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Silvia Fedeli e Francesco Forte

Models of Cross-Border VAT Fraud

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Silvia Fedeli and Francesco Forte

Abstract

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

Keywords: European Union Value Added Tax, income tax and VAT evasion, VAT carousel, Nash equilibrium fraud-chain
JEL Code: H24, H26

Universita' di Roma "La Sapienza"
Facolta' di Economia
Dipartimento di Economia Pubblica
Via del Castro Laurenziano, 9
00161 Roma – Italy
E-mail: silvia.fedeli@uniroma1.it
francesco.forte@uniroma1.it
Tel. and Fax +39 06 4976 6399

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1. Introduction

This paper explores the issue of the value added tax (VAT) evasion in the presence of international trade. The value added tax replaced the different forms of indirect taxation (most of which were *cascade* taxes or cumulative all-stage turnover taxes) applied in the European countries in the 1960s. The switch to VAT was required to neutralise the distorting effects of taxes levied on the full value of output at each stage of the productive process that made it impossible to determine the real tax wedge on the final price of the different goods, with the consequence, amongst others, of subsidising exports because of overestimates of the refundable taxes. The VAT, conceived as a value added tax of consumption-type based on the destination principle, appeared neutral for international trade: Exports may be exonerated from VAT for their full value by means of the rebates on the exporters' purchases and the exemption of their sales; imports can be taxed at the border on their full value, but the VAT paid is deductible from the VAT on sales due in the domestic market. The fact that this method can accommodate multiple VAT rates made the VAT system attractive for European countries at the time of the VAT introduction. The widely recognised self enforcing property of the VAT system (e.g., buyers of intermediate goods and services have opposing interests to the sellers) reduces the scope for tax evasion: in principle, the advocates of VAT suggest that the VAT system gives each trader the incentive to ensure that his suppliers have properly paid VAT in order that the former can claim the proper credits. To this respect, Cnossen (1990) recognises VAT as the probably best tax ever invented for raising tax revenue (see also Cnossen, 1994, 1998, 2001).

For all these reasons, with few exceptions,[1] the behaviour of the firms as tax evaders has been mostly studied out of the VAT system. 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. The firms are left in the background, in spite of their important role in the black labour market and also in tax evasion activities related to indirect taxes for which they act as tax collectors for the government.[2] Nevertheless, since the '80s Hemming and Kay (1981) have stressed on the illusory notion of self enforcement of VAT and more recently Keen (2007) gives an overall description of the main types of VAT frauds, evasions and elusions. Indeed, the VAT frauds appear to be an important and, likely, 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

[1] Fedeli and Forte (1999) and Fedeli (2003) studied into a chain framework the issue of VAT and income tax evasion by business traders.

[2] 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.

[3] International VAT Association (2007), quoted in European Court of Auditors (2008).

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 euro.[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”.

Keen (2007) gives also an overall description of the remedies to frauds devised at the European and national levels, discussed in the literature. However, the literature does not offer theoretical models of these frauds and of their economic effects. As shown in Fedeli Forte (1999) and Fedeli (2003) VAT frauds differ from the income tax and business tax frauds both because, as the frauds of other indirect taxes, they imply a bilateral game and because given the nature of VAT - as a multistage tax on value added - the fraud is spread over the chain of transactions in connection with other fraud games. This paper develops a theoretical model to explore VAT evasion games in presence of international transactions and their effects on international trade and domestic markets.

In the presence of international trade, the frauds might occur according to different modalities: in a “single operation” of fictitious export-import, which unduly benefit of VAT rebate or/and through 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. The importer sells the good to an exporter with VAT added, does not remit the VAT to tax authority and then disappears as “missing trader”. The tax authority of the destination country looses the VAT revenue even in case of discovery of the fraud because the exporter is lawfully entitled to the VAT rebate, unless it can be probed that he was aware of the fraud. A more sophisticated variant of VAT cross-border fraud, known as “carousel”, consists in non-ending the forgery at the domestic stage of the country of import, but in continuing it into another EU country. Possibly the scan is repeated several times with the goods being exported and imported through a complex criminal network up to the final sale. In this paper we formalize these two main types of VAT fraud.

