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International VAT Fraud: The Carousel Game

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The EU market's free circulation principle severs the VAT chain at the EU States' borders, thus, encouraging VAT fraud. The increased "transit traffic" from outside the EU with final destination in EU countries also contributes to VAT fraud. To examine this issue, we model some different collusive features of these frauds, on which basis we explore their effects on the international trade and the domestic market.

Keywords: European Union value added tax, direct and indirect tax evasion, VAT carousel, Nash equilibrium fraud-chain

Introduction

This paper explores the issue of Value Added Tax (VAT) evasion in connection with international trade and in relation to the evasion of other taxes as well as to regulatory burdens relating to labour, health and environment. We present a new model of tax evasion, based on the interaction of fraudsters along the chain of transactions, focusing on its effect on prices.

Sandmo (2005), surveying the formal models on tax evasion, noticed that most of them, built upon Allingham and Sandmo (1972), concern evasion by individual taxpayers. Firms are often left in the background. Moreover, even when studied in the area of indirect taxation as tax collectors for the government, firms as tax evaders have been mostly studied discarding any interaction with other taxpayers.[1] Fedeli and Forte (1999) and Fedeli (2003) focused on this interaction for the domestic chain of exchanges, without considering the effects of VAT evasion on market prices, which are indeed relevant for the distortion of market competition in the EU area. They showed how VAT fraud differs from both income tax and business tax fraud exactly because the former implies a bilateral game among taxpayers. Furthermore, they showed how, given the nature of VAT-as a multistage tax on value added, the fraud at one stage spreads over the chain of transactions stimulating other fraud games.

In the presence of international exchanges, the "chain" model, which may be generally applied to the evasion of indirect taxes, requires additional complications to consider the peculiar phenomenon of fraud by means of a rebate for an unremitted tax. Under the destination principle, the rebate is due for exports and the tax administrations have the double task of a backward control on the chain of the purchases made by the taxpayers who apply for the rebate and a forward control on their presumed exports. In this respect, tax laws/legislations that adopt different modalities for the rebates influence the results of fraud attempts. Moreover, an important factor affecting the result is also the degree of cooperation between the tax administrations of

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[1] This role was first studied in a theoretical framework by Marrelli (1984) and Marrelli and Martina (1988), who extended the Allingham and Sandmo (1972) model to the case of a risk-averse firm. Marrelli (1984) explicitly studied the case of an ad valorem tax.

exporting and importing countries.

International VAT fraud may occur according to different modalities. It may consist of a "single operation" of fictitious export-import which unduly benefits of a VAT rebate, or it may take the shape of a so called "carousel". The "simplest fraud" is that where an importer buys a tax free good from a trader (who may also belong to a non EU country), sells the good to an exporter with VAT added, does not remit the VAT to the tax authority and disappears as a "missing trader". The exporter gets a rebate for the VAT on its purchases even if this tax has never been remitted by the importer. The tax authority of the transit-country looses the VAT rebated even in case of discovery of the fraud, because the exporter is lawfully entitled to that rebate, unless it can be proved that he was aware of the fraud. Moreover, if the importer in the destination country began a black-chain in the domestic market, the VAT revenue of the destination country would also be lost. The carousel-VAT fraud consists in not ending the forgery at the domestic stage of the EU country of destination, but in continuing it by further exporting the goods. Possibly, the scam is repeated several times with the goods being exported and imported through a complex criminal network up to the sale to final consumers.

When considering carousel-frauds, which generally involve two or more countries, there are further complications. First of all, in some of the countries where the good is exported, it may be subject to transformation through (partial) underground production. Thus, beside the case of the transit country, where the tax administration pays the undue rebate to a firm that does not exert any productive activity in relation to the good considered, the carousel also implies the presence of a sui generis "underground" business organization. This is a factor not commonly considered in either the standard literature on tax evasion (which deals with taxpayers who do not like to pay taxes on their legal business) or the literature on contraband (which normally deals with criminal organizations fully outside of the legal market economy as for their illegal activities). Finally, on the side of tax controls there is a plurality of tax administrations normally operating separately, without systematic information on the chain of transactions which occurred in other countries. Therefore, the economic and fiscal effects of the carousel fraud imply different costs (but also benefits) for the countries involved.

In Europe, Value Added Tax replaced different forms of indirect taxation (most of which were *cascade* taxes or cumulative all-stage turnover taxes) applied in European countries in the 1960s. The switch to VAT was required to neutralize the distorting effects of taxes levied on the full value of output at each stage of the productive process. Moreover, the turnover sales tax had made it impossible to determine the real tax wedge on the final price of the different goods, with the consequence of distorting both domestic and international trade. This distorting effect took place because the rebates to export had to be measured on the average amount of the turnover tax incorporated in the various types of goods exported, while the turnover tax on the goods imported had to be determined by considering the average tax that the same type of goods had to pay in the domestic trades. A value added tax of consumption-type, like the VAT adopted in the European Union, based on the destination principle and requiring the deduction of the tax levied on purchases from that on sales, appeared neutral in the international trade, even if each member state adopted different standard and reduced rates, provided that imports were taxed at the same rate as goods of the same type traded domestically, that exports were exonerated, and that there was a reimbursement for the tax paid on the purchases incorporated in the exported goods. This type of value added tax also appeared neutral in the domestic trade in relation to more or less integrated productive and distributive processes because the tax paid on the purchases is fully deductible from the sales. This proviso was expected to induce a form of self-enforcement of the tax, because it is in the interest of the purchasers to receive invoices with the full value of the VAT paid from the sellers, as this will

allow them to reduce the tax burden on their (legal) sales.[2] However, the VAT chain nexus among a sequence of firms, instead of operating as a self enforcing factor, has acted as a stimulus to the growth of the underground economy. Indeed, since the 1980s, Hemming and Kay (1981) have stressed the illusory nature of the notion of VAT self-enforcement. More recently, Keen (2007) gave an overall description of the main types of VAT fraud, evasion and elusion, with the emphasis on international aspects of these phenomena, and presents a detailed analysis of the remedies against fraud devised both at European and at national level considered by the literature. Indeed VAT fraud, particularly in connection with intra-community trade, seems to constitute an important and, in all likelihood, increasing phenomenon. The International VAT Association estimates VAT losses ranging from 60 to 100 billion euros per annum across the European Union.[3] In the United Kingdom alone, HM Revenue and Customs estimated that, in the tax years 2005-2006, the VAT revenue losses amounted to 18.2 billion euros.[4] In Germany, the Ministry of Finance published the results of a study which, for 2005, estimated VAT losses of 17 billion euros.[5] According to the European Court of Auditors (2008), "most VAT evasion is linked to undeclared economic activities (the "shadow economy")". However, "significant VAT evasion also occurs as a side-effect of the VAT arrangements put in place when the single market was introduced in 1993".

In Section 2, we describe the main types of VAT fraud originating from international trade and formalise the collusive games into a model capturing the different types of VAT fraud. We begin with the simplest fraud, where two business traders share the advantages of VAT evasion. Then we assess the effects of the fraud on the prices of the good exchanged and on the earnings of the fraudsters participating in a carousel. Conclusions follow in Section 3.

