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ILLEGAL TRADE IN THE IRANIAN ECONOMY: EVIDENCE FROM A STRUCTURAL MODEL

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Abstract

This study investigates the main causes and indicators of smuggling in both import and export sections of the Iranian Economy and estimates an absolute index of smuggling in Iran during the period 1970-2002. To this effect, Multiple Causes -Multiple Indicators (MIMIC) econometric modelling by LISREL software is applied. This model is ideal for providing a comprehensive analysis of the latent variable of smuggling. The main results of this paper indicate that the rate of fine on smuggling and the total unemployment rate have negative and significant effects on smuggling and that the tariff burden has a positive effect. Regarding the measurement part of the model, smuggling has a negative effect on real governmental revenues and the import price index. Furthermore, the positive effect of smuggling on the petroleum product consumption is also significant. The relative size of smuggling varied from about 6 to 25 percent of total trade in Iran.

ملخص

تفحص هذه الدراسة الأسباب الرئيسية و المؤشرات المتعلقة بالتهريب في شعبتي الواردات والصادرات في الاقتصاد الإيراني وكذا تفحص تقديرات المؤشر المطلق للتهريب في إيران خلال الفترة من 1970 إلى 2002. من اجل هذا قمت بتطبيق نموذج التحليل متعدد المؤشرات ومتعدد العوامل السببية (MIMIC) مما أتاح لي إجراء تحليل شامل علي المتغير الكامن للتهريب. وتظهر النتائج الرئيسية للدراسة أن لمعدل الغرامة علي التهريب ومعدل إجمالي البطالة تأثيرات سلبية و ذات بال علي التهريب وأن عبئ التعريفة الجمركية ذو تأثير إيجابي علي التهريب. وبقياس أحد جوانب ذلك النموذج تبين أن للتهريب تأثيرا سلبيا علي الدخول الحكومية الحقيقية ومؤشر أسعار الواردات. أضف إلى ذلك أن التأثير الإيجابي للتهريب علي استهلاك المواد البترولية ذو بال كذلك. وقد تراوح الحجم النسبي للتهريب من 6% إلى 25% من إجمالي التجارة في إيران.

1. Introduction

Smuggling can be defined as the clandestine import of goods from one jurisdiction to another (Deflem and Henry, 2001). The other definition says that smuggling is the evasion of excise taxes on goods by circumvention of border controls (Merriman, 2002). Regardless of different approaches to definitions of this complex multi-aspect issue, the effects of smuggling are numerous and economically significant. For instance, smuggling creates loss in public revenues, it affects the internal structure of a society by creating powerful illegal institutions, and it changes the patterns of consumption (Dominguez, 1975). Furthermore, it may have a negative effect on official indicators such as growth and income distribution. Basically, it can be argued that smuggling is driven by the primary forces of supply and demand. Whenever state intervention drives a wedge between gross and net prices (through excise duties, trade restrictions and custom duties), there is an incentive for underground activities. Smuggling is an activity that is used to earn income from carrying goods through the state border in violation of existing rules. Smugglers seek to generate income by avoiding state control, regulations and related costs (Lithuanian Free Market Institute, 2004). It involves bribery and other forms of corruption and is of a criminal nature in macroeconomics.

While a large body of literature is devoted to theoretical aspects of the effects of smuggling on social welfare[1], this paper estimates the determinants and effects of smuggling in an abundant natural resource economy. Estimating the true nature of smuggling is challenging because it is an illegal and hidden activity. A number of useful and reliable methods to estimate smuggling are available, but each method has its limitations. The methods most commonly applied to estimate smuggling can be classified into direct and indirect approaches. Direct methods are based on contacts with or observations of persons and/or firms, to gather direct information about smuggled products. Indirect methods of estimating smuggling can be categorized as : (1) Discrepancies between the sale of goods under study and the estimated consumption of those products by using household surveys; (2) discrepancies between the sale of goods and the estimated consumption of those products by using econometric estimation; (3) discrepancies between the imports of goods in the target country with the exports of the trade partner in order to find "under-invoicing"; (4) the model approach or MIMIC (Multiple Indicator and Multiple Choice) method.

The principal technique of detecting illegal trade – the partner-country-data comparison technique – has its origins in the work of Morgenstern (1950) on the accuracy of foreign trade statistics. The technique was further developed by Naya and Morgan (1969) and Bhagwati (1964) who compared the import data of Turkey from the other countries with the recorded figures of export from trade partners of Turkey. He found under-invoicing in Turkey official imports. Naya and Morgan (1969) followed the same methodology for the case of South East Asian countries. He observed irregular patterns in this region's trade, suggesting a large degree of inaccuracy and discrepancy in trade related data. Alano (1984) carried out an econometric analysis of import smuggling in the Philippines during 1965-1978. The dependent variable in his study was import smuggling which was calculated based on partner-country trade data discrepancies. This information was generated by comparing export figures of major trade partners of the Philippines with import figures of this country from its major partners. Probable discrepancies were assumed for possible smuggling amounts. This calculation provided required data for dependent variables in the regression analysis. Alano then proceeded to identify the following variables: the level of income, probability of getting caught, the black market premium, penalty rate, and nominal rate of duty. His estimation of smuggling for the Philippines ranged from 28.95% to 53.81% of the reported exports to this country from the partner-countries considered in his study. Phylaktis (1992) applied an OLS

[1] For example, Bhagwati and Hansen (1974), Bhagwati and Srinivasan (1974), Martin and Panagariya (1983)., Norton .,D.(1988), and Thursby, M., Jensen, R., Thursby J(1991)

model for the case of Chile during the period of 1974-1984. He showed that import tariff raised the black market premium in the long run affecting the flow demand for black dollars by smugglers.

Yavari (2000) followed the methodology of Bhagwati (1964) and estimated the import smuggling and over-valuation of imports in Iran for the period of 1977-1997. Later, by using import tariff as a proxy for smuggling in a panel data for 70 developing countries over the period of 1956-98, Oskooee et.al. (2003) demonstrated the positive effect of smuggling on the black market premium. Pajoyan and Madah (2005) estimated smuggling in Iran through Structural Equation Modelling. However, their estimation neither included the export side of smuggling nor the effects of business cycles on smuggling in Iran. They also did not calculate the relative size of smuggling, which is one of our main goals in this study.

The estimation of smuggling through the investigation of discrepancies between figures of import and export between the host country and its trading partners has its limitations. In fact, these discrepancies do not always refer to the existence of smuggling, but could be due to transport costs (in the case of reporting export data in F.O.B while reporting import data in C.I.F), the existence of different exchange rates; time lags in recordings, differences in commodity classification and coverage, and faking of export declaration and inaccuracies in export reporting (Alano (1984)).

This paper contributes to the existing literature on the subject by assuming import and export smuggling as a latent variable. Empirical studies of smuggling, as explained earlier in this section, used proxies for the unobservable variable of smuggling, which by no means illustrate the comprehensive picture of this complex phenomenon. The modern econometric tool of Structural Equation Modelling with a latent variable enables us to take into account a larger number of both causal and indicator variables of smuggling into account. The estimated absolute index based on this methodology will be much more reliable than building the smuggling index on the basis of one proxy or calculation of discrepancies in trade figures. This study also sheds light on the negative effect of smuggling on the natural resource wealth of a developing country. Furthermore, it explains the effect of the country's rule of law, parallel market of exchange rate and potential rents in this market; total unemployment rate as a sign of general healthiness of an economy, foreign trade openness, and also specific effect of smuggling on the real government revenue; import price index and growth rate of petroleum product consumption. The estimated absolute index of smuggling will be transformed to a relative index of smuggling in total foreign trade by using external calculations of smuggling based on the trade discrepancy approach. The analysis uses the time series data for the case of Iran over the period of 1970-2002.

