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Unintended Consequences: Spillovers from Nigeria's Fuel Pricing Policies to Its Neighbors

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Unintended Consequences: Spillovers from Nigeria's Fuel Pricing Policies to Its Neighbors

Prepared by Montfort Mlachila, Edgardo Ruggiero, and David Corvino[1]

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Abstract

This paper examines the constraints that negative externalities (i.e., smuggling from a large neighbor) impose on the application of automatic fuel price adjustment mechanisms. It is often recommended to establish an automatic price adjustment mechanism to reduce fuel subsidy expenditures, but this approach may not work in the presence of these externalities. The paper illustrates the constraints by examining the case of Nigeria, a major oil exporter that subsidizes gasoline, and that of Togo, an oil importer and neighbor of Nigeria. It finds that the price differential between formal prices in Togo and Nigeria is the main driver of changes in formal sector gasoline consumption. Specifically, the lower the formal price in Nigeria, the higher is smuggling from Nigeria to Togo, and the lower the tax base in Togo. The econometric results suggest that, unless the real economy is performing very well, increases in pump prices in Togo are likely to erode the tax base, unless there are greater border controls. The unintended consequences of Nigeria's pricing policies are the constraint they impose on fuel pricing policies of its neighbors and the subsidy Nigeria transfers to them (equivalent to at least 3 percent of Togo's GDP in 2011), three-quarters of which was captured by smugglers in 2011, while one-quarter enhanced consumers surplus through lower gasoline prices.

JEL Classification Numbers: H2, H3, F5

Keywords: fuel pricing, smuggling, spillovers, optimal taxation

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I. INTRODUCTION

This paper aims to illustrate how the traditional policy recommendation of having an automatic fuel pricing mechanism to curb subsidies can be undermined by the existence of smuggling as a result of lower prices in a neighboring country. The case study of Nigeria—a major oil exporter that subsidizes its domestic gasoline prices—and that of Togo, and to a lesser extent Benin, is analyzed. The results presented here are applicable to other groups of countries.

Fuel price subsidies are among the most intractable fiscal policy issues facing a large number of African countries today. Fuel subsidies typically arise when governments control retail prices and do not adjust them upwards when international fuel prices rise. While most policymakers are fully aware that they are fiscally costly, inefficient, inequitable, encourage corruption and smuggling, and often lead to wasteful consumption, they find them difficult to reduce, let alone eliminate, for various political economy reasons. An important reason fuel subsidies are persistent in sub-Saharan Africa (SSA) is that they are perceived as a relatively efficient and transparent way to redistribute wealth in the absence of effective social safety net and social protection systems.

Fuel price subsidies are particularly costly for government budgets. On average, they cost about 2 percent of GDP per year in SSA (IMF, 2013). They are also inequitable as they are largely captured by the most wealthy as benefits are a direct function of consumption. While the poor undoubtedly also benefit from the subsidies, it is an inefficient way of delivering them. According to Coady and others (2010), it typically costs about US$33 dollars to give US$1 in subsidies to the poor. When subsidies are particularly high, they lead to wasteful consumption and also encourage smuggling to neighboring countries, which is tantamount to unintentionally subsidizing neighboring countries.

It is worth remarking that most African governments do not subsidize fuel prices outright. They often do so implicitly by practicing discretionary forbearance by not collecting legally mandated taxes and by other means. They often do this by reducing customs values, e.g., by using nonmarket exchange rates, ad hoc reductions in tax rates and sometimes by capping distributors' margins. A small minority of countries, especially oil exporters such as Venezuela and Nigeria, do have explicit subsidies whereby retail fuel prices are set below cost.

The first best approach to dealing with subsidy-related problems is to (progressively) reduce blanket subsidies and replace them with targeted ones, e.g., cash transfers. Putting in place an automatic price adjustment mechanism—perhaps combined with smoothing—has the advantage of increasing transparency and reducing political interference. However, as indicated above, most governments find reducing subsidies politically difficult**.** Why? The biggest beneficiaries, are usually also the most politically influential and organized (e.g., urban population, public employees, private sector transporters). Moreover, subsidies do benefit the poor as well; indeed, they may even constitute a significant component of their income. The poor view them as a "bird in hand", and therefore that they are more robust and certain than targeted transfers which may be subject to greater political manipulation. This is particularly the case if the level of credibility of the state is relatively low. And putting in

place targeted transfers does require additional work, which government may not want (or is unable) to do.

The reform can be made even more difficult if there are negative externalities from the fuel pricing policies of a large neighboring country. In the case of countries such as Benin and Togo, Nigeria's high fuel subsidies have led to a significant price differential in official prices that increases the operating margins of smugglers. As a consequence, the higher the subsidy (i.e., the lower the official price) in the neighboring country, the larger the smuggling towards Benin and Togo. This leads to a smaller fuel tax base for legally consumed fuel in these two countries. Indeed, the actual level of fuel sold on the formal (taxed) market has declined precipitously in the case of Benin (to only 15 percent of total consumption) and was on a downward trend in Togo for much of 2012. It started rising again in December 2012, as authorities in both Benin and Togo intensified anti-smuggling efforts.

Most of the analysis of the reform of fuel subsidies has not explicitly taken into account the impact of neighbors' policies. This paper is an attempt to rectify this lacuna. It draws on related literature on cigarette smuggling across US state borders. Specifically, the paper develops a game-theoretic model that combines the optimization behavior of private consumers (utility) and the government (revenue). The model shows that a Laffer-type relationship exists between the level of the effective tax rate and tax revenues, and underscores that the ease with which smuggling can be conducted effectively constrains the government's ability to maximize tax collections.

The paper also empirically estimates the impact of Nigeria's pricing policies on the Togolese formal sector fuel consumption. It shows that Nigeria's price level has a strong and statistically positive impact on Togo's formal sector fuel consumption (and vice versa for informal consumption). Using a natural experiment, given that Nigeria does not subsidize diesel prices, the paper estimates the implicit subsidy conferred to Togo at about 3 percent of Togo's GDP in 2011. Three quarters of this subsidy was actually captured by smugglers and one quarter went to increase the welfare of Togolese consumers, as they purchased gasoline at lower informal prices. Because of these spillovers, the standard prescription to institute an automatic fuel pricing mechanism to reduce subsidies may not be the first best solution, as it can lead to tax base erosion if there is an increase in the price differential.

Two clarifications are useful to justify our focus on Togo—which does not share a border a border with Nigeria—while excluding Benin—which does share a border. First, though geographically no border is shared by Togo and Nigeria, we consider the two countries as neighbors because their economies are closely integrated through formal and informal trade flows. Indeed, Togo is less than 120 km from the Nigerian border. On the formal side, Nigeria is Togo's second trading partner in sub-Saharan Africa (IMF *Direction of Trade Statistics*, 2013). On the informal trade side, Togo is the recipient of large quantities of smuggled fuel originating from Nigeria—through Benin—while Togo informally exports used cars, rice, and fabrics to Nigeria. The formal importation of these items in Nigeria is subject to stringent regulations and high duties. As a result, large quantities are imported in Togo and then informally diverted to Nigeria. Second, in this paper we do not investigate the impact of Nigeria's fuel pricing policy on Benin, because lack of data on formal and informal

quantities and prices effectively prohibits such analysis (see below). In effect, large smuggling volumes have made the formal gasoline market almost irrelevant.[2]

II. RELATED LITERATURE

There is considerable related literature that investigates the impact on tax policies in one jurisdiction on those of another. While a significant portion of this literature focuses on income taxes in the context of tax competition, a more relevant strand for this paper's purpose is the one that looks at cross-border shopping as a result of tax differentials. Leal and others (2010) provide a comprehensive review of this literature. We focus here on the most relevant papers for this study.

Kanbur and Keen (1993) provided the seminal theoretical work in the area of tax competition and coordination when countries differ in size. Based on a game-theoretic approach, they argue that differences in country size exacerbate inefficiencies in tax collections if there is non-cooperative behavior, thereby harming both countries. They derive optimal tax rates based on two strategies: (i) Pareto efficiency, i.e., maximizing the revenue of one country conditional on securing at least some level of revenue for the other; and (ii) joint revenue maximization, their preferred approach. They propose a minimum common tax rate as being the best strategic response of the larger country to ensure sufficient cross-border trade.

A sub-genre of this literature has focused on goods that may have negative externalities, e.g., fuel, cigarettes, and alcohol on which excises are typically levied. The literature typically shows that differences in excise rates often lead to smuggling, e.g., in the case of cigarettes among US states. McLaren (1998) emphasizes the "market thinning" aspect of smuggling, creating multiple equilibria: low-price parallel markets, and high-price official ones. In this context there is a bifurcation of optimal tax strategies: a weak tax administration will follow a "cash cow" pattern with one sector, where tax collection is easier to enforce, bearing all of the tax, while a more effective one follows a modified Ramsey tax rule (the optimal tax rate for consumption is the inverse of the price elasticity of demand). In their summary, Leal and others (2010) conclude that typically in the US, a 1 percent increase in tax rates reduces sales by 6 percent, thus leading to a net loss in revenues.