From a theoretical point of view, in a previous paper, Fedeli and Forte (1999) showed that VAT and income tax evasion is profitable for firms in the presence of forward increasing amounts of black transaction along the domestic chain going from the first producer to the final consumers. Whether this amount was depending on the increasing amount of market share of the firms involved or on the increased added value of the traded goods, in that context, was not discussed. Here, taking as given the amount of goods object of black transaction we look at gains from tax evasion for the firms involved in the black chain as a consequence of the VAT mechanism in the presence of international

[4] HM Revenue & Customs (2006), quoted in European Court of Auditors (2008).

[5] *Monatsbericht des BMF* (2006), quoted in European Court of Auditors (2008).

trade. Two aspects are of some interests here. The first is related to the rule for sharing the gains from tax evasion between fraudsters: this case is of main interest in the presence of the simplest tax fraud. The second is related to the capture of a market share for which the firms organize themselves into a carousel to exploit the system of VAT rebates in the presence of international trade. To this respect the firms organised in an international network bargain their own prices along the chain in order to maximize their joint advantages from tax evasion. We show that tax evasion can serve as a type of government subsidy to firms, which, other than allowing gains from tax evasion to the firms, allows the customers the access to the goods.

In section 2, we describe the main types of VAT frauds originating from international trade[6] and formalise the collusive games into a model capturing the different types of VAT frauds. We begin with the simplest fraud, where two business traders share the advantages of VAT evasion (section 2.1). In section 2.2 we assess the effects on the prices of the good exchanged and on the earnings of fraudsters participating to the complex type of VAT frauds known as carousel also involving income tax evasion. Conclusions follow in section 3.

2. The theoretical framework

In this section, we model, first, the simplest fraud for which two business traders share the gain from VAT evasion. We, second, model the "carousel" over 3 countries to see its effects on the price of the exchanged good as well as on the earnings for fraudsters. In either 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 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,[7] which means that exports are tax-free and the exporter obtains the 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 into the same country the reported value added is taxed and each trader is expected to pay his supplier the VAT due on the reported purchases, with the importer self invoicing his purchases and paying the due amount to his

[6] An overall description of the main types of VAT frauds, evasions and elusions in Keen (2007).

[7] The imports not directly sold to consumer are taxed as domestic goods when they cross the border with a mechanism of self invoicing by part of the importer.

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 tax authority the difference between VAT collected on sales and 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).

For a quantity Q of the goods, henceforth *Q-goods*, taken as given:[8]

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

ϑ_i, i=0,1,..3, are the average VAT rates on exchanges;

D>1 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, which might be inclusive of social security contributions;

F>1 is the fine for income tax evasion to be applied to the evaded income tax base;

In the carousel of section 2.2., we assume that each trader's unit production costs are obtained by the product of L time the purchasing prices of the goods: L>1 is a coefficient to be multiplied to the unit purchasing costs to get the production cost, inclusive labour, for each unit of good exchanged.

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

2.1. The simplest VAT fraud (frode semplice_OK2.MWS)

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 a domestic trader (likely 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 (or, if a domestic trader, he can resell the good in the domestic market in which case as a purchaser from the importer is entitled to deduct the VAT paid on his purchases) 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 *Q-goods* exchanged (e.g., imported and traded), 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.

[8] The assumption that the quantity Q is given implies that all transaction can be absorbed by the (black) market. An extention of the model allowing for endogenous Q is the object of a different paper.

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. Recall that the importer sells *Q-goods* to the exporter. The former draws invoices charging VAT, 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 $D\vartheta_1 P_1$. 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).

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

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.

$$I' = 0 \tag{2}$$

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

$$I - I' = Q\vartheta_1 P_1(\alpha - \pi D) \tag{3}$$

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

$$E = (1-\pi)Q\left[P_2 + (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1)\right] + \pi\, Q\left[P_2 + (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1) - D\vartheta_1 P_1\right] \tag{4}$$

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

$$E' = Q\left[P_2 - (1-\alpha)\vartheta_1 P_1 - P_1 - t(P_2 - P_1)\right] \tag{5}$$

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

$$(E - E') = QP_1\vartheta_1\left[2(1-\alpha) - \pi D\right] \tag{6}$$

and the individual rationality constraint requires $(E - E')$>0, that is the exporter share of twice the rebate is higher than the expected fine. Notice the asymmetry of the individual rationality constraints for the two players that depends on 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.
The importer and the exporter choose α that maximises the product of their expected payoffs (3) and (6) that is

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

$$\hat{\alpha} = \frac{2 + \pi D}{4} \tag{8}$$

and second order conditions require $-4Q^2\vartheta^2 P_1^2 < 0$ and, in the simplest version of the missing trader model 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 $\vartheta_1 = 20\%$, $P_1 = 100$, $\pi = 0.01$, $D = 20$, $F = 20$ and t=0.35, $\alpha = 0.55$ and the expected gains for the importer are 3.5Q, whereas for the exporter are 7Q.