The paper is organized as follows. In section 2, the theoretical literature on smuggling is reviewed. In section 3, the empirical methodology is presented. Section 4 presents the empirical model and explains the variables. Finally, empirical results and main conclusions are presented in sections 5 and 6 respectively.

2. Review of Theoretical Literature

The welfare aspects of smuggling have attracted some attention by economists. Bhagwati and Hansen (1973) study the welfare levels under tariffs with and without smuggling. They conclude that the achievement of a given degree of protection to domestic importable production, in the presence of smuggling, leads to lower levels of welfare than if smuggling were absent.

Pitt (1981) proposes a model of smuggling consistent with the coexistence of smuggling, legal trade and price disparity. By his definition, price disparity can be calculated by comparing the domestic price of the goods (Pd, in domestic currency units) to the quantity of domestic

exchange that can be earned through legal trade (that is the world price, Pf, which is quoted in USD multiplied by the legal effective exchange rate for exportables, EER). Mathematically, price disparity equals ((Pd/Pf*EER)-1)*100. The presence of price disparity can be an indicator of the existence of smuggling. He emphasizes on "technical smuggling" domination in the case of Indonesia. According to him, the greater the legal trade, the easier it is to hide smuggling from enforcement agencies and naturally smuggling would be less costly. Furthermore, He discusses that the quantity of legal trade and subsequently governmental tax revenues in the smuggling situation exceeds that of a non-smuggling situation. He, then, concludes that the policy of complete and effective enforcement against smuggling may not maximize the level of legal trade. This is in contrast with Bhagwati and Hansen's (1973) statement, which implies that in the presence of smuggling, we have to expect lower levels of welfare that results from the reduction in public revenues. Pitt (1981), then uses his theoretical concept for the case of export smuggling of rubber in Indonesia within a simple OLS model during 1949-1972. He establishes a linear relationship between the legal export of rubber, as a dependant variable, and rainfall, incentive to smuggling defined as the rupiah return to a dollar's worth of smuggling relative to the rupiah return to a dollar's worth of legal trade which is the ratio of the black market exchange rate to the legal effective exchange rate for rubber export. Furthermore, he includes the contemporaneous domestic price of rubber relative to the price of its domestic competition (rice). The dominant share of explaining variances in legal trade of rubber belongs to the incentive to smuggle with a negative coefficient.

Martin and Panagariya (1983) show that increased enforcement of anti-smuggling laws raises the real per-unit cost of smuggling and the domestic price of imports, but lowers the absolute quantity and the share of illegal imports in total imports. However, their model does not illustrate an unambiguous effect of smuggling on welfare.

Norton (1988) provides a theoretical model for smuggling agricultural goods within EEC countries, by focusing his empirical test on the Republic of Ireland and Northern Ireland (in the UK). He enters the transport cost for smuggling as well as the probability of detection into his model. He shows that an increase in the tax rate will increase the optimal choice of smuggled goods and the number of firms that are involve in this operation. As tax rates increase, intra-marginal smugglers will increase their expected rents from smuggling and the distance-margin for worthwhile smuggling will be extended. However, there are still some firms which, depending on their transport costs, will not smuggle goods. His model also indicates that increasing the rate of fines in the case of detection will reduce the expected value of their profits. Nevertheless, empirical messages and applications of Norton's model can be focused on showing the negative relationship between the rate of fines on smuggling and the amount of smuggled goods, on one side, and positive links between increased taxes and tariffs on legal imports and the amount of smuggled products on the other side.

Thursby et al. (1991), propose a model in which smuggling is camouflaged by legal sales. They set off to evaluate the effects of market structure and enforcement of law on smuggling and welfare. In their model, if the price effect of smuggling is greater than its cost, then it is possible that smuggling improves the welfare. They indicate that by increasing the level of law enforcement against smugglers, the government, in fact, reduces the welfare of society. Finally, they apply the model for the case of cigarette smuggling in the US during 1975-1982.

3. Empirical Methodology

In this study, structural equation modeling is used. This kind of modelling allows a set of relationships between one or more independent variables and one or more dependant variables to be examined. Both of these sets of variables can be unobservable (factors) or measured variables (indicators). The important issue is that the observed variable(s) represent, nearly

perfectly, the latent variable(s) in the model. As Bollen (1989) mentioned: The structural equation models are "regression equations with less restrictive assumptions that allow measurement error in the explanatory as well as the dependent variables". So this method is theoretically superior to the regression analysis as it explores all information contained in the covariance matrix and not only in the variance. It also allows variables to be measured with error. Compared to regression and factor analysis, SEM is a relatively unknown tool in economics.[2]

The general specification of a SEM can be illustrated as follow:

$$x = \Lambda_x \xi + \delta, \tag{1}$$

$$y = \Lambda_y \eta + \varepsilon, \tag{2}$$

$$\eta = \mathrm{B}\eta + \Gamma\xi + \zeta, \tag{3}$$

Where x = (x1,….,xq)' and y = (y1,….,yp)' are the observed indicators of the latent exogenous and endogenous factors ξ = (ξ1,…., ξn)' and η = (η 1,…., η n)' respectively. A δ (q x 1 vector) and ε (a p x 1 vector) are the measurement errors for x and y, respectively. Λx is a q x n matrix of coefficients (loadings) relating manifest exogenous variables x to exogenous latent variable ξ. Λy, on the other side, is a p x m matrix of coefficients (loadings) relating manifest endogenous variables y to endogenous latent variables η. B is a m x m coefficient matrix, implying the influence of the latent endogenous variables on each other. Γ is the m x n coefficients matrix for the effects of latent exogenous variables ξ on the latent endogenous variables η. The equation (1) is called the exogenous measurement model and equation (2) is called endogenous measurement model. The equation (3) illustrates the structural part of model.

In this study, we only have one endogenous latent variable (smuggling) and there aren't any exogenous latent variables. Therefore, in equation (1) x=I ξ, where x is a vector of exogenous variables. In this situation, the observed exogenous variables contain no measurement errors. (δi = 0) . The measurement model of the latent endogenous variable (here smuggling) which has illustrated in equation (2) can be written as follow:

$$\begin{cases} y_1=\lambda_{11}\eta_1+\varepsilon_1 \\ y_2=\lambda_{21}\eta_1+\varepsilon_2 \\ y_3=\lambda_{31}\eta_1+\varepsilon_3 \\ y_4=\lambda_{41}\eta_1+\varepsilon_4 \end{cases} \tag{4}$$

Where;

yi: one of the observed measures of smuggling (real government revenues, import price index, black market premium, and growth rate of petroleum products consumption) ,

λ_{i1}: factor loadings

η_1: latent variable (smuggling)

ε_i: measurement error terms.

[2] Just to cite the most comprehensive discussions of its applications: for the sociology: Bielby and Hauser (1977), for the psychology: Bentler (1986), for the economics: Goldberg (1972), Aigner et al. (1984) and for an overview about SEM: Hayduk (1987), Bollen (1989), Hoyle (1995), Maruyama (1997), Byrne (1998).

Equation (4) indicates that the latent factor of smuggling η1 causes the observed dimensions of smuggling. The presence of measurement error terms indicates that we cannot observe the extent of smuggling at the four mentioned levels without measurement errors.