The Theoretical Framework

In this section, we model, first, the simplest fraud, in which two traders share the gains from VAT evasion. Second, we consider two different modalities of carousel in order to see their effects on the price of the exchanged good as well as on the earnings of the fraudsters. In each case, we assume that all taxpayers are both risk neutral and ethically neutral to tax fraud. As in Allingham and Sandmo (1972), we assume that tax misreporting requires little time and effort. We assume that direct taxation on registered traders is levied at a constant average rate equal for all taxpayers in all countries. The registered traders have, as their only form of income, the income from their activities. Their direct tax base is determined by the difference between their receipts as stated on the invoices and their production costs (excluding investments, which, however, are not modelled here). We assume that direct taxation is accompanied by indirect taxation on domestic consumption. Imports are subject to a consumption type-VAT according to the country destination principle,[6] which means that exports are tax-free and the exporter obtains a refund of the VAT paid for his purchases. VAT may be levied at different rates depending on the nature of the goods and on the distributive aims of the governments. When VAT is levied on consumption, at each stage of the chain of exchanges within the same country the reported value added is taxed and each trader is expected to pay his supplier the VAT due on the reported

[2] Cnossen (1990) maintained that VAT is probably the best tax ever invented for raising tax revenue (see also Cnossen, 1994, 1998, 2001).
[3] International VAT Association (2007), quoted in European Court of Auditors (2008).
[4] HM Revenue and Customs (2006), quoted in European Court of Auditors (2008).
[5] Monatsbericht des BMF (Monthly report of the Federal Ministry of Finance) (2006), quoted in European Court of Auditors (2008).
[6] The imports not directly sold to a consumer are taxed as domestic goods when they cross the border with a mechanism of self-invoicing by the importer.

purchases, with the importer self invoicing his purchases and paying the due amount to his own tax authority. At the end of each fiscal period (month, quarter, or year), each honest registered trader who has collected VAT from his customers transfers to the tax authority the difference between the VAT collected on sales and the VAT paid on purchases, as stated on the invoices. In this form, the VAT base is given by the difference between VAT on sales and VAT on purchases of goods (excluding investment). We assume that the quantity Q of the good which is the object of fraud, *Q-goods*, is given and that all transactions can be absorbed by the (black) market. [7] In what follows, we shall also maintain the following assumptions and notations:

π indicates the probability of tax control by tax authorities, assumed to be the same in all the countries involved and, thus, for all traders;

ϑ_i , $i = 0, 1 \ldots 3$, are the average VAT rates on exchanges;

$D > \vartheta_i$ is the fine for VAT evasion to be applied to the sum of VAT evaded on sales and VAT evaded on purchases;

t is the average direct tax rate, inclusive of social security contributions;

$F > t$ is the fine for income tax evasion to be applied to the evaded income tax base.

π , *F, D* and *t* are assumed to be the same in all countries. This assumption does not change the essence of the problem.

The Simplest Vat Fraud: The Effects in the Transit Country

The "simplest fraud" occurs in a single operation, where an importer buys (or feigns to buy) a tax free good abroad sells the good to an exporter with VAT added, does not remit the VAT to tax authority and then disappears as "missing trader". The importer-missing trader might add no value to the exchanged good. The exporter, as such, is lawfully entitled to the VAT rebate when selling the good abroad[8] unless it can be probed that he was aware of the fraud. We assume that the two players Nash bargain on the gains from VAT evasion.

To compute the Nash solution determining the share of gains from VAT evasion for the two firms we have to know the outcome the bargain between them. We assume that, given the goods exchanged in the transit country, the two traders bargain on the share of the rebate obtained from the fake transaction, with the importer adding no value to the good and the exporter being a regular firm paying taxes and really exporting the good abroad.

The fraud begins at a border where an importer, not adding value, sells the Q-goods to an exporter. The importer sells the good with VAT added, but he does not remit the VAT charged and disappears as a registered trader. The exporter, apparently paying VAT, is entitled to the VAT rebate when re-exporting the Q-goods. How the two traders share the rebate is the object of their bargain. We assume that the importer purchasing unit price is equal to his sales price P_1, on which basis VAT is added at a rate ϑ_1. The object of the bargain is the share α of the VAT rebate, $QP_1\vartheta_1$, to be given to the importer by the exporter, who keeps $(1-\alpha)\ QP_1\vartheta_1$.

Consider, first, the importer. When the importer sells Q-goods, he draws invoices charging VAT to the exporter, thus, allowing the VAT rebate to the latter, who exports the VAT free Q-goods to a different country. We denote with I the expected payoff of the importer in case of agreement with the exporter. The importer's payoff is given by the expected value of his gains if he is not discovered plus the expected value of his gains if discovered, in which case we assume that the importer is fined for VAT evasion on the full value of the rebate

[7] An extention of the model allowing for endogenous *Q* is the object of a different paper.

[8] He could be domestic trader, who resells the good in the domestic market in which case, as a purchaser from the importer, he is entitled to deduct the VAT paid on his purchases.

$D\vartheta_1 P_1$.[9]

$$I = \underbrace{(1-\pi)}_{\substack{probability\ of\ not\ being\\ controlled\ by\ tax\ authorities}} Q(\alpha\vartheta_1 P_1) + \underbrace{\pi}_{\substack{probability\ of\\ being\ controlled\\ by\ tax\ authorities}} Q(\alpha\vartheta_1 P_1 - \underbrace{D\vartheta_1 P_1}_{fine\ for\ tax\ evasion}) \quad (1)$$

We denote with *I'* the expected payoff of the importer in case of disagreement. We assume that the importer does not loose or gain anything. Thus, in case of disagreement, his payoff is zero.

$$I' = 0 \quad (2)$$

The importer expected payoff from the Nash bargain with the exporter is given by the difference of Equations (1) and (2), that is

$$I - I' = Q\vartheta_1 P_1(\alpha - \pi D) \quad (3)$$

and his individual rationality constraint requires that $(\alpha - \pi D) > 0$, (i.e., the importer share of the rebate must be higher than the expected fine).