Most of the theoretical literature focuses on the derivation of optimal excise rates from a broad social welfare perspective. A typical example is in DeCicca and others (2010) who derive the optimal corrective tax rate $\tau\ (opt)$ that maximizes the social welfare for cigarettes. According to them:

$$\tau(opt) = E^c - \{E^c - \tau *\}\frac{\eta *}{\eta}\frac{Q *}{Q}$$

Where:

[2] By virtue of a shared border, smugglers from Nigeria to Benin face low transaction costs. By one unverified estimate reported in *Jeune Afrique*, the smuggling of petroleum products from Nigeria to Benin implies a cost of over 23 million Euros per year (3 percent of 2009 tax revenue) in fiscal revenue losses to Benin's government (Ballong, 2010)

η, η^* = elasticities of consumption in the home state (country), non-home state (country), respectively;

Q, Q^* = consumption in the home state (country), non-home state (country), respectively;

E^c = externality cost per unit.

The empirical literature has focused on estimating price elasticities of home consumption in the presence of smuggling. For example, Gruber and others (2002) provide estimates of elasticities for cigarettes in the case of Canada, while Asplund and others (2007) investigate how responsive alcohol sales in Swedish municipalities are to foreign (Danish and German) prices and distance from the border. The latter find that elasticities range from -0.1 to -0.3 depending on distance from the border.

While the literature provides a good starting point for our analysis in this paper, it generally provides an assessment of optimal tax rates on the basis of overall social consideration, e.g., taking into account externalities. In the interest of tractability and given uncertainties about estimating externalities related to fuels, our approach is more basic. We focus on investigating elasticities of consumption in the presence of smuggling and also to derive the best strategy for the home country to maximize fuel-related fiscal revenues. We derive a simple theoretical model and also estimate an empirical model.

III. STYLIZED FACTS

A. The Data

Apart from formal retail prices, which are easily obtained, it is interesting that both Benin and Togo regularly track fuel prices in the parallel market and include them in the consumer price index. This underlines the importance of both informal and formal consumption of fuel. The parallel market has generally been tolerated, although it is illegal.[3] Monthly time series are available from January 2008 through December 2012 for the following variables:

- Formal gasoline and diesel consumption for Togo and prices. No data are available for Benin.
- Parallel market prices for gasoline. No time series on such prices is readily available for Benin.[4]

[3] From late 2012, Benin started clamping down on smuggling. In parallel, Togo tightened controls of vendors and traders by security forces. In both countries, as a consequence, the spread between formal and informal market prices narrowed, hence reducing the price incentive to maintain illegal distribution networks. As a result, effective fuel prices increased for consumers—apparently without any noticeable social impact (nor protests).

[4] The absence of time series on quantities traded on the formal market and prices for fuel products in Benin prohibits conducting any quantitative analysis. Such analysis can instead be conducted for Togo.

Nigerian authorities do not set the pump price of diesel fuel and only issue indicative prices. Thus the price of diesel is largely market-determined. Consequently, there is no smuggling for diesel from Nigeria to Togo, thus no parallel market prices. This fact provides a natural experiment to examine comparative dynamics between gasoline and diesel markets.

B. The Fuel Price Mechanism in Togo

The government sets the prices of petrol, diesel, and kerosene in Togo.[5] For each product, the authorities publish monthly a detailed price structure defining the price at the pump as the sum of the following components: (i) import price (CIF); (ii) costs and margins for storage, transportation, distribution, and retail sale; (iii) taxes (custom duties, excises, and VAT); (iv) a specific levy to repay old state debt towards oil importers; minus (v) a variable subsidy to minimize changes in domestic retail price, notwithstanding international price and exchange rate movements (Figure 1).

As a critical component of its package of economic reforms, Togo adopted an automatic price adjustment mechanism for fuel products in December 2010. Each month, retail prices can be raised (lowered) up to 5 percent, with a maximum increase (decrease) of 30 percent within one calendar year. The cap on the monthly change serves to limit fluctuations in domestic retail prices in response to short-term volatility in import prices. A price commission meets monthly to review the price structure and recommend retail price changes, as well as changes in the price structure, to a ministerial committee. However, ministers are not obliged to adopt the technical recommendation.

The price adjustment mechanism was implemented only in June and July 2011, when retail prices of fuel products were increased by 5 percent each month. Given the rising global oil prices, the limited pass-through led to subsidies amounting to CFAF 32.5 billion, equivalent to 1.9 percent of GDP in 2011. To place this amount in the context of the government's fiscal effort, the increase in oil subsidies from 2010 to 2011 absorbed two-thirds of the increase in tax revenue achieved in 2011.[6] In 2012, Togo spent even more for fuel subsidies: CFAF 42.5 billion, equivalent to 2.3 percent of GDP. Apart from high international fuel prices, an important role was played by increased reliance on

Text Table 1a. Togo: Subsidies, Taxes, and Net Taxes on Fuel Products, 2011–12

	Jan-11 - Jan-12[1]	Feb-12 - Dec-12	Percent Change
	(CFAF / liter, unless otherwise indicated)		
Crude Oil (USD/BBL)	104.5	104.8	0.3
Crude Oil (CFA/BBL)	497.0	534.6	7.6
Import Prices			
Gasoline	394.2	422.9	7.3
Kerosene	354.1	386.1	9.0
Diesel	433.6	468.4	8.0
Subsidies			
Gasoline	143.6	153.1	6.7
Kerosene	100.1	117.4	17.3
Diesel	150.5	165.5	10.0
Taxes			
Gasoline	269.1	275.2	2.3
Kerosene	165.4	171.3	3.6
Diesel	268.9	276.1	2.7
Net Taxes			
Gasoline	125.5	122.1	-2.7
Kerosene	65.2	53.9	-17.4
Diesel	118.3	110.6	-6.6

Source: Togolese authorities.
[1] Excluding August 2011.

[5] Kerosene is mostly used for cooking, particularly by low income households in urban areas, as an alternative to coal.

[6] Oil subsidies amounted to CFAF 3.7 billion in 2010 (0.2 percent of GDP).

formal gasoline imports from February 2012 onward, as smuggling activity slowed as a result of higher official prices in Nigeria (Figure 2).

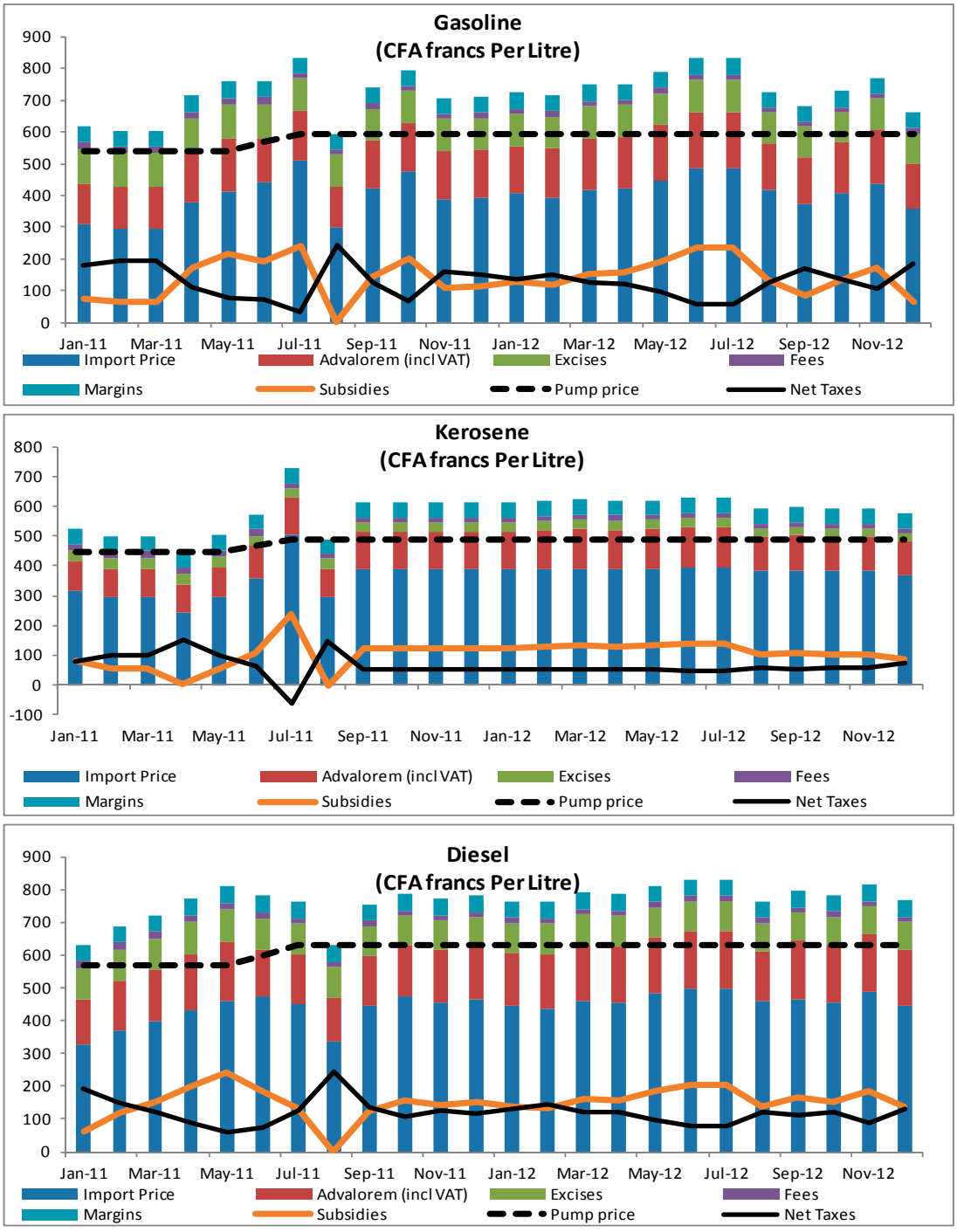
But what happens to fuel-related tax revenue as subsidy expenditures increase? This question is relevant to assess the overall impact on the fiscal position when the volume and unit price of fuel imports increase. So far, the authorities and other stakeholders have only focused on the cost of subsidies when, in fact, as the value of fuel imports increase, so do tax revenue. A key issue for policymakers is thus to understand the net impact on the fiscal position. In turn, this will depend on how the tax base (i.e., the volume of imports) is affected by the differential between official prices in Nigeria and Togo.

