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A PRACTICAL MATHEMATICAL MODEL FOR IMPLICIT EXPORT TAXES

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Johns Hopkins Institute for Applied Economics,
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A Practical Mathematical Model for Implicit Export Taxes

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About the Series

The *Studies in Applied Economics* series is under the general direction of Professor Steve H. Hanke, Founder and Co-Director of The Johns Hopkins Institute for Applied Economics, Global Health, and the Study of Business Enterprise (hanke@jhu.edu).

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Abstract

In economies plagued by weak economic fundamentals and strict exchange rate controls, a phenomenon can occur where the true value of the local currency is less than that of the official rate. This gives rise to a black market exchange rate which heavily subsidizes imports at the expense of exporters. Governments are obligated to finance this discrepancy through implicit export taxation. This paper provides a mathematical framework which captures the dynamic between governments and exports in the context of black market premiums and currency controls.

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Introduction

The most well known method by which governments finance deficit spending is through the issuance of new currency, dubbed seigniorage. There exists a second, less common and unofficial quasi-fiscal operation known as implicit export taxation. Governments are able to generate surpluses of foreign currency by forcing exporters to surrender foreign currency at official, undervalued rates for local currency. However, the ability to implicitly tax exporters is contingent on the existence of a parallel, "black market" exchange rate. Within this scenario, there is an 'official' exchange rate set by the government, and a free floating 'black market rate' that is determined by the forces of supply and demand, the latter dubbed as such due to the illegality in engaging with this rate. The overvalued official exchange rate effectively serves as an implicit import subsidy. Select privileged importers are able to exchange local currency for foreign currency at this rate, allowing them to import goods worth more than the true value of their exchanged local currency. Of course, this discrepancy between the official and true value of imports must be financed by the government through some means. This is achieved at the expense of the exporters; exporters are unable to reap the true value of their exports as the government fleeces them for cheap foreign currency, spawning an interesting dynamic between these two parties. Exporters must decide whether and how deeply to engage in the black market which in turn affects how much implicit export tax the government obtains from them. By obtaining the necessary intuition through a literature review and forming a mathematical framework, this paper hopes to quantitatively capture this dynamic and validate it through the use of real data in a case study of Zimbabwe.

Parallel Markets

The foreign exchange that underlies trade between nations with robust, developed economies is a relatively straightforward affair. If the exporter receives payment in foreign currency, the domestic financial institution holding their funds will convert the foreign currency received for local currency at a single determined exchange rate. The exporter is then able to freely access and use the funds that are now denominated in their own currency.

However, in some developing nations, a phenomenon occurs where a parallel currency "black market" arises. If the central bank is not willing to meet demand for foreign exchange, a parallel currency exchange market emerges to fulfill this role. Excess demand for foreign exchange can arise for a variety of reasons. Usually, black markets in developing countries emerge due to restrictions on foreign trade and capital flows (Agénor, 1992). The imposition of tariffs and quotas can bottleneck demand, which leads to illegal imports and exports, i.e. smuggling. Foreign exchange is traded legally to finance legal trade, and illegally to finance any additional trade (Pitt, 1983). Additionally, political or economic instability can cause capital flight, as people seek to hedge against adverse conditions with foreign currency holdings. Inflation can also cause excess demand for foreign currency, as hedging against an 'inflation tax' occurs and causes excess foreign exchange demand. The size of the market and the parallel exchange rate are determined primarily by the quantity of excess demand for foreign exchange. In countries where demand is not significant, the parallel market may serve as a supplementary foreign exchange marketplace that handles marginal overflow. In this case, the difference between the official and parallel exchange rate is not significant. Contrarily, if the official exchange market is heavily rationed, the parallel market is typically well developed and

organized, featuring a significantly depreciated exchange rate. The supply of 'illegal' foreign currencies generally comes from (Agénor, 1992):

1. Smuggling of exports
2. Under-invoicing of exports
3. Over-invoicing of imports
4. Foreign tourists
5. Diversion of remittances through unofficial channels
6. Corrupt government officials diverting foreign exchange from official to parallel markets.

