Unit Root; I (0) $\rightarrow$ no trend
Table 5 Autocorrelation diagnostics for the Trade Balance Function, 1976q1-2000q4.
\[
\ln TB_t = \lambda_0 + \lambda_1 \ln \text{cocoa}_t + \lambda_2 \ln \text{oil}_t + \lambda_3 \ln \text{iUS}_t + \lambda_4 \ln \text{iUK}_t + \lambda_5 \ln \text{iGer}_t + \lambda_6 \ln \text{iFrance}_t + \lambda_7 \ln \text{iJapan}_t + \lambda_8 \ln \text{iSwissfr}_t + \lambda_9 \ln \text{iXfranc}_t + \lambda_{10} \ln \text{iXpound}_t + \lambda_{11} \ln \text{iXmark}_t + \lambda_{12} \ln \text{iXyen}_t + \lambda_{13} \ln \text{iXdollar}_t + \lambda_{14} \ln \text{iXSwissfr}_t + \lambda_{15} \ln \text{D1} + \lambda_{16} \ln \text{D2} + \epsilon_t
\]

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>13.337**</td>
<td>6.621</td>
<td>2.014</td>
</tr>
<tr>
<td>ln cocoa</td>
<td>-0.717***</td>
<td>0.536</td>
<td>-1.337</td>
</tr>
<tr>
<td>ln oil</td>
<td>1.938*</td>
<td>0.392</td>
<td>4.943</td>
</tr>
<tr>
<td>ln US</td>
<td>-0.134</td>
<td>0.627</td>
<td>-0.213</td>
</tr>
<tr>
<td>ln UK</td>
<td>0.907</td>
<td>1.113</td>
<td>0.814</td>
</tr>
<tr>
<td>ln Ger</td>
<td>-1.08</td>
<td>1.172</td>
<td>-0.921</td>
</tr>
<tr>
<td>ln Franc</td>
<td>-2.308**</td>
<td>1.247</td>
<td>-1.850</td>
</tr>
<tr>
<td>ln Japan</td>
<td>-0.386</td>
<td>0.912</td>
<td>-0.423</td>
</tr>
<tr>
<td>ln Swissfr</td>
<td>1.909***</td>
<td>1.313</td>
<td>1.453</td>
</tr>
<tr>
<td>ln XFranc</td>
<td>-0.545</td>
<td>1.299</td>
<td>-0.419</td>
</tr>
<tr>
<td>ln Xpound</td>
<td>-1.334</td>
<td>1.088</td>
<td>-1.226</td>
</tr>
<tr>
<td>ln Xmark</td>
<td>-0.162</td>
<td>1.314</td>
<td>-0.123</td>
</tr>
<tr>
<td>ln Xyen</td>
<td>0.879</td>
<td>0.976</td>
<td>0.900</td>
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<tr>
<td>ln Xdollar</td>
<td>-0.0512</td>
<td>1.153</td>
<td>-0.072</td>
</tr>
<tr>
<td>ln XSwissfr</td>
<td>0.692</td>
<td>1.165</td>
<td>0.593</td>
</tr>
<tr>
<td>d80</td>
<td>-0.825***</td>
<td>0.544</td>
<td>-1.516</td>
</tr>
<tr>
<td>D86</td>
<td>0.476</td>
<td>0.583</td>
<td>0.816</td>
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</table>

# observations 104
R Square 0.460
SE estimate 0.654
Durbin-Watson 1.986
F-statistic (df1=16; df88) 4.634

Critical Values: (1.282 at 10%); (1.645 at 5%); and (2.326 at 1%)
Significance: *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level

In cocoa (Natural log of cocoa price), ln oil (Natural log of oil price), ln US (Natural log of US interest rate), ln UK (Natural log of UK interest rate), ln Ger (Natural log of German interest rate), ln Franc (Natural log of French interest rate), ln Japan (Natural log of Japan interest rate), ln Swissfr (Natural log of Swiss interest rate), ln Xfranc (Natural log of French franc exchange rate), ln Xpound (Natural log of pound exchange rate), ln Xmark (Natural log of mark exchange rate), ln Xyen (Natural log of yen exchange rate), ln Xdollar (Natural log of dollar exchange rate), ln XSwissfr (Natural log of Swiss franc exchange rate). d80 (Break 1980), d86 (Break 1986)
Table 6 Multicollinearity diagnostics for the variables in the Trade Balance Function, 1976q1-2000q4.

\[
\ln TB_t = \lambda_0 + \lambda_1 \ln cacao_t + \lambda_2 \ln oil_t + \lambda_3 \ln US_t + \lambda_4 \ln UK_t + \lambda_5 \ln Ger_t + \lambda_6 \ln Franc_t + \lambda_7 \ln Yen_t + \lambda_8 \ln Swiss_t + \lambda_9 \ln Xfranc_t + \lambda_{10} \ln Xpound_t + \lambda_{11} \ln Xmark_t + \lambda_{12} \ln Xyen_t + \lambda_{13} \ln Xdollar_t + \lambda_{14} \ln XSwiss_t + \lambda_{15} D1 + \lambda_{16} D2 + \varepsilon_t
\]

<table>
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<tr>
<th>OLS</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Tolerance</th>
<th>VIF</th>
<th>Condition Index</th>
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</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>13.337**</td>
<td>6.621</td>
<td>2.014</td>
<td>0.096</td>
<td>10.459</td>
<td>1.000</td>
</tr>
<tr>
<td>Ln coco</td>
<td>-0.717*</td>
<td>0.536</td>
<td>-1.337</td>
<td>0.096</td>
<td>10.459</td>
<td>1.665</td>
</tr>
<tr>
<td>Ln oil</td>
<td>1.938***</td>
<td>0.392</td>
<td>4.943</td>
<td>0.230</td>
<td>4.341</td>
<td>10.347</td>
</tr>
<tr>
<td>Ln iUS</td>
<td>-0.134</td>
<td>0.627</td>
<td>-0.213</td>
<td>0.128</td>
<td>7.809</td>
<td>11.249</td>
</tr>
<tr>
<td>Ln iUK</td>
<td>0.907</td>
<td>1.113</td>
<td>0.814</td>
<td>0.029</td>
<td>34.093</td>
<td>21.377</td>
</tr>
<tr>
<td>Ln iGer</td>
<td>-1.08</td>
<td>1.172</td>
<td>-0.921</td>
<td>0.054</td>
<td>18.458</td>
<td>23.417</td>
</tr>
<tr>
<td>Ln iFranc</td>
<td>-2.308*</td>
<td>1.247</td>
<td>-1.850</td>
<td>0.048</td>
<td>20.872</td>
<td>34.789</td>
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<tr>
<td>Ln iYen</td>
<td>-0.386</td>
<td>0.912</td>
<td>-0.423</td>
<td>0.022</td>
<td>45.580</td>
<td>63.143</td>
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<td>Ln iSwiss</td>
<td>1.909</td>
<td>1.313</td>
<td>1.453</td>
<td>0.048</td>
<td>20.667</td>
<td>68.212</td>
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<td>Ln iFranc</td>
<td>-0.545</td>
<td>1.299</td>
<td>-0.419</td>
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<td>1065.996</td>
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<td>Ln iPound</td>
<td>-1.334</td>
<td>1.088</td>
<td>-1.226</td>
<td>0.001</td>
<td>999.289</td>
<td>114.520</td>
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<td>Ln iMark</td>
<td>-0.162</td>
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<td>-0.123</td>
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<tr>
<td>Ln iyen</td>
<td>0.879</td>
<td>0.976</td>
<td>0.900</td>
<td>0.001</td>
<td>1047.647</td>
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<td>Ln iDollar</td>
<td>-0.0512</td>
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<td>Ln iSwiss</td>
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<td>269.668</td>
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<td>-1.516</td>
<td>0.107</td>
<td>9.379</td>
<td>282.281</td>
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</table>

Critical Values: (1.282 at 10%); (1.645 at 5%); and (2.326 at 1%)

Significance: *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level

In cacao (Natural log of cocoa price), ln oil (Natural log of oil price), ln iUS (Natural log of US interest rate),
ln iUK (Natural log of UK interest rate), ln iGer (Natural log of German interest rate), ln iFranc (Natural log of French interest rate),
ln iYen (Natural log of Japan interest rate), ln iSwiss (Natural log of Swiss interest rate),
ln iXfranc (Natural log of French franc exchange rate), ln iXpound (Natural log of pound exchange rate),
in iXmark (Natural log of mark exchange rate), ln iXyen (Natural log of yen exchange rate), ln iXdollar (Natural log of dollar exchange rate),
in iXSwiss (Natural log of Swiss franc exchange rate, D80 (Break 1980)
Table 7 Estimates of the Trade Balance Original Model Corrected for Multicollinearity, 1976q1-2000q4.

\[
\ln TB_t = \lambda_0 + \lambda_1 \ln coca_o + \lambda_2 \ln poil_t + \lambda_3 \ln iUS_t + \lambda_4 \ln iGer_t + \lambda_5 \ln XXbasket + \lambda_6 \\
\ln MXbasket + \lambda_7 D1 + \epsilon_t
\]

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variable: lnTradebalance: inexport-lnimport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>7.216** (1.864)</td>
</tr>
<tr>
<td>Price of Crude Oil: ln poil</td>
<td>1.597*** (4.524)</td>
</tr>
<tr>
<td>Price of Cocoa: ln cocoa</td>
<td>-0.062* (-1.389)</td>
</tr>
<tr>
<td>Exchange Rate: ln XXbasket</td>
<td>0.056 (0.861)</td>
</tr>
<tr>
<td>Exchange Rate: ln MXbasket</td>
<td>0.109 (0.937)</td>
</tr>
<tr>
<td>US Lending Rate: ln iUS</td>
<td>0.102 (0.254)</td>
</tr>
<tr>
<td>German Lending Rate: ln iGer</td>
<td>-0.343 (-0.604)</td>
</tr>
<tr>
<td>D1-Break-80</td>
<td>-0.739*** (-2.391)</td>
</tr>
<tr>
<td>Number of observations</td>
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<td>Adjusted R-squared</td>
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<td>Std. Error of the Estimate</td>
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<tr>
<td>Durbin-Watson (DW)</td>
<td>1.970</td>
</tr>
<tr>
<td>F-statistic (Df1=7; df2=92)</td>
<td>7.644***</td>
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</table>