The specification of the measurement part of smuggling model in the matrix form can be written as follows:

$$\begin{bmatrix} \ln \textit{real government revenue} \\ \ln \textit{import price index} \\ \textit{black market premium} \\ \textit{growth rate petroleum consumption} \end{bmatrix} = \begin{bmatrix} \lambda_{11} \\ \lambda_{21} \\ \lambda_{31} \\ \lambda_{41} \end{bmatrix} .[smug] + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \end{bmatrix} \tag{5}$$

On the side of structural part of model demonstrated in equation (3), as far as we have just one latent factor of smuggling in the model, then B=0. As I explained earlier, x=Iξ, then the structural equation can be written as follow:

$$\eta_1 = \gamma_{11} x_1 + \gamma_{12} x_2 + \gamma_{13} x_3 + \gamma_{14} x_4 + \gamma_{15} x_5 + \zeta \tag{6}$$

The specification of the structural part of smuggling model in matrix form can be written as follow:

$$[smug] = [\gamma_{11}, \gamma_{12}, \gamma_{13}, \gamma_{14}, \gamma_{15}] . \begin{bmatrix} \textit{inverse fine rate} \\ \ln \textit{official ex} \\ \ln \textit{black ex} \\ \textit{tariff} \\ \textit{unemployment} \end{bmatrix} + [\zeta_1] \tag{7}$$

In this study, I use ML method which is by far the most common method in the literature. ML makes estimates based on maximizing the probability that observed covariances are drawn from a population assumed to be the same as that reflected in the coefficient estimates.

4. Model Variables

4.1 Explanatory Variables (Causal)

a) Rate of Fine

In the literature, the most popular determinants of smuggling are: the rate of fine, punishment and enforcement of the law (Martin, et.al (1983), Norton (1988)). The common hypothesis is that an increase in the rate of fine increases transaction costs of smuggling and reduces the expected profit. So a negative sign for the parameter associated to this variable is expected. In the case of Iran, the rate of fine on smuggling products calculated as the Rial amount of the USD value of smuggled goods. Up to 1993-94, the rate of fine was very low and negligible. But that year, the punishment regulation on smuggling was revised and the fine rates increased substantially.

b) Black and Official Exchange Rates

Macedo (1987) constructs a detailed model of the relationship between trade taxes, smuggling and black markets in foreign exchange. The behavior of importers and exporters and their choice between legal trade and smuggling is the basis of his analysis. Smuggled imports are paid for using black market foreign exchange obtained from undetected smuggled exports.

The message of this model is that the behavior of exporters and importers determines both the black market premium, and the ratios of smuggled to legal exports and imports. For a given

black market premium, importers and exporters choose their mix of smuggling and legal trade by equating marginal revenue to marginal cost in both activities. Since smuggled imports must be paid for using black market foreign exchange, importer's choices between smuggling and legal trade depend not only on the level of the import tariff and probability of detection, but also on the black market premium.

Barnett (2003) describes a model of a dual exchange rate regime, where one rate (the official rate) presides over the trade account and the other (a parallel rate) presides over informal internal transactions involving currency substitutions. The two exchange rates are determined simultaneously, and their movements are driven at large by speculative actions of agents in the currency markets. If the spread between the two rates becomes large enough, agents have the incentive to engage in smuggling activities. Agents at each date self-select to be one of the two possible types, a smuggler or an entrepreneur in the legal sector. Profits, illegal trade, and the distribution of income in the economy all vary with the parallel market premium. Smuggling also affects the dollarization of the economy. His model suggests that if an aim of policy is to eliminate illegal trade, the policy maker should pursue a strategy of liberalizing current and capital accounts simultaneously.

In this paper, we assume that the parallel market of exchange rate (US dollar against Rial) serves the needs of smugglers, since the foreign exchange necessary to import goods is restricted due to currency exchange controls. That means those groups of smugglers that do not have access to subsidized USD within banking system must finance their smuggling operations through black market operations. Therefore, increasing the black exchange rate will raise the financing costs of their operations, and lower their profit margin of smuggling.

On the other side, technical smugglers who have access to subsidized exchange rates have the incentive to over-value their imports. This fake valuation enables them to obtain much more foreign currency under official rates. The extra illegal dollars they acquire will be re-sold in the black market. By increasing the official exchange rate to the levels of the black market the incentives for fake over-valuation of imports will be reduced. Therefore, the expected signs of official and black foreign exchange rates are negative.

c) Unemployment Rate

The biggest part of the literature has evaluated the role of unemployment on the shadow economy. We can assume that smuggling, because of its hidden nature and tax evasion, is part of the bigger puzzle of a shadow economy.

As Giles and Tedds (2002) state, there are two antagonistic forces which determine the relationship between unemployment rate and the shadow economy. On the one hand, an increase in unemployment could imply a decrease in the black economy as the underground economy could be positively related to the growth rate of GDP and the latter is negatively correlated to unemployment. On the other hand, some "official" unemployed spend part of their time working in the black economy, thus we may find a positive correlation in latter scenario.

Tanzi (1999) also writes that "…the relation between the shadow economy and the unemployment rate is ambiguous." Therefore, economic theory does not help much in determining whether the expected sign of this variable is positive or negative, it has to be solved by empirical analysis in each country.

Also Bajada (2005) introduces the two concepts of "income effect" and "substitution effect" over his study of shadow economy and unemployment rate in Australia. By income effect he means that the decrease in consumption by unemployed people results in a drop in output of both formal and informal economies. On the other side, according to the substitution effect, the decrease of production in the official economy, which leads to increasing the rate of unemployment, encourages agents to search for job opportunities within the informal

economy. In sum, when the income effect is stronger than substitution effect, we expect to have a negative relationship between the rate of unemployment and the illegal economy. A stronger substitution effect, however, can play the role of the auto-stabilizer in the economy by adjusting the pressure on the formal economy.

d) Tariff on Imports

An increase of taxes on legal imports is an incentive for smuggling and operating in the black market, so a positive sign for the parameter associated to this variable is expected. In the econometric framework, the tariff burden is measured by means of the share of import taxes in total imports.

4.2 Indicators

e) Total Governmental Revenue

Smuggling has a significant impact on government revenues. We can assume that total governmental revenue is a function of national income (Y). Increasing national income can be a sign of business prosperity and higher levels of obtainable taxes. Also increasing legal imports leads to higher levels of tax on imports revenues. Consequently, I expect government revenues (GR) to also increase (Total GR= F(Y, IMPL)). By assuming that total domestic demand (Q) is met by legal import and illegal imports, we have Q=IMPL+IMPIL and naturally Total GR= F(Y, Q-IMPIL). According to this assumption, total government revenues will be reduced by an increasing flow of illegal trade because of tariff evasion by smugglers.

f) Import Price Index

An import price index measures the price changes of goods imported by Iran. Theoretical justification for this variable can be found in the study by Thursby et.al (1991) on the welfare effects of smuggling. His model indicates that if the price effect of smuggling is greater than its cost, then it is possible that smuggling improves the welfare. Therefore, he believes in this situation, that combating smuggling might reduce consumer welfare. In the case of Iran, whenever the government tightened its noose on smugglers, the price of smuggled goods increased.

Smugglers, because of evading legal duties and tariffs, have a cost advantage compared to legal importers in the domestic market. Therefore, they are able to earn their expected profit margin with lower prices than the market equilibrium price. Depending on the share of smuggled product in the domestic market, the market equilibrium price of that product will decrease. For clarification, we can assume 2 importers, legal and illegal.

The profit function of the legal importer: $\Pi_L = TR_1\text{-}TC_1$ and $\Pi_S = TR_2\text{-}TC_2$ for the smuggler. By assuming that both similar goods have a similar selling price in market and assuming that $Q_1=Q_2$ (similar quantity of goods are sold by both of the groups), then we have $TR_1=TR_2$. Knowing that, because of tax evasion and considering the weak enforcement of law (low risk of detection and low rate of fine), the total cost of the smuggler is lower than the legal importer: $TC_2<TC_1$. Simply, we have $\Pi_2>\Pi_1$. This means that the smuggler has a financial advantage which can allow him to get the same profit as that of the legal importer but capture a larger share of the market by reducing the price of his goods. The reduction of price of smuggled goods will continue till $\Pi_1=\Pi_2$.

g) Consumption of Petroleum Products

The idea of using this indicator in this study is taken from the pioneering work of Kaufmann and Kaliberda (1996) which used the Physical Input Approach (electricity consumption) to measure the overall (official and unofficial) economic activity in an economy. They assumed that electric-power consumption is the single best indicator of overall economic activity. By having a proxy for the overall economy and subtracting it from the official GDP, Kaufmann

and Kaliberda derived an estimate of unofficial GDP. In the other words, any change in energy consumption which does not correspond to changes in the measured total activity level of the country indicates a change in the size of the shadow economy. As explained in the introduction of this paper, of the main smuggled goods on the export side are petroleum derived ones.

h) Black Market Premium

Oskooee et al. (2003), show that smuggling results in the increased corruption of custom officials who allow illegal activities in exchange for bribes in the form of cash dollars from importers. The bribes obtained by custom officials flow into black market. If there is a large black market premium, there would be a higher incentive to ask for a bribe. They also argued that most of the illegal payments for smuggling activities are cleared via Hundi.[3] The Hundi business is specially implemented in black markets and is considered as a safe haven for smugglers.