The above is considered a black-market system. A dual exchange rate system is where the government sets an 'official' exchange rate for certain transactions that is usually pegged or managed, and all other remaining transactions go through an official floating exchange rate.

A Brief Overview of International Trade

The international buying and selling of goods comes from the age-old assumption that there are gains to be made from international trade. When countries sell goods and services to each other, this transaction is almost always to their mutual benefit (Krugman, Obstfeld, and Melitz, 2018). According to data published by the IMF, the global export of goods was a $19.2 trillion USD industry in 2018.

An exporter is any entity that sends goods or services for sale to a buyer in another nation. An importer is any entity that brings goods or services from another nation. A

commercial invoice is a customs document that lists, in the invoice currency, the payment amount that is agreed upon in a transaction between the importer and exporter. The significant majority of global trade transactions are paid for with US dollars, which is considered the primary vehicle currency of global trade. In 2014, the dollar's share of worldwide currency usage stood at 51.9% (SWIFT, 2015). As of late 2019, 61.78% of global foreign exchange reserves were composed of US dollars.

As such, the US dollar is considered the dominant vehicle currency of international commercial transactions. A globally accepted vehicle currency functions as a medium of exchange among countries. By eliminating the need to set up bilateral currency trading posts among all possible countries, a vehicle currency reduces currency transaction costs (Devereux and Shi, 2013). Additionally, the US dollar is important in the invoicing of world trade for three primary reasons (Goldberg and Tille, 2007):

1. The United States is an important consumer and producer of world markets

2. Exchange rate regime considerations where various countries peg their currencies to the dollar

3. Relatively homogenous goods (oil, steel, wheat, etc), which are an important part of global trade, are priced by foreign sellers in US dollars to remain internationally price competitive

The majority of importers pay their export counterparts with commercial letters of credit, which contracts a bank to guarantee full payment to the seller on the condition that all goods are

shipped, and the terms of the letter are fully complied with. In numbered steps, the method by which a letter of credit functions is listed below (Giovannucci, 2007):

1. Buyer and seller agree on a commercial transaction.
2. Buyer applies for a letter of credit.
3. Issuing bank issues the letter of credit (LC)
4. Advising bank informs the seller that an LC has been opened in his or her favor.
5. Seller sends merchandise and documents to the freight forwarder.
6. Seller sends copies of documents to the buyer.
7. Freight forwarder sends merchandise to the buyer's agent (customs broker).
8. Freight forwarder sends documents to the advising bank.
9. Issuing bank arranges for advising bank to make payment.
10. Advising bank makes payment available to the seller.
11. Advising bank sends documents to the issuing bank.
12. Buyer pays or takes loan from the issuing bank.
13. Issuing bank sends bill of lading and other documents to the customs broker.
14. Customs broker forwards merchandise to the buyer.

For a shipped good to pass inspection at a receiving port, it must have an underlying customs document that has already been drawn up by importer and exporter. A customs document typically includes a bill of entry, a commercial invoice, import license, and purchase order/letter of credit (ITA, 2018). Governments track trade data by examining these aforementioned customs documents (UNSD, 2011). Governments track import and export data for a broad variety of reasons, from passive purposes such as the taxation of said imports and exports to active purposes such as the imposition of quotas on the import or export of certain goods.

The Fiscal Benefit of Parallel Currency Exchange Markets

Outside of borrowing and direct taxation, nations have two secondary methods of financing fiscal deficits: seigniorage, and implicit export taxation (Pinto, 1990). Seigniorage is the value a government garners through the issuance of local currency at the expense of consumers. The second method, implicit export taxation, is when governments indirectly tax exporters for their earned foreign exchange based on the discrepancy between the official and black market rate. Governments benefit by forcing exporters to surrender foreign currency to commercial banks at the official exchange rate, which is typically lower than the free-floating black market rate. Thus, governments can derive an additional source of foreign currency at cheaper prices by taking advantage of the black market. This negatively affects the competitiveness of legal exports, as exporters are underpaid because they do not receive the "true" value of their exports (determined by the black market rate), undermining profitability. This was the case for Ethiopia in the '70s and '80s where the existence of a parallel exchange rate had a "significant negative effect on merchandise exports in both the long run and the short run" (Degefa, 2001, p. 30). Governments tend to tolerate black markets in the short term, not