*t-statistics are in parentheses

**Critical Values:** (1.282 at 10%); (1.645 at 5%); and (2.326 at 1%)

**Significance:** *Significant at the 10% level, **significant at the 5% level, ***significant at 1%

lnCocoa (Natural log of cocoa price), lnpoil (Natural log of oil price), lnUS (Natural log of US interest rate), lnGer (Natural log of German interest rate), lnXXbasket (Natural log of export exchange rate composite), lnXXbasket (Natural log of export exchange rate composite, D1 = -1 for period > 1980; otherwise, 0)
Table 8 Covariance matrix among endogenous variables (interest rates)

<table>
<thead>
<tr>
<th>B</th>
<th>lniswf</th>
<th>lnius</th>
<th>lnifran</th>
<th>lnirk</th>
<th>lniger</th>
<th>lniyen</th>
</tr>
</thead>
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<td>lniswf</td>
<td>1.078</td>
<td>0.084</td>
<td>0.323</td>
<td>-0.242</td>
<td>-0.798</td>
<td>-0.319</td>
</tr>
<tr>
<td>lnius</td>
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<td>0.377</td>
<td>-0.254</td>
<td>-0.013</td>
<td>-0.346</td>
<td>0.33</td>
</tr>
<tr>
<td>lnifran</td>
<td>0.323</td>
<td>-0.254</td>
<td>1.781</td>
<td>-0.144</td>
<td>-0.272</td>
<td>-0.776</td>
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<tr>
<td>lnirk</td>
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<td>0.01</td>
</tr>
<tr>
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<td>-0.346</td>
<td>-0.272</td>
<td>-0.445</td>
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<td>-0.212</td>
</tr>
<tr>
<td>lniyen</td>
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<td>0.33</td>
<td>-0.776</td>
<td>0.01</td>
<td>-0.212</td>
<td>0.813</td>
</tr>
</tbody>
</table>

Table 9 Covariance between endogenous (interest rates) & exogenous (prices of oil and cocoa)

<table>
<thead>
<tr>
<th>A</th>
<th>lncocona</th>
<th>lnpoil</th>
</tr>
</thead>
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<tr>
<td>lnisw</td>
<td>0.061</td>
<td>0.09</td>
</tr>
<tr>
<td>lnius</td>
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<td>-0.013</td>
</tr>
<tr>
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<td>-0.066</td>
</tr>
<tr>
<td>lnirk</td>
<td>-0.098</td>
<td>-0.015</td>
</tr>
<tr>
<td>lniger</td>
<td>0.138</td>
<td>-0.244</td>
</tr>
<tr>
<td>lniyen</td>
<td>0.036</td>
<td>0.068</td>
</tr>
</tbody>
</table>

Table 10 Elasticities, $\lambda_{\text{cocoa}}^{*}$ and $\lambda_{\text{oil}}^{*}$

<table>
<thead>
<tr>
<th>x</th>
<th>$\lambda_{\text{cocoa}}^{*}$</th>
<th>$\lambda_{\text{oil}}^{*}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>lncoona</td>
<td>-0.062</td>
<td></td>
</tr>
<tr>
<td>lnpoil</td>
<td>1.597</td>
<td></td>
</tr>
</tbody>
</table>
### Table 11  \( n = B^{-1}A^*x \) = un-scaled portfolio weights

| \( \lambda_{iswf} \) | -0.22984 |
| \( \lambda_{ius} \)  | -0.58525 |
| \( \lambda_{ifranc} \) | -0.24108 |
| \( \lambda_{iuk} \)  | -0.2805  |
| \( \lambda_{iger} \)  | -0.52578 |
| \( \lambda_{iyen} \)  | -0.08556 |
| **Total**             | -1.94801 |

### Table 12  \( \omega \) = scaled portfolio weights, where \( \omega_{ifr} + \omega_{is} + \omega_{if} + \omega_{iuk} + \omega_{ider} + \omega_{if} = 1 \)

| \( \omega_{iswf} \) | 11.8% |
| \( \omega_{ius} \)  | 30.0% |
| \( \omega_{ifranc} \) | 12.4% |
| \( \omega_{iuk} \)  | 14.4% |
| \( \omega_{iger} \)  | 27.0% |
| \( \omega_{iyen} \)  | 4.4%  |
| **Total**             | 100%  |
### Table 13 Covariance matrix among endogenous variables (exchange rates)

<table>
<thead>
<tr>
<th></th>
<th>lnXFr</th>
<th>lnXuk</th>
<th>lnXsf</th>
<th>lnXgm</th>
<th>lnXyen</th>
<th>lnXus</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnXFr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnXuk</td>
<td>1.926</td>
<td>1.097</td>
<td>0.544</td>
<td>-1.868</td>
<td>0.193</td>
<td>-2.012</td>
</tr>
<tr>
<td>lnXsf</td>
<td>1.097</td>
<td>1.421</td>
<td>0.792</td>
<td>-1.105</td>
<td>-0.144</td>
<td>-2.097</td>
</tr>
<tr>
<td>lnXgm</td>
<td>0.544</td>
<td>0.792</td>
<td>1.131</td>
<td>-0.679</td>
<td>-0.483</td>
<td>-1.372</td>
</tr>
<tr>
<td>lnXyen</td>
<td>-1.868</td>
<td>-1.105</td>
<td>-0.679</td>
<td>1.937</td>
<td>-0.213</td>
<td>2.091</td>
</tr>
<tr>
<td>lnXus</td>
<td>-2.012</td>
<td>-2.097</td>
<td>-1.372</td>
<td>2.091</td>
<td>-0.24</td>
<td>3.909</td>
</tr>
</tbody>
</table>

### Table 14 Covariance between endogenous (exchange rates) & exogenous (prices of oil and cocoa)

<table>
<thead>
<tr>
<th></th>
<th>cocoa</th>
<th>oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnXFr</td>
<td>0.076</td>
<td>0.135</td>
</tr>
<tr>
<td>lnXuk</td>
<td>0.028</td>
<td>0.134</td>
</tr>
<tr>
<td>lnXsf</td>
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<td>0.04</td>
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<td>lnXgm</td>
<td>-0.097</td>
<td>-0.105</td>
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<tr>
<td>lnXyen</td>
<td>-0.002</td>
<td>0.018</td>
</tr>
<tr>
<td>lnXus</td>
<td>0.034</td>
<td>-0.241</td>
</tr>
</tbody>
</table>

### Table 15 Elasticities, $\lambda_{\text{cocoa}}^{\ast}$ and $\lambda_{\text{oil}}^{\ast}$

<table>
<thead>
<tr>
<th></th>
<th>ln coco</th>
<th>ln oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln coco</td>
<td>-0.062</td>
<td></td>
</tr>
<tr>
<td>ln oil</td>
<td>1.597</td>
<td></td>
</tr>
<tr>
<td>Table 16</td>
<td>$n = B^TA^x = \text{un-scaled portfolio weights}$</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{XFr}$</td>
<td>0.096844</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{Xuk}$</td>
<td>-0.30858</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{Xsf}$</td>
<td>-0.44582</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{Xgm}$</td>
<td>0.140968</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{Xyen}$</td>
<td>-0.42864</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{Xus}$</td>
<td>-0.47289</td>
<td></td>
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<tr>
<td>Total</td>
<td>-1.41812</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 17</th>
<th>$\omega = \text{scaled portfolio weights, where } \omega_{distinct} + \omega_{SF} + \omega_{MN} + \omega_{OIF} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Omega_{XFr}$</td>
<td>-6.9%</td>
</tr>
<tr>
<td>$\Omega_{Xuk}$</td>
<td>21.8%</td>
</tr>
<tr>
<td>$\Omega_{Xsf}$</td>
<td>31.4%</td>
</tr>
<tr>
<td>$\Omega_{Xgm}$</td>
<td>-9.9%</td>
</tr>
<tr>
<td>$\Omega_{Xyen}$</td>
<td>30.2%</td>
</tr>
<tr>
<td>$\Omega_{Xus}$</td>
<td>33.4%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table 18  (Average Optimal Interest rate and Exchange Rate Debt Portfolio (%))

<table>
<thead>
<tr>
<th>Currency</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>£xuk</td>
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</tr>
<tr>
<td>£xsf</td>
<td>21.8</td>
</tr>
<tr>
<td>£xem</td>
<td>8.5</td>
</tr>
<tr>
<td>£xyen</td>
<td>17.2</td>
</tr>
<tr>
<td>£xus</td>
<td>31.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 19  Optimal Interest Rate Debt Portfolio (%)

<table>
<thead>
<tr>
<th>Currency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Franc</td>
<td>12.4</td>
</tr>
<tr>
<td>Pound Sterling</td>
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</tr>
<tr>
<td>Swiss Franc</td>
<td>11.8</td>
</tr>
<tr>
<td>Deutsche Mark</td>
<td>27.0</td>
</tr>
<tr>
<td>Japanese Yen</td>
<td>4.4</td>
</tr>
<tr>
<td>U.S. Dollars</td>
<td>30.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
<tr>
<td>Table 20 Optimal Exchange Rate Debt Portfolio (%)</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>French Franc</td>
<td>-6.9</td>
</tr>
<tr>
<td>Pound Sterling</td>
<td>21.8</td>
</tr>
<tr>
<td>Swiss Franc</td>
<td>31.8</td>
</tr>
<tr>
<td>Deutsche Mark</td>
<td>-9.9</td>
</tr>
<tr>
<td>Japanese Yen</td>
<td>30.2</td>
</tr>
<tr>
<td>U.S. Dollars</td>
<td>33.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 21 Average Optimal Interest rate and Exchange Rate Debt Portfolio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Franc</td>
</tr>
<tr>
<td>Pound Sterling</td>
</tr>
<tr>
<td>Swiss Franc</td>
</tr>
<tr>
<td>Deutsche Mark</td>
</tr>
<tr>
<td>Japanese Yen</td>
</tr>
<tr>
<td>U.S. Dollars</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>
Table 22 Actual Currency Composition of Long-Term Debt of Nigeria (%)
The actual currency composition is calculated from the World Debt Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>French Franc</td>
<td>0.0</td>
<td>1.0</td>
<td>11.0</td>
<td>14.0</td>
<td>1.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Pound Sterling</td>
<td>61.0</td>
<td>3.5</td>
<td>14.0</td>
<td>13.0</td>
<td>1.5</td>
<td>22.0</td>
</tr>
<tr>
<td>Swiss Franc</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Deutsche Mark</td>
<td>18.0</td>
<td>28.0</td>
<td>18.0</td>
<td>18.0</td>
<td>1.0</td>
<td>21.5</td>
</tr>
<tr>
<td>Japanese Yen</td>
<td>1.0</td>
<td>2.5</td>
<td>10.0</td>
<td>16.0</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>U.S. Dollars</td>
<td>20.0</td>
<td>65.0</td>
<td>47.0</td>
<td>38.0</td>
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<td>45.0</td>
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<td>Total</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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</tr>
</tbody>
</table>
WHAT DISTINGUISHES WINNERS FROM LOSERS: AN ANALYSIS OF SCHOOL CHOICE IN MASSACHUSETTS

Soma Ghosh
Albright College

ABSTRACT

The school choice program in Massachusetts instituted in 1991 gave parents the right to enroll their child at public schools outside their home district. Districts have to compete with each other to help retain as well as attract more students in this program. Therefore, the open enrollment policy creates winners (districts gaining more students than they lose) and losers (districts losing more students than they gain) in the education market place. This paper examines what characteristics distinguish winners from losers. An insight into the characteristics of winners and losers is crucial in assessing the value of open enrollment as a strategy that improves educational quality and for implementing future incentives. The results suggest that a given district's probability of winning depends not only on its own characteristics but also on the characteristics of neighboring districts.