A useful concept to conduct such analysis is that of net taxes on fuel products. As shown in Figure 1, domestic trading costs and margins, taxes and fees on fuel products create a wedge between international prices and domestic retail prices. The largest component of this wedge are taxes on fuel products, that is the sum of ad valorem custom duties and VAT and specific excises levied on fuel imports and their domestic trade. The net tax per liter retained by the Treasury to finance general state expenditures is equal to the total taxes collected minus those retained to subsidize pump prices.

Although net taxes per liter were always positive during 2011-2012, they declined after January 2012 (Text Table 1.a). This happened because the authorities did not adjust pump prices, notwithstanding an increase in import prices, and unit subsidies increased.[7] This confirms that, on a net basis, the state earns money from fuel consumption, notwithstanding the subsidy policy, but not the full amount it would if the authorities fully applied the tax and price structure including periodic pump price adjustments.

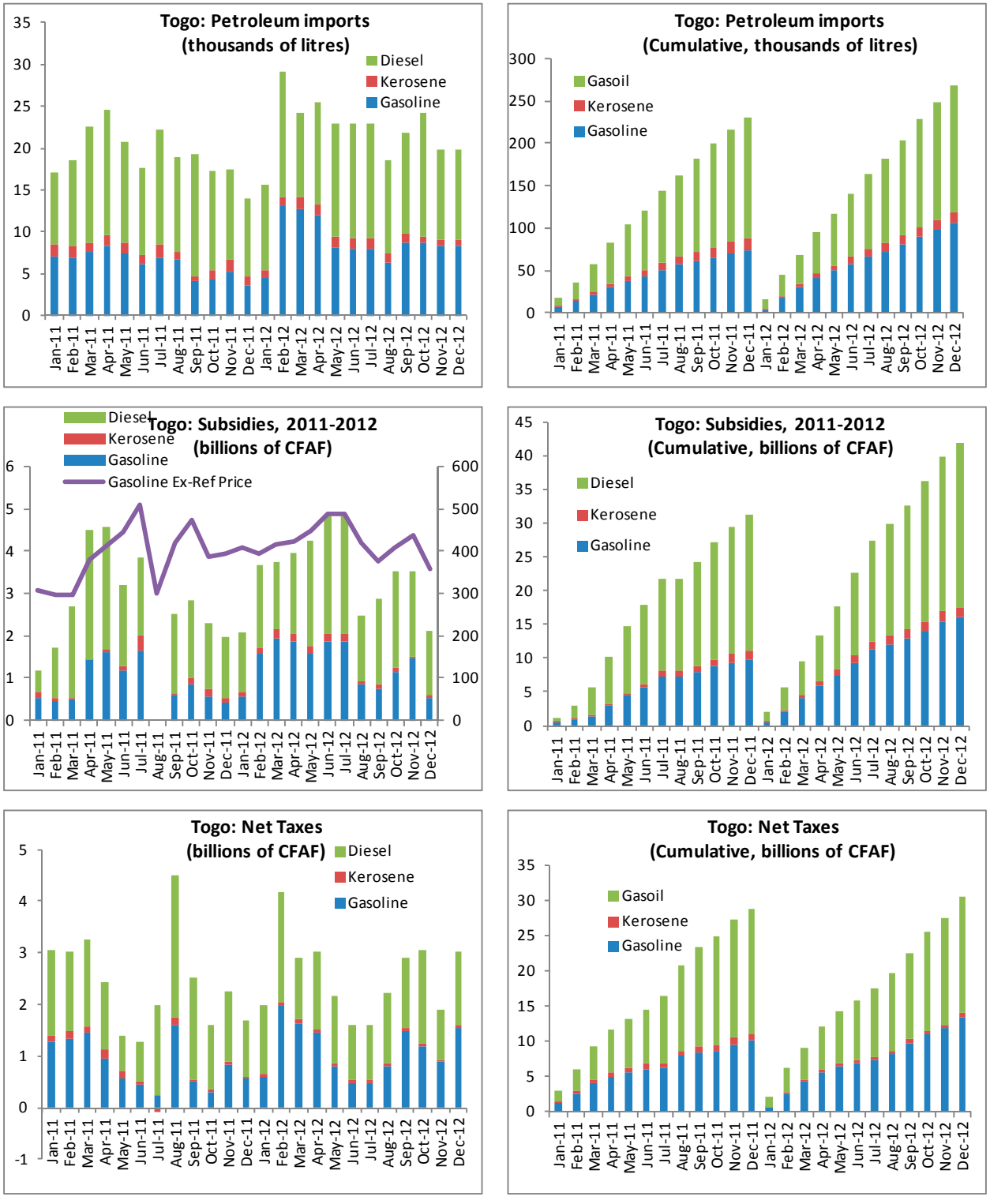
[7] In 2012, the increase in import prices was mainly a reflection of the depreciation of the Euro/CFAF against the US$ over that period.

Figure 1. Togo: Components of Retail Fuel Prices 2011-2012



Sources: Authorities' data; and staff estimates.

Figure 2. Petroleum Products: Imports, Subsidies, and Net Taxes 2011-2012



Source: Authorities' data and staff estimates.

While net taxes per liter declined, total net taxes collected on fuel products increased over the same period because the tax base expanded more rapidly than costs, expressed in CFAF (Text Table 1.b). As the difference between pump prices in Nigeria and Togo narrowed, smuggling declined and monthly volumes of official gasoline imports (i.e., the tax base) shot up by almost 42 percent. This led to an almost 45 percent increase in gross tax collected on gasoline. However, net tax collection increased by less (38 percent), because the volume of subsidies also went up, mirroring the expanded tax base. [8] Overall, over this period, the reduction in the net tax per liter went un-noticed essentially because the volumes of official trade increased.

Text Table 1b. Togo: Subsidies, Taxes, and Net Taxes on Fuel Products, 2011–12

	Jan-11 – Jan-12[1]	Feb-12 – Dec-12	Percent Change
Quantities (Millions of liters)	**227.0**	**252.0**	**11.0**
Gasoline	72.1	102.1	41.6
Kerosene	13.8	12.0	-13.5
Diesel	141.1	137.9	-2.2
Total Subsidies	**33.0**	**39.9**	**20.9**
Gasoline	10.4	15.6	51.0
Kerosene	1.4	1.4	1.5
Diesel	21.2	22.8	7.5
Total Taxes	**59.6**	**68.2**	**14.4**
Gasoline	19.4	28.1	44.8
Kerosene	2.3	2.0	-10.3
Diesel	37.9	38.1	0.4
Total Net Taxes	**26.7**	**28.3**	**6.4**
Gasoline	9.1	12.5	37.7
Kerosene	0.9	0.6	-28.5
Diesel	16.7	15.2	-8.7

Source: Togolese authorities.
[1] Excluding August 2011.

It is thus important to appreciate the impact that smuggling has on the tax base. The change in the tax base ultimately determines the relationship between the level of subsidy and net tax per liter on one side and the total tax collected on fuel products on the other.

