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For Peer Review

Smuggling around the World: Evidence from a Structural Equation Model

Andreas Buehn* and Mohammad Reza Farzanegan**

Abstract

This paper uses a Multiple Indicators Multiple Causes (MIMIC) model to analyze the determinants of smuggling. The analysis reveals that higher corruption and a lower rule of law encourage smuggling. Tariffs and trade restrictions are important push factors, while a higher black market premium (BMP) discourages smugglers. Based on the MIMIC estimates, we calculate an index of smuggling which provides a ranking for 54 countries. We find that smuggling is rampant in Cameroon, Pakistan, and Kenya while it is least prevalent in Switzerland, Finland, and Sweden.

JEL-Classification: O17; H26; C31; H71; K42

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Smuggling around the World: Evidence from a Structural Equation Model

Abstract

This paper uses a Multiple Indicators Multiple Causes (MIMIC) model to analyze the determinants of smuggling. The analysis reveals that higher corruption and a lower rule of law encourage smuggling. Tariffs and trade restrictions are important push factors, while a higher black market premium (BMP) discourages smugglers. Based on the MIMIC estimates, we calculate an index of smuggling which provides a ranking for 54 countries. We find that smuggling is rampant in Cameroon, Pakistan, and Kenya while it is least prevalent in Switzerland, Finland, and Sweden.

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1. Introduction

The motivation of being involved in smuggling operations is to make or save money by avoiding taxes/tariffs and/or to circumvent state controls prohibiting the sale of particular goods. Smuggling often involves other crimes such as fraud, fraudulent conversion, bribery, maybe even extortion and violence. Although smuggling has attracted much attention in policy debates, the empirical literature is rather limited.¹ In this paper we provide an empirical contribution to the literature by applying a structural equation model (SEM) to estimate an index of smuggling for 54 countries around the world.

The hidden and illegal nature of smuggling makes it hard to analyze this economic activity. Estimates of the extent of smuggling in an economy or cross-country comparison often rely on narrow proxies or anecdotal evidence. This paper presents an alternative for the economic analysis of smuggling and contributes to the empirical literature on smuggling in the following two ways: firstly, using a specific form of a SEM with one latent variable, that is a Multiple Indicators Multiple Causes (MIMIC) model, we capture the unobservable nature of smuggling and account for the manifold potential causal and indicator variables of smuggling.² Secondly, we use the MIMIC estimation results to rank the countries according to the extent of smuggling in the economy and compute an index

¹ The literature mostly deals with theoretical aspects of the effects of smuggling on social welfare and the economy (see e.g., Bhagwati and Hansen, 1973; Pitt, 1981; Martin and Panagariya, 1984; and Thursby et al., 1991).

² MIMIC approaches have been applied to estimate the development of the shadow economy (see, e.g., Dell'Anno and Schneider (2003), Schneider (2005), Alañón and Gómez-Antonio (2005), Dell'Anno and Solomon, and Buehn et al. (2009)) and to corruption (Dreher et al., 2007). Interesting, recent applications of this methodology to smuggling are presented in Farzanegan (2009) and Buehn and Eichler (2009).

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3 of smuggling for 54 countries around the world over the period 1991-1999. This is – to
4
5 our knowledge – the first comparable estimate of smuggling across countries that can be
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7 used in further empirical cross-country analysis, for example, to investigate the smuggling
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9 and economic growth nexus.

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11 In general, smuggling includes illegal trade of both legal and illegal goods.³ This paper
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13 follows Pitt's definition of smuggling: "Traded goods are misweighted, misgraded,
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15 misinvoiced or not invoiced at all with or without the cooperation of customs authorities"
16
17 (Pitt, 1981). Hence, this paper does not deal with the illegal trafficking of human beings
18
19 such as illegal immigrants and the illegal trade of generally forbidden goods such as illegal
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21 drugs. Rather it considers illegal trade of legal goods, often referred to as trade
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23 misinvoicing. Given this working definition, the main channel of smuggling is that traders
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25 report false amounts of their actual exports or imports to authorities circumventing high
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27 taxes, tariffs, and custom duties. But, the incentive to smuggle seems not to be exclusively
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29 linked to the level of taxes. For example, in countries with high taxes, such as in the
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31 Scandinavian countries, there is little evidence of smuggling. Contrary, in many Eastern
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33 European countries, where taxes are much lower, smuggling is more common. This might
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35 be due to the observation that countries with a low level of taxes often have less effective
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37 systems of border and tax evasion controls and less transparent administrative rules
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39 (Merriman et al., 2000). The MIMIC model enables us to analyze whether ineffective
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41 administrations and institutions or high tariffs and trade restrictions determine the level of
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43 smuggling.

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45 Our analysis reveals that tariffs and trade restrictions are important push factors of
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47 smuggling while a higher black market premium (BMP) discourages smugglers. Better
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55 ³ Buehn and Eichler (2009) argue that the academic picture of smuggling had been incomplete
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57 and consequently distinguish between the smuggling of legal versus illegal goods.
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3 law enforcement reduces smuggling by increasing the expected costs for illegal traders. A
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5 more corrupt society makes it however easier for traders to increase profits by turning to
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7 illegal means of trade. The impact of smuggling on the official economy is substantial: it
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9 reduces GDP per capita and tax revenues, while it is – as expected – positively correlated
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11 to trade misinvoicing. The estimated smuggling index shows that smuggling is less
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13 common in the Western European countries but seems to be widespread in Latin America,
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15 Asia, and Africa.
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19 The paper is organized as follows. Section 2 presents a short theoretical motivation, a
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21 literature review, and the main hypotheses for the empirical analysis. Section 3 introduces
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23 the empirical methodology. Section 4 discusses the causes of smuggling and how this
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25 activity is reflected in observable indicator variables. Section 5 presents the estimation
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27 results and the smuggling index. Section 6 concludes.
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32 **2. Theoretical Motivation**

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34 In most countries, tariffs or import quotas (restrictions on the quantity of imported goods)
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36 limit the ability of consumers to choose between foreign or domestic goods. Although
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38 financial and capital markets are becoming more integrated, a lot of countries had capital
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40 controls until recently, which limited the ability of financial investors to exchange foreign
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42 into domestic currency units. These two types of restrictions in international markets make
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44 smuggling more attractive. On the one hand, tariffs and trade restrictions create incentives
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46 for traders to resort to illegal means of trade such as the smuggling of products or the
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48 misinvoicing of exports and imports. On the other hand, capital controls and foreign
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50 exchange market restrictions create parallel or black foreign exchange markets and a
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52 premium of the parallel over the official exchange rate. This, so called black market
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54 premium (BMP) is a very attractive incentive for traders: underinvoicing exports, they can
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3 realize additional profits by supplying the unrecorded revenues on the black foreign
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5 exchange market. However, the existence of a BMP might also be a disincentive for illegal
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7 trade. Illegal importers, when underinvoicing imports, have to acquire foreign exchange
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9 on the black market for the amount of imports not reported to authorities. In this case, an
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11 increasing BMP means increasing costs for illegal importers and thus reduces the
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13 incentive to smuggle (see, e.g., De Macedo, 1987).
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18 19 *2.1 Literature Review*