only because of its fiscal benefits but also because of the high cost of prosecution. While the suppression of parallel currency markets is not uncommon, success and the commitment to continued efforts are typically short-lived. (Kiguel and O'Connell, 1994). Examples of nations that tolerated parallel rates are: Venezuela ('83 – '89), Ghana ('83 – '87), and Zambia ('87 – '88). Examples where parallel rates are illegal (with varying degrees of enforcement) are: (Ghana (before '83), Tanzania (till '84), and Turkey (1970s).

A common way for exporters to bypass the implicit export tax is by under-invoicing exports. Exporters understate the value of exported goods and receive the remaining payment through covert, illegal channels.

Under-Invoicing of Goods – An Example: Company A (a foreign exporter) ships 1 million widgets worth $2 each, but invoices Company B (a colluding domestic importer) for 1 million widgets at a price of only $1 each. Company B pays Company A for the goods by sending a wire transfer for $1 million. Company B then sells the widgets on the open market for $2 million and deposits the extra $1 million (the difference between the invoiced price and the "fair market" value) into a bank account to be disbursed according to Company A's instructions.(FATF, 2006)

By under-invoicing exports, exporters boost profits by exchanging the covertly sent foreign currency through the black market rate, thereby receiving a premium on the amount of local currency received. These practices are profitable when this parallel rate 'premium' is greater than the risk premium of accessing the parallel currency market (Barbosa, 1992).

On the opposite side, the existence of a black market and implicit export taxation facilitate an implicit import subsidy. Foreign currency surrendered at unfavorable official exchange rates by exporters are used to finance the activities of a select group of importers.

These importers are able to purchase foreign currency at the official rate and thereby import goods worth more than the underlying local currency used. These manipulations are considered to be 'quasi-fiscal operations', as they are fiscal in all but name only (Rosenburg and Zeeuw, 2000). This was the case in Uzbekistan in the 1990s. The Uzbek central bank profited off of these quasi-fiscal operations by forcing exporters to surrender foreign currency at set government exchange rates, then turning around and selling them to importers at slightly higher rates. Through these operations, governments are able to finance deficits and the implied discrepancy between official and true levels of import spending.

Literature Review of Previous Models

The wide ranging effects of a black market exchange rate on exports have been broadly studied. However, it was not until Brian Pinto's work on black market premia and exchange rate unification in Sub-Saharan Africa did the first quantitative model arise in an attempt to explain the phenomenon of implicit export taxes (Pinto, 1989).

In Pinto's model, for simplicity, it is assumed that government expenditure consists only of imported goods and constant foreign interest payments. Now let *g* and *t* be denoted as government expenditure and official tax revenue respectively in foreign currency units. Let *e* be denoted as the official exchange rate.

$$\Delta M = e(g - t)$$

That is, the official deficit in terms of local currency units is equal to the change in money supply (denoted ΔM). This can also be interpreted as the inflation tax due to an increase in money supply transferring buying power from citizens to the government. Distributing e, this equation can be rewritten as:

$$\frac{\Delta M}{M}\frac{M}{b}\frac{b}{e} = (g - t)$$

where *M* is the money supply, *b* is the black market rate. The first term on the right hand side, $\frac{\Delta M}{M}$, can be thought of as the percentage change in money supply (or rate of inflation tax). The second term, $\frac{M}{b}$, can be thought of as the money base for the inflation tax in terms of the amount of foreign currency obtained through the black market. The third term, $\frac{b}{e}$, can be thought of as the black market premium multiplier (strictly speaking, the black market premium minus 1). Intuitively, this equation can be interpreted as the change in money supply in terms of foreign currency obtained through the official rate being equal to the official government deficit. Now let $\frac{b}{e} = \Theta$, the black market premium multiplier. Rewritten, the above becomes:

$$\frac{g}{\Theta} = \frac{t}{\Theta} + \frac{\Delta M}{M}\frac{M}{b}$$

Consider the following numeric example: The official exchange rate is 3 pesos per dollar, but the black market rate is 4 pesos per dollar, so Θ = 4/3. The government spends \$100 but $\frac{g}{\Theta} = \$75$, which is the only contribution from official taxes and inflation tax. Thus, the remainder of \$25, given by $g - \frac{g}{\Theta} = g\frac{(g-e)}{b} = g(1 - \frac{1}{\Theta})$ is interpreted as the implicit export tax. This gives the following where the final term is the implicit export tax:

$$g = \frac{t}{\Theta} + \frac{\Delta M}{M}\frac{M}{b} + g(1 - \frac{1}{\Theta})$$

It can be seen that as the black market premium multiplier increases, the government relies less on official and inflation taxes, and relies more on implicit export taxes to finance government expenditure.

Pinto's model was the first and only of its kind, attempting to explain the mechanics of black markets rates and implicit export taxes. However, it has many glaring weaknesses. Accounting wise, it essentially assumes that the only sources of government foreign exchange revenue are official and inflation taxes, ignoring the many other significant sources utilized by

real world governments. Furthermore, the model attempts to equate this to government expenditure on foreign imports and interest payments when in reality, government revenue is also used to finance expenditure denominated in local currency.

Despite these flaws, its true Achilles Heel lies in the fact that it disregards the dynamic between exporters, importers, and the government. The model assumes that governments, in order to satisfy fiscal needs such as financing the subsidy importers enjoy through the official rate, procure as much foreign exchange as they can through official channels and then simply turn around and source the rest implicitly from exporters. This implies a view of the black market as a simple "mathematical tool" in which one can naively derive the implicit export tax as a simple difference between actual and theoretical government expenditure. Yet, this completely ignores the very things which made this possible: the black market and exporters! Exporters are not just dogs occasionally beaten by the government for "lunch money". They also have access to the black market and can decide how much of their earnings to invoice through official channels and elsewhere. Therefore, it is imperative for a sound model of implicit export taxes to incorporate the exporter perspective.

Modified Implicit Export Tax Model

While Pinto's model serves quite well as a foundation for the mathematical intuition behind implicit export taxes, it relies upon naive assumptions which makes generalization to the real world difficult. Of its many shortcomings is the assumption that governments spend only on imports and foreign interest payments. The model thereby sets the inflation tax (change in money supply) and official taxes equal to this simplified government expenditure before algebraically deriving implicit export taxes. This model does not take into account export related variables or the true bulk of government spending, a major oversight given that the primary purpose of

implicit export taxes is to cover this very spending. Instead, we offer a more grounded model, based upon and modified from previous ones.

We once again start from Pinto's identity with some modifications.

$$G = (\Delta M = D) + T + oR$$

$$ID = (\Delta M = D) + \Gamma$$

$$ID = Total\ Imports \cdot (b - e)$$

We set government expenditure (G) equal to the summation of the change in money supply (ΔM which can be interpreted as the inflation tax), taxes (T), and other revenue sources (oR). It is important to note that in this context, the change in money supply can also be thought of as the government deficit (D). Then, we set the difference between using the black market and official exchange rates for calculating the value of total imports in local currency units (ID) equal to the summation of the government deficit ($\Delta M = D$) and implicit export taxes Γ. Intuitively, this states that the government deficit (as calculated from official expenditure reports and revenue sources) is used to partially pay for the implicit subsidy importers enjoy. The rest comes from the implicit tax levied upon exporters.

We can further break down implicit export taxes into the following function:

$$\Gamma = (1 - \Phi) \cdot X \cdot (b - e)$$

where Φ is the share of exports invoiced through the black market (between 0 and 1), X is the total value of exports (in foreign currency units), b is the black market exchange rate, and e is the official exchange rate. The rationale is that exporters, which typically receive payment in foreign currency, must decide on a proportion to exchange through the black market exchange rate (thereby gaining more local currency than if done through the official rate). The government would then only be able to profit off the amount ($(1 - \Phi) \cdot X$) invoiced through the official rate.