INTRODUCTION

The debate over school choice has long been the hottest item on the American education-reform agenda with more than forty-six states currently having some form of public-school choice (Open Enrollment: 50-State Report, Education Commission of the States, 2010). School choice reforms depend on the idea that the ability to choose among schools will lead to stronger sorting, promote competition, increase accountability, and thereby improve the quality of public education in the United States.

Education is a form of social capital that includes not only the knowledge and skills learned in school but also the socioeconomic status of the students who attend a particular school (Cookson, 1992). If most parents change schools in search of better academic quality then poorly performing school districts would be forced to improve their quality in fear of losing students and funding to their neighbors. If socioeconomic status of a district is an important criterion for parents who participate in choice or if most families change districts merely for reasons of convenience or other non-academic factors, then school officials can do little to make their schools more attractive in a competitive market. Consequently, this could lower pressure on schools to enhance performance, thereby negating one of the main goals of choice programs.
Massachusetts was among the pioneer states that instituted the inter-district school choice law. Shortly after taking office in 1991, the Republican governor of Massachusetts, William F. Weld, signed into law the open enrollment policy giving parents the right to enroll their child at public schools outside their home district. Open enrollment is a voluntary program in which school committees are required to vote yearly (and report the result to the Massachusetts Department of Education by end of June) on whether to accept choice students from other districts and, if so, in what grades. Further, the decision of whether or not to participate is not a permanent one but can be adjusted for each commencing school year. Districts can designate a maximum number of school choice seats for an upcoming year but cannot apply any criteria to select students and cannot prevent transfers out. Therefore, school districts no longer have the assurance of a fixed supply of students and funding, instead they have to compete with other districts and enact strategies that will help retain as well as attract more students. In this competition, some districts are more successful than others in attracting students and funding, and this inevitably creates winners and losers in the education market place. Hence, the primary focus of this study is to expand the information base about open enrollment in Massachusetts by highlighting the differences between winners (districts gaining more students than they lose) and losers (districts losing more students than they gain).

LITERATURE REVIEW

The open enrollment program in Massachusetts has received some attention from researchers who have examined how the diverse characteristics of school districts may influence inter-district transfers. Using survey data, Fossey (1994) found that on an average, sending districts had lower family incomes and per-pupil expenditures, smaller proportions of educated adult population, and lower test scores than the receiving districts. Armor and Peiser (1997, 1998) also analyzed survey data through the school year 1995-96 and based on simple comparisons of means without significance tests, they concluded that students transfer out of economically disadvantaged school districts to join those with better resources and higher expenditures on school inputs. In a similar study of 1,000 urban Massachusetts parents, Howell (2004) found that quality of teaching, class-size, discipline, and safety and order were ranked as the top four of the 10 most important criteria that parents consider while choosing schools.

Studies from other states include that of Fowler (1996) who investigated the characteristics of open/closed school districts and behavior of school leaders during the first year of full implementation of the Ohio open enrollment policy. His analyses suggest that open districts tend to be smaller, rural, with a lower proportion of minority enrollments and a lower average per pupil expenditures than the closed districts. More recently, Holme and Richards (2009) pick up the issue of social stratification in the context of one metropolitan region, Denver. They reiterate the finding that, in the aggregate, more affluent and white students disproportionately take advantage of inter-district choice, and that choice was more often used by students to exit from districts with lower socioeconomic status to a relatively more advantaged one.

Despite the longevity (more than two decades) and ever-increasing popularity of the open enrollment program in Massachusetts, it has received very little attention from researchers and scholarly work on this topic is sparse. The motivation behind this project is to make an original contribution by highlighting the major differences between winners and
losers. This insight is crucial to both state policy-makers and district-level educational leaders not only in assessing the value of open enrollment as a policy but also, more importantly, in implementing effective future incentives.

AN OVERVIEW OF THE OPEN ENROLLMENT PROGRAM IN MASSACHUSETTS

To date inter-district choice remains the most commonly exercised choice option. Statewide, the number of full-time equivalent (FTE) students participating in the program has gone from 6,039 in 1995-96 to 13,860 in 2011-12, an increase of 129.50%. This exponential growth is partly due to an increase in the number of school districts participating in the program. While only 32 districts participated in 1991, the school districts have increasingly embraced this form of choice, with 174 receiving districts—slightly less than half the districts in Massachusetts—participating in the school year 2011-12 (see Table 1A for some additional statistics).

A school district's primary motivation behind participation in this program is the unique tuition payment policy that provides incentives and penalties and aims at fostering competition, one of the major goals of school choice. The policy requires a sending district to pay tuition to the receiving district for each choice-student that transfers out. Clearly, districts losing students immediately suffer a decrease in revenue, but at the same time, participation in the choice program offers the opportunity to recoup students and the revenues that come with them.

Tuition is deducted from the sending district's quarterly local aid allocation and added to the receiving district's local aid distribution. This financial gain of $5,000 or less is much lower than the average per pupil spending (about $13,369 in the school year 2009-10), but it often exceeds the marginal cost of serving an additional student, due to economies of scale. Therefore, smaller and poorer districts that are operating below their capacity limit might have a greater incentive to participate in the program by taking advantage of economies of scale while bigger and higher-income districts might prefer to remain closed.

There are some recent newspaper articles that provide anecdotal evidence that the primary allure of participation is to bring in much needed additional funds. One of the articles reports that the school committee in Holbrook unanimously voted to join the program in the school year 2010-11 and accept a total of 115 students that could potentially lead to $575,000 in revenue, annually. The school officials noted that the revenue could fund 14 or more teaching positions. Similarly, the school committee in Abington High School unanimously voted to participate in open enrollment and accept five non-resident freshmen in the fall of 2011. The school superintendent Peter Schafer, explained that "The additional $25,000 in revenue will help bolster high school programs "across the board," such as varsity sports. Students will be able to "enjoy a full offering at the high school".

Having presented an overview of the open enrollment program that serves as an essential backdrop for understanding the exploratory analysis, we now provide a comprehensive discussion of the data and variables.
DATA AND METHODOLOGY

The primary data source for this study is the Massachusetts Department of Education (http://www.doe.mass.edu) that contains annual district-level data on several variables including per-pupil expenditures, student characteristics, teacher characteristics, pupil-teacher ratios, and several choice-related variables. Data on district-level controls such as percent of population aged 25 and over with at least a bachelor’s degree and urban/rural status of the district are obtained from the US Census 2000. Using these two sources, a panel data set is compiled with district-level data for 255 school districts for the school years 2003-04 to 2008-09. Summary statistics and a brief description of each variable are presented in Table 1.

The data on school districts in Massachusetts are aggregated at the district-rather than school-level, providing data on the total number of students leaving a district to attend a different school district (i.e. outgoing transfer students), as well as the number of out-of-district students coming into a district (i.e. incoming transfer students). There is no information on the number of applications, characteristics of the students applying to transfer or actually transferring out of a district. The data simply reveal the number of outgoing and incoming students, rather than the transfers out of a particular district and into another particular district. Thus, given this constraint with the data, it is not possible to follow students from the sending districts to their respective receiving districts and we cannot compare the districts that lose students to the particular districts that take away those students from them. Nonetheless, each district can be categorized as a net-receiver or winner if it receives more students than it loses and as a net-sender or loser if it loses more students than it receives.3

Figure 1 displays the spatial segregation among the winners and losers across the state, with the largest proportion of losers concentrated in the eastern part and are mostly closed districts. The summary statistics for the winners and losers are reported in Table 2 and some interesting differences are highlighted below.4

DISTINGUISHING WINNERS FROM LOSERS

Socio-economic Characteristics

Previous studies comparing the demographic characteristics of districts have found that districts that tend to “win” under inter-district choice are those that serve relatively greater number of white and affluent students than districts that lose students under such policies. Several variables are analyzed to study the socioeconomic as well as education level of residents in the winning and losing districts. The results corroborate the findings from prior research. On an average, the mean enrollment of special education (SPECED), limited English proficient (NOENG), low-income (LOWINC) and non-white students (NONWH) was much lower among winners than in losers. Further, winners had a better-educated adult population than losers, as shown by the percentage of the adult population having a college degree (COLLEGE).

It is plausible that parents who consider peer-effect and social status as important criteria for their child’s education environment might prefer to transfer their child from school districts with lower socioeconomic status to those with higher status. Figure 2 reveals the association between the winners/losers and the percentage of low-income
students in a district. The losers that do have a substantial number of economically advantaged open neighbors (receiving districts with a 10 percent or lower proportion of low-income students) often see big losses in student enrollments and revenue. For example, in 2008-09 the largest sending district, Springfield, a low-income district in southwestern Massachusetts, lost 633 students and paid over $3 million in tuition payments to other school districts followed by another low-income district, Worcester, that lost 341 students and was forced to pay $1.4 million in sending tuition.\textsuperscript{5} By contrast, the largest net-receiving district, Quabbin, with 339 net transfers-in was predominantly white (93.5%) with a smaller share of low-income students (15.9%).

\textit{Size and Location Variables}

There is a considerable difference in size as measured by the number of full-time equivalents (FTE). The summary statistics reveal that winners were smaller in size with an average FTE count of 2,373 while the average for losers is more than double at 4,847 FTEs. This might be due to the fact that smaller districts are able to accept more non-resident students by taking advantage of economies of scale as compared to larger districts that are already operating at full-capacity. Moreover, smaller districts might be attractive to most parents due to the smaller class sizes and personal attention students there can receive.