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21 The existing literature on smuggling consists of two strands. One strand demonstrates that
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23 tariffs and restrictions lead to smuggling and misinvoicing in international transactions.
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25 The other strand analyzes the welfare effects of smuggling. In their seminal paper,
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27 Bhagwati and Hansen (1973) refuted the common argument that smuggling, by evading
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29 taxes on trade which are always sub-optimal, improves social welfare. Instead, they found
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31 a welfare reducing effect of smuggling when it coexists with legal trade. Introducing a
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33 third non-traded good, Sheikh (1974) showed that this coexistence could however be
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35 welfare improving. Pitt (1981), in an alternative model of smuggling, demonstrated that
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37 the welfare consequences of smuggling are ambiguous. In his model legal and illegal trade
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39 do also coexist but, in addition, firms trading illegally use legal trade to camouflage
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41 smuggling. This model explains the coexistence of legal trade, illegal trade, and a price
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43 disparity defined as the difference between the domestic market price and the tax-inclusive
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45 world price of a commodity.
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49
50 The theoretical literature focusing on the *determinants* of smuggling confirms the
51
52 obvious incentives for smuggling, i.e., the existence of trade taxes and restrictions. Several
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54 influential contributions proved – see e.g. Bhagwati (1964), Bhagwati and Hansen (1973),
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56 and Sheik (1974) – that traders, facing high trade taxes or trade restrictions, resort to
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3 illegal means of trading such as smuggling and the misinvoicing of exports and imports,
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5 i.e., the false declaration of trade documents. Pitt (1981) showed that tariffs cause a price
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7 disparity which in turn provides an incentive for illegal imports. Pitt (1984) analyzed the
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9 BMP as a determinant for smuggling. He showed that the black market equilibrates the
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11 supply and demand for foreign exchange from smuggling activities. Biswas and Marjit
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13 (2007) found that import (export) underinvoicing is negatively (positively) correlated to
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15 the BMP, since the foreign exchange from unreported transactions is paid (sold) on the
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17 black market.
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21 Martin and Panagariya (1984) and Norton (1988) focused on the *cost of smuggling* and
22
23 examined the effect of law enforcement. They showed that increasing the probability or
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25 cost of confiscation by intensifying law enforcement is a deterrent to smuggling and
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27 enables authorities to reduce the extent of smuggling. The reason is that smugglers try to
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29 maximize their net gain from smuggling, i.e., the difference between expected revenues
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31 and expected costs. The expected costs of smuggling arise from the risk of being caught
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33 and punished by authorities and stricter enforcement increases the costs of smuggling
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35 making it less attractive for illegal traders. Thursby et al. (1991) investigated the
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37 consequences of law enforcement with respect to smuggling for welfare. Because the
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39 market price in the presence of smuggling is below the price when all sales are legal,
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41 smuggling might improve welfare if the price effect outweighs its cost. Hence, reducing
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43 smuggling by increasing law enforcement might come at the cost of reduced welfare of
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45 consumers.
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49 Most of the empirical studies use the trade discrepancy which is calculated using
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51 balance of payments data as a proxy for smuggling. For example, if import figures
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53 reported by the importing country (adjusted for shipping and insurance costs) significantly
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55 exceed (fall short of) the export figures reported by the exporting country, these studies
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3 conclude that import overinvoicing (underinvoicing) takes place in the importing country.
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5 Bhagwati (1964) analyzed trade between Turkey and its major trading partners and
6
7 observed import underinvoicing for machinery and transport equipment. McDonald
8
9 (1985) analyzed trade in 10 developing countries and found that export underinvoicing is
10
11 positively correlated with export taxes and the BMP. Pohit and Taneja (2003) analyzed
12
13 informal trade between India and Bangladesh and found that the potential reduction of
14
15 transaction costs is a strong motive for smuggling. Fisman and Wei (2004) presented
16
17 strong empirical evidence that higher tax rates cause tax evasion in the form of trade
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19 misinvoicing between China and Hong Kong. Fisman and Wei (2007) studied illicit trade
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21 in cultural properties in the United States finding that misinvoicing is highly correlated
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23 with the extent of corruption in the exporting country. Berger and Nitsch (2008) confirmed
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25 this finding in an extended analysis. Beja (2008) estimated that China's unrecorded trade
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27 amounted to \$1.4 trillion between 2000 and 2005. While Farzanegan (2009) used the
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29 MIMIC approach to estimate the size of smuggling in Iran, Buehn and Eichler (2009)
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31 applied this methodology to study illegal trade of illegal and legal goods across the U.S.-
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33 Mexico border. Table 1 presents a summary of the most important findings of the
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35 empirical literature on smuggling.
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Table 1. Review of the Empirical Literature on Trade Misinvoicing

Study	Subject of investigation	Approach	Main findings
Bhagwati (1964)	Import underinvoicing in Turkey	Descriptive analysis of trade from Turkey to its major trading partners France, Germany, Italy, Netherlands and the United States.	Import underinvoicing in transport equipment and machinery
McDonald (1985)	Incentives for export misinvoicing	OLS regressions for 10 developing countries; Dependent variable: trade discrepancies; Independent variables: BMP and export taxes	Weak statistical evidence that the BMP and export taxes explain variations in trade discrepancies
Pohit and Taneja (2003)	Informal trade between India and Bangladesh	Direct survey approach encompassing 100 traders in each country	Anonymous trading transactions characterize informal trade; motivations are the quick realization of payments, less paper work, and procedural delay
Fisman and Wei (2004)	Tax evasion in Chinese imports from Hong Kong	Analysis of 2,043 product categories at the six-digit classification level; Dependent variable: trade discrepancies (evasion gap); Independent variables: tax rate (sum of tariffs and the VAT), tax on similar products, tariff exemptions, interaction terms	One percent increase in the tax rate increases evasion by three percent; evasion takes place in two ways: first, through the reclassification of high-tax product categories to lower-taxed categories and second, through the underinvoicing of imports

Table 1. Continued.

Fisman and Wei (2007)	Illegal trade in cultural properties in the United States.	Worldwide unbalanced panel for 1996-2005; Dependent variable: trade discrepancies in cultural object and antiques; Independent variables: corruption, GDP per capita	Highly positive correlation between trade discrepancies and corruption, i.e., more corrupt countries are more likely to misreport data
Beja (2008)	Trade misinvoicing in China	Descriptive analysis of trade discrepancies	Trade misinvoicing occurs mainly between Hong Kong and the United States.
Berger and Nitsch (2008)	Bilateral trade discrepancies at the 4-digit product level	OLS regressions for misinvoicing in bilateral trade with the United States, Germany, China, the United Kingdom, and Japan Dependent variable: trade discrepancies; Independent variables: corruption, GDP per capita, distance measure	Trade discrepancies differ widely across importers; export underinvoicing is prevalent in antiques and bulky products; strong positive correlation with corruption in the source country
Farzanegan (2009)	Illegal trade in Iran	MIMIC approach and trade misinvoicing; Causes: penalties, BMP, tariffs, GDP per capita, unemployment rate, openness, education, institutional quality; Indicators: government revenues, import price index, petroleum consumption	Illegal trade is related positively to tariffs and negatively to fines and the unemployment rate; Trade openness and a higher BMP encourage illegal trade while better institutional quality reduces it; Adverse effects on government revenues and the import price index; Smuggling is about 13% of total trade

Table 1. Continued.

Buehn and Eichler (2009)	Determinants and long-term trends of smuggling across the U.S.-Mexico border	MIMIC approach for export and import misinvoicing; Causes: BMP, real exchange rate, taxes on income/profits, taxes on international trade Indicators: errors and omissions, export misinvoicing, import misinvoicing	Export misinvoicing is positively correlated to a real peso depreciation and Mexican taxes on income/profits; Import misinvoicing is negatively correlated to a real peso depreciation and Mexican taxes on income/profits, and positively correlated to Mexican import tariffs; Mexico's accession to GATT (1987) and NAFTA (1994) had a major impact on the smuggling of legal goods
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2.2 Main Hypotheses

Following the theoretical and empirical literature on smuggling we now summarize the main findings of the theoretical literature and formulate our hypotheses regarding the determinants of smuggling. We present the hypotheses about the effects of smuggling section 4.2 where we also discuss the indicators of smuggling.

Facing high tariff rates and trade restrictions, traders often resort to illegal ways of trade, such as the smuggling of products or the misinvoicing of exports and imports. Liberalizing foreign trade and eliminating non-tariff barriers and similar red tapes reduce traders' incentives to smuggle. Also, better law enforcement makes smuggling less attractive/profitable. Of course, if smugglers have been apprehended and their operations exposed, they can facilitate their activities through the bribing of officials to turn a blind eye (Brodie et al., 2000). Thus, more corrupt bureaucrats make it relatively easy for smugglers to get – in exchange for a “small” fee – around certain export restrictions and to avoid punishment when caught. To summarize, our main hypotheses are as follows:

- (1) The more trade restrictions, the higher the level of smuggling, *ceteris paribus*.
- (2) The higher tariffs, the higher the level of smuggling, *ceteris paribus*.
- (3) The stricter the law enforcement, the lower the level of smuggling, *ceteris paribus*.
- (4) The higher the level of corruption, the lower the level of smuggling, *ceteris paribus*.

Because of the two contrasting types of evidence in the literature regarding the effect of the BMP on smuggling, we do not formulate a specific hypothesis about the relationship between the BMP and smuggling. Depending on what kind of smuggling dominates in the countries included in the sample, i.e., import or export smuggling, we expect to observe a negative or positive effect of an increasing BMP on smuggling.

3. Empirical Methodology

SEMs examine relationships between unobservable variables and different observable variables which are classified into causes and indicators. In this paper we investigate a particular alternative of a SEM with one latent endogenous variable which is smuggling. This so-called MIMIC model allows us to analyze the relationship between smuggling and its determinants. Moreover, the key benefits of the MIMIC approach are that it allows modeling of smuggling as a latent variable and dealing with the multiple causes and the multiple effects of smuggling in an economy.⁴

Formally, the MIMIC model consists of two parts: the structural model and the measurement model.⁵ The structural model is given by:

$$\eta = \gamma'x + \zeta \quad , \quad (1)$$

where η is a latent variable, i.e., smuggling, $x' = (x_1, x_2, \dots, x_q)$ is a q vector and each x_i , $i = 1, \dots, q$ is a potential cause of η . $\gamma' = (\gamma_1, \gamma_2, \dots, \gamma_q)$ is a q vector of coefficients in the structural model describing the “causal” relationships between smuggling and its determinants. Thus, η is linearly determined by a set of exogenous causes. Since they only partially explain η , the error term ζ represents the unexplained component. The variance of ζ is abbreviated by ψ and Φ is the $(q \times q)$ covariance matrix of the causes x .

The measurement model links smuggling to its indicators, i.e., smuggling is expressed in terms of observable variables assuming that the indicators chosen are sound measures of the latent variables. Formally, the measurement model is specified as:

⁴ Jöreskog, (1970) and Goldberger (1972) introduced structural equation models into economics.