In a situation of no externalities—i.e., no smuggling—if the authorities were to increase pump prices to match international oil price increases, net tax collection would increase, because custom duties and VAT are ad valorem. However, in the presence of rapidly increasing smuggling, it is entirely possible that both total subsidies and net tax collected could actually decline, if Nigeria left its official prices unchanged. The effects would be compounded by adverse relative exchange rate developments, i.e., a depreciation of the naira against the CFAF/Euro. In such condition, smuggling would increase, reducing the tax base. The final impact on the net fiscal position of the government is a function of the elasticity of smuggling—and, thus of the tax base—to the differential between Togolese pump prices and Nigerian prices, expressed in CFAF (see below).

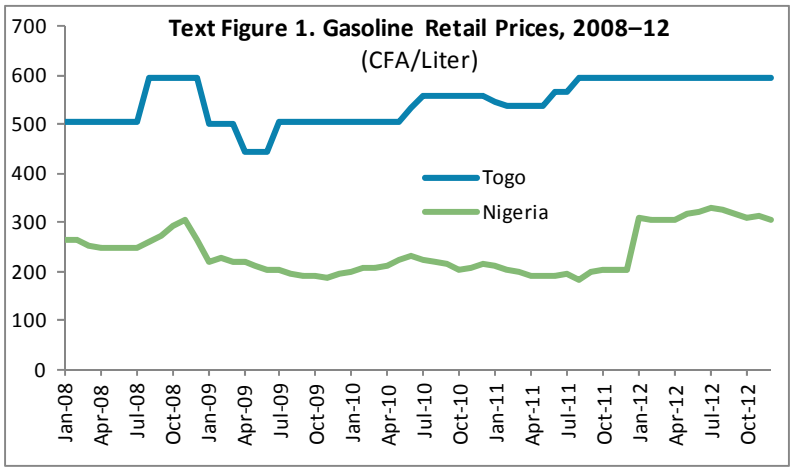
As the Togolese authorities consider their fuel price adjustment options, they have to contend with an important externality that limits their room for maneuver in reducing fuel subsidies. A large price differential with Nigeria reduces the tax base, while a small differential increases it.

C. Graphical Analysis

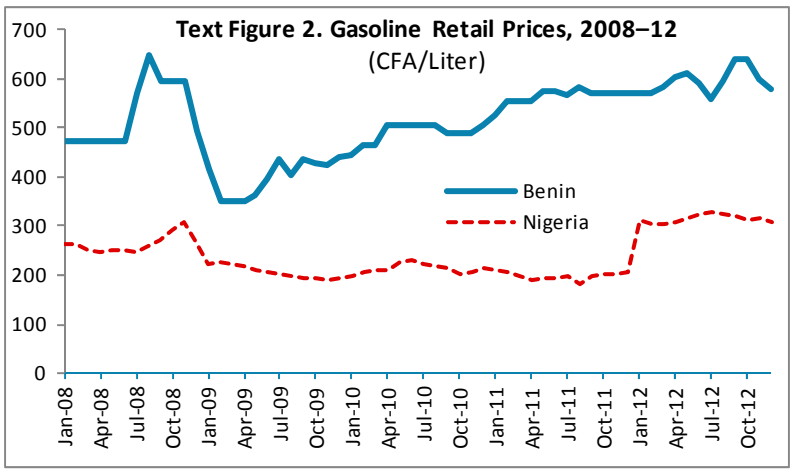
A number of interesting stylized facts emerge from an analysis of the evolution of various key price and quantity variables over time. First, there is a large difference between Togo's formal market prices and Nigeria's. This is mainly because Nigeria's prices have largely remained fixed in local currency until January 2012 (and the naira/CFAF exchange rate did

[8] In fact, total net taxes on the other two fuel products (kerosene and diesel) declined, because subsidies increased while the tax base did not change (there is no smuggling into Togo for these two products).

not change much during 2012), while Togo's have moved more in line with international oil price trends—although with significant lags, implying incomplete pass-through (Text Figure 1). The price differential was sharply reduced when Nigeria raised its prices by about 45 percent in January 2012.[9] Overall, the price difference in absolute terms has been about CFAF 300/l (about US$0.6/l), making it quite conducive to smuggling.

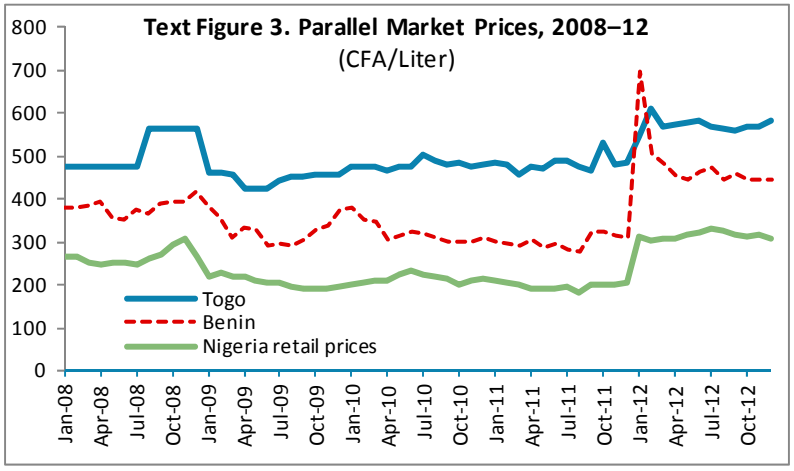


Second, the situation is relatively similar in the case of Benin in that there is also a considerable price differential with Nigeria's prices (Text Figure 2). That said, a number of differences are worth noting. While the price differential in Togo has remained relatively stable over time, in Benin it has increased over time, not least because Benin allowed for more flexible pass-through. That is, formal prices in Benin have tracked international oil prices better, and they have shown a trend increase since 2009. They also fluctuate a lot more. Perversely, because Benin has adjusted prices more flexibly, smuggling has become worse than in Togo.



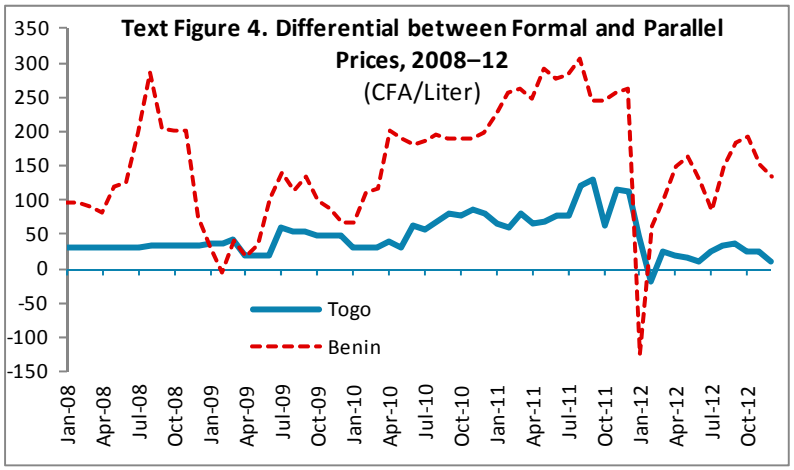
[9] Initially, the price increase was much higher, close to doubling, but, following violent protests, it was reduced in half.

Third, both Benin and Togo's parallel market prices track Nigeria's domestic prices very well, with coefficients of correlation of over 0.95 (Text Figure 3). There is also near-instant pass-through. Indeed, lagged levels (or changes) of Nigeria's prices have statistically no impact on Benin's and Togo's informal prices. Due to geographic proximity, inter alia, Benin's informal prices are more closely linked to those of Nigeria than Togo's. In addition, within Benin, informal prices increase with distance from the Nigerian border, reflecting transport costs.

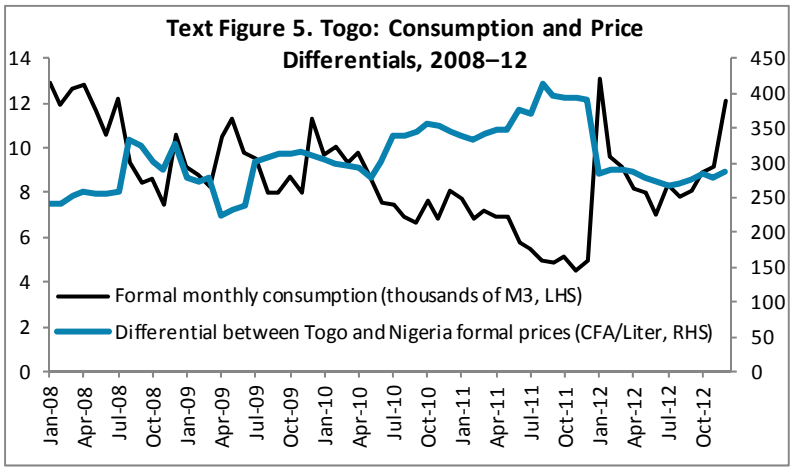


Fourth, the differential between Benin's formal and parallel prices is three times higher than that in Togo, on average (Text Figure 4). As a consequence, all things being equal, the dampening impact on the consumption of gasoline in the formal market is likely to be much higher in Benin than in Togo. That said, the two series are correlated (0.6).