We now consider the exporter expected payoff from the Nash bargain with the importer. In case of agreement the *Q-goods* are exported and sold tax free at the price P_2 and the exporter gets the rebate of the presumed VAT paid on his purchases (against a true invoice). He keeps the share $(1-\alpha)$ $QP_1\vartheta_1$ of the VAT rebate giving the remaining to the importer. The exporter is expected to pay the income tax on his invoiced income. If discovered by the tax authority he is fined for VAT evasion on the full value of the rebate, $D\vartheta_1 P_1$. As before we do not model here the fine for income tax evasion on the gain from VAT evasion not reported for income tax assessment. In case of agreement with the importer, the exporter expected payoff is

$$E = (1-\pi)Q[P_2 + (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1)] + \pi Q[P_2 + (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1) - D\vartheta_1 P_1] \quad (4)$$

Here, in case of disagreement with the importer, we assume that the exporter fully reports VAT and income tax, and looses the share of rebate. In this case the exporter payoff is

$$E' = Q[P_2 - (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1)] \quad (5)$$

The expected payoff of the exporter from the Nash bargain with the importer is given by the difference between Equations (4) and (5) that is

$$(E - E') = QP_1\vartheta_1[2(1-\alpha) - \pi D] \quad (6)$$

and the individual rationality constraint requires $(E - E') > 0$, that is the exporter share of twice the rebate is higher than the expected fine. The asymmetry of the individual rationality constraints for the two players is due to the assumption that in case of disagreement the payoff of the importer is zero whereas the exporter considers as a loss the missed VAT rebate.[10]

The importer and the exporter choose α that maximizes the product of their expected payoffs (3) and (6) that is

$$\underset{\alpha}{Max}(I - I')(E - E') \quad (7)$$

from which

$$\hat{\alpha} = \frac{2 + \pi D}{4} \quad (8)$$

and second order conditions require $-4Q^2\vartheta^2 P_1^2 < 0$ and, in the simplest version of the missing trader model

[9] He could also be fined for income tax evasion on the black gains not reported for income tax assessment (e.g., F times the unreported income tax base $\alpha\vartheta_1 P_1$). Given that these two fines affect the payoff in the same direction, for the sake of simplicity, here we charge the D fine only (in the carousel below, we shall consider the effects of both fines).

[10] This asymmetric assumption bears on the assumed "missing" traders' behaviour of disappearing after the transaction, which may simply consist in changing the name of the company for tax purposes, whereas the exporter is basically a firm-and not a fictitious company-legally recognised that wishes to continue his activity in the market.

are always satisfied for positive quantity, price and VAT rates.

Notice first that the share of rebate (from Equation (8)) between tax evaders is affected by the π and D. It is not affected by the VAT rate ϑ, which, however, determines the amount of the rebate. For example, when $\vartheta_1 = 20\%$, $P_1 = 100$, $\pi = 0.01$, $D = 20$ and t = 0.35, $\alpha = 0.55$ and the expected gains for the importer are 3.5*Q*, whereas for the exporter are 7*Q*.

Now we consider the policy implications of the above model to limit the simplest VAT fraud. Unless the tax authorities are in the position of allowing for rebate only to those traders really having the title to it (for example, under the type of VAT mechanism proposed by Sinn, Gebauer and Parsche, 2004), the type of intervention to reduce this practice can only be in the direction of increasing probability of tax control and fines for tax evasion. That is, a high "credible" expected penalty should reduce the incentive for the importer (because his individual rationality constraint would not be satisfied). Moreover, looking at the reduced form equations of the payoffs of the players, obtained by substituting Equation (8) into Equations (3) and (6),

$$\tilde{I} = \frac{1}{4} Q \vartheta_1 P_1 (2 - 3\pi D) \tag{9}$$

$$\tilde{E} = \frac{1}{2} Q \vartheta_1 P_1 (2 - 3\pi D) \tag{10}$$

it turns out that both Equations (9) and (10) are affected by π and D in that $\partial \tilde{I} / \partial \pi < 0$, $\partial \tilde{I} / \partial D < 0$, $\partial \tilde{E} / \partial \pi < 0$ and $\partial \tilde{E} / \partial D < 0$ (that is, both players reduce their expected gains if the expected fines increase), whereas the sign of $\partial \tilde{I} / \partial \vartheta$ and $\partial \tilde{E} / \partial \vartheta$ follows the sign $(2 - 3\pi D)$.

Finally, one must notice that the evasion determined by the missing trader is of the worst type in that there is a real disbursement by part of the tax authority of the transit country equal to the amount of the rebate, which would be undue because the transit goods, as such (e.g., in the absence of fake transaction) are fully exonerated by the VAT system. This implies that the VAT mechanism would also work as a type of subsidy for given goods, with benefits for the consumers arising in the destination country. This issue shall be explored in the next sections.

The Carousels of VAT Frauds

We now model the carousel as a chain of bargaining between each couple of fraudsters along a chain of exchange assuming that traders bargain the unit price of the considered good.[11] The purpose of this section is to study the effects on prices of the exchanged goods in the countries involved in the carousel, restricting the case to complete information and considering a finite number of exchanges. We consider the case where the carousel begins in the origin country and the fraudsters determine the sale prices along the production chain. In this case we shall assume that the final price (to consumers) is equal to the unit production cost as determined by the carousel plus a given unit margin.

Sales prices adjustments to tax frauds. We now model the carousel as a chain of bargaining between each couple of fraudsters assuming that they determine the final price of the considered good exploiting the advantages of tax frauds. We assume that at the last stage of the chain, the price is not bargained with the consumers, but it is equal to the unit production cost of the retailer plus a given unit margin. The chain of black transactions originates in the country of origin. The bargaining equilibrium prices and earnings of all agents are consequently affected, as depicted in Figure 1.

Figure 1 represents the basic carousel as composed by more than one round of the "simple fraud" by missing traders. The carousel involves an import from country A to an EU country B by part of fraudster 1,

[11] For the basic analysis of the chain of Nash bargain, see Basu, Bhattacharya and Mishra (1991).

who is assumed to begin the carousel. Fraudster 1, having bought the *Q-goods* tax free, sells them to fraudster 2 in country B (stage 1) charging VAT (but he does not remit VAT to the tax authority nor he self invoices the imported *Q-goods*) and after disappears as a registered trader. Fraudster 2 who has formally regularly purchased the *Q-goods* with invoice is in the position of getting the rebate of the VAT paid when exporting the good to a third EU country C. Stage 1, thus, generates a first VAT revenue loss for the Treasury of country B which is equal to country B's disbursement of the amount of VAT rebate to fraudster 2 given that the revenues from VAT due by fraudster 1 is missed. At the subsequent stage 2, fraudster 2 sells the *Q-goods* VAT free to fraudster 3 in country C of the EU.