⁵ Section 3 briefly explains the MIMIC model. See Bollen (1989) for details.

$$y = \lambda\eta + \varepsilon \quad (2)$$

where $y' = (y_1, y_2, \dots, y_p)$ is a p vector of several indicator variables of smuggling, $y_j, j = 1, \dots, p$. $\varepsilon' = (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)$ is a p vector of disturbances where every $\varepsilon_j, j = 1, \dots, p$ is a white noise error term. Their $(p \times p)$ covariance matrix is given by Θ_ε . The single $\lambda_j, j = 1, \dots, p$ in the p vector of regression coefficients λ represents the magnitude of the expected change of the respective indicator for a unit change of smuggling. Figure 1 provides a general path diagram of a MIMIC model.

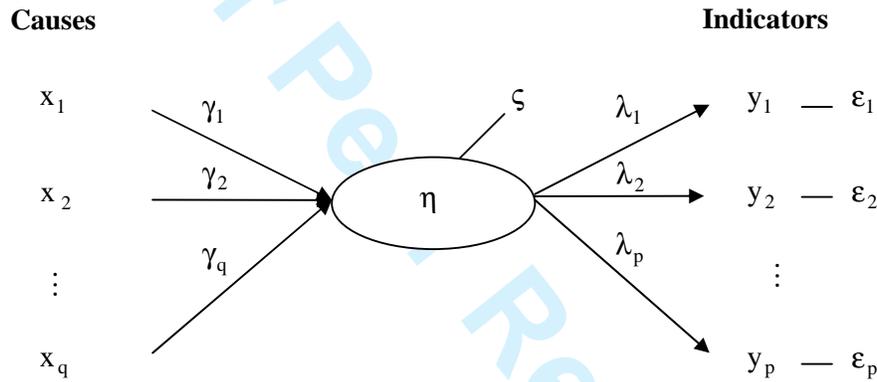


Figure 1. Structure of a MIMIC Model

Substituting equation (1) into (2) yields a reduced form multivariate regression model where the endogenous variables $y_j, j = 1, \dots, p$ are the smuggling's indicators and the exogenous variables $x_i, i = 1, \dots, q$ its causes. This model is given by:

$$y = \Pi x + z \quad (3)$$

where $\Pi = \lambda\gamma'$ is a matrix with rank equal to 1 and $z = \lambda\zeta + \varepsilon$. The error term z in equation (3) is a p vector of linear combinations of the white noise error terms ζ and ε from the structural and the measurement model, i.e., $z \sim (\mathbf{0}, \Omega)$. The covariance matrix Ω

is given as $\text{Cov}(z) = E[(\lambda\zeta + \varepsilon)(\lambda\zeta + \varepsilon)'] = \lambda\lambda'\psi + \Theta_\varepsilon$ and similarly constrained like Π .

Identification and estimation of the MIMIC model therefore requires imposing constraints on the model (Bollen, 1989). A popular constraint imposed in order to achieve identification and produce meaningful estimates of the coefficients is to normalize one of the elements of the vector λ to an a priori value (see e.g. Dell'Anno and Schneider, 2009).

Under the assumption that smuggling generates the pattern of covariances among the causes and indicators, the coefficients are estimated by decomposing the MIMIC model's covariance matrix $\Sigma(\theta)$ which is a function of the parameters λ , γ and the covariances contained in Φ , Θ_ε , and ψ . The values for the parameters and covariances are chosen in order to produce an estimate for $\Sigma(\theta)$, $\hat{\Sigma} = \Sigma(\hat{\theta})$, that is as close as possible to the sample covariance matrix S of the observed causes and indicators, i.e., of the x 's and y 's. The estimation procedure minimizes the following fitting function:

$$F = \ln|\Sigma(\theta)| + \text{tr}\left[S\Sigma^{-1}(\hat{\theta})\right] - \ln|S| - (p+q). \quad (4)$$

The first step in the MIMIC model estimation is to confirm the hypothesized relationships between smuggling and its causes as well as indicators. Once these relationships are identified and the parameters estimated, the MIMIC model estimation results are used to calculate a MIMIC score η_k for each country, $k = 1, \dots, K$, in the sample. The scores for the K countries in the sample make up an index that provides the countries' ranking of smuggling. Before we present these results, the next section discusses causes and indicators of smuggling in detail, presents their empirical implementation, and specifies the empirical MIMIC model of smuggling.

4. Causes and Indicators of Smuggling

4.1 Causes of Smuggling

4.1.1 Tariff Rates and Trade Restrictions

As discussed in the literature review, the theoretical and empirical literature shows that tariffs and trade restrictions encourage traders to resort to illegal ways of trade, such as smuggling of products or misinvoicing of exports and imports. To test hypotheses (1) and (2), that higher tariffs and the more trade restrictions encourage smuggling, we use the tariff rate provided by Wacziarg and Welch (2003) and a restriction index. For the tariff rate we expect a positive correlation to smuggling. The restriction index is part of the KOF Index of Globalization (Dreher, 2006) and comprises hidden barriers, mean tariff rates, taxes on international trade (per cent of current revenues), and capital account restrictions. This variable ranges from 0 to 100 with higher values of this index indicating a better situation for free trade in a country. Thus, we refer to this index as a lack of trade restrictions index and expect a negative correlation to smuggling, i.e., by liberalizing foreign trade and eliminating non-tariff barriers and similar red tapes, the incentives to smuggle should be reduced. Another alternative to test hypothesis (2) is applying the Openness Index of Penn World Table 6.1 (PWT 2002) (Openness). We thus use this index, instead of the lack of trade restriction index, as a robustness check in some MIMIC model estimations. The expected correlation between Openness and smuggling is negative.

4.1.2 Rule of Law

The literature shows that law enforcement is a deterrent to smuggling because higher expected costs, including fines and punishment costs, reduce the net gain of smuggling. The expected costs of smuggling depend on the probability of being caught and punished

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3 by law enforcing authorities, i.e., on the efficiency of the monitoring system and efforts of
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5 the police.
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7 To test hypothesis (3), that better law enforcement reduces the level of smuggling, we
8 use the rule of law index from World Governance Indicators (WGI) (Kaufmann et al.,
9 2007). This index measures the quality of contract enforcement, the police, and the courts
10 and is thus an appropriate proxy for penalties and the perceived costs of smuggling. This
11 index ranges from -2.5 to 2.5 with higher values indicating a stronger police and judiciary
12 system. We thus expect this index to have a negative correlation to smuggling.
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20 21 22 23 4.1.3 Corruption

24 Previous empirical research shows that smuggling is positively correlated to corruption:
25 smuggling is easier in countries with corrupt bureaucracies who are more likely to abuse
26 public power for private gains and allow smugglers this type of escape when caught.⁶ To
27 test hypothesis (4), that more corrupt societies have a higher level of smuggling, we use
28 the corruption variable from the Index of Economic Freedom of the Heritage Foundation
29 (Holmes et al., 2007). Alternatively, and as a robustness check, the measure of corruption
30 from WGI (Kaufmann et al., 2007) is used. Both of these corruption indices are defined in
31 a way that higher values of the index indicate a lower level of corruption. Therefore we
32 refer to each of them as a lack of corruption index and expect a negative effect on
33 smuggling.⁷
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49 ⁶ This is the most general definition of corruption often used in the literature. The World Bank
50 provides a narrower one: “[corruption] distorts the rule of law, weakens a nation's institutional
51 foundation, and severely affects the poor who are already the most disadvantaged members of the
52 society.” (World Bank, 2009a).
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57 ⁷ Corruption might also be an indicator of illegal trade in an economy. In fact, smuggling is in
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4.1.4 BMP

As explained above, a BMP can be an attractive incentive for smuggling. Smugglers can underinvoice exports and exchange the unrecorded revenues on the black foreign exchange market to realize additional profits. But a high BMP can also reduce the incentive to smuggle. This is the case for illegal importers who have to acquire foreign exchange for the amount of imports not reported to authorities on the black market (De Macedo, 1987). Because of the two contrasting types of evidence in the literature we do not formulate a specific hypothesis about the relationship between the BMP and smuggling. Depending on what kind of smuggling dominates in the countries (import/export smuggling), we expect to observe a negative/positive effect of an increasing BMP on smuggling.⁸ The sources for the BMP are Easterly and Sewadeh (2002) and Reinhart and Rogoff (2004).

4.2 Indicators of Smuggling

4.2.1 GDP per capita and Tax Revenues

Smuggling involves both real and monetary costs. Real costs of smuggling arise from the transfer of production factors such as capital and labor to the illegal and hidden part of the

close connection with bribery and other forms of corruption. Increasing illegal trade may affect the perception of corruption in the society. To consider this issue, we also estimated specification 10 which uses the lack of corruption index as an indicator.

⁸ The main analysis examines the effect of the BMP as a causal variable on smuggling. However, it can be argued that changes of the BMP are due to changes in smuggling transactions. Export smugglers supply unreported foreign exchange in the black market and import smugglers demand the foreign exchange in the black market for financing their operations. Thus, in the specifications 8 and 9 we used the BMP as an indicator of smuggling.