Now we consider the policy implications of the above model to limit VAT frauds. Unless 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, "credible" expected penalty higher than unit 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 (8) into equations (3) and (6),

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

$$\tilde{E} = \frac{1}{2} Q \vartheta_1 P_1 (2 - 3\pi D) \qquad \text{(6 bis),}$$

it turns out that both (3bis) and (6bis) 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 is 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 terms of VAT revenue loss in that there is not only a missed revenue, but a real disbursement by part of the tax authority equal to the amount of the rebate. This implies a VAT revenue loss twice than that by standard VAT evasion (e.g., VAT evasion plus government disbursement for the rebate equal to the missed VAT revenue). This mechanism can work as a type of subsidy for given goods, for this reason, when modelling the carousel in the next section we shall look at its effects on the prices of the exchanged goods.

2.2. The carousel of VAT fraud (carosello_bis_formule.MWS)

We now model the carousel as a chain of bargaining between each couple of fraudsters along a chain of exchange assuming that these traders bargain the unit price of the considered Q-good.[9] Following the purpose of the present paper and unlike Fedeli and Forte (1999) and Fedeli (2003), here we concentrate on the effects on prices of the exchanged goods, restricting the case to complete information and considering a finite number of exchanges. Only at the last stage of the chain, we shall assume that the price is not bargained with the purchasers, but it is equal to the unit production cost plus a given unit margin. As Fedeli and Forte (1999), here the black traders lead the chain of black transactions, which originate at the border (see below). The bargaining equilibrium prices and earnings of all the agent are consequently affected, as depicted in Figures 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

[9] For the basic analysis of the chain of Nash bargain see Basu et al. (1991).

part of fraudster 1, 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 Treasury 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 the missed revenues from VAT due by fraudster 1 plus country B's disbursement of the equal amount of VAT rebate to fraudster 2. At the subsequent stage 2, fraudster 2 sells the *Q-goods* to fraudster 3 in country C of the EU. 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.[10] 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 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.

[10] Notice, however, that between fraudster 1 and frauster 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.

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

BORDER BETWEEN COUNTRY A AND COUNTRY B

FRAUDSTER 1

STAGE 1:

Fraudster 1 is assumed to be an importer of country B purchasing tax-free *Q-goods* in country A. Fraudster 1 is assumed to sell all the *Q-goods* in country B to fraudster 2 who purchases the good with VAT charged. Fraudster 1 charges VAT without paying it to the Treasury nor self-invoicing his purchases. Fraudster 2 is supposed to exports the same good to country C, thus, obtaining the rebate of the VAT paid against a presumed regular invoice.
The unit price of the Q good is the object of the bargaining between the two fraudsters (1 and 2).

FRAUDSTER 2

BORDER BETWEEN COUNTRY B AND COUNTRY C

STAGE 2:

Fraudster 2 exports all the *Q-goods* from country B to country C, gets the VAT rebate and sells the tax-free goods to fraudster 3.
Fraudster 2 and fraudster 3 bargain the unit price of the good. Fraudster 3 is assumed to be the last trader of the carousel. He sells the good in the market of country C on the basis of the price bargained with fraudster 2 plus a unit margin and with (presumed) regular invoice to other traders. He does not self-invoice his imports, nor remit the Treasury the VAT charged on the invoice. The goods then either enter the "regular" market chain in country C or enter the black chain of country C or are available for another round of the carousel with subsequent export and VAT rebate. New traders purchasing the goods after this stage might also be not aware of the carousel.

FRAUDSTER 3

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.

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.

3.1.1. The Payoffs of the Players

We indicate by Q the quantity of goods imported and traded in the black chain (i.e., the *Q-goods*). The carousel begins at a border where an importer from country A (fraudster 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 *Q-goods* 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.