This profit can then be modeled as the difference between invoicing this amount through the black market rate versus the official rate.

This leads naturally to the question; how are X and Φ derived? At first glance, one might assume X can be easily obtained by converting export statistics into foreign currency units using either the official or black market rate. However, as demonstrated previously, it is not so straightforward in countries with thriving black markets. In fact, there is no reliable source for such data. Instead, X can be derived through the following:

$$E = (1 - \Phi) \cdot X \cdot e$$

$$\Rightarrow X = E\,/((1 - \Phi) \cdot e)$$

Here, E is officially reported exports in terms of local currency units.

All that finally remains is the derivation of Φ. Shifting perspectives, exporters wish to maximize revenue (R in terms of local currency units) which can be modeled as the following maximization problem (Kamin, 1988):

$$R = [\Phi \cdot X \cdot b] + [(1 - \Phi) \cdot X \cdot e] - \left[\Phi \cdot X \cdot e \cdot \left(1 - exp\left(-\left(\frac{b}{e}\right) \cdot \Phi\right)\right)\right]$$

$$such\ that\ 0 \leq \Phi \leq 1, e \leq b$$

Therefore, revenue is the summation of exports invoiced through the black market rate and exports invoiced through the official rate subtracted by a convexing term. Mathematically, the convexing term allows for the solvability of Φ. Economically, the term serves as a type of marginal cost for allocating export payments to the black market rate. It can be interpreted as the "chance" of being caught for illegal, black market activities. This "chance" is modeled using the cumulative exponential distribution function with lambda being the black market premium multiplier ($\frac{b}{e}$) and Φ as the domain. Note that as either the multiplier or the share allocated to

the black market (Φ) increases, the probability of "being caught" increases as well. This probability is multiplied with the revenue lost if caught (the share of export payments allocated to the black market in terms of the official rate) to calculate the expected losses for any given Φ. The derivative with respect to Φ is then taken and set to 0:

$$0 = -(X{\cdot}exp\left(-\frac{b}{e}\Phi\right){\cdot}[(e^2 + (exp - b){\cdot}e){\cdot}exp\left(\frac{b}{e}\Phi\right) + (exp{\cdot}b{\cdot}\Phi) - (exp{\cdot}e)]) \,/\, e$$

While at first glance it may seem that solving for Φ requires X, an unknown variable, since the equation is set equal to 0, X may be distributed over and removed without consequence. Therefore, we see that the share of exports allocated to the black market rate is a function of the black market rate and the official exchange rate. It is important to note that this equation cannot be solved analytically for Φ. This is not problematic since, with actual black market and official rates, Φ can be easily approximated to arbitrary accuracy using computer software.

However, like with all models, this comes with a few caveats. The identities outlined are not so-called "hard and fast" rules due to the complexity of real-life government finances. For example, it is not always the case where government expenditure matches with all sources of revenue plus deficit perfectly (or even closely for that matter). These identities serve more so as a simplified "general rule of thumb." Along with intuitive limitations exist mathematical ones. The black market rate must be equal to or greater than the official exchange rate. If not, then the model will imply a negative share of raw exports towards the black market which is economical nonsense. Practically, the black market rate is, roughly speaking, never less than the official exchange rate since mass arbitrage would push the rate to at least the official. The model also begins to break down once the black market multiplier rises above a certain threshold (roughly 4.1). Past this point, the derivative never reaches 0 which implies a 100% share of raw exports towards the black market. This is due to the assumption that the only cost to turning to the black

market is the worth of the under invoicing exports using official rates. In reality, however, exporters often face much harsher penalties for repeat/egregious offenses such as operation shutdowns and/or incarceration.