1
2
3 economy. Monetary costs arise from the evasion of taxes and tariffs. Tax revenues are the
4
5 predominant source of government revenues in most countries. While developed countries
6
7 rely more on direct taxes such as taxes on income, profits, and capital gains, developing
8
9 countries depend more on indirect taxes, including taxes on international trade (Askari,
10
11 2006, p. 135). This is due to the fact that administrative and implementation costs are
12
13 lower for indirect taxes than for direct ones. It is thus easier to levy indirect taxes in an
14
15 environment of lower institutional quality like in developing countries.
16
17

18
19 Smugglers, by evading legal duties and taxes/tariffs, are an extra burden for the
20
21 government's budget. Naturally, their activities reduce the government's ability
22
23 (especially in developing countries as they rely more on indirect taxes) to provide public
24
25 goods. This may have harmful consequences for the governments' ability to provide
26
27 public goods. As shown by others (e.g. Loayza, 1996; Johnson et al., 1997), the provision
28
29 of public goods increases productivity of firms in the official economy. Thus, smuggling –
30
31 by wasting scarce resources – has a negative effect on productivity, development, and
32
33 economic growth.⁹ Our fifth hypothesis therefore is:
34
35

36
37 (5) The higher the level of smuggling, the lower foreign trade tax revenues, economic
38
39 development and growth, *ceteris paribus*.¹⁰
40
41

42 To test hypothesis (5) empirically, we use the GDP per capita and a measure of tax
43
44 revenues as indicators. The source of GDP per capita is Penn World Table (PWT, 2002)
45

46
47 ⁹ See e.g., Norton (1988) and Deardorff and Stolper (1990).
48

49 ¹⁰ There is also another way to look at the relationship between smuggling and GDP per capita.
50
51 If countries become richer, they can invest more in monitoring institutions and efficient and
52
53 transparent trade procedures. Thus, we expect a negative effect of an increasing real GDP per
54
55 capita on smuggling. We have tested this hypothesis by estimating specification 10 which uses
56
57 GDP per capita as a causal variable.
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1
2
3 and the expected correlation between smuggling and the GDP per capita is negative. Faced
4
5 with lots of missing data on international trade taxes, we decided to use a broader measure
6
7 of government revenues instead. Using the total tax revenues from World Bank (2006) as
8
9 data source, we expect a negative correlation between smuggling and government's total
10
11 tax revenues.¹¹
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13

14 15 16 4.2.2 Misinvoicing

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18 Illegal foreign trade transactions are detectable using balance of payment data, in
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20 particular partner country trade statistics. A reporting gap or trade data discrepancy occurs
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22 if the true value of exports or imports deviates from the amount of exports or imports
23
24 entrepreneurs report to the authorities. Without smuggling (and measurement error), no
25
26 systematic reporting gap should exist. It is thus common practice in the literature to use
27
28 trade discrepancies in official trade data to uncover smuggling.¹² We follow this approach
29
30 and expect a positive correlation between trade discrepancies and the true level of
31
32 smuggling among countries.¹³ Our sixth and final hypothesis therefore is:
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34
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38
39 ¹¹ Another effect could be that smuggling is accompanied with increased activities in the
40
41 shadow economy making the size of the shadow economy an appropriate indicator of smuggling.
42
43 We have thus estimated all specifications of the MIMIC model of smuggling using the size of the
44
45 shadow economy in the respective country instead of tax revenues as indicator of smuggling.
46
47 Because the estimation results are qualitatively very similar regarding the causes and other
48
49 indicators of smuggling, we do not report these estimations in the paper. They are however
50
51 available upon request.

52
53 ¹² For recent empirical applications see e.g. Fisman and Wei (2004, 2007), Berger and Nitsch
54
55 (2008), Farzanegan (2009), and Buehn and Eichler (2009). Makhoul and Otterstrom (1998)
56
57 provide a comprehensive investigation of statistical discrepancies in the IMF's international trade
58
59 figures between 1948 and 1994.

60
¹³ We used two similar control groups, namely industrialized economies and the rest of the

(6) The higher the level of smuggling, the higher the reporting gaps/trade discrepancies in the partner country trade statistics, *ceteris paribus*.

We use official trade figures to test hypothesis (6), i.e., that a higher reporting gap or trade discrepancy indicate a higher level of smuggling. The data are taken from the Directions of Trade Statistics (DOTS) database of the International Monetary Fund (IMF). In this database, the export figures are in FOB (Free on Board) and imports are in CIF (cost, insurance and freight) prices. In order to make them comparable, we multiply the export figures by an adjustment factor of 1.1 as suggested by the IMF (1993), taking into account transport and insurance costs. More precisely, we used the following two equations to calculate import and export misinvoicing:

$$\text{Export Misinvoicing} = X_i - (X_c \cdot \text{CIF factor}), \quad (5)$$

$$\text{Import Misinvoicing} = M_c - (M_i \cdot \text{CIF factor}), \quad (6)$$

where X_i are imports from a specific country as recorded by industrial economies (or rest of the world), X_c are exports as reported by a specific country to industrial economies (or rest of the world), M_c are imports as reported by a specific country from industrial economies (or rest of the world), and M_i are exports of industrial economies (or rest of the world) to a specific country.

While positive values in equation 5 refer to underinvoicing of exports, negative ones refer to overinvoicing of exports by a specific country. In equation 6, positive values refer to overinvoicing of imports and negative ones to import underinvoicing. The total misinvoicing is the sum of absolute amount of import and export misinvoicing. The

world, to calculate trade discrepancies. Relying on the smuggling literature we assume that trade data reported by industrialized countries are accurate. This enables us to interpret discrepancies in trade figures as evidence for misinvoicing.

1
2
3 definitions and sources of all variables are summarized in Table A.1 in the Appendix.
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5
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7 8 *4.3 The Empirical MIMIC Model of Smuggling*

9
10 In summary, we employ the following main causal variables in the MIMIC approach to
11 smuggling: lack of trade restrictions, tariffs, lack of corruption, BMP, and rule of law.
12
13

14 Therefore, the precise specification of the structural equation (1) in the model is:
15

$$16 \quad [\text{Smuggling}] = [\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5] \times \begin{bmatrix} \text{Lack of Trade Restrictions} \\ \text{Tariffs} \\ \text{Lack of Corruption} \\ \text{BMP} \\ \text{Rule of Law} \end{bmatrix} + [\zeta] \quad (7)$$

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25 On the side of the measurement model and as indicators of smuggling we use the GDP per
26 capita, the trade discrepancy, and tax revenues. Thus, equation (2) of the measurement
27 part of the model results in:
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31

$$32 \quad \begin{bmatrix} \text{GDP per capita} \\ \text{Trade Discrepancy} \\ \text{Tax Revenues} \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} \times [\text{Smuggling}] + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix} \quad (8)$$

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38 The concrete path diagram of the empirical MIMIC model is shown in Figure 2. The small
39 squares attached to the arrows indicate the expected signs in the empirical analysis
40 following our hypotheses (1) to (6).
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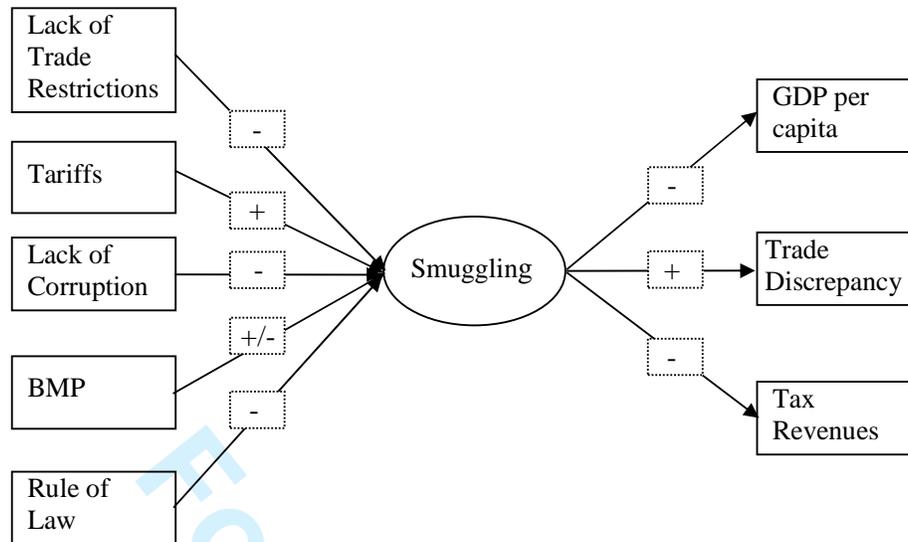


Figure 2. Path Diagram of the Smuggling MIMIC Model

5. Results

5.1 Estimation Results

The results of the MIMIC model estimations for smuggling are illustrated in Table 2. We present 10 different MIMIC model specifications. Specification 1 is the baseline estimation.¹⁴ The estimation period is 1991-1999 and we use the average value of the available data over this period due to data limitations.¹⁵ We also use different data sources or vary either the set of causes and/or indicators to check the robustness of our results. We report standardized regression coefficients in Table 2, because the interpretation of the relative effects of the causes on the dependent, unobservable variable requires the

¹⁴ All calculations have been carried out with LISREL® version 8.80.

¹⁵ The time period was limited to the cut-off of 1999 because of the unavailability of information on some key variables such as the BMP beyond this period. Moreover, some of them – the tariff rate for example – are only available as averages over the estimated period.