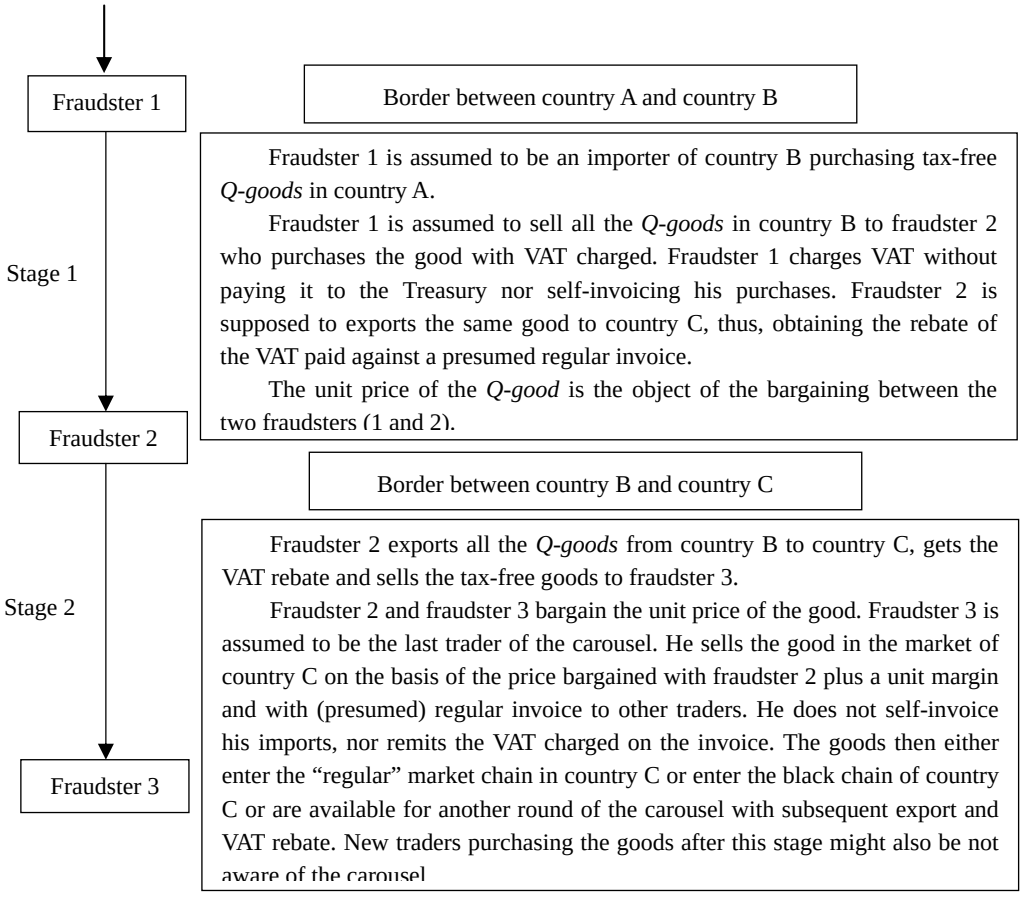

Figure 1. The chain of black transactions involving carousel among 3 EU countries.

The object of their bargain is again the unit price of *Q-goods*, which should be self invoiced by fraudster 3 (importer into country C). Fraudster 3 does not self invoice, but sells the *Q-goods* in his own country charging VAT (which is pocketed by fraudster 3). From this stage on the basic carousel may end.[12] Yet fraudster 3's purchasers can either continue the carousel with further similar rounds, or sell the *Q-goods* in the black chain in the same country, or

[12] Notice, however, that between fraudster 1 and fraudster 2 there might be multiple buffer companies that might be wholly unaware of the fraud as well as bogus traders set to generate invoices allowing recovery of VAT before they arrive to fraudster 3. Buffer and bogus companies can add no value. These companies are used with the purpose of making it impossible a cross checking of the issued invoices (Keen, 2007).
We have not introduced these traders in the model because they are not relevant players in affecting the final prices. Yet they are important because they might reduce the *key fraudsters*' risk of detection by obscuring the latter tracks.

become a regular traders (of country C), who-having bought the *Q-goods* with regular invoice from fraudster 3-introduce them in the regular market chain. In either case fraudster 3, who charges the VAT to his purchaser and does not remit it to tax authority, generates a second VAT revenue loss for the Treasury of country C.

If the carousel is repeated with several imports and exports of the same *Q-goods* among a number of EU countries both the effects on the amount of earnings for fraudster, partially financed by the States involved by means of the VAT rebates, and the effects on prices are clearly exacerbated.

In order to compute the Nash solution determining the prices for each couple of bargains in the carousel (between fraudster 1 and fraudster 2 and between fraudster 2 and fraudster 3) at each stage, we have to know the outcome of each bargain between any two agents in the chain both in terms of cooperative agreement and in terms of stalemate, if no agreement between traders is reached. We shall assume that, given the *Q-goods* exchanged in the black chain, each pair of agent bargains on the unit price, but the last fraudster of the basic chain, who is assumed to sell the *Q-goods* at the production costs plus/minus a unit margin.

The carousel begins at a border where an importer from country A (fraudster 1 in Figure 1) tries to sell *Q-goods* to fraudster 2 in his own country B at the price P_1 that must be defined by the Nash bargain. We assume that the importer purchasing unit price is P_0, which is taken as given, whereas P_i-with I = 1, 2-are bargained by the traders. They represent the purchasing prices of, respectively, fraudster 2 and fraudster 3 as well as the sale prices of, respectively, fraudster 1 and fraudster 2.

Recall that fraudster 1 sells to fraudster 2. The former draws invoices to fraudster 2 (charging VAT, thus, allowing the VAT rebate to fraudster 2, who exports to country C) and then disappears from the regular market chain, pocketing the charged VAT (that is not given to tax authority) and also gaining from direct tax evasion. Fraudster 1, as importer, runs a low risk of being fined for tax evasion, given that he can easily enter the regular chain by a mechanism of self-invoicing. Fraudster 2, in turn, might be willing to buy fraudster 1's *Q-goods* paying VAT because he further exports the goods and gets the rebate on the VAT paid. Moreover, if he after disappears as a missing trader, he also gains from direct tax evasion. Fraudster 3 importing the *Q-goods* into country C, purchasing them tax free from fraudster 2, might have the incentive to act again as fraudster 1 when selling the *Q-goods* in his own country, thus beginning another round of the carousel. Therefore, here we assume that fraudster 3 is the last player of the carousel.

We denote with *M1* the expected payoff of fraudster 1 if fraudster 2 accepts to enter the carousel.

$$M1 = \underbrace{(1-\pi)}_{\substack{probability\ of\ not\ being\\ controlled\ by\ tax\ authorities}} Q\Bigg[\underbrace{\underbrace{P_1}_{\substack{sales\\ price}} + \underbrace{\vartheta_1 P_1}_{\substack{VAT\ charged\\ and\ kept}} + \underbrace{\lambda_o P_o L}_{\substack{gains\ from\ increased\ share\ of\ market\ and/or\\ from\ cost\ reduction}} - \underbrace{LP_o}_{production\ cost}}_{unit\ gain\ from\ black\ transactions}\Bigg] +$$

$$+ \underbrace{\pi}_{\substack{probability\ of\ being\ controlled\\ by\ tax\ authorities}} Q\Bigg[\underbrace{\underbrace{P_1}_{\substack{sales\\ price}} + \underbrace{\vartheta_1 P_1}_{\substack{VAT\ charged\\ and\ kept}} + \underbrace{\lambda_o P_o L}_{\substack{gains\ from\ increased\ share\ of\ market\ and/or\\ from\ cost\ reduction}} - \underbrace{LP_o}_{production\ cost}}_{unit\ gain\ from\ black\ transactions} - \underbrace{t((1+\vartheta_1)P_1 + \lambda_o P_o L - LP_o)}_{direct\ tax\ due} - \underbrace{((1+\vartheta_1)\vartheta_1 P_1 - \vartheta_0 P_0)}_{VAT\ due} + \tag{11}$$

$$- \underbrace{D(\vartheta_0 P_0 + (1+\vartheta_1)\vartheta_1 P_1)}_{\substack{fine\ for\\ VAT\ evasion}} - \underbrace{F((1+\vartheta_1)P_1 + LP_o)}_{\substack{fine\ for\ direct\\ tax\ evasion}}\Bigg]$$

In order to take into account the direct tax evasion also on the labour market, in this model we introduce the exogenous parameters λ_i, for i = 0, 1, 2 capturing the cost reduction along the production chain exploiting the black labour market.[13] Thus, $\lambda_o P_o$ is the unit gain from black transaction assumed to be the share λ_o of the purchasing cost. In real life the black gains may come from cost savings due, for example, to a lack of security norms for labour, which are possible if labour is hired in the black market,[14] but also, in the same direction, to decreasing production costs associated to the value of the whole black transaction. These factors, which may justify different values of λ_o, are not modelled here.