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

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

$$\left. - \underbrace{D(\vartheta_0 P_0 + (1+\vartheta_1)\vartheta_1 P_1)}_{\textit{fine} \text{ for VAT evasion}} - \underbrace{F((1+\vartheta_1)P_1 + LP_o)}_{\text{fine for direct tax evasion}}\right]$$

where $\lambda_o P_o$ 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, as well as 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 fraudster 1 is

$$M1' = Q\left[\underbrace{(1+\vartheta_1)P_1}_{unit\ sale\ price} - \underbrace{LP_o}_{production\ \cos t} - \underbrace{\lambda_o P_o L}_{lost\ gain\ from\ black\ transaction} - \underbrace{t((1+\vartheta_1)P_1 - LP_o)}_{\text{direct tax}}\right] \qquad (2)$$

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 (2))[11] 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 fraudster 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 1.

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

(M1-M1') (3)

and his individual rationality constraint requires that *(M1-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

$$M2 = \underbrace{(1-\pi)}_{\substack{probability\ \text{of} \\ \text{not being controlled} \\ \text{by tax authority}}} Q\underbrace{\left[P_2 + \lambda_1 P_1 L - LP_1\right]}_{\substack{\text{unit gain from black} \\ \text{transactions}}} + \qquad (4)$$

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

[11] This seems to be a standard practice to persuade the purchaser to comply in tax evasion: if the purchaser does not want to accept tax evasion, the price charged is increased of a margin which is often equal to the VAT rate. This is not in contrast with the "missing" traders' behaviour of disappearing after the transaction, which simply consists 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 reveal to tax authority the real person behind the fraud.

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 payoff if he does not enter the chain of black transaction is

$$M2' = Q\left[\underbrace{P_2 - (1+\vartheta_1)LP_1}_{(unit)\ revenues\ net\ of\ production\ costs} - \underbrace{t(P_2 - (1+\vartheta_1)LP_1)}_{\text{direct tax}} - \underbrace{\lambda_1 P_1 L}_{lost\ black\ gains}\right] \tag{5}$$

where the purchasing cost of fraudster 2 are higher than when he complies with fraudster 1 on tax evasion, [12] 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 (4) and (5) that is

$$(M2 - M2') \tag{6}$$

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

At stage 1, fraudster 1 and fraudster 2 choose the price P1 that maximises the product of their expected payoffs (3) and (6) that is

$$\underset{P_1}{Max}(M1 - M1')(M2 - M2') \tag{7}$$

By analogous reasoning, at stage 2, fraudster 2 bargains the price with fraudster 3. Fraudster 2 expected payoff is still given by equation (6). 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 he 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 $\Delta > 0$.[13] 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

[12] See previous footnote.

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

$$M3 = \underbrace{(1-\pi)}_{\substack{\textit{probability}\text{ of} \\ \text{not being controlled} \\ \text{by tax authority}}} Q\big[\underbrace{(1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - P_2 L}_{\text{unit gain from black transactions}}\big] +$$

$$+ \underbrace{\pi}_{\substack{\textit{probability}\text{ of} \\ \text{being controlled} \\ \text{by tax aquthority}}} Q\Bigg[\underbrace{(1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - P_2 L}_{\text{unit gain from black transactions}} - \underbrace{t((1+\vartheta_3)P_2L\Delta + \lambda_2 P_2 L - LP_2)}_{\text{direct tax due}} - \underbrace{F((1+\vartheta_3)P_2L\Delta + P_2 L)}_{\text{fine for direct tax evasion}} + \tag{8}$$

$$- \underbrace{D(\vartheta_3(1+\vartheta_3)P_2L\Delta + \vartheta_2 P_2)}_{\text{fine for VAT evasion}} - \underbrace{(\vartheta_3(1+\vartheta_3)P_2L\Delta - \vartheta_2 P_2)}_{\text{VAT due}}\Bigg]$$

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

$$M3' = Q[(1+\vartheta_3)P_2L\Delta - \lambda_2 P_2 L - P_2 L - t((1+\vartheta_3)P_2L\Delta - P_2 L)] \tag{9}$$

The Nash bargaining expected payoff of fraudster 3 is given by the difference of (8) and (9) that is

$$(M3 - M3') \tag{10}$$

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

$$\underset{P_2}{Max}(M2 - M2')(M3 - M3') \tag{11}$$

3.1.2. The Nash bargaining equilibrium prices and frausters' payoffs

We now solve the game by backward induction beginning by stage 2.[14] By differentiating (11) with respect to P_2[15] and solving for P_2

$$\hat{P}_2 = \frac{P_1(2\lambda_1 L + \pi t L - \pi F L - \pi D\vartheta_1 + \vartheta_1 L - \vartheta_1 L t - tL - \lambda_1 \pi t L - \pi\vartheta_1)}{2(\pi t + \pi F - t)} \tag{12}$$

By substituting back (12) into (7) and maximising with respect to P_1 we get[16]

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[14] In appendix 1 we report the equilibrium solutions when the direct tax base in case of disagreement between players is negative, which implies t=0 in equation (2), (5) and (9). Notice that a loss (negative tax base) in case of agreement of tax fraud is excluded by the individual rationality contraint, being the direct tax base inclusive of the (exogenous) gains from black transactions represented by λ_i .