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2
3 examination of the standardized coefficients if the variables are measured on different
4
5 scales.¹⁶ The standardized coefficients then indicate – *ceteris paribus* – the response in
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7 standard deviation units of the latent variable for a one standard deviation change in an
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9 explanatory, causal variable (Bollen, 1989). In the following we explain the estimation
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11 results starting with the causes of smuggling.
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52 ¹⁶ The standardized coefficients are calculated as $\hat{\gamma}_{ji}^s = \hat{\gamma}_{ji} \sqrt{\hat{\sigma}_{ii} / \hat{\sigma}_{jj}}$. Thereby the subscript *s*
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54 indicates the standardized coefficient; *i* denotes the causal and *j* the latent variable. $\hat{\sigma}_{ii}$ and $\hat{\sigma}_{jj}$
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56 are the predicted variances of the *i*th and *j*th variable, respectively.
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59
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Table 2. Estimations Results (Standardized Coefficients)

Specification	1	2	3	4	5	6	7	8	9	10
Causes										
Lack of trade restrictions	-0.16 [*] (1.69)	-0.16 [*] (1.71)	-0.18 [*] (1.90)	-0.18 [*] (1.88)		-0.16 [*] (1.68)	-0.17 [*] (1.76)	-0.16 [*] (1.71)		
Tariffs	0.12 ^{**} (1.96)	0.12 [*] (1.95)	0.09 (1.47)	0.12 [*] (1.94)	0.18 ^{***} (3.36)	0.12 [*] (1.85)	0.11 [*] (1.76)	0.11 [*] (1.81)	0.18 ^{***} (3.19)	0.02 (0.25)
Trade openness					0.04 (0.77)	0.03 (0.57)			0.04 (0.76)	-0.09 (1.11)
Lack of corruption	-0.21 ^{***} (2.55)	-0.21 ^{***} (2.58)	-0.26 ^{***} (3.21)	-0.30 ^{c)} (1.54)	-0.23 ^{**} (2.73)	-0.26 ^{***} (3.20)	-0.26 ^{**} (3.15)	-0.23 ^{***} (2.90)	-0.25 ^{***} (3.09)	
BMP	-0.10 ^{**} (2.00)	-0.10 ^{**} (1.98)	-0.05 ^{b)} (1.08)	-0.10 ^{**} (1.96)	-0.10 ^{**} (2.06)					-0.14 [*] (1.68)
Rule of law	-0.64 ^{***} (6.10)	-0.64 ^{***} (6.08)	-0.56 ^{***} (5.66)	-0.51 ^{***} (2.39)	-0.74 ^{***} (8.36)	-0.56 ^{***} (5.65)	-0.56 ^{***} (5.60)	-0.59 ^{***} (5.89)	-0.69 ^{***} (8.34)	-0.36 [*] (1.67)
GDP per capita										-0.66 ^{***} (2.94)
Indicators										
GDP per capita (fixed)	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95
Misinvoicing	0.50 ^{***} (4.17)	0.53 ^{a),***} (4.45)	0.51 ^{***} (4.28)	0.49 ^{***} (3.97)	0.49 ^{***} (4.03)	0.51 ^{***} (4.27)	0.51 ^{***} (4.27)	0.51 ^{***} (4.25)	0.50 ^{***} (4.11)	0.52 ^{***} (4.13)

Table 2. Continued.

Specification	1	2	3	4	5	6	7	8	9	10
Tax revenues	-0.45*** (3.64)	-0.45*** (3.64)	-0.43*** (3.39)	-0.44*** (3.48)	-0.44*** (3.55)	-0.42*** (3.35)	-0.42*** (3.37)	-0.42*** (3.35)	-0.41*** (3.25)	-0.45*** (3.50)
BMP								0.33*** (2.57)	0.34*** (2.60)	
Lack of corruption (fixed)										-0.86
Goodness-of-fit statistics										
Observations	54	54	54	54	54	54	54	54	54	54
Degrees of freedom	21	21	21	21	21	21	15	21	21	21
Chi-square	20.11	19.41	11.95	21.20	19.52	12.64	11.88	29.68	29.20	17.09
(<i>p</i> -value)	(0.51)	(0.56)	(0.94)	(0.45)	(0.55)	(0.92)	(0.69)	(0.09)	(0.11)	(0.71)
RMSEA	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.09	0.09	0.00

a) Misinvoicing with control group rest of the world; b) BMP taken from Reinhart and Rogoff (2004); c) Corruption index of WGI

Note: *** Significance at the 1% level. ** Significance at the 5% level. * Significance at the 10% level. Absolute z-statistics in parentheses. The degrees of freedom are determined by $0.5(p + q)(p + q + 1) - t$; with p = number of indicators; q = number of causes; t = the number for free parameters. If the model fits the data perfectly and the parameter values are known, the sample covariance matrix equals the covariance matrix implied by the model. The null hypothesis of perfect fit corresponds to a p -value of 1. The root mean squared error of approximation (RMSEA) measures the model's fit based on the difference between the estimated and the actual covariance matrix. RMSEA values smaller than 0.05 indicate a good fit (Browne and Cudeck, 1993).

1
2
3 The lack of trade restrictions index has a negative effect on smuggling in all specifications. As
4
5 higher values of this index indicate fewer trade restrictions, the observed negative relationship
6
7 between the lack of trade restriction index and smuggling means that fewer trade restrictions
8
9 will – as expected – lower the level of smuggling. We also separately controlled for the effect
10
11 of average tariffs on imports. The results show that tariffs are positively correlated to
12
13 smuggling. This relationship is statistically significant in all estimated specifications, except
14
15 for specification 3 and 10. That is, the higher tariffs the more smuggling takes place, *ceteris*
16
17 *paribus*. For example, in specification 1, a one standard deviation increase in average tariffs
18
19 increases smuggling by 0.12 standard deviations. Trade openness enters in specifications 5, 6,
20
21 9, and 10. Its effect on smuggling is not conclusive. On the one hand one can argue that more
22
23 openness decreases the incentive for illegal trade, but on the other hand – as Pitt (1981)
24
25 mentions – legal trade is used by illegal traders to camouflage their illegal activities.
26
27 However, neither the positive correlation of this variable to smuggling in specifications 5, 6,
28
29 and 9 nor the negative correlation in specification 10 is statistically significant. In summary,
30
31 the statistical evidence confirms our hypotheses (1) and (2) that more trade restrictions and
32
33 higher tariffs increase the level of smuggling. Openness seems not to be an important
34
35 determinant of smuggling.

36
37
38 The negative and strongly significant impact of the rule of law index is illustrated in all
39
40 specifications. As explained in subsection 4.1, this index is used to proxy fine rates on
41
42 smuggling and the quality of the police and the courts in a country. The negative effect of the
43
44 rule of law on smuggling is stable through different specifications. A one standard deviation
45
46 increase in this index reduces smuggling by more than 0.50 standard deviations. The
47
48 statistical evidence thus confirms hypothesis (3). Given the large standardized coefficient of
49
50 the rule of law it seems that rather the ease to circumvent administrative rules than high tariffs
51
52 and trade restrictions determine the level of smuggling.

53
54
55 The lack of corruption index shows a consistent and negative effect on smuggling. This
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1
2
3 effect is statistically significant in all specifications, except for specification 4 which uses the
4
5 corruption index from WGI (Kaufmann et al., 2007).¹⁷ A one standard deviation increase in
6
7 the lack of corruption index decreases the level of smuggling by more than 0.20 standard
8
9 deviations. The statistical evidence thus confirms hypothesis (4) that higher levels of
10
11 corruption make smuggling easier, *ceteris paribus*. Since a high level of corruption
12
13 undermines the rule of law in a society, both variables may depend on each other. To assure
14
15 that our results are not driven by the possible collinearity between corruption and the rule of
16
17 law, we additionally estimate baseline specification 1 excluding the measure of corruption.
18
19 Our results nevertheless remain robust. All remaining causal variables, i.e., the measure of
20
21 average tariffs, the lack of trade restrictions index, the BMP, and the rule of law as well as all
22
23 indicators are statistically significant with the theoretically expected sign. We thus conclude
24
25 that the possible dependency between the rule of law and corruption does not drive the
26
27 estimation results.¹⁸
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30

31
32 Finally, the BMP shows a stable and significant negative effect on smuggling. This case is
33
34 highly possible for import smuggling, where smugglers must finance their illegal imports
35
36 from the black market of exchange. An increasing premium functions like an extra burden for
37
38 this group of illegal traders.¹⁹
39
40

41
42 ¹⁷ Recall from subsection 4.1 that for both indices lower index values imply a higher level of
43
44 corruption.
45

46 ¹⁸ The estimated standardized coefficients of the causes (z-statistics) in this robustness specification
47
48 are as follows: lack of trade restrictions -0.18* (-1.84); average tariffs 0.14** (2.18); BMP -0.14*** (-
49
50 2.72); rule of law -0.81*** (-9.15). For the indicators we estimate: GDP per capita -0.94 (fixed);
51
52 Misinvoicing 0.49*** (3.98); tax revenues -0.44*** (-3.56). The goodness of fit statistics point to a good
53
54 fit: the chi-square is 20.06, its p-value 0.17, and the RMSEA 0.08.
55

56
57 ¹⁹ Specification 3 making use of the BMP from Reinhart and Rogoff (2004) does not confirm this
58
59 effect at any convenient significance level.
60