If fraudster 2 does not accept to enter the black chain, the expected payoff for fraudster 1 is

$$M1' = Q\Bigg[\underbrace{(1+\vartheta_1)P_1}_{unit\ sale\ price} - \underbrace{LP_o}_{production\ cost} - \underbrace{\lambda_o P_o L}_{lost\ gain\ from\ black\ transaction} - \underbrace{t((1+\vartheta_1)P_1 - LP_o)}_{direct\ tax}\Bigg] \tag{12}$$

[13] Notice, however, that the black untaxed sector interacts with the taxed sector in different ways (not modelled here) and a portion of tax evasion is passed on to the consumer in either sector.

[14] Consider the following report from the press on this issue.

"Every dress they sew is paid between the 3.5 and the 5 Euro. It is to be sold in the shops of the Capital for the so called 'shopping for all pockets' at a price between the 50 and the 100 Euros. Hundreds of Chinese work crowded in the warm and dark laboratories, on the outskirts of Rome, with nearby their small children, even for 17 hours a day, to supply the maison of the Italian prêt a porter (*ready-to-wear*) of clothes without brand name at a little price that can be found in the shop-window of via Nazionale and via del Corso. In the laboratories discovered from the Police of Rome, the labels of one of the famous brands of the Italian prêt a porter, Sandro Ferrone, were sewn on the ready clothes. The authenticity of the labels, the police explained, is still to be ascertained. At the moment, between the Chinese and the brand, the police said there is no direct contact: a third subject furnishes with the raw materials and the models. Then he withdraws the ended product. The Chinese do not treat with Ferrone directly; they know only the labels, the fabrics and the models, which are reproduced with great precision. (...) That of last night is the third intervention, in the last ten days. In the sheds, the scene found is always the same: Chinese guys of 20-30 years old all coming from the region of the Zhejiang; tables with sewing machines, quintals of cloths and threads; zero safety measures; little cots and rests of food and babies playing, because people work and survive in the sheds. The production never stops until the whole product is fully concluded. In the last three operations, the police seized 32 laboratories and sheds. In the sheds the police also found cheap-goods (made in China) destined only to the shops of the Roman Chinatown. But this is another story. The policemen, gifted only of torches and pens, after the preliminary detective activity, during never ending nights, transcribed complicated names, communicated with people that know few words of Italian, sharing with the modern slaves the unhealthy environments, with the smell of the oriental kitchen mix with the sweaty bodies and the oil of the sewing machines. This reality also embarrassed the veterans of the police that would have liked not to discover the jails from which the Italian prêt a porter comes out ready for the shopping." ("*Chinese fashion houses, here slaves make the Italian prêt a porter"*, ANSA *(Associated Press National Agency), May 2008)*

Notice that, in this case, fraudster 1, purchasing goods by a non resident, can write the invoice himself in order to regularly enter the chain of (honest) transactions. In this case, however, the unit price charged is higher of an amount equal to the VAT on purchases (on which VAT is further charged and remitted to the tax authority, therefore it cancels out into Equation (12))[15] and his payoff is given by his income net of tax, which is levied on the higher base due to the higher price charged, which, in turn, determine a loss of missed gains from black transactions (or increased production costs) equal to $-\lambda_o P_o LQ$. In order to avoid inconsistent solutions, in case of disagreement between the two fraudsters, we assume that in case of negative direct tax base the direct tax is equal to zero. The equilibrium solution for this case is in Appendix.

Fraudster 1 expected payoff from the Nash bargain with fraudster 2 is given by the difference of Equations (11) and (12), that is

$$(M1\text{-}M1') \tag{13}$$

and his individual rationality constraint requires that $(M1\text{-}M1') > 0$.

We now consider fraudster 2 expected payoff from the Nash bargain with fraudster 1. If fraudster 2 accepts to enter the carousel, he is expected to export the *Q-goods* at the subsequent stage so as to get the rebate of the VAT paid against a presumed true invoice. Fraudster 2 expected payoff is:

$$M2 = \underbrace{(1-\pi)}_{\substack{probability\ of\\ not\ being\ controlled\\ by\ tax\ authority}} \quad Q\underbrace{\left[P_2 + \lambda_1 P_1 L - LP_1\right]}_{\substack{unit\ gain\ from\ black\\ transactions}} +$$

$$+ \underbrace{\pi}_{\substack{probability\\ of\ being\\ controlled\\ by\ tax\ authority}} Q\left[\underbrace{P_2 + \lambda_1 P_1 L - LP_1}_{\text{unit gain from black transactions}} - \underbrace{t(P_2 + \lambda_1 P_1 L - LP_1)}_{\text{direct tax due}} - \underbrace{\vartheta_1 P}_{\substack{\text{undue VAT}\\ \text{rebate refunded}}} - \underbrace{F(P_2 + LP_1)}_{\text{fine for direct tax evasion}} - \underbrace{D(\vartheta_1 P_1)}_{\substack{\text{fine for undue VAT}\\ \text{rebate obtained}}}\right] \tag{14}$$

where, VAT on purchases paid to fraudster 1 is refunded by tax authority given that fraudster 2 exports the goods purchased. P_2 is the unit price to be bargained between fraudster 2 and his purchaser at the subsequent stage in country C. As before, $\lambda_1 P_1 LQ$ is the gain from black transaction assumed to be the share λ_1 of fraudster 2's production costs.

Fraudster 2's payoff if he does not enter the chain of black transaction is

$$M2' = Q\left[\underbrace{P_2 - (1+\vartheta_1)LP_1}_{\substack{(unit)\ revenues\ net\ of\ production\\ costs}} - \underbrace{t(P_2 - (1+\vartheta_1)LP_1)}_{\text{direct tax}} - \underbrace{\lambda_1 P_1 L}_{\substack{lost\ black\\ gains}}\right] \tag{15}$$

where the purchasing cost of fraudster 2 is higher than when he complies with fraudster 1 on tax evasion,[16] whereas fraudster 2's sale prices to his purchasers are tax free, being fraudster 2 an importer. Moreover, now fraudster 2 regularly pays direct tax on the new tax base (if positive), determined with higher purchasing cost and without reduction of production cost in the absence of black transaction.

The expected payoff of fraudster 2 is given by the difference between Equations (14) and (15) that is

$$(M2 - M2') \tag{16}$$

and the individual rationality constraint requires $(M2 - M2') > 0$.