[15] With S.O.C. for a maximum at stage 2 requiring:
$(\pi FL + \pi D\vartheta_2 - 2\lambda_2 L - \vartheta_3 L\Delta t + \pi D\vartheta_3^2 L\Delta + \pi FL\Delta + \pi tL\Delta - \pi tL - tL\Delta + Lt - \pi\vartheta_2 + \pi\vartheta_3 L\Delta + \pi F\vartheta_3 L\Delta + \pi t\vartheta_3 L\Delta + \pi t\lambda_2 L + \pi D\vartheta_3 L\Delta + \pi\vartheta_3^2 L\Delta)(\pi t + \pi F - t) < 0$.

[16] With S.O.C. for a maximum at stage 1 requiring:
$(\pi t + \pi F + \pi D\vartheta_1 - t + \pi\vartheta_1)$ $(\pi FL + \pi D\vartheta_1 + tL - 2\lambda_1 L - L\vartheta_1 + tL\vartheta_1 - \pi tL + \pi t\lambda_1 L + \pi\vartheta_1)$ <0.

$$\hat{P}_1 = \frac{P_0(2\lambda_o L + \pi t L - \pi F L - \pi D \vartheta_o - tL + \pi \vartheta_o - \pi t \lambda_o L)}{2(1+\vartheta_1)(\pi t + \pi F - t + \pi D \vartheta_1 + \pi \vartheta_1)} \qquad (13)$$

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

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

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

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

FRAUDSTER 1 : $\qquad \breve{(\overline{\text{M1 - M1'}})} = \frac{Q P_0(2\lambda L + \pi \vartheta + \pi t L - \pi F L - \pi D \vartheta - tL - \pi t \lambda L)}{2}$

FRAUDSTER 2: $\qquad \breve{(\overline{\text{M2 - M2'}})} = \breve{(\overline{\text{M1 - M1'}})} \frac{(2\lambda L + \pi t L - \pi F L - \pi D \vartheta + \vartheta L - \vartheta L t - tL - \pi t \lambda L - \pi \vartheta)}{2(\pi t + \pi F + \pi \vartheta\ + \pi D \vartheta\ - t)(1+\vartheta)}$

FRAUDSTER 3:

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

The model allows for more than one solution, depending on the parameters affecting the direct tax base.[17] 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 the initial unit price is $P_o = 100$ and that $\lambda = 0.6,\ \ \pi = 0.02,\ \ D = 20,\ \ L = 2.5,\ \ \Delta = 0.8$ and $F = 20$.

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 (kept 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 their underground economic activity allows them to broaden the activity in both the illegal and the legal market. Underground economic activities may imply costs' reduction because labour contracts, environment, safety and health regulations are not respected. On the other

[17] See appendix 1.

hand, lower prices of the good, 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.

Notice further that we have kept a low probability of tax control joint with high fees for both direct and indirect tax evasion, which seems to be the actual case in Europe. 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 is not relevant the case of different VAT rates along the chain (see below). 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, unexpectedly, for fraudster 3, who buys in the third country rather than for fraudster 2, who gets the unlawful reimbursement from the tax authority. The lowest considered (10%) VAT rate 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 gains unless fraudster 2 is successful in his previous game. On the other hand, as expected, fraudster 1, the importer in country B, gets a benefit generally much smaller than the others. He cannot get his illicit gain unless finds a fraudster 2 willing to collude with him. Thus, a key of successful anti fraud strategy for the carousel has to focus on fraudsters' incentives to enter in the VAT fraud game.