1
2
3 Turning to the indicators, we find fairly consistent results across different specifications.
4
5 As explained in section 3, one of the coefficients of the indicators has to be normalized. We
6
7 selected GDP per capita and set the coefficient of this variable to -1. The reasoning is that
8
9 smuggling canalizes resources of an economy from the productive, official part to the grabby,
10
11 unofficial part, hindering the entire use of the economy's potential capacity and reducing
12
13 economic growth and development.²⁰ The second most important indicator of smuggling is
14
15 the trade discrepancy or trade misinvoicing, respectively.²¹ The standardized coefficient in the
16
17 various specifications shows that a one standard deviation increase in smuggling increases
18
19 misinvoicing by about 0.50 standard deviations, *ceteris paribus*. Trade discrepancies –
20
21 calculated as trade misinvoicing – are a sound indicator variable for smuggling. The statistical
22
23 evidence thus confirms hypothesis (6).
24
25
26

27 The last indicator is tax revenues. Smugglers by evading legal tariffs and duties are an
28
29 extra burden for government budgets. Increasing smuggling by one standard deviation
30
31 reduces tax revenues by about 0.40 standard deviations. Again, this effect is stable and
32
33 significant across different specifications supporting hypothesis (5).
34
35

36 While the main analysis examines the effect of the BMP as a causal variable on smuggling,
37
38 specification 8 and 9 use the BMP as an indicator. In both specifications, we find a positive,
39
40 statistically significant correlation between smuggling and the BMP. This correlation can
41
42 occur in the case of import misinvoicing. The higher the level of import underinvoicing the
43
44 higher the BMP, *ceteris paribus*, because illegal importers have to acquire foreign exchange
45
46 on the black market for the amount of imports not reported to authorities. A higher level of
47
48
49

50 ²⁰ The choice of the indicator for normalization does not affect the results (Bollen, 1989).
51
52 Typically, one selects the indicator that loads most on the unobservable variable, i.e., GDP per capita
53
54 in the MIMIC model of smuggling.
55

56 ²¹ In specification 2, we demonstrated the robustness of our result using the rest of the world
57
58 instead of the industrialized countries as control group for trade misinvoicing.
59
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3 import smuggling thus increases the price for black foreign exchange. In specification 10, we
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5 use GDP per capita as a cause to test the hypothesis that if countries become richer, they may
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7 invest more in monitoring institutions and efficient and transparent trade procedures which
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9 reduces smuggling. The empirical evidence supports this hypothesis. The observed correlation
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11 between GDP per capita and smuggling is statistically significant negative. That is, the more
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13 developed a country the lower the level of smuggling, *ceteris paribus*.
14
15

16 All estimated specifications show satisfactory goodness-of-fit statistics. The main statistics
17
18 such as the chi-square and the RMSEA are given in Table 2 while additional goodness-of-fit
19
20 statistics are presented in Table A.2 in the Appendix. In order to check the robustness of our
21
22 results further, we estimate all specifications excluding the 3 highest and lowest ranked
23
24 countries according to our index of smuggling.²² By doing so, we find that the correlations
25
26 between smuggling and its causes/indicators remain robust. Although the estimated
27
28 coefficients and z-statistics change slightly, the results are all in all qualitatively identical. As
29
30 the model fits the data fairly well and the estimation results remain robust, we accept the
31
32 validity of the estimated MIMIC model for smuggling. We have used the most important
33
34 determinants of smuggling as causal variables in the empirical analysis. They show the
35
36 theoretically expected signs and are statistically significant. We thus conclude that the model
37
38 is suitable to estimate an index of smuggling for 54 countries around the world. This is done
39
40 in the next subsection.
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42
43
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46

47 5.2. The Smuggling Index

48
49 We use baseline specification 1 to demonstrate the calculation of the smuggling index for the
50
51 54 countries in the sample. The smuggling index is calculated by applying the coefficients of
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53

54 ²² Table 3 in section 5.2 presents the country ranking of the calculated index of smuggling. The 3
55
56 highest (lowest) ranked countries in this index are Switzerland, Finland, and Sweden (Kenya,
57
58 Pakistan, and Cameroon). The estimation results are available upon request.
59
60

the significant causal variables to the corresponding observed variables. For the numerical example of specification 1 the smuggling index is given as:

$$\text{Smuggling} = 0.12 \cdot x_1 - 0.16 \cdot x_2 - 0.21 \cdot x_3 - 0.10 \cdot x_4 - 0.64 \cdot x_5^{23}. \quad (9)$$

The higher the amount of the smuggling index the higher is the level of smuggling over the period of 1991-1999 in a particular country. To check the result for its robustness, we also calculate the smuggling index using two other specifications, i.e. specification 5 and 10. All three indices are presented in Table 3. The ranking of countries corresponds to specification 1 while the third and fourth columns give the countries' ranking according to specification 5 and 10.

Table 3. Ranking of Countries (1991:1999)

Country	Specification 1	Specification 5	Specification 10
Switzerland	1 (-1.574)	1 (-1.709)	1 (-1.984)
Finland	2 (-1.453)	2 (-1.585)	12 (-1.242)
Sweden	3 (-1.429)	3 (-1.559)	7 (-1.452)
Singapore	4 (-1.413)	5 (-1.537)	3 (-1.609)
Austria	5 (-1.413)	4 (-1.544)	2 (-1.629)
Netherlands	6 (-1.404)	6 (-1.534)	4 (-1.520)
Iceland	7 (-1.324)	7 (-1.447)	8 (-1.437)
Canada	8 (-1.308)	8 (-1.437)	6 (-1.507)
Belgium	9 (-1.190)	9 (-1.312)	11 (-1.317)
Australia	10 (-1.175)	10 (-1.285)	5 (-1.508)

²³ x_1 , x_2 , x_3 , x_4 , and x_5 represent tariffs, the lack of trade restriction index, the lack of corruption index, the BMP, and the rule of law, respectively.

Table 3. Continued

France	11 (-1.160)	11 (-1.282)	10 (-1.331)
Japan	12 (-1.1)	12 (-1.225)	9 (-1.426)
Spain	13 (-0.875)	14 (-0.943)	14 (-0.828)
Portugal	14 (-0.874)	13 (-0.951)	16 (-0.641)
Italy	15 (-0.729)	15 (-0.815)	13 (-0.995)
Estonia	16 (-0.557)	16 (-0.507)	21 (-0.045)
Greece	17 (-0.436)	17 (-0.476)	18 (-0.285)
Korea, Rep.	18 (-0.337)	18 (-0.412)	20 (-0.242)
Slovenia	19 (-0.304)	20 (-0.302)	17 (-0.582)
Malaysia	20 (-0.263)	19 (-0.330)	25 (0.086)
Uruguay	21 (-0.175)	21 (-0.214)	23 (0.042)
Cyprus	22 (-0.151)	22 (-0.187)	15 (-0.650)
Costa Rica	23 (-0.116)	24 (-0.135)	26 (0.210)
Mauritius	24 (-0.109)	23 (-0.164)	19 (-0.259)
Trinidad and Tobago	25 (0.028)	25 (-0.001)	22 (0.018)
Latvia	26 (0.097)	26 (0.118)	28 (0.334)
Croatia	27 (0.199)	27 (0.338)	27 (0.310)
Jordan	28 (0.331)	28 (0.339)	33 (0.581)
Jamaica	29 (0.388)	30 (0.429)	37 (0.712)
Panama	30 (0.389)	29 (0.364)	31 (0.541)
Tunisia	31 (0.423)	31 (0.450)	32 (0.542)
Mexico	32 (0.483)	32 (0.474)	35 (0.635)
Turkey	33 (0.499)	34 (0.512)	34 (0.621)

Table 3. Continued

Algeria	34 (0.512)	52 (1.228)	24 (0.045)
Ghana	35 (0.539)	33 (0.499)	51 (1.104)
Brazil	36 (0.544)	36 (0.601)	30 (0.494)
Egypt, Arab Republic	37 (0.559)	35 (0.587)	36 (0.672)
Bulgaria	38 (0.609)	37 (0.646)	29 (0.485)
Sri Lanka	39 (0.639)	38 (0.657)	41 (0.782)
Philippines	40 (0.678)	39 (0.706)	43 (0.795)
Guatemala	41 (0.781)	40 (0.796)	49 (1.057)
China	42 (0.784)	44 (0.939)	39 (0.760)
Zambia	43 (0.797)	41 (0.821)	52 (1.163)
Ecuador	44 (0.837)	42 (0.896)	44 (0.841)
Peru	45 (0.850)	43 (0.908)	46 (0.928)
Ukraine	46 (0.855)	45 (0.958)	42 (0.787)
Nicaragua	47 (0.910)	46 (0.996)	47 (0.932)
Dominican Republic	48 (0.919)	47 (0.999)	38 (0.744)
Indonesia	49 (1.005)	48 (1.081)	48 (0.941)
Paraguay	50 (1.023)	50 (1.121)	45 (0.847)
India	51 (1.029)	49 (1.090)	40 (0.768)
Kenya	52 (1.125)	51 (1.183)	53 (1.273)
Pakistan	53 (1.407)	53 (1.457)	50 (1.072)
Cameroon	54 (1.627)	54 (1.698)	54 (1.360)

The ranking of the countries is not surprising, the developing countries being typically reported as countries with higher levels of smuggling. According to specification 1, the