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[15] The "missing" traders' behaviour of disappearing after the transaction might simply consist in changing the name of the company for tax purposes. Although fraudster 1 is always in the position of disappearing as fictitious company, a purchaser not complying with him in the fraud is still a threat for fraudster 1, given that he can anonymously reveal to tax authority the real person behind the fraud.

[16] See previous footnote.

At stage 1, fraudster 1 and fraudster 2 choose the price P_1 that maximizes the product of their expected payoffs Equations (13) and (16) that is

$$\underset{P_1}{Max}(M1 - M1')(M2 - M2') \tag{17}$$

By analogous reasoning, at stage 2, fraudster 2 bargains the price with fraudster 3. Fraudster 2 expected payoff is again given by Equation (16). As mentioned, we assume that fraudster 3 is the last player of the basic carousel, which, thus, stops at stage 2. Therefore, we assume that fraudster 3 does not contract with further traders the price, but charges a price equal to his unit production cost plus/minus a margin on his production costs: the unit margin is taken as given and is equal to $\Delta > 0$.[17] Fraudster 3 can either be himself a missing trader thus charging VAT without paying in it to the Treasury and evading both income tax and social security contributions or fully paying taxes, but loosing the cost reduction due to black transactions.

Fraudster 3 entering the carousel is assumed to have an expected payoff equal to

$$\begin{aligned} M3 = {} & \underbrace{(1-\pi)}_{\substack{probability\ of \\ \text{not being controlled} \\ \text{by tax authority}}} Q\underbrace{\left[(1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - P_2 L\right]}_{\text{unit gain from black transactions}} + \\ & + \underbrace{\pi}_{\substack{probability\ of \\ \text{being controlled} \\ \text{by tax aquthority}}} Q\Bigg[\underbrace{(1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - P_2 L}_{\text{unit gain from black transactions}} - \underbrace{t((1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - LP_2)}_{\text{direct tax due}} - \underbrace{F((1+\vartheta_3)P_2L\Delta + P_2L)}_{\text{fine for direct tax evasion}} + \\ & - \underbrace{D(\vartheta_3(1+\vartheta_3)P_2L\Delta + \vartheta_2 P_2)}_{\text{fine for VAT evasion}} - \underbrace{(\vartheta_3(1+\vartheta_3)P_2L\Delta - \vartheta_2 P_2)}_{\text{VAT due}}\Bigg] \end{aligned} \tag{18}$$

In this case, given the assumption on fraudster 3's sale price equal to his production costs plus/minus a margin, fraudster 3 expected payoff, if he does not accept to enter the carousel, is equal to

$$M3' = Q[(1+\vartheta_3)P_2L\Delta - \lambda_2 P_2 L - P_2 L - t((1+\vartheta_3)P_2L\Delta - P_2L)] \tag{19}$$

The Nash bargaining expected payoff of fraudster 3 is given by the difference of Equations (18) and (19) that is

$$(M3 - M3') \tag{20}$$

and fraudster 3's individual rationality constraint requires $(M3 - M3') > 0$.

Under the mentioned assumption the Nash bargaining at stage 2 between fraudster 2 and fraudster 3 is

$$\underset{P_2}{Max}(M2 - M2')(M3 - M3') \tag{21}$$

We now solve the game by backward induction beginning by stage 2.[18] By differentiating Equation (21) with respect to P_2[19] and solving for P_2

$$\hat{P}_2 = \frac{P_1(2\lambda_1 L + \pi t L - \pi F L - \pi D\vartheta_1 + \vartheta_1 L - \vartheta_1 L t - tL - \lambda_1 \pi t L - \pi\vartheta_1)}{2(\pi t + \pi F - t)} \tag{22}$$

By substituting back Equation (22) into Equation (17) and maximizing with respect to P_1 we get[20]

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[17] This means that the unit price, not being determined by the bargain, at the subsequent stage is Δ times the production costs.

[18] In Appendix we report the equilibrium solutions when the direct tax base in case of disagreement between players is negative, which implies t = 0 in Equations (12), (15) and (19). Notice that a loss (negative tax base) in case of agreement of tax fraud is excluded by the individual rationality constraint, being the direct tax base inclusive of the (exogenous) gains from black transactions represented by λ_i.

[19] With S.O.C. for a maximum at stage 2 requiring:

$(\pi FL + \pi D\vartheta_2 - 2\lambda_2 L - \vartheta_3 L\Delta t + \pi D\vartheta_3^2 L\Delta + \pi FL\Delta + \pi tL\Delta - \pi tL - tL\Delta + Lt - \pi\vartheta_2 + \pi\vartheta_3 L\Delta + \pi F\vartheta_3 L\Delta + \pi t\vartheta_3 L\Delta + \pi t\lambda_2 L + \pi D\vartheta_3 L\Delta + \pi\vartheta_3^2 L\Delta)(\pi t + \pi F - t) < 0$.

[20] With S.O.C. for a maximum at stage 1 requiring:

$$\hat{P}_1 = \frac{P_0(2\lambda_o L + \pi tL - \pi FL - \pi D\vartheta_o - tL + \pi\vartheta_o - \pi t\lambda_o L)}{2(1+\vartheta_1)(\pi t + \pi F - t + \pi D\vartheta_1 + \pi\vartheta_1)} \tag{23}$$

We now express the Nash bargain equilibrium prices at the two stages in terms of P_0, under the assumption that $\vartheta_o = \vartheta_1 = \vartheta_2 = \vartheta_3 = \vartheta$ and that $\lambda_o = \lambda_1 = \lambda_2 = \lambda$. We obtain

$$\hat{P}_1 = \frac{P_0(2\lambda\ L + \pi tL - \pi FL - \pi D\vartheta - tL + \pi\vartheta - \pi t\lambda L)}{2(1+\vartheta)(\pi t + \pi F + \pi\vartheta + \pi D\vartheta - t)} \tag{24}$$

$$\hat{P}_2 = \frac{P_0(2\lambda\ L + \pi tL - \pi FL - \pi D\vartheta - tL + \pi\vartheta - \pi t\lambda L)(2\lambda L + \pi tL - \pi FL - \pi D\vartheta - \vartheta Lt - tL - \lambda\pi tL - \pi\vartheta + \vartheta L)}{4(\pi t + \pi F - t)(1+\vartheta)(\pi t + \pi F + \pi\vartheta + \pi D\vartheta - t)} \tag{25}$$

The reduced form equations for the expected payoffs from the Nash bargaining of each agent are

Fraudster 1:

$$\overline{(\text{M1 - M1'})} = \frac{QP_0(2\lambda L + \pi\vartheta + \pi tL - \pi FL - \pi D\vartheta - tL - \pi t\lambda L)}{2} \tag{26}$$

Fraudster 2:

$$\overline{(\text{M2 - M2'})} = \overline{(\text{M1 - M1'})}\,\frac{(2\lambda L + \pi tL - \pi FL - \pi D\vartheta + \vartheta L - \vartheta Lt - tL - \pi t\lambda L - \pi\vartheta)}{2(\pi t + \pi F + \pi\vartheta\ + \pi D\vartheta\ - t)(1+\vartheta)} \tag{27}$$