Case Study: Zimbabwe

A sub-Saharan African country prominent in recent years for its burgeoning black market rate is Zimbabwe. For the years of 2016 to 2018 (any many years prior), the Reserve Bank of Zimbabwe maintained an official exchange rate of 1 local bond note to 1 USD. However, beginning in 2017, the black market rate began to climb which was accompanied by rising (eventually hyper) inflation.

Despite this predicament, Zimbabwe's expenditure not only continued to exceed that of its revenue, but even led to an increased deficit from 3.6 billion LCU in 2016 to 5.6 billion LCU in 2018. Furthermore, imports continued to exceed exports over the 3 year duration. While budget and current account deficits are usually not crippling issues (provided they are not massive) for sound governments, they were coupled with an expanding black market for foreign currency. Thus, imports began to be implicitly subsidized by the artificially overvalued local currency, further burgeoning the Zimbabwean government with an "implicit" current account deficit. Yet, official numbers showed no signs of how the government was paying for this discrepancy. Of course, though, these implicit import subsidies were simply the opposite side of the same coin, the other side being implicit export taxes. It was this source that the government drew upon to fuel its need for foreign exchange.

Zimbabwe			
Year	2016	2017	2018
Gov. Expenditure (Billions LCU)	4.863	6.169	7.497
Gov. Revenue (Billions LCU)	3.564	3.943	5.586
Exports (Billions LCU)	4.098	4.333	7.107
Imports (Billions LCU)	6.427	6.694	7.909
GDP (Billions LCU)	20.806	27.438	42.795
Deficit (ΔM=D)	1.299	2.226	1.911
Import Discrepancy (ID)	0.000	7.298	13.420
Official Exchange Rate	1	1	1
Average Black Market Rate	1	2.090	2.697
Average BM Multiplier	1	2.090	2.697
Share Invoiced Through BM	0.00%	11.44%	15.76%
True Exports (X) (Billions USD)	4.098	4.893	8.437
Implicit Export Tax (ϕ)(Billions LCU)	0.000	4.724	12.059
ID - D	N/A	5.072	11.509
Absolute % Deviation	N/A	6.86%	4.78%

As depicted in the figure above, as the black market rate began to grow, the government began to find itself needing more and more supplies of foreign exchange to finance the growing discrepancy between official and true import worth (Billions LCU). At the same time, exporters

found themselves being faced with the question of how large a share of their earned foreign exchange they wished to invoice through either official channels or the black market. By capturing this dynamic through this paper's described model, it can be seen that the implicit export tax on officially invoiced exports accounted for the majority of the import value discrepancy minus deficit with deviations of 6.86% and 4.78% for the years of 2017 and 2018 respectively.

Conclusion

In countries where the official currency is held at a fixed exchange rate, factors such as weak economic fundamentals, strict currency controls, and lack of confidence can lead to a phenomenon where the official value of the currency is greater than its true value. This leads to what is called a black market rate, an unofficial, illegal exchange rate between the local and foreign currencies.

A burgeoning black market rate is generally regarded as both a symptom and cause of a stricken economy. Surprisingly, however, there may be reasons why the government may tolerate this. Chief of those reasons is the government's ability to acquire foreign exchange at a cheaper price in order to satisfy its many obligations. One of these are the implied subsidies that importers enjoy. Importers are, by using the official exchange rate, able to import goods with value greater than the true value of the local currency used to pay.

Of course, the government must address this discrepancy in value through some means. The unfortunate bearers of this burden are, like the flip side of a coin, the exporters. Exporters, receiving payment in initially foreign currency, must surrender this to the government through the official exchange rate for local currency, thereby earning less than the true value for their exported goods and services. However, exporters may also choose to "invoice" a share of its

earned foreign currency through the black market. It is the remainder through which the government reaps its spoils. This is deemed the "implicit export tax."

Due to the obvious lack of transparency regarding exporter dealings in the black market, the implicit export tax's value is not immediately clear at any given time. However, by using relevant data through the framework of an optimization problem, this paper is able to derive the share of exporter earnings invoiced through the black market and provide an estimation of implicit export taxes consistent with expectations.

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