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2
3 country least hit by smuggling is Switzerland, followed by Finland, Sweden, Singapore, and
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5 Austria. With the exception of Singapore, Canada, Australia, and Japan, only Western
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7 European countries are among the top 15. At the bottom of the scale, Cameroon, Pakistan,
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9 Kenya, India, and Paraguay are found to be most hit by smuggling. As can be seen, the
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11 bottom of the scale is more heterogeneous. Among the 15 countries hit most by smuggling are
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13 6 Latin American and Caribbean countries, 5 Asian countries, 3 African ones, and one
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15 country from Eastern Europe. A comparison of the indices calculated according to
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17 specification 1, 5, and 10, i.e. column 2, 3, and 4 of Table 3, shows that the results are robust,
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19 although some differences in the ranking exist. For example, Austria has the 5th lowest level
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21 of smuggling according to specification 1 but ranks 4th and 2nd according to specification 5
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23 and 10. It can also be seen that for some countries the ranking according to specification 10 is
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25 somewhat different compared to specification 1 and 5. This might have to do with the
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27 different set of indicators in specification 10. While specification 1 and 5 use GDP per capita
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29 as causal variable and the corruption index of the Heritage Foundation as indicator, we
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31 reversed this classification in specification 10. Although almost all available evidence
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33 suggests that corruption varies strongly inverse with development (see, among others, Mauro,
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35 1995; Paldam, 2003). The estimation results demonstrate that perceived corruption is in fact
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37 higher in countries that experience higher levels of smuggling but also that GDP per capita is
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39 the slightly better indicator. The differences in the ranking between specification 1/5 and 10 are
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41 thus not surprising. The chosen three MIMIC model specifications yield nevertheless a similar
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43 outcome with respect to the ranking of countries.
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49 To get a better understanding of the regional differences in smuggling, we also calculated
50
51 the average smuggling index for different regions/country groups of the world which is shown
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53 in Table 4.²⁴ According to specification 1, smuggling is by far lowest in High income OECD
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56 ²⁴ The classification/grouping of countries is based on the World Bank's definition (World Bank,
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58 2009b).
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3 countries, with an average index of -1.167. The ranking for the other regions is as follows:
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5 Eastern Europe (0.150), Asia (0.243), Middle East and North Africa (MENA) (0.362), Latin
6
7 America and the Caribbean (0.569), and finally Africa (0.668). Within the High-income
8
9 OECD countries, smuggling is the biggest problem in Greece followed by Italy and Portugal.
10
11 The countries with the highest level of smuggling in Eastern Europe are the Ukraine and
12
13 Bulgaria. While in Asia Pakistan and India are the least, Egypt and Algeria rank last in the
14
15 MENA region. Among the Latin American and Caribbean countries Uruguay and Costa Rica
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17 perform best, while Paraguay, the Dominican Republic, and Nicaragua are at the bottom of
18
19 the scale. Although only a few African countries are in the sample, we conclude that this
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21 region of the world is most affected by smuggling. Within this region, smuggling is the
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23 biggest problem in Cameroon and Kenya.
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Table 4. Ranking of Countries According to Regions

Country	Specification 1	Specification 5	Specification 10
High income OECD members			
Switzerland	1 (-1.574)	1 (-1.709)	1 (-1.984)
Finland	2 (-1.453)	2 (-1.585)	12 (-1.242)
Sweden	3 (-1.429)	3 (-1.559)	7 (-1.452)
Austria	5 (-1.413)	4 (-1.544)	2 (-1.629)
Netherlands	6 (-1.404)	6 (-1.534)	4 (-1.520)
Iceland	7 (-1.324)	7 (-1.447)	8 (-1.437)
Canada	8 (-1.308)	8 (-1.437)	6 (-1.507)
Belgium	9 (-1.190)	9 (-1.312)	11 (-1.317)
Australia	10 (-1.175)	10 (-1.285)	5 (-1.508)
France	11 (-1.160)	11 (-1.282)	10 (-1.331)
Spain	13 (-0.875)	14 (-0.943)	14 (-0.828)
Portugal	14 (-0.874)	13 (-0.951)	16 (-0.641)
Italy	15 (-0.729)	15 (-0.815)	13 (-0.995)
Greece	17 (-0.436)	17 (-0.476)	18 (-0.285)
<i>Average</i>	<i>-1.167</i>	<i>-1.227</i>	<i>-1.263</i>
Eastern Europe			
Estonia	16 (-0.557)	16 (-0.507)	21 (-0.045)
Slovenia	19 (-0.304)	20 (-0.302)	17 (-0.582)
Latvia	26 (0.097)	26 (0.118)	28 (0.334)
Croatia	27 (0.199)	27 (0.338)	27 (0.310)
Bulgaria	38 (0.609)	37 (0.646)	29 (0.485)

Table 4. Continued

Ukraine	46 (0.855)	45 (0.958)	42 (0.787)
<i>Average</i>	<i>0.150</i>	<i>0.209</i>	<i>0.215</i>
Asia			
Singapore	4 (-1.413)	5 (-1.537)	3 (-1.609)
Japan	12 (-1.1)	12 (-1.225)	9 (-1.426)
Republic of Korea	18 (-0.337)	18 (-0.412)	20 (-0.242)
Malaysia	20 (-0.263)	19 (-0.330)	25 (0.086)
Sri Lanka	39 (0.639)	38 (0.657)	41 (0.782)
Philippines	40 (0.678)	39 (0.706)	43 (0.795)
China	42 (0.784)	44 (0.939)	39 (0.760)
Indonesia	49 (1.005)	48 (1.081)	48 (0.941)
India	51 (1.029)	49 (1.090)	40 (0.768)
Pakistan	53 (1.407)	53 (1.457)	50 (1.072)
<i>Average</i>	<i>0.243</i>	<i>0.243</i>	<i>0.193</i>
MENA			
Cyprus	22 (-0.151)	22 (-0.187)	15 (-0.650)
Jordan	28 (0.331)	28 (0.339)	33 (0.581)
Tunisia	31 (0.423)	31 (0.450)	32 (0.542)
Turkey	33 (0.499)	34 (0.512)	34 (0.621)
Algeria	34 (0.512)	52 (1.228)	24 (0.045)
Egypt, Arab Republic	37 (0.559)	35 (0.587)	36 (0.672)
<i>Average</i>	<i>0.362</i>	<i>0.488</i>	<i>0.301</i>

Table 4. Continued

Latin America and the Caribbean			
Uruguay	21 (-0.175)	21 (-0.214)	23 (0.042)
Costa Rica	23 (-0.116)	24 (-0.135)	26 (0.210)
Trinidad and Tobago	25 (0.028)	25 (-0.001)	22 (0.018)
Jamaica	29 (0.388)	30 (0.429)	37 (0.712)
Panama	30 (0.389)	29 (0.364)	31 (0.541)
Mexico	32 (0.483)	32 (0.474)	35 (0.635)
Brazil	36 (0.544)	36 (0.601)	30 (0.494)
Guatemala	41 (0.781)	40 (0.796)	49 (1.057)
Ecuador	44 (0.837)	42 (0.896)	44 (0.841)
Peru	45 (0.850)	43 (0.908)	46 (0.928)
Nicaragua	47 (0.910)	46 (0.996)	47 (0.932)
Dominican Republic	48 (0.919)	47 (0.999)	38 (0.744)
Paraguay	50 (1.023)	50 (1.121)	45 (0.847)
<i>Average</i>	<i>0.569</i>	<i>0.603</i>	<i>0.665</i>
Africa			
Mauritius	24 (-0.109)	23 (-0.164)	19 (-0.259)
Ghana	35 (0.539)	33 (0.499)	51 (1.104)
Zambia	43 (0.797)	41 (0.821)	52 (1.163)
Kenya	52 (1.125)	51 (1.183)	53 (1.273)
Cameroon	54 (1.627)	54 (1.698)	54 (1.360)
<i>Average</i>	<i>0.668</i>	<i>0.673</i>	<i>0.777</i>

As argued earlier and also demonstrated by others (see, e.g. Fisman and Wei, 2007; Berger and Nitsch, 2008), smuggling often involves other types of criminal and corrupt activities. we