Fraudster 3:

$$\overline{(\text{M3-M3'})} = \overline{(\text{M2-M2'})}\,\frac{(2\lambda L - \pi FL\Delta - \pi D\vartheta + t\vartheta L\Delta - \pi D\vartheta L\Delta - \pi FL - \pi tL\Delta + Lt\Delta - tL + \pi tL - \pi F\vartheta L\Delta - \pi t\vartheta L\Delta - \pi t\lambda L - \pi D\vartheta^2 L\Delta - \pi\vartheta L\Delta + \pi\vartheta - \pi\vartheta^2 L\Delta)}{(\pi t + \pi F - t)} \tag{28}$$

The model allows for more than one solution, depending on the parameters affecting the direct tax base.[21] In order to appreciate the effects of the carousel, we make some numerical example. Table 1 reports the effects of the carousel on the equilibrium unit prices at each stage and the equilibrium unit earnings of each fraudster for different direct tax and VAT rates. In the numerical example, we assume that $\lambda = 0.6$, $\pi = 0.02$, $D = 20$, $L = 2.5$, $\Delta = 0.8$ and $F = 20$ and that the initial unit price is $P_o = 100$.

With the above parameters, the last player equilibrium sale price is consistent with a unit margin $\Delta < 1$, (e.g., the saving in costs due to black transactions allows fraudster 3 a further reduction of the sale price to his purchasers). For different direct tax and VAT rates, we report in the columns the gross unit prices inclusive of VAT (retained by the fraudsters as a unit margin) and the fraudsters' gains.

Recall that $\lambda = 0.6$ allows for production costs savings, a sort of extra gain for fraudsters caused by the fact that the purchase of *Q goods* with black transactions allows them to broaden their activity in both the illegal and the legal market. As already noted underground economic activities allow costs' reduction because labour contracts, environment, safety and health regulations are not respected. On the other hand, lower prices of the Q goods, as in the example considered, may allow the fraudsters to increase their sales at decreasing unit costs. Part of these sales may also occur in the regular market without (much) tax evasion. Clearly, in this occurrence (not modelled here) the distortions in the market due to the carousel would increase.

We have kept a low probability of tax control joint with high fees for both direct and indirect tax evasion, as occurs in most European countries. The VAT rates at each stage are assumed to be either 20% or 10%. All the transactions considered in the carousel are among registered traders, so that the case of different VAT rates along the chain is not relevant. The burden of the direct taxes is assumed to be either 30% or 35%, or 40% of the taxable bases. It is interesting to note that, at any VAT rate and direct tax burden, in the carousel, the greatest gain is for fraudster 3, who buys in the third country rather than for fraudster 2, who gets the unlawful reimbursement from

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$(\pi t + \pi F + \pi D\vartheta_1 - t + \pi\vartheta_1)\ (\pi FL + \pi D\vartheta_1 + tL - 2\lambda_1 L - L\vartheta_1 + tL\vartheta_1 - \pi tL + \pi t\lambda_1 L + \pi\vartheta_1) < 0$.

[21] See Appendix.

the tax authority. The lowest considered VAT rate (10%) increases the gains of fraudster 3 over those of fraudster 2 and well above those of fraudster 1. Fraudster 3, however, cannot make this big illicit gain unless fraudster 2 is successful in his previous game. On the other hand, fraudster 1, the importer in country B, gets a benefit generally much smaller than the others. He cannot get his illicit gain unless he finds a fraudster 2 willing to collude with him. Thus, a successful anti fraud strategy for the carousel, under the assumptions of the game modelled here, has to focus on fraudsters' incentives to enter in the VAT fraud game.

The VAT rate at 10% causes a greater increase in price and in gains of fraudsters (particularly at the last stage) as compared with the case of a VAT rate at 20%. A reduced VAT implies increase of prices net of VAT as compared with those under a higher VAT rate, because fraudsters have a smaller tax saving. A gain is greater than that obtained by the fraudsters evading a bigger VAT may appear counter intuitive. The reason is that the legal VAT rate is perceived by the fraudsters as a fix margin (to be pocketed) over the bargained price. If this *fix* margin is reduced (by the law), fraudsters increase the prices net of VAT. In so doing, the relative gains from direct tax evasion increase with respect to those obtained by indirect tax evasion and, thus, also the expected gains from fraud increase.

Moreover, one should consider whether the market is more or less competitive also among fraudsters. Greater tax evasions may result in lower prices with smaller gains for each fraudster, with a dissipation of the rents of VAT fraud. In this case, the share of gains from a given direct tax evasion would further increase with respect to those obtained by VAT evasion. Thus a reduction of VAT rates may not be relevant to reduce the incentive to begin or stay in the carousel of VAT frauds. It merely reduces the signal of a VAT frauds at the retail stage given by anomalous prices. On the other hand, it should be noted that in the comparison with the market price without tax evasion, the percentage difference of price, with a VAT rate of 10%, over the price with a VAT rate of 20%, is still important and signals VAT evasion.

Table 1
Examples for the Carousel When $\lambda = 0.6$

		Fraudster 1 (origin)	Fraudster 2	Fraudster 3
Market sales prices = production costs	100	250	625	1,562.5
Market sales prices = production costs plus 20% VAT	120	300	750	1,875
Market sales prices = production costs plus 10% VAT	110	275	687.5	1,718.75
Equilibrium price from the model including the VAT margin, if any, of 20% and t = 30%	100	196.94	489.51	1,174.84
Equilibrium unit gains for fraudsters for t = 30% and VAT = 20%		96.5	198.74	369.1
Equilibrium price from the model including the VAT margin, if any, of 10% and t = 30%	100	219.64	544.43	1,197.76
Equilibrium unit gains for fraudsters for t = 30% and VAT = 10%		98.4	221.04	534.85
Equilibrium price from the model including the VAT margin, if any, of 20% and t = 35	100	196.63	487.77	1,170.66
Equilibrium unit gains for fraudsters for t = 35% and VAT = 20%		96.55	198.52	367.1
Equilibrium price from the model including the VAT margin, if any, of 10% and t = 35	100	219.27	542.41	1,193.29
Equilibrium unit gains for fraudsters for t = 35% and VAT = 10%		98.45	220.76	532.21
Equilibrium price from the model including the VAT margin, if any, of 20% and t = 40	100	196.341	486.04	1,166.5
Equilibrium unit gains for fraudsters for t = 40% and VAT = 20%		96.6	198.3	365.11
Equilibrium price from the model including the VAT margin, if any, of 10% and t = 40	100	218.89	540.39	1,188.87
Equilibrium unit gains for fraudsters for t = 40% and VAT = 10%		98.5	220.48	529.59

Conclusions

The purpose of this paper has been to analyze, through a theoretical model, international VAT fraud, which is an important component/determinant of the persisting and perhaps growing presence of an underground economy in the EU. Since the abolition of border controls among the member states of the EU, with the creation of the "European Single Market", the possibility of VAT fraud has increased and a new kind of distortion of competition has replaced those wiped out by the abolition of intra-community borders. The increase in the number of EU countries has extended the number of intra-community borders trough which fraud may be practiced and has also increased the number of tax administrations that must exchange information to cope with this kind of fraud.