Another related characteristic of a school district is the rural/urban aspect as measured by the percentage of residents that live in an urban area (URBAN). This variable captures certain aspects of a district that are indirectly related to its economic status and may be associated with student outcomes. Further, on an average, the percentage of urban population was much lower among winners as compared to the losers (72.65\% versus 87.12\%). In short, net-receivers were primarily suburban school districts that are usually less crowded; they have less poverty and fewer challenges than urban districts and these could be primary reasons for attracting non-resident students.

Finally, the number of grades served by a school district is likely to influence the availability of spaces for transfer students and might be an important criterion not only in the decision to serve as an open district but also in the capacity to accept transfers and thereby become a winner or a loser. While 63\% of school districts in Massachusetts contain every grade level from pre-kindergarten through 12\textsuperscript{th} grade (PKto12), there are districts that have pre-kindergarten through 8\textsuperscript{th} grade, pre-kindergarten through 6\textsuperscript{th} grade, and grades 9-12 only. However, the difference in means for the PKto12 variable is not statistically significant.

\textit{School Resources}

The literature employs two types of measures of school resources\textsuperscript{6} impacting school quality; the real resources of the classroom (teacher education, teacher experience, and pupil-teacher ratios) and financial resources (per-pupil expenditures and teacher salaries). Consistent with previous research, four district-level resources are used as measures of school quality inputs. They are per-pupil expenditures (PPE), the number of students per teacher (PTRATIO), LICEN, the percentage of teachers that hold a valid Massachusetts
license and demonstrate subject matter competency in the areas they teach, and the percentage of classrooms with internet access (TECH).

It may be argued that the availability of better classroom and financial resources is an important factor in parents' transfer decisions. There is a modest difference in average per-pupil expenditures between the two sub-samples with net-senders spending consistently more ($11,479) than the net-receiving districts ($10,627) but the average PTRATIO is almost the same between the two sub-samples (13.58 versus 13.50). However, the t-statistics for the difference in the mean levels is significant for only two (LICEN and TECH) of the four school resources. This implies that the winners are equipped with better technology and a higher percentage of licensed teachers and these factors might provide an advantage in retaining current students as well as attracting new ones.

*Academic Performance and Discipline Variables*

School districts with better academic standing might be more successful in attracting non-resident students. On the contrary, districts with higher rates of disciplinary problems might lead to a higher exit rate and also dissuade non-resident students from applying. To examine this academic performance is measured by three types of variables indicating the percentage of students that are “advanced”, “proficient”, and “failing”. Data on each of the three levels are available for the two major subjects, English Language Arts (ELA) and Mathematics. Note that these variables measuring the proportion of students achieving a level of proficiency is more recent and sometimes more preferable to parents as opposed to the widely used linear approach (i.e. average test scores).

The means of several academic variables confirm that winners held a better academic position as compared to the losers. The results indicate that the net-receiving districts had a much higher proportion of advanced students and lower share of failing students than net-sending districts and the differences are large and highly significant as demonstrated by the t-statistics. Moreover, a microscopic examination of the data throws light on stark differences between the top winners and biggest losers. In particular, receiving districts (with more than 100 net transfers-in) had an average 37% of the students that were advanced and 4.71% that were failing while for the senders (with more than 100 net transfers-out) the mean was 18.24% and 14.57% for advanced and failing students, respectively. Another variable that draws attention is OUTSUS; the statistics reveal that on an average, losers have more disciplinary problems with a significantly higher percentage of non-compliant students.

*Neighborhood Characteristics*

There are several reasons why neighbors’ influence is important in the analysis of school choice policies and transfers. First, a district with a larger number of open neighbors is more likely to participate in the program and accept transfers since it is faced with an increased risk of losing students and funding to similarly situated districts. In other words, having more neighbors that are participating in the open enrollment program allows more opportunities of choice for students and results in more competition for a district. Second, a district’s relative attractiveness for potential transfer students depends heavily on a district’s characteristics relative to its neighbors. For instance, having test scores higher than the average scores in the neighborhood makes a district a more attractive choice for
potential transfer students, resulting in strong effects on net flows. Hence, the potential to
gain or lose students depends not only on the district's own characteristics but also on the
characteristics of the neighboring districts. Finally, as mentioned earlier, a major constraint
on school choice is that school districts are not responsible for providing transportation to
choice students. Due to transportation to more distant schools being either very costly or
unavailable, parents are most likely to consider nearby districts rather than districts that are
far away. In addition, parents usually have better information about school resources and
quality of education provided by nearby districts. Therefore, in the present case, there is a
fundamental theoretical justification to consider geographical proximity as an important
criterion for defining neighbors.

It is difficult to choose the optimum number of neighbors since no general criterion
for discriminating between alternatives is available. Looking at a map of Massachusetts
school districts, on average, each district shares a border with four other districts.
Therefore, a four-nearest-neighbors weight matrix seems to be a suitable choice based on
which, two sets of neighborhood variables are constructed. The first set consists of
variables defined as the difference between a district's own attribute and the mean of this
attribute for the four contiguous (border-sharing) neighbors. The second is a set of five
dummy variables (CHOICE0 to CHOICE4) describing a district's relative position with
respect to the choice status of its neighbors. They capture outside transfer space availability
as well as the degree of competition faced by a particular district.

The above differences assert that students transfer out of districts with economically
disadvantaged student population to join those with better resources, better educated adult
population, less minority, and higher academic performance. This is also an indication of
affluent districts benefiting from the open enrollment program as money flows from low
income to higher income districts. These preliminary findings reinforce the hypothesis that
a district's probability to win is a function of its own characteristics and how those
characteristics differ from its neighbors. Probit functions are used to test this hypothesis
and generate predictions. The estimation method is described in the next section followed
by a discussion of the empirical results.

**EMPIRICAL MODEL AND RESULTS**

The probit model is a statistical model relating the probability of occurrence of
discrete random events that take 0, 1 values, such as winning or losing, to some set of
explanatory variables. To model the probability of winning \(y_t\), it is considered that in
each period \(t\), a school district \(i\) will win if the number of students transferring into a
district is higher than the number of students leaving a district. The regression model is
specified as:

\[
y^*_t = \beta X_{it} + \epsilon_t, \quad i=1, \ldots, n; \quad t=1, \ldots, T
\]

\[
y_t = \begin{cases} 1 & \text{if } y^*_t > 0 \\ 0 & \text{if } y^*_t \leq 0 \end{cases}
\]

where \(y^*_t\) is an index latent variable of school district \(i\) in period \(t\), \(X\) is a vector of
exogenous regressors, \(\beta\) is a vector of coefficients associated with those regressors and \(\epsilon\) is
the idiosyncratic error term.

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Due to the panel nature of the data, time fixed effects can possibly exist, as well as unobserved heterogeneity across districts. Year dummies are included to capture time-fixed effects. Equation (1) assumes that heterogeneity in a district’s probability to win is only affected by observable characteristics. However, unobserved district factors such as teacher and administration leadership and relations, changes in the local political environment, and changes in state aid may have a bearing on districts’ outcomes. To account for the district-level unobserved factors, the error term in equation (1) is decomposed as follows:

\[ \varepsilon_{it} = \alpha_{i} + u_{it} \]  \hspace{1cm} (2)

where \( \alpha_{i} \) is the unobserved heterogeneity of district \( i \) and \( u_{it} \) is a random error term. Dealing with the unobserved heterogeneity is not straightforward for panel non-linear choice models. Since many of the demographic variables of interest do not change much over time and/or they are only available from the US Census, while varying across districts, the RE Probit model seems to be more appropriate for this analysis.

One potential problem for the RE Probit model is that it becomes inconsistent when regressors are correlated with unobserved heterogeneity. Since the RE models are more efficient, yet inconsistent under this situation, one often adopts the usual Hausman test to see if the RE estimates are different from the corresponding FE estimates. Unfortunately, this analysis cannot be done in the present case since no corresponding FE estimates are readily available.\(^7\)

It might be argued that the current transfer rates are more likely to be influenced by past district characteristics, perhaps due to lags in the flow of information such as availability of test score results. Therefore, all the time-variant explanatory variables are included with 2-year lags and this also has the benefit of avoiding potential endogeneity issues. The primary estimation results are presented in Table 3. The first step in the analysis is to run baseline regressions where the potential impact of neighbors’ characteristics is ignored. The only difference between Model 1 and Model 2 is that the latter includes the four choice dummies. The main advantage of Model 1 is that the estimates provide evidence concerning which types of districts gain (lose) students regardless of the availability of outside opportunities. The sign of the coefficient on URBAN, SPECEDE and NONWH are consistently negative and significant across all the models implying that the probability of winning is negatively related to the urbacity of a district, and students are less likely to transfer to a district with a higher percentage of minorities and special education students. PTRATIO is the only school resource that is significant with a negative coefficient which is consistent with a disposition of parents to stay away from school districts with oversize classes. Contrary to expectation, all the academic variables are insignificant indicating that the proficiency level of a district does not influence the probability of winning.\(^8\) These findings are surprising but somewhat similar to Welsch et al. (2010) as they show that parents’ transfer decisions are not affected by the percentage of proficient or basic level students but only by the level of outstanding students. Further, a note of caution in the interpretation of this result is that all the academic variables are for tenth grade students only and may not capture the overall performance or academic reputation of a district.

Turning to Model 2, all the choice dummies except CHOICE1 are positive and highly significant implying that having more open neighbors increases the likelihood of winning. More important is to note that the magnitude of the coefficient increases going from CHOICE2 to CHOICE3 but is slightly lower for CHOICE4.\(^9\) This result is consistent with the hypothesis that a district with a larger number of open neighbors is exposed to more
competition that might pressure the district to change its policies and opt for innovative programs. These policies and programs in turn will attract more students leading to an increase in the probability of being a winner. For example, there is some evidence that students are more likely to transfer to districts with more extracurricular opportunities (Welsch et al., 2010) or popular sports teams (Reback, 2005, 2008)." Finally, similar to Model 1, none of the year dummies are significant but all the other variables still hold their signs except for PTRATIO which is no longer significant.