1
2
3 illustrate the strong positive correlation between smuggling and corruption in Figure 3 by
4 using the specification 1 of the smuggling index calculated in this paper and the corruption
5 perception index of Transparency International (1999) (henceforth, CPI99). As higher levels
6 of the CPI99 represent a lower level of corruption in a particular country, we use its reverse.
7 The reverse of CPI99 displayed on the x-axis ranges from 0 to 9 while the estimated index of
8 smuggling is displayed on the y-axis. Figure 3 shows that countries like Switzerland or
9 Australia not only have a low level of corruption but are also less affected by smuggling.
10 They are amongst the best performing countries according to the smuggling index. Similarly,
11 countries with very high levels of corruption like Cameroon, Kenya, and Pakistan also have
12 very high levels of smuggling. Some exception should be noted. Belgium, for example, has a
13 much lower level of smuggling compared to Slovenia or Estonia but performs worse with
14 respect to corruption. The same holds for example for Croatia where corruption is as high as
15 in the most corrupt countries but smuggling seems to be less of a problem. Nevertheless,
16 despite few exceptions it is obvious from Figure 3 that smuggling and corruption are all in all
17 positively correlated.
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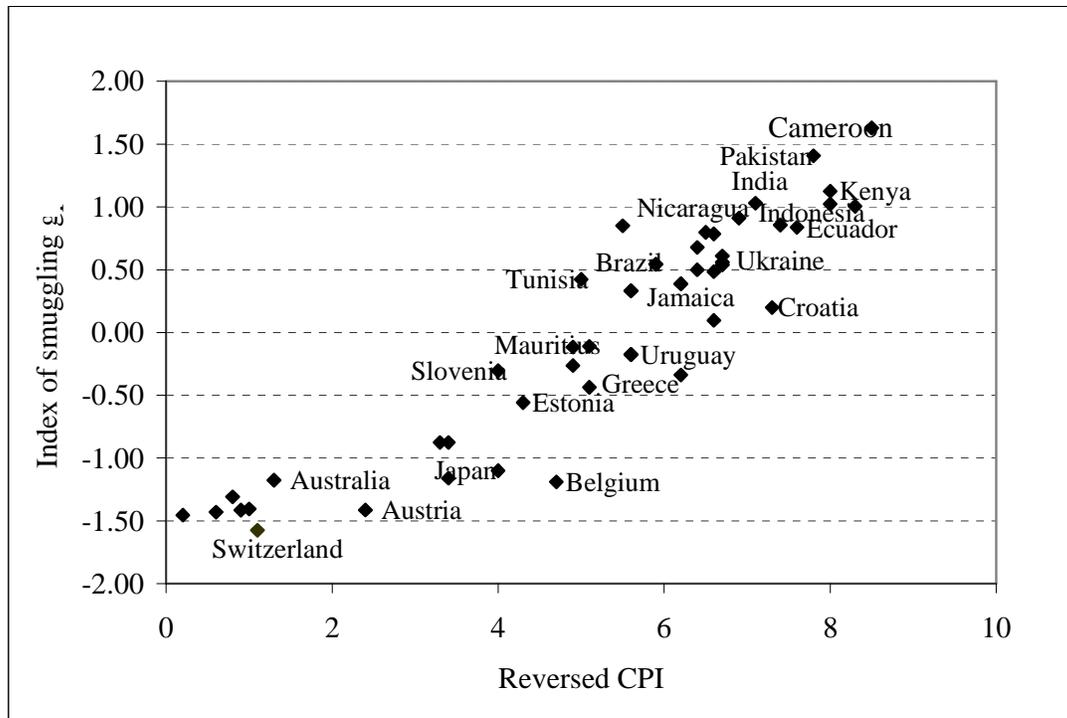


Figure 3. Relationship between Smuggling and Corruption

6. Conclusion

The smuggling index presented in this paper provides the first ranking of smuggling around the world during the 1990s. While previous research mostly employs trade discrepancies to uncover smuggling in a country, we employ a structural model of smuggling that simultaneously deals with the causes and indicators of smuggling within a unified framework for 54 countries around the world. This approach has some important advantages. First, in contrast to existing empirical studies which use narrow concepts as a proxy of smuggling, the MIMIC approach enables us to use the most relevant factors to explain smuggling. The empirical analysis shows a highly statistically significant influence of the rule of law and of the level of corruption on smuggling. Trade restrictions and tariffs provide incentives for traders to engage into smuggling. The magnitude of the standardized coefficients indicates that rather the inferiority of institutions than high tariffs and trade restrictions drive smuggling, although the latter are also important determinants. The second advantage is that

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3 the ranking one retrieves across countries is tied to the causal variables that were used to
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5 estimate the model. As such, the model produces a cardinal index of smuggling and considers
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7 the common criticisms aimed at perception based indices. According to the index of
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9 smuggling presented in this paper, Switzerland, the Scandinavian countries Sweden and
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11 Finland, the Netherlands, Singapore, and Austria are among the countries with the lowest
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13 level of smuggling. Paraguay, India, Kenya, Pakistan, and Cameroon have the highest level.

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16 Of course, one may argue that the estimated model does not capture the extent of
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18 smuggling. There are however two ways to test for the validity of a structural model (Bollen,
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20 1989). First, it is necessary to examine the fit of the model. Secondly, variables related to the
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22 latent variable in the theoretical literature should have the expected impact. We have dealt
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24 with these two validity tests above: all variables show the theoretically expected correlation to
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26 smuggling and the various estimated specifications show satisfactory goodness-of-fit
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28 statistics.
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32 Some policy conclusions may be drawn. Countries that endeavor to reduce the size of
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34 smuggling can strengthen their institutions. Increasing the rule of law and reducing corruption
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36 are most suitable to get hold of smuggling. Reducing trade barriers such as tariffs and quotas
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38 is another possibility. Although even the countries most committed to free trade still have
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40 restrictions. Of course, it has changed for the better since the mid 1990s: average tariffs have
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42 become lower and are still getting lower. Moreover, the smuggling index based on the
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44 MIMIC approach is likely to be of interest for different user groups. One such group might be
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46 the policy-based academic community which evaluates the consequences of smuggling. Since
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48 the index derived here gives a cardinal ranking of smuggling across countries, it has the
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50 potential to provide reliable estimates of the impact of smuggling. For various non-
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52 government organizations that make decisions based on the institutional environment of a
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54 particular country the MIMIC approach would also be useful. Calculating an index of
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56 smuggling as outlined here for different time periods may help them to monitor how
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3 smuggling – being a potential indicator of the general institutional quality in a particular
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5 country – varies over time. Since the method outlined here is based on measurable time
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7 variant causes and indicators, this allows measuring a country's performance in controlling
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9 smuggling.
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12 Clearly, the MIMIC approach to smuggling presented in this paper is only an additional
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14 step in furthering our understanding about smuggling. Depending on data availability, the
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16 model can be estimated over different sub-periods to assess how smuggling has changed over
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18 time for each country. Another promising avenue for future empirical research on smuggling
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20 is the analysis of the impact of economic, political, and institutional reforms such as the
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22 implementation of free trade zones or the improvement of institutional quality on smuggling.
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Appendix

Table A.1. Data Sources and Definitions

Name of variable	Definition	Sources
Causes		
Tariff burden	Average tariff rate (%).	Wacziarg and Welch (2003).
Trade restrictions	Index of restrictions.	Index of globalization, KOF Swiss Economic Institute (Dreher, 2006).
Openness	Openness index defined as sum of exports and imports over GDP.	PWT (2002)
Black market premium	Difference between the parallel exchange rate and the official exchange rate divided by the official exchange rate (The exchange rate is defined as number of units of domestic currency per US dollar.).	Easterly and Sewadeh (2002).
Lack of corruption	Based on quantitative data which assess the perception of corruption in the business environment, including levels of governmental legal, judicial, and administrative corruption.	1) Index of Economic Freedom, Heritage Foundation (Holmes et al., 2007). 2) WGI, World Bank, (Kaufmann et al., 2007).

Table A.1. Continued.

Rule of law	Measure for the extent of agents' confidence in and abidance by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence.	WGI, World Bank, (Kaufmann et al., 2007).
Indicators		
Real GDP per capita		PWT (2002).
Tax revenues		World Bank (2006).
Trade discrepancy	Calculated according to equation (4.7) and (4.8).	IMF Directions of Trade Statistics (DOTS).

Table A.2. Further Goodness-of-Fit Statistics

Goodness-of-fit statistics	Specification									
	1	2	3	4	5	6	7	8	9	10
AGFI	0.85	0.86	0.91	0.84	0.86	0.90	0.89	0.79	0.79	0.88
PGFI	0.53	0.53	0.55	0.53	0.53	0.55	0.50	0.51	0.51	0.56
ECVI	0.96	0.96	0.96	0.97	0.96	0.96	1.06	1.13	1.12	0.94
ECVI independence model	8.36	8.45	7.97	8.88	5.68	8.19	7.87	8.36	5.68	5.68
ECVI saturated model	1.36	1.36	1.36	1.36	1.36	1.36	1.05	1.36	1.36	1.36
AIC	50.11	49.40	41.95	51.20	49.52	42.64	37.88	59.68	59.20	45.09
AIC independence model	442.96	447.86	422.53	470.61	300.96	434.12	417.21	442.96	300.96	300.96
AIC saturated model	72.00	72.00	72.00	72.00	72.00	72.00	56.00	72.00	72.00	72.00

The adjusted goodness-of-fit index (AGFI) and the parsimony goodness-of-fit index show how closely the reproduced covariance matrix comes to the observed covariance of causes and indicators by taking into account the degrees of freedom and the complexity of the model. Values larger than 0.90 and 0.50 for the AGFI and the PGFI indicate a good fit (Mulaik et al., 1989). Another useful indicator for the evaluation of a model's overall fit is the (ECVI). The expected cross validation index (ECVI) measures the discrepancy between the fitted covariance matrix and the expected covariance matrix in another sample of equivalent size. The

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5 ECVI must be compared to the ECVIs of the independence and the saturated model. The fit of the estimated model is acceptable if
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7 its ECVI is below the ECVI of both the independent and saturated model (Byrne, 1998). In all estimated specifications the model's
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9 Akaike information criterion (AIC) is reasonably smaller than the independent and saturated models AIC also indicating a good fit
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11 of the hypothesized MIMIC model of smuggling.
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