In a panel data regression for 70 countries over 43 years, Oskooee et al. (2003) show that smuggling, which in their model is measured by tariff rates, increases black market Premium (BMP) in developing countries. Besides their study, Phylaktis (1992) shows the same relationship in the case of Chile.

5. Estimation and Results

In this section, estimations of different MIMIC- models to calculate the absolute index of smuggling in Iran during the period of 1970-2001 are presented. In order to select the best model specification, both theoretical justification and fit indices have been taken into account. In the most general model specification (M1), the inverse of rate of fine on smuggling (arf), the natural logarithms of official exchange rates (lnef), the natural logarithm of black market exchange rate (lnei), tariff on imports(t), and the unemployment rate (unemp) are included as causal variables. The natural logarithms of real government revenues (lnrg), natural logarithms of import price index (lnim), black market premium (bmp), and growth rate of petroleum products consumption (gpconsum) are included as indicators. All the variables in the model have normal distributions, which is an essential assumption for the convergence of the model. Considering the sample size, the maximum likelihood method is selected for estimation. Table 1 presents some of the estimated models.

- The inverse of rate of fine (arf) is statistically significant in all models and has the expected positive sign.[4] The rate of fine has a negative relationship with the level of smuggling in all of the estimated models.
- The other causal variable, natural logarithm of official exchange rate (lnef) is also statistically significant when included in selected models. The sign of this variable meets our expectation and has a negative effect on technical smuggling. While increasing the official exchange rate can be desirable for the Iranian exporters (when they export products and receive the foreign currency, they can exchange it and earn more Rials), but for legal importers, it would be considered an extra financial burden. They have to pay more Rials to obtain required foreign currency for importing goods, which in turn makes legal imports more expensive. At first glance, this seems to increase the desire for

[3] Hundi is defined as a negotiable instrument like a bill of exchange or promissory note, used by native bankers in India, also money remitted by such an instrument. This term has gained popularity because of the increasing trend of transferring black money across borders. Businessmen, engaged in unhealthy 'Hundi' trade, send money to exporters in countries like India, Japan, Australia, Sweden, Hong Kong, Singapore, Myanmar etc. The local businessmen would open LCs showing a price and quantity of goods that are less than the factual, and later, they would send the actual price of the goods to the foreign exporters through 'Hundi'.

[4] The use of the rate of fine's inverse index is for meeting the essential assumption of normality.

smuggling, but the negative sign of this factor in all of the estimated models indicates the costly effects of increasing the official rate on technical smuggling. That may be an indicator of the dominant role of technical smugglers in Iran.

- The black exchange rate (lnei), in all of the selected models, has demonstrated the expected negative sign and is highly significant in all of the included models, which confirms theoretical discussions. Smugglers and criminal bands in most occasions finance their illegal business through the black market. The negative sign of this variable shows that by increasing the exchange rate in the black market, the financing cost of smuggling will increase, leading to lower levels of technical import smuggling in Iran
- The coefficient for the tariff rate (T) confirms theoretical discussions. The positive sign and the high statistical significance (except model 5) of this factor show the considerable effect of the tariff rate on increasing illegal business in Iran.
- The unemployment rate shows a positive sign in models 1, 5, 7, and 8; while in the other models it demonstrate a negative sign. However, it is not statistically significant in all models, which indicates a positive role on smuggling. Its negative impact on the level of smuggling in Iran has statistical significance in model 4 and marginal significant (at 10% level) in model 9. This may confirm the Giles and Tedds (2002) idea of the existence of two antagonistic forces which determine the relationship between unemployment rate and shadow economies (naturally smuggling because of evading legal taxes can be considered part of the shadow economy).
- Regarding smuggling indicator variables, it should be emphasized that including black market premium (BMP) in the selected models (1, 4 and 8) makes the adjustment diagnostics poor and the sign is also opposite to what was expected. This variable is also not statistically significant in selected models.
- As factors represent theoretical constructs, we seldom have a clear definition for the measurement scale of the concept. For our example, we do not know in advance what type of scale to choose a priori for the general factor of smuggling. Moreover, the observed measures we employ for constructing the factor often come with different measurement scales. For making estimation possible, a scale of the latent variable (smuggling) must be assigned to the scales of measured indicators. For this goal, it is enough to fix one of the measurement loadings to unit. The positive or negative sign of the scale depends on theoretical discussion.
- In the case of opting for lnim as a scale variable, the impact of smuggling on real government revenues (lnrg) and growth rate of petroleum products consumption (gpconsum) meet the expected sign and are both highly significant. In this scenario, the impacts of smuggling on gpconsum is approximately two times larger than its impact on import price index.
- In the case of selecting real government revenues as a scale variable, the impact of smuggling on petroleum products consumption is still much higher than its impact on government revenue and import price index , still meets the expected sign and is statistically significant.
- Taking into account the Chi-square and the root mean squared error of approximation (RMSEA) as adjustment diagnostics, we can reject the models 1, 4, 6, 7, and 8 because of their poor fit indices. Among the remaining models, model 5 meets the fit indices but includes the unemployment variable which is not statistically significant. This model also excludes the reverse index of rate of fine (arf). Therefore, I prefer to focus on the models 2, 3, 9 and 10. In spite of the acceptable overall fit indices of models 3 and 10, the PSI matrix (Ψ)[5] is not positive -definite in both models.[6] Model 2, which meets most of the

[5] m*m symmetrical variance-covariance matrix among the m residual errors for the m endogenous latent variables.

[6] For more details on these problematic results refer to Byrne, B. (1998), pp: 174-175.

theoretical expectations regarding the effects of casual variables on smuggling, faces the problem of negative error variance for import price index (lnim). Therefore, despite the acceptable sign of the variables and their significance, the diagnostic evaluations do not recommend using this model for projecting the smuggling index. Consequently, model 9 is selected for further analysis. In general, this model covers the major fit requirements and thus will be used for estimating the latent variable.

- Figure 1 (path diagram for model 9, unstandardized estimation) summarizes the causal relationships between the different variables and smuggling. The path estimations in this figure are not standardized. Figure 2 demonstrates the standardized estimates for model 9. The interpretation of unstandardized parameter estimates is straightforward. Their magnitude illustrates the resulting change in a dependent variable (smuggling) from a unit change in an independent variable, with all other independent variables being held constant. The direction of the change is captured by the sign of the relevant parameter. These estimates demonstrate the effects that variables have in absolute value. Any change in the measurement unit of causal and indicator variables changes the value and comparability of parameters across the population. On the other hand (Figure 2), by representing standardization paths, helps identify the relative contribution of independent variables in influencing the latent variable. (Diamantopoulos and Siguaw, 2000).
- Although in appendices D and E there are more details of the diagnostics from the model, it is interesting to illustrate how the indicator variables, import price index (lnim), real government revenues (lnrg), and growth rate of petroleum products consumption (gpconsum), explain 96, 33, and 25 percent of the variation of the smuggling, as shown by the model's measurement equations in Table 2.
- The structural equation model, depicted in Table 2, also demonstrates that the causal variables explain up to 70% of the variability of smuggling in Iran. By applying standardized structural coefficient estimates, it is possible to analyze the total effects. These estimates are used to compare the direct effects on a given endogenous latent variable and the relative importance of the independent variables.
- Table 3 shows the dominant share of causal variables on explaining the smuggling phenomenon in Iran. An increase in the standard deviation of the tariff (t) variable makes an increase of 0.76 standard units in smuggling, while increases of standard deviation in the inverse of fine rates reduces the level of smuggling by 0.53 unit). Also, an increase in the standard deviation of the unemployment rate causes a decrease in smuggling by 0.21 standard units. Finally, the increase in the standard deviation in smuggling causes an increase of 0.50 in the growth rate of petroleum products consumption, and a decrease of (0.98) and (0.57) standard units in import price index (lnim) and real government revenues (lnrg) respectively.