Table 1. Examples for the carousel when $\lambda = 0.6$

	Market sales prices = production costs	**Market sales prices = production costs plus 20% VAT**	**Market sales prices = production costs plus 10% VAT**	**Equilibrium price from the model including the VAT margin, if any, of 20% and t=30%**	**Equilibrium unit gains for fraudsters for t=30% and VAT=20%**	**Equilibrium price from the model including the VAT margin, if any, of 10% and t=30%**	**Equilibrium unit gains for fraudsters for t=30% and VAT=10%**	**Equilibrium price from the model including the VAT margin, if any, of 20% and t=35**	**Equilibrium unit gains for fraudsters for t=35% and VAT=20%**	**Equilibrium price from the model including the VAT margin, if any, of 10% and t=35**	**Equilibrium unit gains for fraudsters for t=35% and VAT=10%**	**Equilibrium price from the model including the VAT margin, if any, of 20% and t=40**	**Equilibrium unit gains for fraudsters for t=40% and VAT=20 %**	**Equilibrium price from the model including the VAT margin, if any, of 10% and t=40**	**Equilibrium unit gains for fraudsters for t=40% and VAT=10%**
	100	**120**	**110**	**100**		**100**		**100**		**100**		**100**		**100**	
Fraudster 1	**250**	**300**	**275**	**196.94**	**96.5**	**219.64**	**98.4**	**196.63**	**96.55**	**219.27**	**98.45**	**196.341**	**96.6**	**218.89**	**98.5**
Fraudster 2	**625**	**750**	**687.5**	**489.51**	**198.74**	**544.43**	**221.04**	**487.77**	**198.52**	**542.41**	**220.76**	**486.04**	**198.3**	**540.39**	**220.48**
Fraudster 3	**1562.5**	**1875**	**1718.75**	**1174.84**	**369.1**	**1197.76**	**534.85**	**1170.66**	**367.1**	**1193.29**	**532.21**	**1166.5**	**365.11**	**1188.87**	**529.59**

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 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 (see below), 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.

3. Conclusion

The purpose of this paper has been to study the effects of the VAT frauds arising in the European Union from the intra community trade, which, in turn, are a subset of the VAT frauds in the international trade. Inside the EU, after the abolition of the controls at borders among the member states and the creation of the "unique European market", the VAT frauds present peculiar problems, mainly a distortion of the competition that the abolition of the intra community borders wanted to avoid.

We have considered, first, the "simplest fraud" according to which an importer buys (or feigns to buy) a tax free good abroad sells the good to a domestic trader (likely an exporter) with VAT added, does not remit the VAT to tax authority and then disappears as "missing trader". The missing trader (importer) generates invoices with the only purpose of allowing his purchaser (exporter) to get the rebate for the VAT paid. We have modelled the sharing of the rebate between the two traders. The peculiarity of the game is that the evasion determined is of the worst type in terms of VAT revenue loss for the countries involved. There is, in facts, not only a missed VAT revenue, but a real disbursement by part of the tax authority of the country equal to the amount of the rebate. This implies an overall VAT revenue loss twice than that by standard VAT evasion (e.g., VAT evasion plus government disbursement for the rebate equal to the missed VAT revenue). This is not the only negative consequence. If the gain of the fraud is employed to reduce the price below the market price to gain market shares, there is a distortion of the competition, whose size depends from the amount of the aggregate loss of the Treasury. In this context, in this the fraud allowed by the VAT mechanism works as a type of government subsidy for goods object of frauds. For this reason, when modelling the more complex type of fraud, known as carousel (e.g., a repeated forgery of VAT rebates and tax evasions over EU countries), we have considered its effects on the prices of the exchanged goods to measure the possible size of the distortion of competition. We have shown, by stylized cases that the amount of market distortion caused by the reduced prices may be quite relevant, with their size depending on the amount of multiple illicit rebates and on the amount of VAT and direct taxes evaded

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Appendix 1

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 equation (2), (5) and (9). 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

$$\hat{P}_2 = \frac{P_1(2\lambda_1 L + \pi t L - \pi F L - \pi D \vartheta_1 + \vartheta_1 L - \lambda_1 \pi t L - \pi \vartheta_1)}{2\pi(t+F)} \qquad (12A)$$

$$\hat{P}_1 = \frac{P_0(2\lambda_o L + \pi t L - \pi F L - \pi D \vartheta_o + \pi t L - \pi F L - \pi t \lambda_o L)}{2\pi(\vartheta_1{}^2 + t + F + \vartheta_1 t + \vartheta_1 + D\vartheta_1 + D\vartheta_1{}^2 + F\vartheta_1)} \qquad (13A)$$

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

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

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

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

FRAUDSTER 1 :

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

FRAUDSTER 2:

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

FRAUDSTER 3:

$$\overline{(\text{M3 - M3'})} =$$

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

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