Table 4 reports the results from the models including the neighborhood variables, where the main goal is to identify the impact of a district's characteristics relative to its neighbors on the probability of winning. All of the coefficients retain their previous signs and significance from Table 3 and in addition, variables that were insignificant in the previous specifications emerge as significant in these models. The focus will be on highlighting the latter, some of which provide new insight about the preferences associated with the inter-district transfer decisions. The probability of winning is higher when a district has fewer residents with no high school diploma and a higher percentage with a bachelor's degree. These results are consistent with the notion that parents want to transfer their children into districts with better educated population. A surprising result that draws attention is the coefficient on LOWINC which is positive and significant. One possible explanation could be that students from low-income families are less likely to participate in inter-district choice thereby lowering the out-of-district transfers and net loss of students from a district. However, the low-income variable when examined in the context of the neighboring districts has the expected sign and suggests that districts with a percentage of low-income students higher than the average in its neighboring districts are less likely to attract transfer students. Similarly, the negative coefficient on OUTSUS confirms that a district with a higher percentage of out-of-school suspensions relative to its neighbors might deter students as it might be viewed as less successful in promoting a better learning environment. The results also suggest that districts that are more urban or have more technologically efficient classrooms (TECH) might be more likely to win. The last model (Model 2) in Table 4 includes the choice dummies but the results do not change much except that the coefficients on LOWINC and URBAN (neighbor variable) are no longer significant. Comparing across all models, the combined models that include neighborhood characteristics performs better and the one with the choice dummies is the best in terms of fit with the underlying data, as is evident from the log-likelihood values.

CONCLUSIONS AND POLICY IMPLICATIONS

School choice policies are designed to bring the 'invisible hand' of competition to the public education arena. Examination of the characteristics of school districts that are winners and losers in the Massachusetts open enrollment program uncovers several potentially important findings and contributes to the sparse literature on open enrollment programs.

The research indicates that districts with better classroom resources, better educated parent population, smaller percentages of minorities, and lower out-of-school suspension rates are more likely to attract students. These results corroborate the findings from previous research specifically that of Fossey (1994). More interesting and perhaps more important is to note that open enrollment choice patterns have not changed much almost two decades after the program was first implemented. Incorporating neighboring district
characteristics, we find evidence that an increase in the number of open neighbors has a significant and substantial positive impact on the likelihood of being a winner. Some unfamiliar and clearly surprising results that draw attention are the academic performance variables which are consistently insignificant in all the regressions. This finding suggests that when opting for choice, parents place a higher preference on districts with a socioeconomically advantaged student body rather than higher academic quality. In summary, these results imply that the probability of being a winner in the inter-district school choice program depends largely on the socioeconomic characteristics and school resources (inputs) of the district rather than the outputs.

The fundamental premise for the success of school choice policies is ingrained in the incentive structure faced by school officials and the Massachusetts open enrollment program is no different. The findings raise questions about the incentive structure of this program which uses financial incentives and penalties to induce schools to improve their educational quality. By taking away much needed funds from already disadvantaged districts, such programs could make poor districts worse off and promote racial segregation rather than encourage fair competition—a major concern of choice opponents. On the other hand, choice proponents argue that the initial loss of funds are necessary to impel school district improvement, particularly if low-performing districts change their policies and programs to win students back, as some have done.

Having uncovered evidence of factors that affect the probability of success, a better understanding of the effects of such success, and more importantly failure, is clearly warranted. Future research exploring the fiscal and educational impacts of school districts that experience a net inflow (or outflow) of students is crucial in understanding the long-term benefits and limitations of the inter-district school choice policy.
ENDNOTES

1 If more students apply than there are spaces available, the district holds a lottery to select which students would be admitted. A sibling of a child currently attending school in another district under school choice receives preference in the admissions lottery. If a district has fewer applicants than it has seats for school choice students, it may choose to accept students at any time during the school year.

2 In a 1992 amendment to the law, this tuition rate was capped at 75% of actual per-pupil operating expenditures in the receiving district, up to a maximum of $5,000, except for special education students for whom the reimbursement rate is 100% or based on an Individualized Education Plan (IEP). Details of the reimbursement procedure is available at http://finance1.doe.mass.edu/schools/schoolead.html.

3 Table 1B provides the year-by-year statistics on the number of winners and losers for 2003-04 to 2009-10 and some additional information.

4 It should be noted that the descriptive analyses is limited to district-level trends and do not provide insights into patterns at the micro (school) level.

5 The percentage of low-income students was 77.8% and 65.8% in Springfield and Worcester, respectively.

6 The exact impact of school resources on student performance is still open to debate and is outside the scope of this paper. Here we examine the impact of school resources on the transfer rate of a district.

7 There does not exist a sufficient statistic allowing the fixed effects to be conditioned out of the likelihood. Unconditional fixed-effects probit models may be fitted but the estimates are biased.

8 In Massachusetts, a unique measure of student performance is a 100-point index called the Composite Performance Index (CPI). A CPI is available for English language arts and mathematics. An average of CPI-ELA and CPI-MA indices is taken to construct a variable that controls for the overall academic performance of the district (CPIAVG). CPIAVG is not significant in any of the specifications.

9 Zan zig (1997) identifies the threshold number (approximately three to four districts per county) of districts in California needed to achieve a fully competitive education market. He found that beyond this threshold level further additions of districts prove irrelevant in inducing competition.

10 In a Heartland Institute article dated October 1, 2005, it was reported that in spite of low MCAS scores in both Math and English being five percent below state averages, Fitchburg school district received 148 students and lost 255 students in the school year 2004-05. The
school superintendent speculated that innovative programs like the Museum Partnership School and the Alternative Evening High School might be drawing outside students.

11 Three other variables, the truancy-rate, the drop-out rate, and the graduation rate were also tested. The truancy rate has the expected sign but the other two variables are not significant.

12 The number of students per computer (student-computer ratio) was used as an alternative measure for technological resources available to a school district. However, the coefficient on this variable is not statistically significant.
REFERENCES


<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DESCRIPTION OF THE VARIABLE</th>
<th>MEAN</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Win</td>
<td>Dummy = 1 if the school district is a net-receiver, 0 otherwise</td>
<td>0.30</td>
<td>0.45</td>
</tr>
<tr>
<td>Resident characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NODIP</td>
<td>Percent of population with no high school diploma</td>
<td>2.46</td>
<td>5.60</td>
</tr>
<tr>
<td>COLLEGE</td>
<td>Percent of population aged 25 years and over with a bachelors degree</td>
<td>14.30</td>
<td>7.59</td>
</tr>
<tr>
<td>URBAN</td>
<td>Percentage of residents that live in an urban area</td>
<td>83.37</td>
<td>23.86</td>
</tr>
<tr>
<td>Student characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOWINC</td>
<td>Percent of enrollment who are eligible for free or reduced price lunch or receives Transitional Aid to Families benefits or are eligible for food stamps</td>
<td>19.29</td>
<td>17.61</td>
</tr>
<tr>
<td>SPECED</td>
<td>Percent of special education students who have an Individualized Education Program (IEP)</td>
<td>16.73</td>
<td>5.36</td>
</tr>
<tr>
<td>NOENG</td>
<td>Percent of enrollment whose first language is not English</td>
<td>7.74</td>
<td>12.46</td>
</tr>
<tr>
<td>NONWH</td>
<td>Percent of enrollment that is non-white</td>
<td>15.29</td>
<td>17.04</td>
</tr>
<tr>
<td>School resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LICEN</td>
<td>Percentage of teachers who are licensed with Provisional, Initial of Professional licensure to teach in the area(s) in which they are teaching</td>
<td>96.50</td>
<td>3.74</td>
</tr>
<tr>
<td>PPE</td>
<td>Per-pupil expenditures in 1000 of dollars calculated by dividing district's total operating expenditures by its average pupil membership</td>
<td>11.22</td>
<td>3.57</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>DESCRIPTION OF THE VARIABLE</td>
<td>13.37</td>
<td>2.04</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>PTRATIO</td>
<td>Total number of students per teacher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TECH</td>
<td>Percentage of classrooms with internet access</td>
<td>98.74</td>
<td>5.40</td>
</tr>
<tr>
<td></td>
<td><strong>Academic performance/Discipline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADV</td>
<td>An average of the percentage of tenth grade students that are identified as above proficient/advanced in English language arts (ELA) and Mathematics in the MCAS test</td>
<td>32.57</td>
<td>15.66</td>
</tr>
<tr>
<td>PROF</td>
<td>An average of the percentage of tenth grade students that are identified as proficient in ELA and Mathematics in the MCAS test</td>
<td>39.87</td>
<td>6.77</td>
</tr>
<tr>
<td>FAIL</td>
<td>An average of the percentage of tenth grade students that are identified as failing in ELA and Mathematics in the MCAS test</td>
<td>6.58</td>
<td>5.89</td>
</tr>
<tr>
<td>OUTSUS</td>
<td>The percentage of enrolled students that received one or more out-of-school suspensions</td>
<td>5.22</td>
<td>4.68</td>
</tr>
<tr>
<td>Other variables PKto12</td>
<td>Dummy=1 if a school district serves all grades from pre-kindergarten through 12th, 0 otherwise</td>
<td>0.80</td>
<td>0.39</td>
</tr>
<tr>
<td>CHOICE0-4</td>
<td>Five dummy variables that capture the choice status of the four-nearest neighbors of a district. For e.g., CHOICE1 is a dummy variable that takes the value 1 if only one of the four-nearest neighbors of a district is an open district, 0 otherwise. CHOICE2, CHOICE3 and CHOICE4 are similarly constructed and CHOICE0 is the base group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>Winners (N=463)</td>
<td>Losers (N=780)</td>
<td>t-statistics</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>----------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>Mean (S.D)</td>
<td>Mean (S.D)</td>
<td></td>
</tr>
<tr>
<td>NODIP</td>
<td>1.82 (1.12)</td>
<td>2.41 (4.56)</td>
<td>2.71*</td>
</tr>
<tr>
<td>COLLEGE</td>
<td>14.59 (6.61)</td>
<td>13.15 (6.72)</td>
<td>-3.60*</td>
</tr>
<tr>
<td>URBAN</td>
<td>72.65 (29.23)</td>
<td>87.12 (19.97)</td>
<td>10.34*</td>
</tr>
<tr>
<td>LOWINC</td>
<td>15.04 (10.68)</td>
<td>23.89 (21.08)</td>
<td>8.41*</td>
</tr>
<tr>
<td>SPECED</td>
<td>15.83 (4.18)</td>
<td>16.80 (5.00)</td>
<td>3.49*</td>
</tr>
<tr>
<td>NOENG</td>
<td>3.89 (4.82)</td>
<td>10.90 (15.88)</td>
<td>9.24*</td>
</tr>
<tr>
<td>NONWH</td>
<td>9.69 (7.52)</td>
<td>19.26 (21.27)</td>
<td>9.32*</td>
</tr>
<tr>
<td>LICEN</td>
<td>97.09 (3.36)</td>
<td>96.24 (3.84)</td>
<td>-3.93*</td>
</tr>
<tr>
<td>PPE</td>
<td>10.62 (2.91)</td>
<td>10.98 (3.32)</td>
<td>1.91</td>
</tr>
<tr>
<td>PTRATIO</td>
<td>13.50 (1.95)</td>
<td>13.58 (1.94)</td>
<td>0.71</td>
</tr>
<tr>
<td>TECH</td>
<td>99.39 (2.97)</td>
<td>98.20 (6.66)</td>
<td>-3.65*</td>
</tr>
<tr>
<td>ADV</td>
<td>35.61 (14.81)</td>
<td>30.09 (14.38)</td>
<td>-6.45*</td>
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<tr>
<td>PROF</td>
<td>40.47 (6.31)</td>
<td>39.78 (6.60)</td>
<td>-1.80</td>
</tr>
<tr>
<td>FAIL</td>
<td>5.11 (3.85)</td>
<td>7.94 (6.75)</td>
<td>8.23*</td>
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<tr>
<td>OUTSUS</td>
<td>4.20 (3.80)</td>
<td>5.84 (4.79)</td>
<td>6.45*</td>
</tr>
<tr>
<td>PKto12</td>
<td>0.83 (0.37)</td>
<td>0.85 (0.35)</td>
<td>0.85</td>
</tr>
</tbody>
</table>
Note 1:*The t-statistics reject the hypotheses that the difference in means between the two sub-samples (winners and losers) equal zero.