5.1 Obtaining the Size of Smuggling

Now, the absolute index of smuggling in Iran over the period under study can be estimated. For this purpose, I apply the coefficients of the structural equation in order to obtain ordinary estimations of smuggling. The trend of estimated smuggling over the period of 1970-2002 is illustrated in Figure 3. In order to obtain a relative index of smuggling, we need to scale the absolute index to a value in 1993, which is for comparison reasons; the estimation of smuggling share can be compared with another source (Yavari, 2000). For the estimation details of smuggling according to the trade discrepancy method see Appendix F. The benchmark strategy used in this study follows Giles and Tedds (2002):

$$\frac{\eta_t}{trade_t} = 12.74 \times \left[\frac{\eta^{\circ}_{\ t}}{\eta^{\circ}_{\ 1993}} \right] \qquad (8)$$

Where $\frac{\eta^{\circ}_{1993}}{trade_{1993}} = 12.74$ is the size of smuggling estimated by trade discrepancy approach (Appendix F). η_t° and η°_{1993} represents the estimated absolute index of smuggling in time t and with 1990 as a base year. The relative size of smuggling calculated by equation 8 is illustrated in Figure 4.

- As seen in Figure 4, the smuggling share in trade experienced a high record in the period 1970-1973. By analyzing the main causal variables in the structural equation, the high real tariff rates on imports and the negligible real fine rates have a dominant role. During the period 1973-1976 we can observe the rapid reduction in the size of smuggling, which results from the considerable decrease in real tariffs and thus the import tax burden.
- According to the model, an increasing unemployment and recession reduce the level of consumption and consequently lowers incentives for illegal imports. Negligible rates of fine up to 1979 and the steady increase of tariff rates cause a rapid jump in the smuggling index and provide higher incentives for smugglers. Since 1975 according to official figures, the Iranian economy has experienced a decreasing trend of unemployment which reflects the boom cycle caused by the considerable increase of oil revenues during this period.
- In the first decade after the revolution, due to the implementation of import substitution policies put in place to protect domestic industry, and the strict control on foreign exchange which increased the premium on the black market, we observed a steady increase in the relative share of smuggling in total trade from about 17 percent in 1979 to over 20 percent in 1988. Over the same period, fine rates on smuggling remained very low.
- After ending the eight years war in 1988-89, liberalization of foreign trade, the elimination of non-tariff barriers was followed by the central government. During 1988-1995, the size of smuggling was reduced from 20 percent of total trade to approximately 6 percent. The rapid fall of the index, especially around the year 1992-1995 was mainly due to the revision in governmental punishment regulations on smuggling. The most important development that took place in regulations was the Expediency Council of Iran's approval of the new version of punishment codes on smugglers in 1993-94. By implementing the new regulations, the rate of fine on smuggling increased about 45 times in 1994 compared to 1993.
- Among other contributing factors –not included in model 9– is the increase of the foreign exchange rate in the black market, which consequently led to a rise in the cost of smuggling into the country. Since 1995, the share of smuggling of total trade has stabilized at around 10 percent.

6. Conclusions

The main objective of this paper is to estimate the size of smuggling products into Iran, by applying the structural equation models and MIMIC approach. The estimation of several models and their results provide some specific policy recommendations. The main conclusions of this study are as follows:

- **Tariff Rate:** State interventions and protectionist policies in the foreign trade sector, reflected by higher tariff rates and other taxes on legal imports play the greatest role compared to other causal variables in the selected model. Actually, high tariff rates have a positive and significant effect on smuggling in all of the models. Policy reforms such as liberalizing foreign trade, the gradual elimination of inefficient subsidies to domestic industries, and promoting competition will enhance the quality and management of

domestic industry. In turn this will increase the demand on local products on one side and the reduction of legal imports charges on the other side.

- **Rate of Fine**: The second significant factor affecting smuggling (according to standardized coefficients) is the level of fines levied on smuggling. This variable has a significant and negative impact on the dynamics of smuggling in all models (Its reverse index has a positive relationship with smuggling). By increasing the fine rate as well as the efficiency of the judicial system, the risk associated with smuggling will increase for illegal agents. In turn, this will make illegal trade uneconomical and not profitable for smugglers. Improving the quality of institutions and rule of law will have an obvious affect on controlling and reducing illegal business in Iran.
- **Unemployment:** The behavior of this variable in the models is interesting. The common belief is that when unemployment in official economy increases, one would expect an increasing tendency toward illegal businesses such as smuggling. On the other side, there is another school of thought which believes that higher unemployment within an economy reflects a general recession which reduces purchasing power and consumption of products regardless of their legal or illegal nature. The results of this study demonstrate both positive and negative links between this variable and smuggling. However, only the negative links are statistically significant. This indicates that the shift of resources from the official economy to illegal business is not significant, and that higher unemployment levels are not accompanied by an increase increases in the size of an illegal business such as smuggling.
- **Exchange Rates:** The goal of including exchange rates in black and official markets was to evaluate the Macedo (1987) and Barnett (2003) theories for the case of Iran. The literature suggests that smugglers and agents, active in illegal business, finance their operations through black foreign exchange markets. Therefore, increasing the foreign exchange rate on the black market raises the financial charges of a smuggling operation. Thus, a negative relationship between (Ei) and smuggling is expected. A significant and expected sign in all of the models which included this variable as a causal facto have proved this theory right. On the other hand, the behavior of the official exchange rate as a cost element in legal imports did not behave as one might have expected in the models that included this variable. Actually, increasing this factor may increase the financial costs of legal imports, making illegal imports seem more attractive to smugglers. Accordingly, one may expect a positive effect of this variable on smuggling. However, this is not the case in all models that show a negative impact of this factor on smuggling in Iran.
- **Real Government Revenue:** As one indicators of the latent variable, which was used in some of the models as a scale variable, the prior expectation of the negative effects of smuggling on the government revenues has been empirically proved for the case of Iran. There is a negative effect of smuggling on this indicator in all of the models, which allows the estimation of its coefficient freely, is clear and significant. This means that by increasing illegal business, which evades legal taxes and social contributions, the government loses an important source of revenues every year. The loss of revenues will most probably result in lower quality of public goods and social services, thus decreasing the welfare of the population.
- **Growth Rate of Petroleum Products Consumption:** Another interesting finding in this study is the significant inflationary effects of smuggling on petroleum consumption in Iran. The gap between domestic subsidized petroleum products' prices and their regional prices has provided a high incentive for the illegal trade in this strategic material. The high consumption of these products has become a great challenge for the government. In 2006, the amount of energy subsidy reached $ 40 billion or about 17.5% of the Iranian GDP. According to an official source, almost 30 million liters of gasoline disappear in Iran daily. The transport and traffic vice president of Tehran's Mayor explains that the total

number of 6 million autos which uses gasoline as fuel should consume about 33 million liters per day, and also the daily consumption of 5 million motorcycles in Iran is about 7.5 million liters which together add up to 40.5 million liters per day. By comparing this figure with the real current real figure of 73.5 million liters per day, the lost amount of gasoline reaches 32.5 million liters per dai.[7] It is indeed a considerable amount. There are a great number of reports and news on the illegal export of petroleum products from Iran to neighboring countries such as Afghanistan, Turkey, and Iraq. This study empirically confirms the positive role of smuggling on this variable over the past 30 years.

