# The Nominal Exchange Rate Implication of VAT Harmonization in EEC

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September 1995

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June 1996

**Abstract:** This paper examines, in a one-good two-country Cournot competition model, the implication of European VAT reform on the nominal exchange rate parities which will be pegged in the third stage of monetary union. As result of the reform, the deutchmark needs to be reevaluated so as to prevent generating systematic external disequilibrium of some other European countries, which is inconsistent with pegging nominal exchange parities of European currencies.

JEL Classification N°: F31
Key words: nominal exchange rate parities, value-added-tax reform, monetary union

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# I Introduction

Same good can be taxed in different countries at very different value-added-tax (VAT) rates. In the countries of the European Economic Community (EEC), we have observed large diversity in the VAT rates and significant changes have been made. Further modification of them is waited in the near future. As we can see from the table 1, actual European normal rates vary from 15% to 25%.

In France, normal rate came down from 23% (surcharged rate being 33.33%) in 1970's to 18,6% actually. French government is now planning to increase it to 20%. Italian reduced rates 9% and 13% have been respectively increased to 10% and 16% in March 1995. The government of United-Kingdom has introduced in January 1995 a VAT of 8% instead of 0% for energy products.

The European Commission is preparing a reform which will harmonize the VAT in EEC countries. As result of this coming reform, new rates will be between 15% and 20%.

The implication of VAT reform for the EMU is very important. In the third stage of transition to European unique money, it is required, according to some proposition, to peg nominal exchange rates of member countries to some fixed official parities. Our beginning point is that the VAT reform may be inconsistent with the exigency of the Maastricht treaty which requires stability of nominal exchange parities, convergence of inflation rates and satisfaction of other criteria by member countries during this third stage.

For the purpose of our study, we use a monetary extension (Dai, 1995) of the Cournot competition model proposed by Brander and Krugman (1983). Our objective is to give out clearly VAT reform incidences on nominal exchange rates. For not to complicate the issue, this one-good-two-country model is suitable. Of course, the nominal exchange rates are influenced by many factors. It may in particular be influenced by irrational speculation, changes of real exchange terms induced by these in the taste of consumers and the adopted technology package in each country, and structural adjustment of tradable and non-tradable sectors.

We demonstrate clearly the European VAT reform will change significantly the nominal exchange rates, i.e. the VAT reform is not neutral for the process of the European Monetary Union. Further implication for the purchasing power parity (PPP) literature is that we might test econometrically the influence of the VAT reforms in the past periods over the nominal exchange rates. Certainly, it will not explain totally the empirical deviation of the nominal exchange rates from its PPP rates[1], but it may be an important explication.

| Countries | Reduced rates (%) | Normal rates (%) |
|---|---|---|
| Austria | 10/12 | 20 |
| Belgium | 1/6/12 | 20.5 |
| Denmark | -- | 25 |
| Finland | 6/12 | 22 |
| France | 2.1/5.5 | 18.6 |
| Germany | 7 | 15 |
| Greece | 4/8 | 18 |
| Ireland | 2.5/12.5 | 21 |
| Italy | 4/10/16 | 19 |
| Luxembourg | 3/6 | 15 |
| Netherlands | 6 | 17.5 |
| Portugal | 5 | 17 |
| Spain | 4/7 | 16 |
| Sweden | 12/21 | 25 |
| United-Kingdom | 8 | 17.5 |

Table 1. The VAT rates in EEC (March 1995)
*Source: Investir N°1115, Paris*

## II. The Model

Let us assume there are two qualitatively identical countries, one ‘‘domestic’’ and one ‘‘foreign’’ and each country has one representative household and one firm producing the same good as does its foreign rival. The government of each country spends its revenues (which may come from different kinds of taxes or emission of money) only on the national

[1] See Dornbusch (1987a) for a survey of theoretical and empirical issues about PPP. For a recent survey of empirical studies on long-run relation between real exchange terms and PPP, see Froot and Rogoff (1994).

market. The money is only held by national residents in each country, so there is no problem of competition between good and bad currencies.

### *A. The Problem of Household*

It is assumed that the domestic representative household has the following preference function[2]:

$$C^c \left[ \frac{M}{P} \right]^{1-c}, \tag{1}$$

where *C, M, P, c* represent respectively the real consumption, the nominal quantity of money to be held by the household for future transactions, the price level of the unique good on the domestic market and a constant parameter.