Table 3. Coefficient estimates from the Random Effects Probit Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NODIP</strong></td>
<td>-0.138 (1.33)</td>
<td>-0.160 (-1.34)</td>
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<tr>
<td><strong>COLLEGE</strong></td>
<td>0.067 (1.53)</td>
<td>0.069 (0.91)</td>
</tr>
<tr>
<td><strong>URBAN</strong></td>
<td>-0.047 <strong>(-4.74)</strong></td>
<td>-0.045 *<strong>(-3.22)</strong></td>
</tr>
<tr>
<td><strong>LOWINC</strong></td>
<td>0.016 (0.57)</td>
<td>-0.035 (-0.44)</td>
</tr>
<tr>
<td>SPECED</td>
<td>-0.089 <strong>(-1.90)</strong></td>
<td>-0.136 <strong>(-1.75)</strong></td>
</tr>
<tr>
<td>NOENG</td>
<td>0.037 (0.69)</td>
<td>0.145 (1.49)</td>
</tr>
<tr>
<td>NONWH</td>
<td>-0.134 *<strong>(-3.26)</strong></td>
<td>-0.164 <strong>(-1.92)</strong></td>
</tr>
<tr>
<td>LICEN</td>
<td>0.033 (0.83)</td>
<td>0.048 (0.85)</td>
</tr>
<tr>
<td>PPE</td>
<td>-0.047 <strong>(-0.57)</strong></td>
<td>-0.009 (-0.07)</td>
</tr>
<tr>
<td>PTRATIO</td>
<td>-0.244 <strong>(-2.29)</strong></td>
<td>-0.156 <strong>(-0.92)</strong></td>
</tr>
<tr>
<td>TECH</td>
<td>-0.0004 (-0.02)</td>
<td>-0.0004 (-0.01)</td>
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<tr>
<td>ADV</td>
<td>-0.009 <strong>(-0.37)</strong></td>
<td>0.016 (0.45)</td>
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<tr>
<td>PROF</td>
<td>0.009 (0.24)</td>
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<td>0.007 (0.12)</td>
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<td>0.764 (1.21)</td>
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<td>CHOICE1</td>
<td>-</td>
<td>0.528 (0.68)</td>
</tr>
<tr>
<td>CHOICE2</td>
<td>-</td>
<td>3.049 (2.58)**</td>
</tr>
<tr>
<td>CHOICE 3</td>
<td>-</td>
<td>6.988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.68)***</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>CHOICE4</td>
<td>-</td>
<td>6.577</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.49)***</td>
</tr>
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<td>Year dummies</td>
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<td>Yes</td>
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<tr>
<td>Log-likelihood</td>
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<td>-233.00</td>
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<tr>
<td>No. of observations</td>
<td>1020</td>
<td>1020</td>
</tr>
</tbody>
</table>

*Note 1:* z-statistics in parentheses

*Note 2:* *** significant at 1% level; ** significant at 5% level; * significant at 10% level
Table 4. Coefficient estimates from the Random Effects Probit Models including neighborhood effects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Coefficient</td>
</tr>
<tr>
<td><strong>NODIP</strong></td>
<td>-0.362 (-2.49)**</td>
<td>-0.087 (-0.41)</td>
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<tr>
<td><strong>COLLEGE</strong></td>
<td>0.246 (1.93)**</td>
<td>0.151 (1.26)</td>
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<tr>
<td><strong>URBAN</strong></td>
<td>-0.165 (-3.59)**</td>
<td>-0.045 (-1.38)</td>
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<tr>
<td><strong>LOWINC</strong></td>
<td>0.127 (1.79)*</td>
<td>0.046 (0.73)</td>
</tr>
<tr>
<td><strong>SPECED</strong></td>
<td>-0.250 (-2.41)**</td>
<td>-0.336 (-2.48)**</td>
</tr>
<tr>
<td><strong>NOENG</strong></td>
<td>0.119 (1.13)</td>
<td>0.144 (1.19)</td>
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<td>-0.214 (-2.62)**</td>
<td>-0.178 (-1.93)**</td>
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<td><strong>LICEN</strong></td>
<td>0.034 (0.59)</td>
<td>0.031 (0.51)</td>
</tr>
<tr>
<td><strong>PPE</strong></td>
<td>-0.009 (-0.07)</td>
<td>0.056 (0.41)</td>
</tr>
<tr>
<td><strong>PTRATIO</strong></td>
<td>-0.168 (-0.92)</td>
<td>-0.111 (-0.61)</td>
</tr>
<tr>
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<td>0.014 (0.36)</td>
<td>0.009 (0.20)</td>
</tr>
<tr>
<td><strong>ADV</strong></td>
<td>0.004 (0.11)</td>
<td>0.019 (0.54)</td>
</tr>
<tr>
<td><strong>PROF</strong></td>
<td>0.031 (0.66)</td>
<td>0.049 (0.92)</td>
</tr>
<tr>
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<td>0.013 (0.17)</td>
<td>0.008 (0.09)</td>
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<tr>
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<td>0.005 (0.06)</td>
<td>0.002 (0.02)</td>
</tr>
<tr>
<td><strong>PKto12</strong></td>
<td>-0.313 (-0.11)</td>
<td>-0.365 (-0.14)</td>
</tr>
</tbody>
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* Neighbor variables

66
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<th>Variable</th>
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<td>TECH</td>
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<td>CHOICE2</td>
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<td>CHOICE 3</td>
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<td>CHOICE4</td>
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Note 1: *All the neighbor variables are defined as the difference between a district's own attribute and the mean of this attribute for the four contiguous neighbors.

Note 2: z-statistics in parentheses

Note 3: *** significant at 1% level; ** significant at 5% level; * significant at 10% level

Table 1 A. Open enrollment statistics from 2004-2012

<table>
<thead>
<tr>
<th>Year</th>
<th>FTE participating in Inter-district Choice</th>
<th>% Increase</th>
<th>Total Public School Enrollment</th>
<th>% Exercising Choice as Share of Total Enrollment</th>
<th>Districts Accepting choice students</th>
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<tbody>
<tr>
<td>2003-04</td>
<td>8,869</td>
<td>-</td>
<td>957,926</td>
<td>0.93%</td>
<td>142</td>
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<tr>
<td>2004-05</td>
<td>9,285</td>
<td>4.68%</td>
<td>952,293</td>
<td>0.98%</td>
<td>149</td>
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<tr>
<td>2005-06</td>
<td>9,738</td>
<td>4.87%</td>
<td>950,826</td>
<td>1.02%</td>
<td>150</td>
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<tr>
<td>2006-07</td>
<td>10,363</td>
<td>6.41%</td>
<td>968,661</td>
<td>1.06%</td>
<td>155</td>
</tr>
<tr>
<td>2007-08</td>
<td>10,794</td>
<td>4.15%</td>
<td>954,116</td>
<td>1.13%</td>
<td>158</td>
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<tr>
<td>2008-09</td>
<td>11,300</td>
<td>4.69%</td>
<td>958,910</td>
<td>1.18%</td>
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</tr>
<tr>
<td>2009-10</td>
<td>11,807</td>
<td>4.49%</td>
<td>957,053</td>
<td>1.23%</td>
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<td>2010-11</td>
<td>12,196</td>
<td>3.29%</td>
<td>955,563</td>
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<td>2011-12</td>
<td>13,860</td>
<td>13.64%</td>
<td>953,369</td>
<td>1.45%</td>
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</table>

Source: Massachusetts Department of Education
Table 1B. Statistics for winners and losers in the school choice program from 2004-2010*

<table>
<thead>
<tr>
<th>Year</th>
<th>Winners</th>
<th>Losers</th>
<th>Districts with sending FTE=receiving FTE</th>
<th>Average receiving FTE</th>
<th>Average sending FTE</th>
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<tr>
<td>2003-04</td>
<td>70</td>
<td>129 (86)</td>
<td>56</td>
<td>32.30</td>
<td>32.21</td>
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<td>2004-05</td>
<td>74</td>
<td>131 (86)</td>
<td>50</td>
<td>33.73</td>
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<tr>
<td>2005-06</td>
<td>80</td>
<td>134 (94)</td>
<td>41</td>
<td>35.40</td>
<td>35.65</td>
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<tr>
<td>2006-07</td>
<td>81</td>
<td>125 (83)</td>
<td>49</td>
<td>37.42</td>
<td>37.93</td>
</tr>
<tr>
<td>2007-08</td>
<td>79</td>
<td>132 (86)</td>
<td>44</td>
<td>38.79</td>
<td>39.66</td>
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<tr>
<td>2008-09</td>
<td>79</td>
<td>129 (85)</td>
<td>47</td>
<td>40.49</td>
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<td>2009-10</td>
<td>84</td>
<td>123 (78)</td>
<td>48</td>
<td>42.24</td>
<td>43.08</td>
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*Statistics are calculated based on data available for 255 school districts.
Fig 1: Top Winners and Losers
Fig 2: Winners/Losers and Percentage of Low-Income Students

% of low-income students
- Less than 30 percent
- 30-60 percent
- Greater than 60 percent

Losers
Winners
ECONOMIC IMPACT OF THE EARNED INCOME TAX CREDIT (EITC) FOR ERIE COUNTY, PENNSYLVANIA

Kosin Isariyawongse
Edinboro University of Pennsylvania

Lei Zhang
North Dakota State University

Shuang Feng
Edinboro University of Pennsylvania

Michael Hannan
Edinboro University of Pennsylvania

ABSTRACT

The Earned Income Tax Credit (EITC) was created in 1975 as an anti-poverty, non-welfare program to reduce poverty among the working poor. This paper explores the economic impact of the Earned Income Tax Credit on Erie County, Pennsylvania. The analysis in this paper makes use of the IMPLAN input-output model. We consider the various impacts of EITC including direct effect, indirect effect and induced effect on output (sales), employee compensation, labor income, and employment. The results of this paper indicate a significant benefit of EITC to Erie County and its residents. Furthermore, we analyze the forgone impact of EITC, the results of which also suggest an increase in the level of support to outreach efforts such as Volunteer Income Tax Assistance (VITA) program. In addition, policies to promote and raise awareness and participation of EITC should also be implemented.