An interesting episode happened in January 2012. Following the price increase in Nigeria, the price differentials between the formal and parallel market prices sharply declined and briefly even became negative, as smuggling all but evaporated in the immediate aftermath of the price increase. In Togo, the immediate impact was an increase in demand on the formal market, which led to shortages (and queuing).



Togo's formal market consumption is inversely related to the price differential between formal prices in Togo and Nigeria (Text Figure 5).[10] The coefficient of correlation is -0.85. As a result of the relatively flat nominal prices in Nigeria—the observed fluctuations are mainly a result of exchange rates changes—the differential has shown an upward trend, which was only reversed in January 2012, when Nigeria increased its official prices, leading to an increase in formal consumption in Togo.[11]



IV. Modeling Approach

A. Theoretical setting

In this section, we postulate a Laffer curve-type relationship between the amount of fuel tax revenue collected (R) and the effective rate of taxation (τ) based on a simple game theoretical model. We assume that there exists a representative consumer who decides to allocate total fuel consumption between the official (taxed) and parallel market. Let total fuel consumption be denoted as Q_{Total}, comprising the public sector's (Q_{Gov}) and private sector's (Q_{Priv}) fuel consumption:

$$\mathrm{Q_{Total}} = \mathrm{Q_{Priv}} + \mathrm{Q_{Gov}}. \qquad [1]$$

Assume that the private sector is captured by a representative consumer who decides to allocate a proportion μ of Q_{Priv} to consumption from the parallel market. Then, private sector's consumption can be decomposed as follows:

$$\mathrm{Q_{Priv}} = (1-\mu)\mathrm{Q_{Priv}} + \mu\mathrm{Q_{Priv}} \qquad [2]$$

[10] Data for Benin on formal gasoline consumption and parallel market prices are not readily available.

[11] The increase in formal consumption in December 2012 is also due to enhanced anti-smuggling activities in Benin and Togo.

Let p be the local domestic official market price, and $p*$ be Nigeria's (official) pump price. Denote the price differential with Nigeria as $(p - p^*)$. By purchasing on the parallel market, the consumer's personal income benefit from tax avoidance (vis-à-vis tax compliance) is equal to:

$$(\mathrm{p} - \mathrm{p}^*)\mu\mathrm{Q}_{\mathrm{Priv}} \quad [3]$$

We assume that policymakers in Togo (or Benin) can only act on their own formal prices by modifying the effective tax rate (τ):

$$\mathrm{p} = \mathrm{c}(1 + \tau) \quad [4a]$$

where c = the landed cost of fuel plus other costs (e.g., local transportation, storage, profit margins, etc).

and analogously for Nigeria:

$$\mathrm{p}^* = \mathrm{c}^*(1 + \tau^*) \quad [4a]$$

Assume that the cost of consuming in the parallel market for the representative consumer is a standard convex cost function (C) equal to:

$$\mathrm{C}=\frac{1}{2\mathrm{k}}\mu^2\mathrm{Q}_{\mathrm{Priv}} \quad [5]$$

Where k is a parameter that denotes the ease of evading the fuel tax. Then, the net benefit from tax evasion for the private sector's representative consumer (B) becomes equal to:

$$\mathrm{B} = (\mathrm{p} - \mathrm{p}^*)\mu\mathrm{Q}_{\mathrm{Priv}} - \frac{1}{2\mathrm{k}}\mu^2\mathrm{Q}_{\mathrm{Priv}} \quad [6]$$

The representative consumer will choose the proportion μ that maximizes [6]. Taking the first order condition (FOC) for this problem and solving for μ yields:

$$\mu = \mathrm{k}(\mathrm{p} - \mathrm{p}^*) = \mathrm{k}(\mathrm{c}(1 + \tau) - \mathrm{c}^*(1 + \tau^*)) \quad [7]$$

Given that [6] is strictly concave in μ, then [7] represents the unique optimal value for the consumer's problem. Equation [7] represents the optimal reaction function of the representative consumer who adjusts her decision variable μ based on the taxation policies of the domestic and the foreign governments.

Domestic tax revenue (R) is given by:

$$\mathrm{R} = \tau\mathrm{Q}_{\mathrm{Taxable}} \quad [8]$$

Where:

$$Q_{Taxable} = (1-\mu)Q_{Priv} + Q_{Gov}. \qquad [9]$$

Expanding [9] to account for the reaction function [7] of the consumer, we obtain:

$$R = \tau Q_{Taxable}$$

$$= \tau(1-\mu)Q_{Priv} + \tau Q_{Gov}$$

$$= \tau(1 - kc(1+\tau) + kc^*(1+\tau^*))Q_{Priv} + \tau Q_{Gov}$$

$$= \left(\tau - kc(\tau+\tau^2) + \tau kc^*(1+\tau^*)\right)Q_{Priv} + \tau Q_{Gov} \qquad [10]$$

The domestic government's objective is to maximize [10] with respect to its decision variable, τ. Note that [10] is strictly concave in τ. Therefore, assuming an interior solution, the unique tax rate that maximizes [10] is given by the solution of the following first order constraint:

$$\frac{\partial R}{\partial \tau} = 0$$

$$\Rightarrow \left(1 - kc(1+2\tau) + kc^*(1+\tau^*)\right)Q_{Priv} + Q_{Gov} = 0$$

$$\Rightarrow kc(1+2\tau)Q_{Priv} = Q_{Priv} + c^*k(1+\tau^*)Q_{Priv} + Q_{Gov}$$

$$\Rightarrow (1+2\tau) = \frac{Q_{Priv}}{kcQ_{Priv}} + \frac{c^*k(1+\tau^*)Q_{Priv}}{kcQ_{Priv}} + \frac{Q_{Gov}}{kcQ_{Priv}}$$

$$\Rightarrow \tilde{\tau} = \frac{1}{2kc} + \frac{c^*(1+\tau^*)}{2c} + \frac{Q_{Gov}}{2kcQ_{Priv}} - \frac{1}{2} \qquad [11]$$

Several intuitive comparative static results can be obtained from [11]. The optimal tax $\tilde{\tau}$ rate is highly state contingent. Specifically, it is:

- Increasing in the foreign tax rate parameter τ^*.
- Decreasing in the ease of smuggling parameter k.
- Decreasing in the domestic landed cost of fuel plus other costs parameter c.
- Increasing in the foreign landed cost of fuel plus other costs parameter c^*.
- Increasing in the relative fuel consumption of the government vis-à-vis the private sector $\frac{Q_{Gov}}{Q_{Priv}}$.

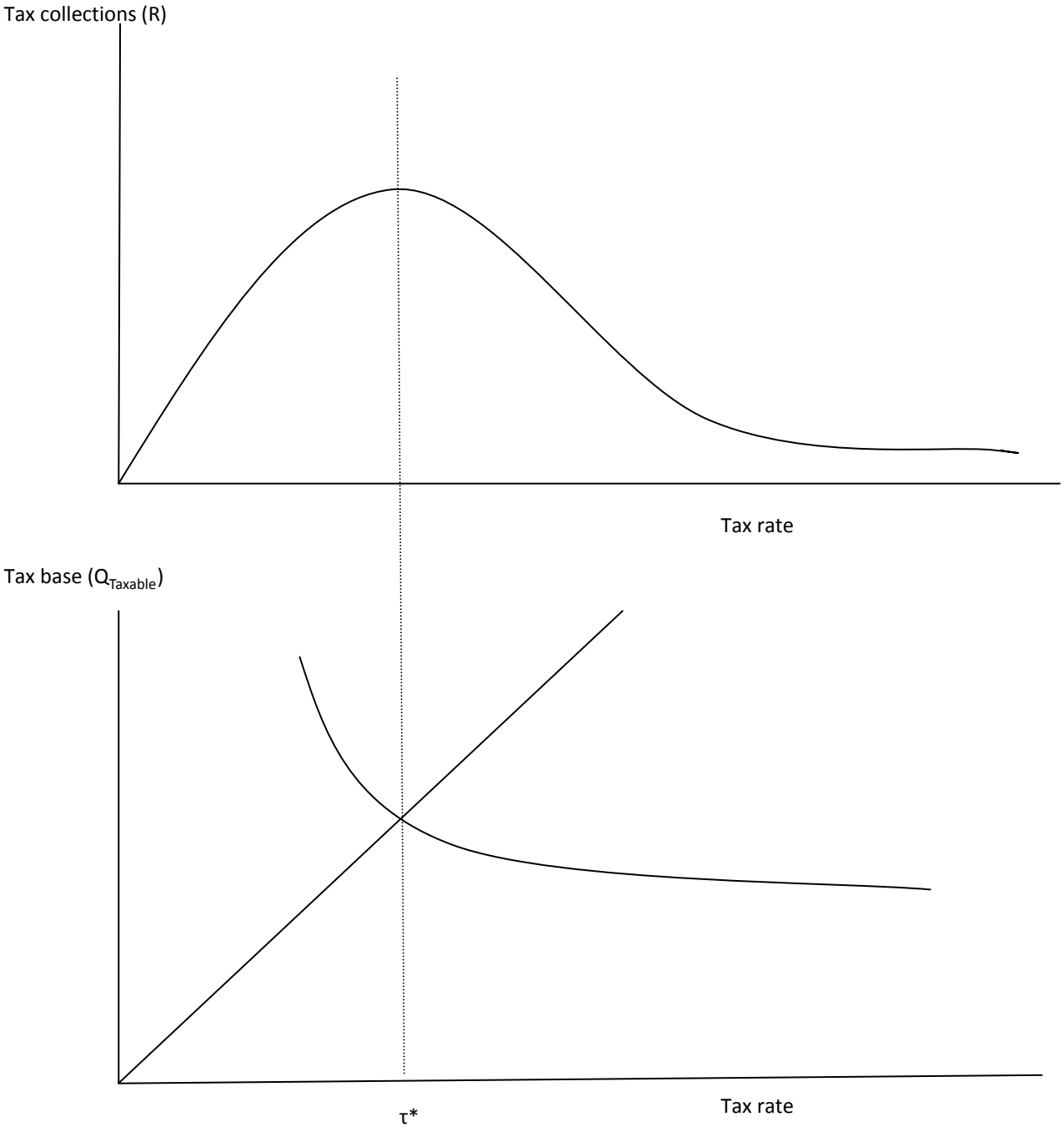
Substituting [9] into [8], we obtain an analytic expression for the optimal tax revenue of the government as a function of the parameters of the problem:

$$R = \left(\tau - kc(\tau + \tau^2) + \tau kc^*(1 + \tau^*)\right)Q_{Priv} + \tau Q_{Gov} \qquad [12]$$

Figure 3 is a simple stylized graphical representation of the model presented above. If the Laffer curve relationship exists, then increasing tax rates beyond a certain point will be counterproductive for raising further tax revenue, as the tax base (i.e., the gasoline purchased in the formal market) shrinks more than the increase in unit tax.[12] We conjecture that rather than a simple parabolic function, it is likely that the curve would have a "long tail"—there will always be some residual demand (from "non-law breaking" consumers, companies, formal entities, etc). The biggest challenge in actually estimating the optimal tax rate and tax revenue is the parameter *k* (ease of smuggling), which is unknown, but to a good extent under the authorities' influence.

[12] The original Laffer curve was derived in the context of a debate on US income tax rates. Estimates of empirical Laffer curves are controversial and revenue-maximizing tax rates have varied widely in the literature.

Figure 3. Fuel Tax Rate, Tax Base and Tax Collections



B. Estimating Consumption of Formal Market Fuel

An empirical equation of the consumption of fuel on the formal market of the following format can be estimated:

$$\ln Q_t = \beta_0 + \beta_1 ln\,(p_t/p_t^*) + \beta_3 X_t + \varepsilon_t \qquad [13]$$

Where *X*= are state variables proxying for the state of the economy and available liquidity.

Rather than use the price differential in the empirical equation, we prefer to use relative prices ($\frac{p}{p^*}$). Using price differentials would de facto force p^* to be negative.

Note that from equation [4a], the relationship between the tax rate τ and the domestic retail prices (p)can be expressed as:

$$\tau = \frac{\mathrm{p}}{\mathrm{c}} - \mathrm{c} \qquad [14]$$

To the extent that p has not been modified frequently, τ is *de facto* largely determined by landed costs (c). The overall tax rate itself τ is composed of two parts:

$$\tau = \tau_{\mathrm{e}} + \tau_{\mathrm{v}}(\mathrm{c}) \qquad [15]$$

where τ_e and
τ_v are the excise taxe rates and value added taxe rates, respectively.

Thus in the short run, to the extent that p is not (frequently) modified, tax rates and tax collections become endogenously determined. While the theoretical model does posit an optimal tax rate, the empirical search is hampered by the fact that insufficient variation in τ_e during the period under review, in addition to the difficulty of estimating the ease of smuggling parameter, *k*. In fact, we only observe four changes in the nominal rate, hardly enough for an empirical search.

To estimate the consumption of fuel in the formal market, we propose to use three state variables that are available on monthly basis. Since parallel market operations are typically done in cash (to avoid detection), currency in circulation would seem a good proxy for liquidity. A priori it is not obvious which way liquidity would affect consumption of fuel on the formal market. However, on the one hand, increased cash availability would likely increase the means for smuggling. On the other, if higher cash availability and overall demand are the result of economic growth, it would also increase consumption of formal market fuel. Ultimately, the source of growth for liquidity matters: if it is mainly from the formal sector, then consumption of formal market fuel is likely to be positively related to increased liquidity. Otherwise, if increased demand for liquidity mainly reflects growth of informal transactions, then increased liquidity should be negatively associated with lower demand on the formal market. In this interpretation, it is implicitly assumed that the informal sector of the economy has a higher propensity to satisfy its fuel needs on the informal market, thus tending to lead to illicit fuel market transactions.

This interpretation would be consistent with the idea that the demand for currency in circulation is a function, among other things, of the level of underground economic activity, itself a function of the level of taxation (Tanzi, 1980, 1983). In this approach, cash is the preferred means of settlement for activities that go undetected by the tax system, such as fuel

smuggling.[13] Essentially, when Togolese smugglers buy gasoline from Nigerians, they need CFAF to purchase US$ and pay for the imports. *Ceteris paribus*, the transaction demand for cash in circulation increases with the volume of informal transactions. Ultimately, confirming if this relationship between currency in circulation and the informal economy holds, is an empirical issue. Ideally, we should also include income variables as a driver of demand. Unfortunately, this type of variable is not available at high frequencies. Instead, we examine two other variables: the index of industrial production and the index of turnover (sales) in the formal sector. The three variables thus identified—currency in circulation, industrial production, and turnover sales—are used in section VI to estimate gasoline consumption.

V. COMPARATIVE STATICS

Given the lack of sufficient observed variations in most of the key parameters of the theoretical model, it is however reasonable to simulate the model based on a plausible parameterization of the key exogenous variables. The following table provides the key assumptions:

Exogenous parameters	
c*	1
c	1
τ^*	-0.3
Q_{Gov}	0.2
Q_{Priv}	0.8

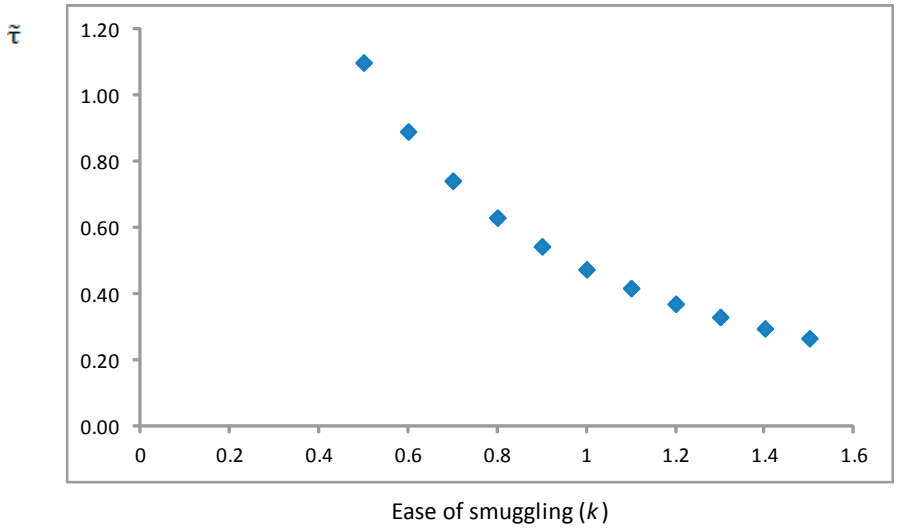
Where c and $c*$ are normalized to 1 and Q_{Gov} and Q_{Priv} are normalized to sum up to 1. τ^* is estimated on the basis of observations in Nigeria, where the landed retail price is less than the landed cost of gasoline by about 30 percent.

From equation [11], we can examine the relationship between the key two endogenous parameters $\tilde{\tau}$ and k. The relationship is nonlinear (Figure 4): the easier it is to smuggle, the lower is the optimal tax revenue. Under the above parameterization, it can be shown (or simulated) that τ and k are bounded, i.e., outside the ranges identified below the results are nonsensical:

$$0.5 \leq k \leq 1$$
$$0.54 \leq \tilde{\tau} \leq 1.1$$

[13] This is favored by a strong general cash preference, in the absence of deeper financial integration and efficient formal payments systems.