- **Black Market Premium:** The goal of including this indicator in some of models was to evaluate the theses of Winston (1969) and Oskooee et al. (2003) discussing the positive effects of smuggling on the black market premium. However, including this indicator not only shows a negative relationship but also makes the general robustness of models poor Meanwhile, its coefficient implies no statistical significance.
- **Import Price Index**: In the majority of models, this indicator was selected as a scale variable, fixing its loading to -1. The rationale behind selecting the negative unit for this indicator is that by increasing the level of smuggling, assuming that total domestic consumption is covered by imports, we expect a higher level of price competition. This fact reflects itself in reducing the import price index for an affected economy. In some other models, in which government revenue was selected as scale variable, the negative impact of smuggling on the import price index is observed as well.

[7] Meeting of Hashemi with a group of journalists:
http://www.eqtesadepenhan.com/comments.asp?category=1&id=2197 (Access: 12 March, 2007 in Persian)

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Figure1: Path Diagram for Model 9 (Non-Standardized Solution)

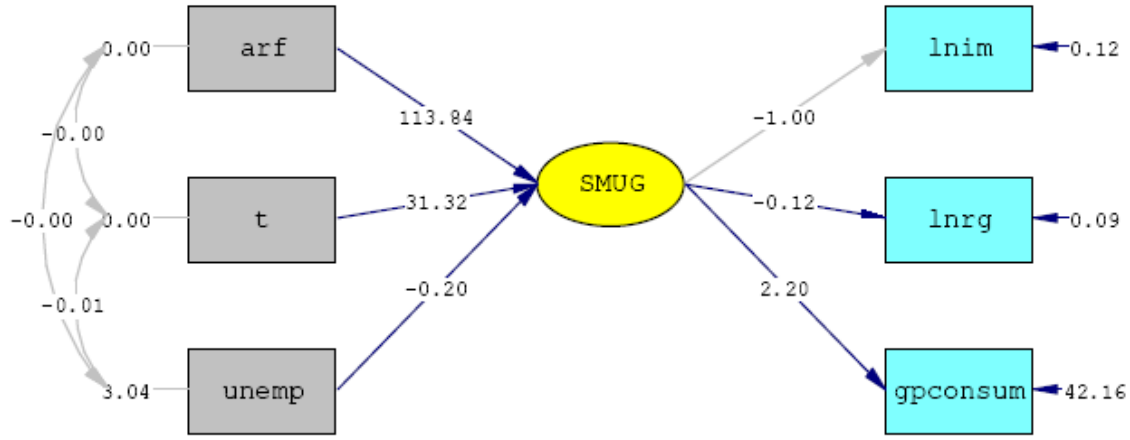

Figure 2: Path Diagram for Model 9 (Standardized Solution)

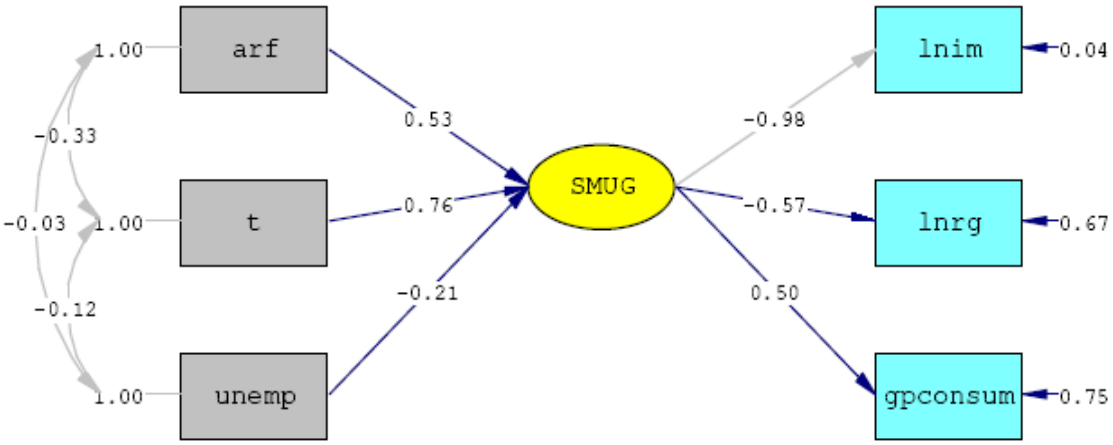

Figure 3: Ordinal Index of Smuggling in Iran (1970-2002)

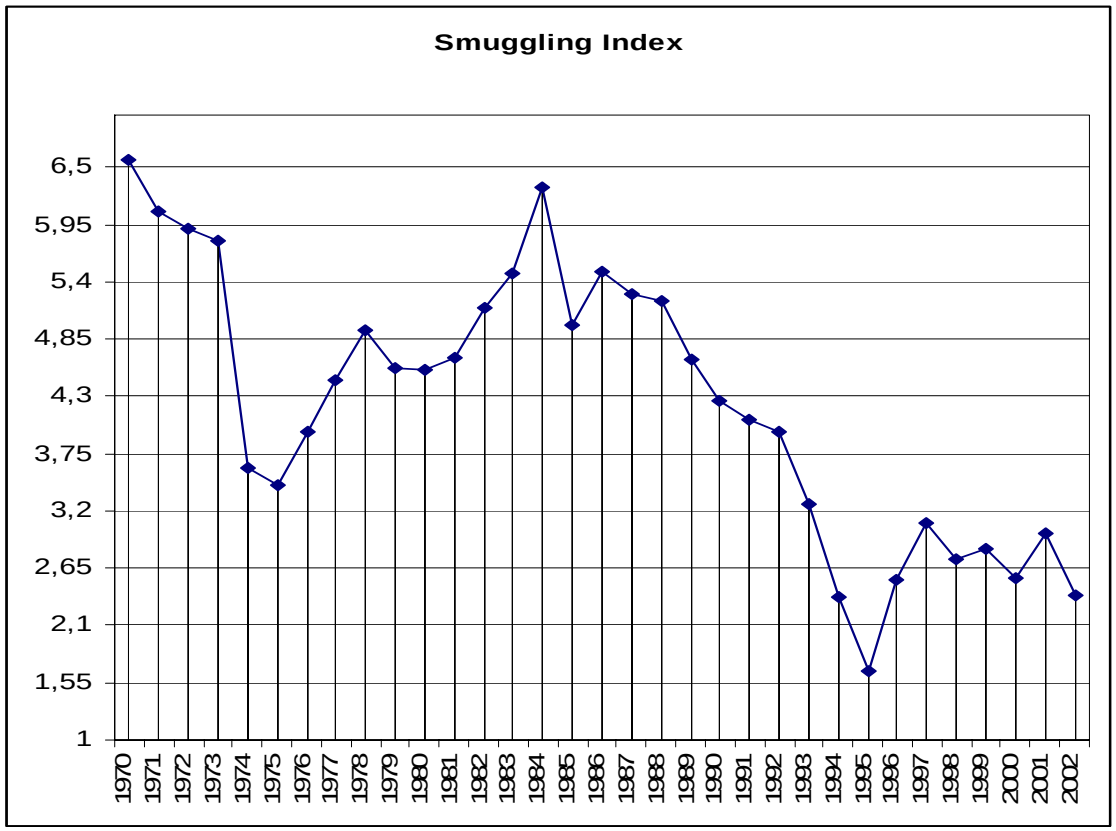

Figure 4: Iran Smuggling as a Percentage of Total Trade (1970-2002)