The household supplies a fixed quantity of labor, noted $\overline{N}$, which is the only factor of production. The household's budget constraint is:

$$PC + M \leq WN + \Pi + M_{-1} - T, \tag{2}$$

where $W, N, \Pi, M_{-1}, T$ are respectively the rigid nominal wage[3], the level of employment for $N \leq \overline{N}$, the nominal profits, the initial nominal money balances and the lump-sum tax levied by the government[4].

In assuming that the household optimizes its utility function given out in (1) under the constraint (2), we can get the following demand functions:

$$M = (1-c)(WN + \Pi + M_{-1} - T), \tag{3}$$

$$PC = c(WN + \Pi + M_{-1} - T). \tag{4}$$

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[2] An interesting extension may be to adopt, rather than this Cobb-Douglas utility function, a more general utility function.

[3] We do not give explicitly the reason of rigidity of the nominal wage. One can refer to Stiglitz (1986) for a discussion. In their two-country model, Fender and Yip (1994) based the nominal rigidity of wage on the nominal unemployment benefit rigidity.

[4] The government finances its spendings with lump-sum taxes and VAT.

As the supply of money is perfectly controlled by the central bank under the floating exchange rate regime, by the equation (3) and the equilibrium condition on the domestic money market, the nominal revenue of the household during the current period is given by:

$$WN + \Pi + M_{-1} - T = \frac{M}{1-c}, \tag{5}$$

which is considered, by the domestic and foreign firms, as given.

Using the asterisks to denote the foreign corresponding variables[5] and assuming that the foreign household has identical preference function and behavior, we can obtain:

$$M^* = (1-c^*)(W^* N^* + \Pi^* + M_{-1}^* - T^*), \tag{6}$$

$$P^* C^* = c^* (W^* N^* + \Pi^* + M_{-1}^* - T^*). \tag{7}$$

The equilibrium condition on the foreign money market implies that the foreign nominal revenue is given by

$$W^* N^* + \Pi^* + M_{-1}^* - T^* = \frac{M^*}{1-c^*}, \tag{8}$$

which is considered similarly to be given for the firms.

### *B. The Firm's Behavior*

To simplify the model, we do not introduce transport costs incurred in exporting goods from one country to the other, and we assume that there is neither trade barriers to international trade nor constraints of full employment or other economic and policy constraints. The basic idea is that each firm regards the other country as a separate market. Consequently, it chooses the profit-maximizing quantity for each country separately. In considering that the other firm will hold fixed the quantity of its output sold in both countries, each firm has then a Cournot perception.

[5] In the following, the asterisks generally denote corresponding variables associated with the foreign country.

The domestic firm will sell a quantity $x$ at price $P$ on the domestic market and a quantity $x^*$ at price $P^*$on the foreign market. The foreign firm will sell a quantity $y$ at price $P$ on the domestic market and a quantity $y^*$ at price $P^*$on the foreign market. They have respectively an increasing return technology of production of the type:[6]

$$x + x^* = N - \underline{N},$$

$$y + y^* = N^* - \underline{N}^*,$$

with respectively a minimum of labor $\underline{N}$, $\underline{N}^*$necessary in beginning the period production in each country. We assume in this paper, that there is no free entry and exit[7]. The fact that the domestic firm is totally owned by the domestic residents, and the absence of non-monetary assets imply that there is no problem of international investment in pursuing higher profits.

The value-added tax rate is respectively $\theta$ , $\theta^*$ on the domestic and foreign markets. The domestic and foreign firms maximize respectively their nominal profit function[8] measured respectively in domestic and foreign currency:

$$\Pi = P(1-\theta)x + EP^*(1-\theta^*)x^* - W(x + x^* + \underline{N}), \tag{9}$$

$$\Pi^* = \frac{P(1-\theta)y}{E} + P^*(1-\theta^*)y^* - W^*(y + y^* + \underline{N}^*). \tag{10}$$

where $E$ is the nominal exchange rate of foreign currency in terms of domestic currency. It is given for firms[9]. Given the domestic government nominal spending *G*, the domestic central bank supply of money, and the quantity of good sold by the foreign firm, *y*, the domestic firm will perceive the following objective demand curve on the domestic market:

$$P = \frac{G + c(WN + \Pi + M_{-1} - T)}{x + y}, \tag{11}$$

[6] This assumption is introduced to justify the Cournot competition.
[7] We can introduce the free entry and exit as Huw D. Dixon does (1994). But the main conclusion will not be very different.
[8] The nominal profits maximization is adopted by d'Apremont , Dos Santos and Gérard-Varet (1989), Dixon (1994) and other authors. It may be justified by the presence of exogeneously given nominal variables such as wage, public spending and lump-sum tax etc..
[9] This assumption is necessary for the existence of international trade in this model with only two firms. Otherwise, a model with n firms is needed as firms' quantity and price behaviors become functions of nominal exchange rate. See, Dornbusch, 1987b.