INTRODUCTION

The Earned Income Tax Credit (EITC) was created in 1975 to provide supplemental income to low-income families in the United States. It has become the federal government's largest "refundability" program. About 15 percent of households qualified for the EITC in the 1990s (Hoffman and Seidman, 2002). In 2008, approximately 25
million families benefited from the EITC, which costs the federal government $51 billion

The EITC has been shown to be a successful tax policy in helping alleviate
poverty for the working poor. Neumark and Wascher (2001), Eamon et al. (2009) and Lim
(2009) indicate that the EITC is associated with poverty reduction. For recipient families
with children under 18, the EITC raises disposable income by 10% and reduces poverty
rate by 27% (Kim, 2001). For tax years 2002 through 2004, Simpson et al. (2010) finds that
the EITC significantly lowers the poverty rate of EITC recipients from 57% to 49%. The
EITC has been estimated to have lifted 4.5 million people above the poverty line in 2006
(Center on Budget and Policy Priorities, 2006).

Another benefit of the EITC is that it encourages work. To be eligible for the
credit, the taxpayer is required to work and the EITC has been found to encourage work
among individuals in single-parent families (Beverly, 2002). Grogger (2004) also points
out that EITC expansions contributed to one-third of the increase in employment among
single mothers between 1993 and 1999.

Moreover, the EITC can affect maternal and infant health and improve human
well-being. According to Strully et al. (2010), the EITC increases birth weights and reduces
maternal smoking. In general, the EITC has a positive impact on the health of the
American public (Arno et al., 2009).

In 2009, the Erie County poverty rate was 15.8% among all residents, which was
1.5 percentage points higher than the U.S. average and 3.3 percentage points higher than
the Pennsylvania average. The poverty rate of Erie County was as high as 31.6% for
African American residents in 2009. In 2011, the Erie county unemployment rate was 9%,
which was 0.3 percentage point higher than the U.S. average rate. It can be expected that
the EITC dollars will have noteworthy effects on Erie County’s local economy.

Despite the importance of EITC to the local economy, EITC dollars are usually
underclaimed. Researchers agree that a large amount of EITC refunds are unclaimed,
although there is some disagreement on the exact amount. A Government Accountability
Office (GAO) study estimated that 25% of EITC refunds go unclaimed. An IRS study
found that 17.8% of refunds nationally go unclaimed. Beverly (2002) and Twohey (2001)
find that approximately 14% to 20% of individuals in the U.S. who are eligible to the EITC
do not claim it.

About two-thirds of the EITC recipients spend their refund on immediate
expenses (Spader et al., 2005). Due to multiplier effects, each dollar of EITC monies
stimulates the local economy by more than one dollar. For example, the city of San
Antonio estimated that each additional $1 in the EITC claims would generate $1.58 in local
economic activity (Texas Perspectives, the Annie E. Casey Foundation, 2003).

In this paper, we use the IMPLAN input-output model developed by MIG Inc. to
capture various multipliers to prove the effectiveness of using EITC to stimulate the local
economy. We use the model to analyze how changes in household income affect the
economic activities or trade flows among businesses, and households. Specifically, we
estimate the economic impact of the EITC on the output, employment, and earnings
impacts of the local economy of the Erie County.

This paper provides support for the importance of raising EITC participation to
further decrease the Erie County poverty rate. This research also contributes to the regional
economic analysis of the Erie area and can be extended to study the regional effects of
other public policies.
DATA AND METHODOLOGY

We employ the 2010 IMPLAN data for Erie County, Pennsylvania, which comprises the input-output (IO) tables of the county. The IMPLAN data also includes the various effects as well as multipliers for output (sales), employee compensation, labor income, and employment impacts.

The EITC data for Erie County is obtained from the United Way of Erie and the Internal Revenue Service. The EITC data includes the number of filings and the dollar amount of EITC claims for each zip code in Erie County during the period of 2007 through 2010. In order to estimate the expenditure pattern of EITC spending, we obtained the data for the expenditure profile of the lowest 20% of income families from the Consumer Expenditure Survey by the U.S. Bureau of Labor Statistics.

The analysis in this paper makes use of the IMPLAN input-output model, which allows us to build an economic model to estimate the impact of EITC on the regional economy. The impact of the EITC has multiplier effects on the local economy, categorized as the direct effect, the indirect effect, and the induced effect. The total economic impact of the EITC is equal to the sum of all three effects. Due to multiplier effects, the total effect will be a multiple of the initial expenditures. The direct effect is the immediate spending caused by residents when they spend their EITC payments. The direct effect initiates a series of rounds of income creation, spending, and re-spending that result in indirect and induced effects. The indirect effect is composed of changes in production, employment, and income that result from the inter-industry purchases initiated by the direct effect. The induced effect is the response by an economy to an initial change (direct effect) that occurs through re-spending of income received by a component of value added.

For each type of economic effect, two types of multipliers are reported in the IMPLAN data: Type I multipliers and Type SAM (Social Accounting Matrix) multipliers. A Type I multiplier is calculated by dividing the direct effect plus the indirect effect by the direct effect. A Type SAM multiplier is the sum of direct, indirect and induced effects divided by the direct effect. In this paper, we use Type SAM multipliers to calculate the total economic impact on various variables, which is consistent with the recent literature.\(^\text{a}\) The methodology of this paper is outlined as follows. The input-output model requires values of initial effects in certain industries. We assume that the EITC dollars are spent in a manner consistent with a typical pattern for households with the lowest 20% of pre-tax income. According to the Consumer Expenditure Survey by the U.S. Bureau of Labor Statistics, households with the income level of the EITC recipients spend most of their income on food, housing, and transportation (See Table 2). Table 2 provides the expenditures on average for low income families. In order to obtain the initial effects, we match the expenditure categories of the Consumer Expenditure Survey for the lowest 20% income families with the industry categories in the IMPLAN model. Then we calculate the weighted average economic effects and multipliers of output, employee compensation, labor income, and employment, using the low-income expenditure structure and the IMPLAN input-output tables. Finally, the economic impacts of EITC are estimated as the product of EITC levels and IMPLAN input-output effects.\(^\text{b}\)

The EITC payments are injected into the regional economy when they are spent locally. The impact of EITC dollars is made smaller when there are leakages such as savings and dollars spent outside the local economy. Following previous research on EITC
impact such as Haskell (2006) and Jacob France Institute (2004), we assume that 80% of the EITC payments are spent within the local economy.

Literature suggests that about 15%-25% of EITC refunds are unclaimed. For the estimation of foregone impacts of EITC, we assume that 20% of all qualified EITC claims are foregone.\textsuperscript{vi}

**EMPIRICAL RESULTS**

Four types of economic impacts are examined in this paper: final output, employee compensation, labor income and employment impacts. Output impacts examine how much of final outputs (sales) are generated. Employee compensation impacts examine how much wages, salaries, and supplements to wages and salaries are generated. Labor income impacts examine the effects on employee compensation and proprietor income.\textsuperscript{vii} The employment impacts examine how many new jobs are created through new spending resulting from the EITC program.

We derive the multipliers of various economic impacts from the IMPLAN model, using the weighted average of the Type SAM multipliers based on the low-income expenditure structure. The output multiplier of Erie County is 1.54, which indicates that the total increase on the output (sales) will be $1.54, for each $1 of initial increase in total output. The employee compensation multiplier of the Erie County is 1.53, which indicates that the total increase in employee compensation is $1.53, for any $1.00 increase in employee compensation. The labor income multiplier is 2.00, implying that a total increase of $2.00 in labor income can be generated from every $1.00 increase in labor income. The employment multiplier of 1.55 indicates that if one job is created initially in the Erie County, the total new full-time, part-time and temporary jobs created will be 1.55.

The economic impacts of the EITC on Erie County are reported in Tables 3-5. The first important impact of the EITC program is on the final output production and sales in Erie County, which is reported in Table 3. The results show that the EITC program has increasing impacts on the output (sales) of the Erie County from 2007 to 2010. The total effects of EITC on output (sales) increased from $53.42 million in 2007 to $64.41 million in 2010. The total increase in output (sales) resulted from EITC payments of $238.02 million over the four years of study.

The EITC program also contributes significantly to employee compensation and labor income Erie County. Table 4 shows that the total impact on county-level employee compensation increases from $16.02 million in 2007 to $19.32 million in 2010. With proprietor income included, the labor income generated by the EITC increases from $18.64 million in 2007 to $22.48 million in 2010. The total increase in employee compensation and labor income over the four years of study is $71.41 million and $83.06 million, respectively.

The EITC program also makes increasing contributions to job creation in Erie County from 2007 to 2010. Considering the higher-than-average unemployment rate and poverty rate in this area, this is a very important economic impact to study. As reported in Table 5, we find EITC generated hundreds of new jobs each year, from 624.42 jobs in 2007 to 752.86 jobs in 2010. A total of 2782.17 jobs were generated in the Erie County by the EITC program over the four years of study.