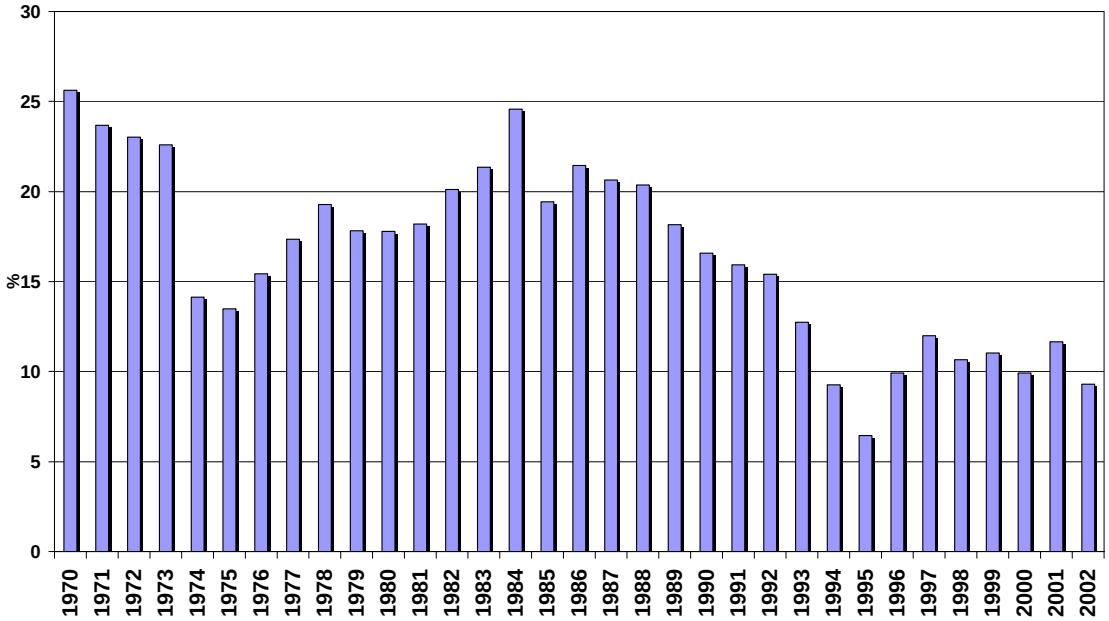

Table1: Estimations of MIMIC-Model

	M1:5-1-4	M2:4-1-3	M3:3-1-3	M4:3-1-4	M5:3-1-3	M6.4-1-3	M7:3-1-3	M8:5-1-4	M9:3-1-3	M10:3-1-3
Causal Variables										
Arf	32.61	32.65	51.38	112.27		32.65	31.43	3.92	113.84	5.90
	(4.18)	(4.20)	(8.44)	(4.65)		(4.20)	(3.99)	(2.86)	(4.69)	(3.34)
Lnef	-0.31	-0.30				-0.30		-0.04		
	(-3.18)	(-3.05)				(-8.92)		(-2.47)		
Lnei	-0.64	-0.64	-0.84		-0.96	-0.64	-0.99	-0.08		-0.10
	(-8.95)	(-8.92)	(-25.56)		(-17.28)	(-8.92)	(-25.10)	(-3.60)		(-3.60)
T	6.45	6.54	8.96	31.20	3.04	6.54		0.77	31.33	1.03
	(4.36)	(4.46)	(6.39)	(6.66)	(1.45)	(4.46		(2.92)	(6.69)	(3.16)
Unemp	0.02			-0.21	0.02		0.03	0.00	-0.20	
	(0.82)			(-2.04)	(0.42)		(0.88)	(0.80)	(-1.96)	
Indicator Variables										
Lnim	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-8.33	-1*	-8.70
								(-3.95)		(-3.60)
Lnrg	-0.12	-0.12	-0.11	-0.10	-0.12	-0.12	-0.12	-1*	-0.123	-1*
	(-3.95)	(-4.02)	(-3.60)	(-3.01)	(-4.07)	(-4.02)	(-3.68)		(-3.47)	
BMP	-24.81			-27.58				-206.68		
	(-1.53)			(-1.85)				(-1.44)		
gpconsum	2.02	1.95	2.32	1.93	1.59	1.95	2.22	16.86	2.19	20.15
	(3.04)	(2.93)	(3.53)	(2.88)	(2.44)	(2.93)	(3.34)	(2.43)	(2.95)	(2.53)
Selected Fit Indices										
Chi^2	50.94	18.44	11.67	24.75	10.50	18.44	12.83	50.94	10.59	11.67
P value	(0.01)	(0.43)	(0.47)	(0.10)	(0.57)	(0.07)	(0.04)		(0.56)	(0.47)
RMSEA	0.14	0.028	0.0	0.12	0.0	0.15	0.19	0.14	0.0	0.0
df	32	18	12	17	12	11	6	32	12	12

Table 2: Measurement and Structural Equations from Model 9

Measurement Equations:

Gpconsum = 2.20*SMUG, Errorvar.= 42.16 , R^2 = 0.25
(0.74) **(10.78)**
2.95 **3.91**

Lnim = - 1.00*SMUG, Errorvar.= 0.12 , R^2 = 0.96
(0.40)
0.29

lnrg = - 0.12*SMUG, Errorvar. = 0.090 , R^2 = 0.33
(0.036) (0.023)
-3.47 3.84

Structural Equation:

SMUG = 113.84*arf + 31.32*t - 0.20*unemp, Errorvar.= 0.92 , R^2 = 0.68
(24.27) (4.68) (0.10) (0.46)
4.69 6.69 -1.96 2.02

Table 3: Total Effects of Model 9

Standardized Total Effects of X on ETA

	Arf	**T**	**Unemp**
Smuggling	**0.528**	**0.758**	**-0.210**

Standardized Total Effects of ETA on Y

	Smuggling
Lnim	-0.98
Lnrg	-0.57
Gpconsum	0.50

Appendices:

- **Appendix A** – Table 4**:** Sources of data. Annual data for 1970-2002
- **Appendix B -** Table 5: Analysis of normality
- **Appendix C –** Table 6 and 7**:** Unit root and cointegration tests
- **Appendix D –** Table 8: Analysis of residuals
- **Appendix E** – Average variance extracted
- **Appendix F**- Estimating smuggling with trade discrepancy methodology

Appendix A

Table 4: Data Explanation

Var.	Causes	Sources	Transf. Used[1]	Annotations
X_1	Rate of Fine on Smuggling (arf)	Pajoyan & Madah (2005)	Inverse	(arf=1/rf) That is the the rate of fine in rial per each US$ smuggled goods on the constant prices of 1990
X_2	Unemployment Rate (unemp)	Central Bank of Iran	-	percentage
X_3	Foreign Exchange rate in black market	Central Bank of Iran	LN	-That is the informal exchange rate of US$ per rials.
X_4	Official Exchange Rate	Central Bank of Iran	LN	-That is the official exchange rate for US$ in Iran
X_5	Tariff Burden	Central Bank of Iran	-	- TAX on Imports / Total Imports
	Indicators		-	
Y_1	Real Government Revenues	Central Bank of Iran	LN	(Government General Revenues market price value /deflator of CPI1990)
Y_2	Import Price Index	Central Bank of Iran	LN	
Y_3	Petroleum Products Consumption	Ministry of Energy , Energy Planning Department- Energy Balances of Islamic Republic of Iran	Growth rate	Growth rate of total final consumption of petroleum products includes: Residential & Commercial Industrial Transport Agricultural Non - energy uses
Y4	Black Market Premium	Central Bank of IRAN	-	(Black foreign exchange rate- Official rate)/Official rate

Note: "LN" means natural logarithm.

Appendix B: Analysis of Normality

The following Table 5 presents the tests of normality (univariate) of the variables used in MIMIC models. This test has performed by Eviews 5 software and presents the p-value of the Jarque-Bera Test. The p-values larger than 5% confirm the acceptance of null hypothesis, indicating normal distribution of respected variables.