taking into account (5), it can be written as:

$$P = \frac{\Omega}{x+y}, \qquad \text{with} \quad P_y^{'} = P_x^{'} = -\frac{\Omega}{(x+y)^2}, \; \Omega = G + \frac{cM}{1-c}. \qquad (12)$$

Similarly, the objective demand for its product on the foreign market can be written as:

$$P^* = \frac{\Omega^*}{x^*+y^*}, \quad \text{with } P_{y^*}^{*'} = P_{x^*}^{*'} = -\frac{\Omega^*}{(x^*+y^*)^2}, \; \Omega^* = G^* + \frac{c^* M^*}{1-c^*}. \qquad (13)$$

Each firm maximizes its nominal profits with respect to its own quantity decisions in assuming the quantity decisions of the other as given. This yields the following first-order conditions:

$$\Pi_x^{'} = P_x^{'}(1-\theta)x + P(1-\theta) - W = 0, \qquad (14)$$

$$\Pi_{x^*}^{'} = EP_{x^*}^{*'}(1-\theta^*)x^* + EP^*(1-\theta^*) - W = 0, \qquad (15)$$

$$\Pi_y^{*'} = \frac{P_y^{'}(1-\theta)y}{E} + \frac{P(1-\theta)}{E} - W^* = 0, \qquad (16)$$

$$\Pi_{y^*}^{*'} = P_{y^*}^{*'}(1-\theta^*)y^* + P^*(1-\theta^*) - W^* = 0. \qquad (17)$$

It is easy to verify that the second-order conditions of optimality are satisfied for the firms' problems.

## III. VAT Rates Reform and Nominal Exchange Rate Parity: Implication for European Monetary Union

We can complete the model with the balance of payment equation under the floating exchange rate regime. Under the assumption of no capital and labor movement, the balance of payments, identical to the trade balance, must be in equilibrium:

$$EP^*(1-\theta^*)x^* = P(1-\theta)y. \qquad (18)$$

In using the partial derivatives of prices in (12) and (13), and the trade balance equilibrium relation (18), form the first-order conditions, the reaction functions of the firms can be deduced as:

$$y - \frac{\alpha}{1-\theta}(x+y)^2 = 0, \tag{19}$$

$$yy^* - \frac{\alpha}{1-\theta}(x+y)(x^* + y^*)x^* = 0, \tag{20}$$

$$xx^* - \frac{\beta}{1-\theta^*}(x+y)(x^* + y^*)y = 0, \tag{21}$$

$$x^* - \frac{\beta}{1-\theta^*}(x^* + y^*)^2 = 0 \tag{22}$$

to simplify notations, we use $\alpha = \frac{W}{\Omega}, \beta = \frac{W^*}{\Omega^*}$.

The equations (12-18) constitute the complete model. Before we discuss the implication of the European VAT reform, we indicate that when the VAT rates are zero, the absolute purchasing power parity (PPP) is verified in the simple model with $\frac{EP^*}{P} = 1$. The nominal exchange rate is determined by the following formula[10]:

$$E = \frac{\sqrt{\Omega W}}{\sqrt{\Omega^* W^*}}. \tag{23}$$

From this formula, one can see easily that there is no one-to-one relation between the money growth rate, inflation rate and exchange rate variation. This is due to the presence of sticky wages and that public spending is fixed in nominal terms. Money is not neutral in this model, and fiscal policies can also influence exchange parity. However, the absolute and relative PPP is verified.

[10] See Appendix.