Although the EITC has significant impacts on the local economy, the benefit of EITC is not fully employed due to an underutilization of the EITC by qualified individuals.
and households. The foregone impacts of unreported EITC are examined in Table 6, where we assume that 20% of qualified households do not claim the EITC. The foregone impact of EITC also increases over the period of 2007-2010. The total foregone dollar amount of EITC is more than $48 million, which leads to $59.51 million of foregone output (sales), $17.85 million of foregone employee compensation, $20.76 million of foregone labor income, and 695.54 foregone jobs.

CONCLUDING REMARKS

In this paper, we examine the economic impact of the EITC for Erie County, Pennsylvania. Four types of impacts (output, employee compensation, labor income, and employment) are explored. EITC dollars affect the local economy through a ripple effect. We observe this effect from 2007 to 2010, EITC dollars raised total output, employee compensation, and labor income in Erie County by $238.02 million, $71.41 million, and $83.06 million, respectively. During the same time period, 2,782 jobs were created. Meanwhile, assuming consistency with national rates, approximately 20% of individuals eligible to receive the EITC did not claim it, which caused a significant amount of foregone effects. Lack of knowledge of EITC is the main reason why these individuals did not claim the credit. Very poor parents, welfare and food stamp participants, and Hispanic parents are less likely to know about the EITC (Beverly, 2002). Increasing awareness of the EITC will increase the participation rate of the EITC program, further boost the economy and lift a larger number of people above the poverty line.

Outreach efforts would augment awareness of the economic impact of the EITC and increase the number of people who file for the credit. Efforts may include programs such as VITA (Volunteer Income Tax Assistance), posters, filers, articles in the local newspaper, programs in the local broadcast channels, etc. (Browne, 2004). Introduction of electronic filing can also increase the participation in the EITC. Kopezuk and Pop-Eleches (2007) provide the evidence that the introduction of electronic filing has a significant effect on the EITC program participation.

Although our study has successfully reached its aims, there are some limitations. First, because of the data limitation and the original purpose of the study, this research is conducted only for Erie County, Pennsylvania. However, our methodology can be easily applied to other regions to explore the regional impact of the EITC program. Second, our foregone impact results are based on the assumption that 20% of individuals eligible to receive the EITC did not claim it. The actual percentage of the unclaimed EITC may vary by region. If we obtain data on the unclaimed EITC for the Erie area, it would allow us to make a more precise estimate.

The methodology of this paper can be applied to the analysis of the impact of other economic policies and programs. Future study can be conducted by expanding the research area to Northwest Pennsylvania or the whole state of Pennsylvania for more generalized results.
Acknowledgements: We wish to thank Alan Biel, Rene Hearn and Edinboro University office of Grants and Sponsored Programs for the support on the source of data used in this paper.

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REFERENCES


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<thead>
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<th>2008</th>
<th>2009</th>
<th>2010</th>
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<td>$657,109</td>
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<td>$848,215</td>
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<td>Corry</td>
<td>$1,979,653</td>
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<td>Total of the Erie County</td>
<td>$43,281,967</td>
<td>$45,357,017</td>
<td>$52,024,825</td>
<td>$52,184,954</td>
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*Source: The Internal Revenue Service*
**Table 2: Expenditures by Low Income Families**

<table>
<thead>
<tr>
<th>Category of Expenditure</th>
<th>Estimated Expenditure</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>$3,462</td>
<td>17.28%</td>
</tr>
<tr>
<td>Shelter</td>
<td>$5,167</td>
<td>25.79%</td>
</tr>
<tr>
<td>Utilities, fuels, and public services</td>
<td>$2,216</td>
<td>11.06%</td>
</tr>
<tr>
<td>Household operations</td>
<td>$373</td>
<td>1.86%</td>
</tr>
<tr>
<td>Housekeeping supplies</td>
<td>$343</td>
<td>1.71%</td>
</tr>
<tr>
<td>Household furnishings and equipment</td>
<td>$568</td>
<td>2.83%</td>
</tr>
<tr>
<td>Apparel and services</td>
<td>$774</td>
<td>3.86%</td>
</tr>
<tr>
<td>Transportation</td>
<td>$2,868</td>
<td>14.31%</td>
</tr>
<tr>
<td>Health care</td>
<td>$1,524</td>
<td>7.61%</td>
</tr>
<tr>
<td>Entertainment</td>
<td>$1,018</td>
<td>5.08%</td>
</tr>
<tr>
<td>Personal care products and services</td>
<td>$277</td>
<td>1.38%</td>
</tr>
<tr>
<td>Reading</td>
<td>$45</td>
<td>0.22%</td>
</tr>
<tr>
<td>Education</td>
<td>$635</td>
<td>3.17%</td>
</tr>
<tr>
<td>Tobacco products and smoking supplies</td>
<td>$323</td>
<td>1.61%</td>
</tr>
<tr>
<td>Personal insurance and pensions</td>
<td>$446</td>
<td>2.23%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Induced Effects</th>
<th>Total Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$32,713,763</td>
<td>$8,842,403</td>
<td>$11,864,917</td>
<td>$53,421,083</td>
</tr>
<tr>
<td>2008</td>
<td>$34,282,145</td>
<td>$9,266,331</td>
<td>$12,433,752</td>
<td>$55,982,228</td>
</tr>
<tr>
<td>2009</td>
<td>$39,321,868</td>
<td>$10,628,548</td>
<td>$14,261,603</td>
<td>$64,212,019</td>
</tr>
<tr>
<td>2010</td>
<td>$39,442,898</td>
<td>$10,661,262</td>
<td>$14,305,499</td>
<td>$64,409,659</td>
</tr>
<tr>
<td>Total</td>
<td>$145,760,673</td>
<td>$39,398,544</td>
<td>$52,865,772</td>
<td>$238,024,989</td>
</tr>
</tbody>
</table>
Table 4: Employee Compensation and Labor Income Impacts of EITC on Erie County

Panel A: Employee Compensation Impact

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Induced Effects</th>
<th>Total Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$10,238,897</td>
<td>$2,356,636</td>
<td>$3,430,289</td>
<td>$16,025,823</td>
</tr>
<tr>
<td>2008</td>
<td>$10,729,777</td>
<td>$2,469,619</td>
<td>$3,594,746</td>
<td>$16,794,143</td>
</tr>
<tr>
<td>2009</td>
<td>$12,307,131</td>
<td>$2,832,671</td>
<td>$4,123,200</td>
<td>$19,263,003</td>
</tr>
<tr>
<td>2010</td>
<td>$12,345,012</td>
<td>$2,841,390</td>
<td>$4,135,891</td>
<td>$19,322,293</td>
</tr>
<tr>
<td>Total</td>
<td>$45,620,817</td>
<td>$10,500,315</td>
<td>$15,284,125</td>
<td>$71,405,261</td>
</tr>
</tbody>
</table>

Panel B: Labor Income Impact

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Induced Effects</th>
<th>Total Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$12,048,614</td>
<td>$2,763,302</td>
<td>$3,829,174</td>
<td>$18,641,090</td>
</tr>
<tr>
<td>2008</td>
<td>$12,626,256</td>
<td>$2,895,782</td>
<td>$4,012,754</td>
<td>$19,534,792</td>
</tr>
<tr>
<td>2009</td>
<td>$14,482,406</td>
<td>$3,321,482</td>
<td>$4,602,658</td>
<td>$22,406,547</td>
</tr>
<tr>
<td>2010</td>
<td>$14,526,982</td>
<td>$3,331,706</td>
<td>$4,616,825</td>
<td>$22,475,513</td>
</tr>
<tr>
<td>Total</td>
<td>$53,684,259</td>
<td>$12,312,272</td>
<td>$17,061,411</td>
<td>$83,057,941</td>
</tr>
</tbody>
</table>
Table 5: Employment Impact (Jobs Created) of EITC on Erie County

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
<th>Induced Effects</th>
<th>Total Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>430.11</td>
<td>81.06</td>
<td>113.25</td>
<td>624.42</td>
</tr>
<tr>
<td>2008</td>
<td>450.73</td>
<td>84.94</td>
<td>118.68</td>
<td>654.35</td>
</tr>
<tr>
<td>2009</td>
<td>516.99</td>
<td>97.43</td>
<td>136.12</td>
<td>750.55</td>
</tr>
<tr>
<td>2010</td>
<td>518.59</td>
<td>97.73</td>
<td>136.54</td>
<td>752.86</td>
</tr>
<tr>
<td>Total</td>
<td>1916.43</td>
<td>361.15</td>
<td>504.59</td>
<td>2782.17</td>
</tr>
</tbody>
</table>
### Table 6: Foregone Impacts of EITC on Erie County

<table>
<thead>
<tr>
<th>Year</th>
<th>EITC</th>
<th>Output</th>
<th>Employee Compensation</th>
<th>Labor Income</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$10,820,492</td>
<td>$13,355,271</td>
<td>$4,006,456</td>
<td>$4,660,272</td>
<td>156.10</td>
</tr>
<tr>
<td>2008</td>
<td>$11,339,254</td>
<td>$13,995,557</td>
<td>$4,198,536</td>
<td>$4,883,698</td>
<td>163.59</td>
</tr>
<tr>
<td>2009</td>
<td>$13,006,206</td>
<td>$16,053,005</td>
<td>$4,815,751</td>
<td>$5,601,637</td>
<td>187.64</td>
</tr>
<tr>
<td>2010</td>
<td>$13,046,239</td>
<td>$16,102,415</td>
<td>$4,830,573</td>
<td>$5,618,878</td>
<td>188.21</td>
</tr>
<tr>
<td>Total</td>
<td>$48,212,191</td>
<td>$59,506,247</td>
<td>$17,851,315</td>
<td>$20,764,485</td>
<td>695.54</td>
</tr>
</tbody>
</table>

---

i See US General Accounting Office (2001)

ii See IRS - Small Business Self-employed Research (2002).

iii For example, Johnson et. al. (2010) and Munn et. al. (2010)

iv For output, employee compensation and labor income impacts, each type of impact (i.e. direct, indirect, induced and total) is calculated as the product of EITC payments and the corresponding “effect” calculated from the previous step. IMPLAN employment effects are defined as increase in jobs from $1 million increase in sales, so employment impact is calculated as (EITC payments / $1 million) × employment effects.


vi 20% of non-filer rate of EITC is an assumption used in many studies, including Jacob France Institute (2004) and Avalos, A. and Alley, S. (2010).

vii As defined on Implan.com, proprietor income consists of payments received by self-employed individuals and unincorporated business owners. This income also includes the capital consumption allowance and is recorded on Federal Tax form 1040C.