Table 5: J-Bera Test (p-value) of Univariate Normality

Causes	J-Bera test (P value)
Arf (reverse of fine rates)	0.109818
Lnef (natural logarithm of official exchange rate)	0.194410
Lnei (natural logarithm of black exchange rate)	0.284913
Tariff burden(t)	0.120557
Unemp (Unemployment rate)	0.294020
Indicators	
Lnim (natural logarithm of import price index)	0.195895
Lnrg (natural logarithm of real government revenues)	0.514966
BMP (black market premium)	0.331927
Gpconsum(growth rate of petroleum goods consumption)	0.907181

Appendix C: Unit-Root and Cointegration Tests

Following guidelines of Breusch(2005) which asserts that with integrated or tending data, the levels of variables are strongly informative. If there is co-integration, the strategy of estimating on the differences throw such information away.

The Econometric software Eviews 5 was used for this purpose.

Table 6: Unit-Root Test

Causal Variables	Included in Equation	Level		1st Diff.		2ned Diff	
		ADF	PP	ADF	PP	ADF	PP
ARF	C	0.29	0.29	0.00*	0.00*		
Lnef	C & T	0.77	0.83	0.11	0.18	0.00*	0.00*
Lnei	C&T	0.26	0.22	0.00*	0.00*	-	-
T	C&T	0.15	0.16	0.00*	0.00*	-	-
Unemp.	C&T	0.00*	0.49	0.02	0.02	-	-
Indicators							
Lnim	C&T	0.55	0.65	0.37	0.43	0.00*	0.00*
Lnrg	C&T	0.66	0.55	0.00*	0.00*	-	-
BMP	C&T	0.64	0.63	0.00*	0.00*	-	-
Gpconsum	C&T	0.00*	0.00*	-	-	-	-

Note: For ADF and PP show the MacKinnon(1996) one sided p values; * means stationary at 0.05 level.

Table 7: Johansen Co-integration Test

Variables (n)	L_{trace} value	no.Cointegrated Eq.	H0: rank=0 vs. H1: rank>0
Arf, lnei,t, and unemp.(4)	65.99	2	Rejection of H0: no co-integration at 5%
lnrg and bmp (2)	4.29	1	Rejection of H0: no co-integration at 5%
arf, t, unemp, lnim, lnrg(5)	81.86	2	Rejection of H0: no co-integration at 5%
arf, t, unemp, lnim (4)	60.20	1	Rejection of H0: no co-integration at 5%
arf, t, lnei, unemp, and lnrg(5)	88.69	2	Rejection of H0: no co-integration at 5%

Appendix D: Analysis of Residuals

The analysis of residuals which is presented in table 8 allows the validity of the model to be accepted. Normal probability or Q plots the standardized residuals (horizontal axis) against the quantiles of the normal distribution. The best possible fit would be indicated if all residuals were lying in a straight vertical line, whereas the worst possible fit would be indicated if all residuals were lying in a horizontal line. An acceptable fit is indicated when the residuals lie approximately along the diagonal, with steeper plots showing the better fits (Diamantopoulos,et.al,2000). For the selected model in this study (figure7) the Q-plot of standardized residuals is around diagonal and greater than 45 degrees. That is acceptable indicator of the fitness of model with empirical data. Furthermore, as it is clear from table 8, the residuals obtained are small and lower than 2. The residuals are clustered symmetrically around the zero point, with most residuals lying in the middle of distribution and fewer in the tails, following an almost symmetrical positive-negative pattern.

Table 8: Analysis of Residuals of Model 9

Standardized residuals	Lnim	Lnrg	Gpconsum	Arf	T	Unemp
Lnim	0.000					
Lnrg	-0.056	0.000				
Gpconsum	-0.136	1.011	0.000			
Arf	0.044	-1.780	-0.721	-		
T	-0.012	0.315	-0.154	-	-	
Unemp	0.029	-1.341	-0.661	-	-	-

Summary Statistics for Standardized Residuals
Smallest Standardized Residual = -1.780
Median Standardized Residual = 0.000
Largest Standardized Residual = 1.011
Stemleaf Plot
- 1|83
- 0|77211000000000000
0|3
1|0

Appendix E: Average Variance Extracted (p_v) and Further Assessment of Measurement Model

This index shows directly the " amount of variance that is captured by the construct in relation to the amount of variance due to measurement errors" (Diamantopoulos,et.al,2000).Pv less than 0.50 indicate that measurement errors account for a greater amount of variance in the indicators than does the underlying latent variable. In such a situation, one can doubt about the soundness of the indicators and/or the latent variable itself. The LISREL program does not calculate this index. However, by using the *Completely Standardized Solutions* estimated by the model and following formula , we can estimate this index:

$$\rho_v \equiv \left(\sum \lambda^2\right) / \left[\sum \lambda^2 + \sum (\theta)\right]$$

where pv is the average variance extracted , λ is the indicator loadings, θ is the indicator error variances, and Σ is summation over the indicators of the latent variable.

$$\rho_v = \left[(-0.981)^2 + (-0.574)^2 + (0.498)^2\right] / \left[\begin{array}{l}(-0.981)^2 + (-0.574)^2 + (0.498)^2 + \\ (0.039 + 0.671 + 0.752)\end{array}\right] = 0.512$$

Since Pv>0.50, we can conclude that substantially higher amount of variance in the indicators is captured by the construct compared to that accounted for measurement error. This index provides more confidence in operationalization and reliability of smuggling and its indicators.

Appendix F: Estimating Smuggling by Trade Discrepancy Methodology

Mis-invoicing of import and export among Iran and its main 19 trading partners (eg. United Kingdom, Hungary, China, P.R.: Mainland, Indonesia, India, United Arab Emirates, Saudi Arabia, Brazil, Australia, Turkey, Japan, Canada, Switzerland, Sweden, Netherlands, Italy, Germany, France, and Austria). The weight of trade with these countries use by IMF to calculate the real effective Exchange rate f Iran for recent years. The main differences between import and export figure usually arise because most exports are recorded on a F.O.B basis and most imports on C.I.F basis. The difference represents the cost of transport and insurance. Therefore, we adjust the export figures by adding 10% to original value of exports. The 10% factor is an approximate value of the costs of the insurance and freight. (IMF, 1993). Consequently, the rest discrepancies after this adjustment will be interpreted as illegal imports or exports by mis-invoicing of tread documents.

Table 9: Import Mis-invoicing (million USD)

Year	Under-invoicing of imports	Over-invoicing of imports
1988	849.223	
1989		1353.0626
1990		1302.2909
1991		4526.6547
1992		4184.4239
1993		**2922.7846**
1994	183.4126	
1995		73.1655
1996		647.7069
1997	380.2756	
1998		474.3407
1999		377.1785
2000		53.1018
2001		168.1432
2002		2148.758
2003		2.88
2004	48.2196	
2005	0.0212	
2006	0.0059	

Source: own calculation

Table 10: Export Smuggling (million USD)

Year	Under-invoicing of exports	Over-invoicing of exports
1988		1563.162
1989		2256.979
1990		3421.792
1991		196.216
1992		753.651
1993	**169.788**	
1994		2482.787
1995		1043.547
1996		2577.244
1997		1507.081
1998		1531.743
1999		3343.953
2000		0.0118
2001		0.0029
2002		0.002
2003		7.9798
2004	134.9124	
2005		0.0264
2006		0.0369

Source: Own calculation

Table 11: Total Mis-invoicing (million USD)

Year	Total Mis-invoicing
1988	-2412.39
1989	-903.916
1990	-2119.5
1991	4330.439
1992	3430.773
1993	**3092.573**
1994	-2666.2
1995	-970.382
1996	-1929.54
1997	-1887.36
1998	-1057.4
1999	-2966.77
2000	53.09
2001	168.1403
2002	2148.756
2003	-5.0998
2004	86.6928
2005	-0.0476
2006	-0.0428

Source: Own calculation