Figure 4. Optimal Tax Rate and Ease of Smuggling

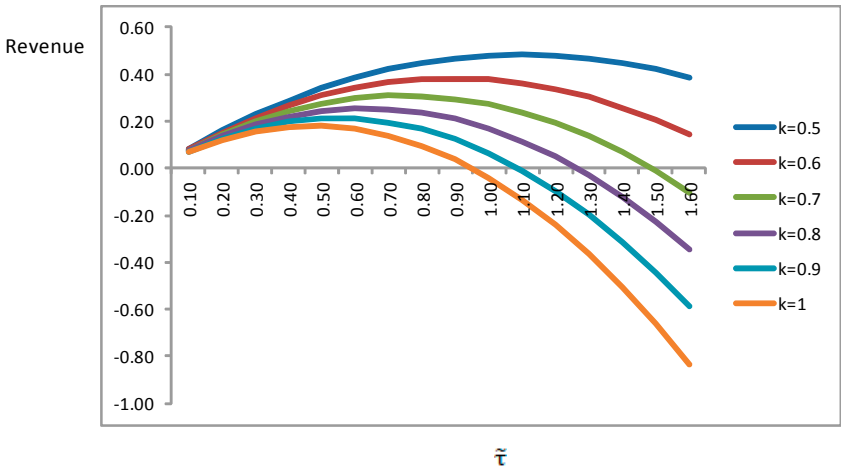


Logically, from equation [7], the remaining endogenous parameter μ is also bounded:

$$0.6 \leq \mu \leq 0.75$$

From the foregoing, a number of simulations can be made to derive total revenue (Figure 5)—i.e., the variable government would like to maximize. Figure 5 illustrates the relationship between the revenue, the optimal tax rate, and the ease of smuggling. It notably shows that the higher the ease of smuggling (or, put differently, the lower its cost), the lower the domestic tax rate in Togo has to be and the lower the overall revenue collection. This finding is important and shows that to the extent that the authorities in neighboring countries to Nigeria cannot affect Nigeria's tax policies, their only policy lever is to combat the ease of smuggling. Thus they can only increase total domestic revenue by raising the cost of smuggling, e.g., greater border controls, fines, combating corruption, etc.

Figure 5. Optimal Tax Rate, Ease of Smuggling, and Revenue

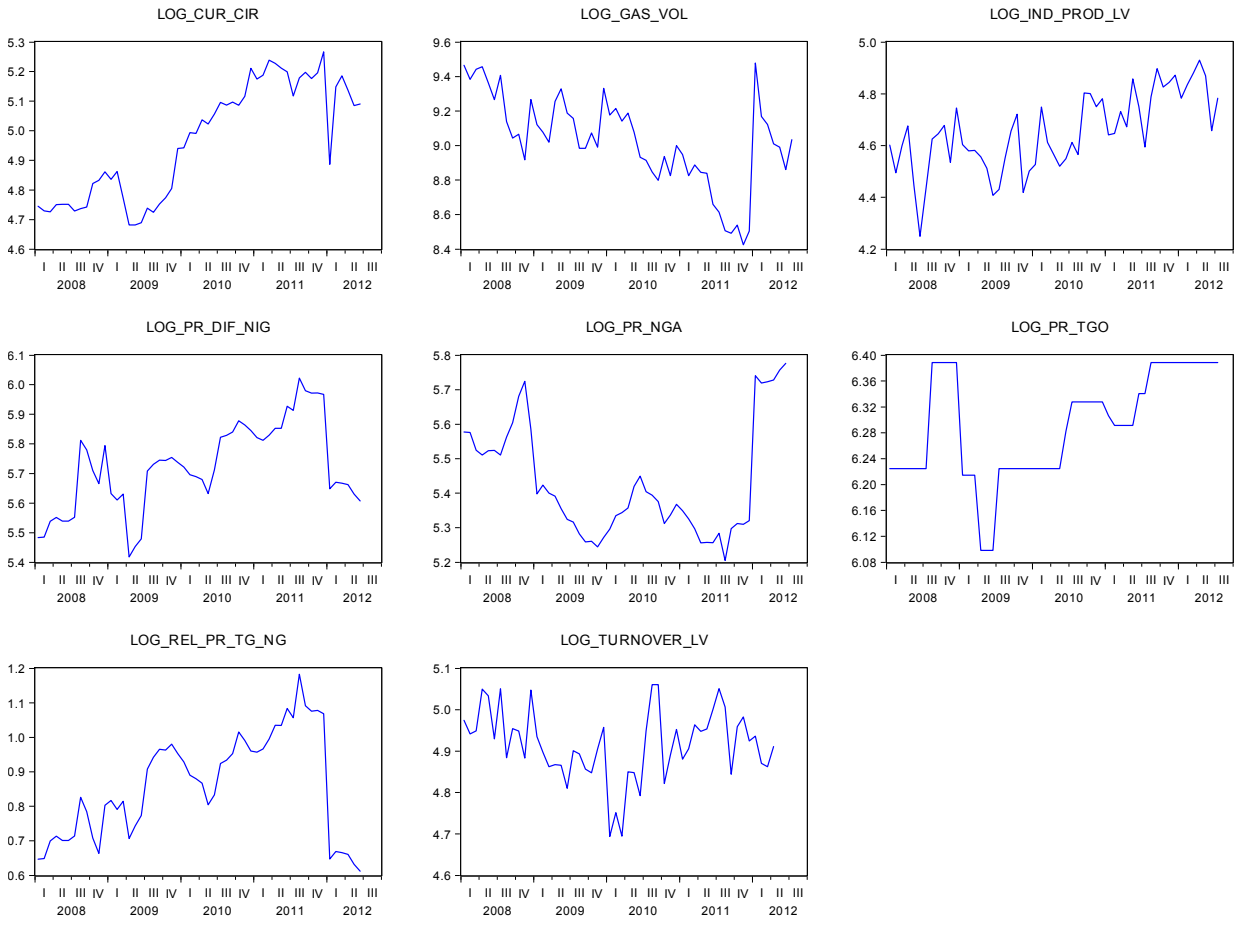


VI. Empirical Estimates

A. Main variables

Figure 6 is a graphical presentation of the variables in equation 13 for Togo. Ideally, we can test to see if a cointegrating relationship exists among the variables in equation 6. However, Augmented Dickey-Fuller unit root tests show that some of the variables are I(0), notably formal market fuel consumption (Q), while most of the rest are I(1), making it unlikely to find cointegration when Q is included. Consequently, our preferred modeling strategy is to estimate the equation in changes. This is close to the methodology used in Asplund and others (2007), who estimate the demand for regional sales in alcohol between Sweden (high tax country) and Denmark and Germany (relatively lower tax countries). The main difference is that they had introduced distance to the border as a variable.

Figure 6. Togo: Evolution of Main Variables



Note: The variables are for Togo (unless otherwise specified) and in logarithms. They are:

CUR_CIR: currency in circulation, in billion CFA francs.
GAS_VOL: gasoline consumption, in cubic meters.
IND_PRD_LV: industrial production index.

PR_DIF_NIG: gasoline price difference between Togo's formal market and Nigeria' formal sector market , in CFA francs.
PR_NGA: Nigeria's gasoline price, in CFA francs.
PR_TGO: gasoline prices, in CFA francs.
REL_PR_TG_NG: gasoline relative prices between Togo and Nigeria, in CFA francs.
TURNOVER_LV: index of turnover for formal sector companies.

B. Econometric estimations

Before estimating the empirical equation [13], it is worth exploring further how Nigeria's formal sector gasoline market prices are transmitted to Togo's parallel market prices (p_{PARt}). As seen earlier, the two series are highly correlated. However, it is useful to ascertain whether they are cointegrated and what is the pattern of the error correction mechanism (ECM). Using the basic Johansen approach, we find that the two variables are strongly cointegrated and their long-run relationship is of the form:

$$\ln p_{PARt} = 4.052 + \underset{(0.063)}{0.396} ln\,(p_t^*)$$

and the ECM parameter is quite high at about 0.412, implying that any shock in Nigeria's prices is fully absorbed by Togo's prices in about 2½ months.

The results of the empirical estimations are generally in line with the priors presented above. The main driver of changes in formal market gasoline consumption is the relative price between formal prices in Togo and those in Nigeria, expressed in CFAF. The coefficient for relative prices—the elasticity—is -1.21, and it is highly significant at 1 percent. Increases in currency in circulation are associated with a decline in formal consumption, with a highly significant coefficient of -0.75.[14] This result is consistent with the prior that changes in the volume of fuel smuggling are associated with an increased transactional demand for cash. Changes in both industrial production and formal sector turnover, as expected, exert a positive influence on consumption of gasoline, respectively, 0.44 and 0.56.

[14] Compare also the marked decline in currency in circulation (first chart) associated to the increased in formal consumption of gasoline (second chart) when Nigeria increased its official prices in early 2012 (Figure 4).