The simplest type of fraud begins with an importer who buys (or feigns to buy) a bundle of tax free goods abroad, sells these goods to an exporter with an invoice inclusive of VAT, but does not remit the tax to the relevant revenue administration and disappears, becoming a "missing trader". The invoices generated by the missing trader allow the purchaser to get a rebate on the exports for the VAT paid on the goods acquired by the missing trader. The rent deriving from this operation, through a fictitious rebate, has to be shared between the two traders. We have modelled this type of fraud using a standard equilibrium Nash game. The peculiarity of this fiscal fraud is that it takes place in a case in which the tax is not due and, therefore, *per se*, there is no proper revenue loss; rather, what takes place is the disbursement of a rebate which had never been remitted by the missing trader. On the other hand, with the carousel system, the illicit rebates may also operate as a subsidy to the underground economy, both in the origin and in the destination country, thus creating a distortion of competition against legal firms. Moreover, if the carousel involves goods imported from non-EU countries, the welfare loss caused by the distortion in the EU countries also affects theirs international transactions, with particular regard to the EU common market. Obviously, these effects may take place also in the case of the so-called simple international VAT fraud, but with the carousel they are magnified.

A reason for focusing on prices at different stages is that the different countries involved may have different interests in combating the carousel, in relation to the changes in prices that it generates. We have shown how, the carousel fraud gradually displaces its effects on the prices of the traded good, thus affecting the markets of various countries along the production chain (those of origin, transformation, transit and destination). In the countries where the goods which are the object of the fraud are finally sold, there is always a positive effect for the consumers, through a price reduction that might even compensate or exceed the loss of revenue for the Treasury. However, even in the case of full shifting of the taxes evaded (and of the illicit rebates) to consumers, there is a market distortion whose benefits concentrate only on some groups of consumers. In the countries of origin, transit or transformation of the goods, the situation is different. On the one side, in the countries of origin and transformation, the producers of the carousel-good might have a counterpart-benefit which may be tolerated by the governments if these benefits exceed the loss of revenue. For the transit country there is a net loss without any compensation for both the producers and the consumers. Thus, one may have countries suffering fiscal losses, countries (where the carousel ends) obtaining benefits for the consumers without fiscal losses, countries where there are fiscal losses and distorting effects against the local legal businesses without benefits for the final consumers, countries suffering fiscal losses and benefiting from lower prices without distorting effects on local business, and countries where there are fiscal losses, distorting effects on local business, and benefits for the consumers. Furthermore if we consider non-EU countries of origin of the

goods which are the object of the carousel, where the goods are produced legally and then exported to EU countries, where the carousel begins, we may also find countries with a net benefit from the increase of their exports without any loss of fiscal revenue. The increased controls on exports and imports in intra-community trade may contradict the abolition of the fiscal borders among the EU countries and, therefore, they may raise objections from the business community. Thus, the international fiscal cooperation aiming to combat carousel fraud may encounter conflicting interests among different countries, even within the EU.

Of course, if different criminal organizations simultaneously play a number of carousels, most of the countries involved might end up with a loss. But there are efficient and less efficient fiscal administrations and even if all the countries involved are willing to cooperate, this cooperation may not be successful. On the other hand, one of the effects of carousels on which the present paper has tried to throw light is an anomalous reduction of the final prices of the goods through which the game is performed. Therefore, one of the strategies that may derive from our analysis is to focus on anomalous consumer prices of goods. Obviously, not all kinds of goods are suitable to the carousel. These must be non perishable goods that can be easily hidden and transported. Preferably they should have high value, but they should also be goods of frequent trade, so that the request for a rebate may pass unobserved. Even in this way, the list of the goods that might be object of carousel fraud is enormous. However, once we also consider the list of goods sold at anomalous price, the range is reduced.

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Appendix

We report the equilibrium solutions for the carousel when the direct tax base in case of disagreement between players is negative, which implies $t = 0$ in Equations (12), (15) and (19). Notice that a loss (negative tax base) in case of agreement of tax fraud is excluded by the individual rationality constraint, being the direct tax base inclusive of the (exogenous) gains from black transactions represented by λ_i.

The Nash bargaining equilibrium prices are the following

$$\hat{P}_2 = \frac{P_1(2\lambda_1 L + \pi tL - \pi FL - \pi D\vartheta_1 + \vartheta_1 L - \lambda_1 \pi tL - \pi\vartheta_1)}{2\pi(t+F)} \tag{22A}$$

$$\hat{P}_1 = \frac{P_0(2\lambda_o L + \pi tL - \pi FL - \pi D\vartheta_o + \pi tL - \pi FL - \pi t\lambda_o L)}{2\pi(\vartheta_1^{\,2} + t + F + \vartheta_1 t + \vartheta_1 + D\vartheta_1 + D\vartheta_1^{\,2} + F\vartheta_1)} \tag{23A}$$

As in the main text, they can be expressed in terms of P_0, under the assumption that $\vartheta_o = \vartheta_1 = \vartheta_2 = \vartheta_3 = \vartheta$ and that $\lambda_o = \lambda_1 = \lambda_2 = \lambda$. We obtain

$$\hat{P}_1 = \frac{P_0(2\lambda\ L + \pi tL - \pi FL - \pi D\vartheta + \pi\vartheta - \pi t\lambda L)}{2\pi(1+\vartheta)(t+F+\vartheta+D\vartheta)} \tag{24A}$$

$$\hat{P}_2 = \frac{P_0(2\lambda\ L + \pi tL - \pi FL - \pi D\vartheta + \pi\vartheta - \pi t\lambda L)(2\lambda L + \pi tL - \pi FL - \pi D\vartheta - \pi\vartheta - \lambda\pi tL + \vartheta L)}{4\pi^2(t+F)(1+\vartheta)(t+F+\vartheta+D\vartheta)} \tag{25A}$$

The reduced form equations for the expected payoffs from the Nash bargaining of each agent are now

Fraudster 1:

$$\overline{(\text{M1 - M1'})} = \frac{QP_0(2\lambda L + \pi\vartheta + \pi tL - \pi FL - \pi D\vartheta - \pi t\lambda L)}{2} \tag{26A}$$

Fraudster 2:

$$\overline{(\text{M2 - M2'})} = \overline{(\text{M1 - M1'})}\,\frac{(2\lambda L + \pi tL - \pi FL - \pi D\vartheta + \vartheta L - \pi t\lambda L - \pi\vartheta)}{2\pi(t+F+\vartheta+D\vartheta)(1+\vartheta)} \tag{27A}$$

Fraudster 3:

$$\overline{(\text{M3 - M3'})} = \overline{(\text{M2 - M2'})}\,\frac{(2\lambda L - \pi FL\Delta - \pi D\vartheta + \pi t\vartheta L\Delta - \pi D\vartheta L\Delta - \pi FL - \pi tL\Delta + \pi tL - \pi F\vartheta L\Delta - \pi t\lambda L - \pi D\vartheta^2 L\Delta - \pi\vartheta L\Delta + \pi\vartheta - \pi\vartheta^2 L\Delta)}{\pi(t+F)} \tag{28A}$$