Table 1. Togo: Determinants of Formal Market Gasoline Consumption

Dependent Variable: Gasoline consumption		
	[1]	[2]
Relative Prices	-1.208 ***	
	-4.022	
Formal market prices		-1.325 ***
		-2.725
Nigerian prices		1.179 ***
		3.723
Currency in circulation	-0.752 **	-0.759 **
	-2.478	*-2.470*
Industrial production	0.439 ***	0.450 ***
	2.682	*2.662*
Formal sector turnover	0.561 ***	0.562 ***
	2.669	*2.662*
Constant	-0.005	-0.005
	-0.263	*-0.236*
R^2	0.552	0.553

1/ All variables are in log changes.
***, **, * means significant at 1, 5 and 10 percent levels.
Numbers below coefficients are t-statistics.

Source: Togolese authorities, and IMF staff estimates.

To understand the relationship better, in equation 2 (Table 1), we break down the components of the relative price. Both components are statistically significant, but the Togolese formal prices have a relatively stronger impact (-1.32) than Nigeria's (1.18). This means that, all things being equal, an increase of CFAF 10/l in the pump price reduces the volume demanded by around 2 million liters (2.23 percent).[15] The impact on gross tax revenue collection would be a *reduction* of CFAF 540 million (about US$ 1.1 million), equivalent to 0.02 percent of GDP on a yearly basis.[16] Conversely, each increase equivalent to CFAF 10/l in Nigeria's price increases demand in Togo by 1.8 million liters, thus *increasing* gross tax revenue by CFAF 490 million.[17]

Taken together, the results indicate that unless the formal sector economy is performing very well, i.e., there is strong growth in industrial production and formal sector turnover, increases in formal prices are likely to erode the tax base. The actual impact on gross revenue collected will be the result of the relative change in prices in CFAF terms compared to that of volumes.

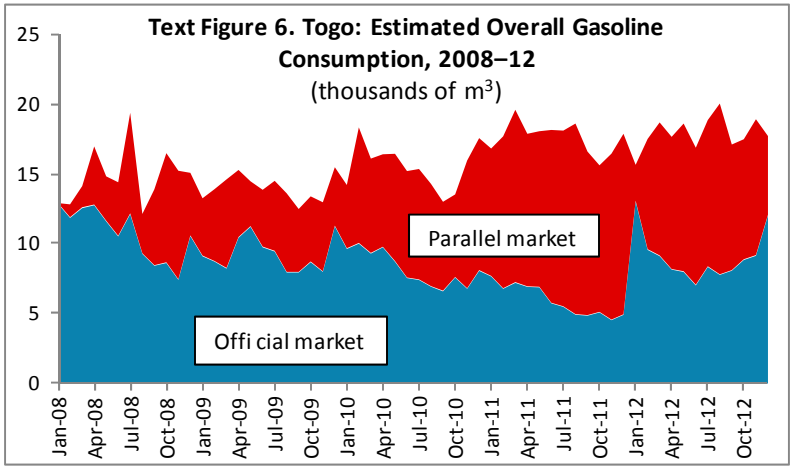
[15] Annualized figures using point estimates based on averages in Q3/2012.

[16] Note that taxes net of the reduction in subsidy expenditures would *increase* by CFAF 660 million (US$ 1.3 million). Net taxes increase because, while tax losses occur only on the reduction in demand, the retail price adjustment generates subsidy savings on each liter sold, not only on the reduction in demand.

[17] In this case, net tax revenue would also *increase*, albeit by only CFAF 216 million, because, while subsidies do increase in relation to the expansion in volumes, the unit subsidy on each liter sold does not change.

VII. A NATURAL EXPERIMENT

Although the volume of consumption in the parallel market is unknown, there is a way to approximate *general tendencies.* One way is to assume that, *ceteris paribus,* the *overall* consumption of gasoline is growing in a similar manner to that of diesel. As discussed above, since diesel prices are not controlled in Nigeria, smugglers find no profit in this trade. Thus, there is no informal market for diesel fuel in Togo and official trade data reflect total demand. If we make this assumption starting in January 2008[18], the conclusion that emerges is that, on average, the overall consumption of gasoline is roughly double that on the formal market (Text Figure 6). In other words, the formal sector is providing only half of the national needs.[19]



On this basis, we can compute the implicit subsidy unintentionally granted by Nigeria to Togo, namely the difference between formal prices in Togo and the Nigerian formal prices, multiplied by the parallel market consumption.[20] This can be further broken down between consumers' surplus and smugglers' gross profits. The former is the difference between formal and parallel market prices in Togo, while the latter is the difference between parallel market prices in Togo and formal market prices in Nigeria, both multiplied by the volume on the parallel market. The results are given in Table 2. From this table, we can see the overall subsidy conferred by Nigeria was worth at least 3 percent of Togo's GDP in 2011. Three quarters of the subsidy was appropriated by smugglers. The level of subsidies from Nigeria was nearly halved in 2012 as a result of the increase in average formal market prices in Nigeria by over 50 percent (in CFA franc equivalent).

[18] January 2008 is chosen as a starting experiment date, based on data availability.

[19] This obviously underestimates the volume of the parallel market since, at the starting point, the volume of informal consumption is assumed to be zero.

[20] This likely overestimates the "subsidy" as it does not take into account transportation and other costs.

On the positive side, consumers in Togo are benefitting from lower gasoline prices. Our estimate indicates that smuggling increased consumer surplus by about 0.7 percentage points of GDP in 2011, thus enhancing consumers' welfare. While the distribution of these gains would not be equally shared—as households in the lower income quintiles do not own cars or motorcycles—nevertheless, the household sector as a whole experiences a non-trivial increase in surplus.

Table 2. Togo: Amounts of Parallel Market, 2008–12

	2008	2009	2010	2011	2012
Togo official prices (CFA/Liter)	543	489	535	568	595
Togo parallel market prices (CFA/Liter)	511	447	479	482	574
Nigeria official prices (CFA/Liter)	264	206	214	198	315
Differential Togo official / parallel (CFA/Liter)	31	41	56	86	21
Differential Togo parallel / Nigeria official (CFA/Liter)	247	241	265	283	259
Parallel market consumption (thousands of M^3)	49.1	56.6	87.6	140.1	105.5
Amount earned by parallel market consumers (billions of CFA)	1.52	2.34	4.87	12.08	2.26
In percent of GDP	*0.11*	*0.16*	*0.31*	*0.69*	*0.12*
Smugglers profits (billions of CFA)	12.13	13.65	23.23	39.71	27.33
In percent of GDP	*0.86*	*0.91*	*1.48*	*2.28*	*1.45*

Source: Togolese authorities, and IMF staf estimates.

The above estimates of the size of the informal market can also be used to estimate the tax revenue loss due to smuggling. In 2011—admittedly a year of large volumes of smuggling—informal consumption of gasoline was twice the formal consumption (Text Figure 6 above). On this basis, we estimate the tax revenue loss due to smuggling at about CFAF 36 billion (2 percent of GDP, or about 13 percent of tax revenue). This loss is considerable, dwarfing any recent improvement in tax collection, and argues for the authorities to devote more attention to reducing revenue leakage due to smuggling.

VIII. CONCLUSION

The paper has shown that there are negative externalities from Nigeria's fuel policies on its neighbors. Nigeria's fuel subsidy policies have been costly not only for itself but also for its neighbors. In the case of Benin, the policies have led to the near wiping of the formal fuel market thereby depriving the government of much-needed revenue. In the case of Togo, Nigeria's policies make it very difficult to apply the automatic fuel pricing mechanism. Absent a change in Nigeria's domestic fuel pricing policies, in the face of higher international prices, it is not obvious that increasing Togo's (or Benin's) domestic fuel prices will lead to higher revenue.

On the contrary, the paper has shown that formal sector fuel consumption in Togo is negatively correlated with the price differential with Nigeria. Thus, unless the economy is doing well, i.e., official sector (public sector, companies) demand is rising, ceteris paribus, increasing Togo's fuel prices will lead to an erosion of the tax base.

This finding has implications on the standard prescription to have automatic fuel pricing mechanism. The policy is effective only in the context of tight border controls. The paper has shown theoretically that the lower the costs of smuggling, the more difficult it is to optimize revenue; indeed, particularly in the presence of a porous border and ineffective anti-smuggling operations, the optimal strategy may be to lower the tax rate, which is tantamount to lowering the domestic price. In this context, the first best approach is to have greater cooperation with Nigeria to better control borders to reduce smuggling, which is also in Nigeria's interest since it will reduce unintended subsidies to its neighbors. In fact, most of these subsidies are captured by smugglers, and only less than one-third ends up as increased consumer surplus in Togo—a positive unintended consequence of Nigeria's fuel pricing policies.

Our simulated model shows that taking Nigeria's fuel tax policies as given, the only policy lever the Togolese authorities have is to reduce the ease of smuggling through a combination of greater border controls and fines. In the absence of tighter border controls, which is the first best, our conclusion is that fuel price adjustment should be carried out less automatically, and only after careful assessment of the underlying demand from the official sector. Put differently, to avoid tax base erosion, fuel prices should be increased slowly in order to observe first their impact on official sector demand.

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