The model with value-added taxes has a unique non trivial solution satisfying the restrictions $0 < x^* < \frac{1-\theta^*}{\beta}$, $0 < y < \frac{1-\theta}{\alpha}$, $x > 0$, $y^* > 0$, and compatible with the firms' reaction functions and the trade balance equilibrium. As $x^* = y$, a modified absolute PPP is verified, i.e. $\frac{EP^*(1-\theta^*)}{P(1-\theta)} = \frac{y}{x^*} = 1.$ Or equivalently, we have

$$\frac{EP^*}{P} = \frac{1-\theta}{1-\theta^*}. \tag{24}$$

If the value-added tax rates are the same in the two countries, the absolute PPP is verified. If the value-added tax rates are unchanged, the relative PPP is expected to be true.

An intuitive explanation is that firms are interested in (taxes deduced) net prices measured in same currency. As there is no other constraint limiting arbitrage (entry barriers combining with macroeconomic asymmetry[11]), they will make the best quantity decisions so that the net prices in the same currency are equal in the two countries. In other word, each firm will try to exploit the higher price in one country until the law of one (net) price[12] is applied and no more profits can be earned in lowing price.

With VAT, the nominal exchange rate can be given as:

$$E = \frac{\sqrt{\Omega W(1-\theta)}}{\sqrt{\Omega^* W^*(1-\theta^*)}}. \tag{25}$$

From (25), if it is admitted that only the domestic VAT rate adjusts, the exchange rate will vary according to:

$$\frac{\Delta E}{E} \approx \frac{-1}{2(1-\theta)} \Delta\theta . \tag{26}$$

[11] The macroeconomic asymetry is refered to the different nominal wage/agregated nominal demand. Entry barriers can be import or export taxes and transport costs. See Dai (1995) for details.
[12] As this is one-good model, we can speak indifferently absolute PPP and law of one price.

In the case of Germany, the VAT rate is originally at 15%. If it is increased to 20%, the deutchmark will need a reevaluation of about 3% vis-à-vis the currency of another country whose VAT rate is already at 20%. Otherwise, the foreign country must devaluate its currency in order to prevent the resulting external disequilibrium which can incite speculative attacks. In the case of Sweden or Denmark, its VAT rate must be reduced to 20%, as the German VAT rate is increased to 20%, the reevaluation of deutchmark will be about two times as important as in the precedent case, i.e. approximately 6%.

The effort needed to manage pegged nominal exchange parity may be quite high in terms of welfare if VAT reform is taking place during the third stage of EMU. Its importance depends of course the macroeconomic policies used. As the European governments pursue an objective of inflation rate as required by the convergence criteria of Maastricht treaty, the costs may be much higher and quickly doubled. That is easy to see. Assume that domestic and foreign prices are unchanged, i.e. $P$ and $P^*$ are constants, from (24), we have:

$$\frac{\Delta E}{E} \approx \frac{-1}{(1-\theta)}\Delta\theta + \frac{1}{(1-\theta^*)}\Delta\theta^*, \tag{27}$$

The equilibrating reevaluation of deutchmark will be respectively 6% and 12% in the two cases considered above.

## IV Conclusion

A two-country macroeconomic monetary model with Cournot competition is used here in order to show the nominal exchange rate implication of the harmonization of VAT rates in EEC. The result is that major modification of VAT rates in EEC has important influence on exchange rate parities of European currencies. Policy implication is that the European VAT reform must be taken before or after the third stage of EMU, otherwise other macroeconomic policies are needed to defense the irrevocably pegged parities in the case where external disequilibrium is accentuated and speculative attacks are imminent as a consequence of the VAT reform. The costs of these macroeconomic policies may be very high, and they might provoke very strong public anti-Maastricht opinions in some EEC countries.

The above interpretation is meanwhile limited as the model is atemporal, without capital and international capital market, without non-traded goods, and the imperfect competition introduced is very simple. An extensive welfare analysis is needed in the case where VAT reform is taking place during the third stage of EMU and macroeconomic policies are taken to manage the pegged nominal exchange parities between currencies of EEC member countries. More theoretical and empirical works are necessary to understand the full implication of past and coming VAT reforms.

**Appendix: The Solution of the Model**

The reduced model is as follows:

$$y - \frac{\alpha}{1-\theta}(x+y)^2 = 0, \tag{A.1}$$

$$yy^* - \frac{\alpha}{1-\theta}(x+y)(x^* + y^*)x^* = 0, \tag{A.2}$$

$$xx^* - \frac{\beta}{1-\theta^*}(x+y)(x^* + y^*)y = 0, \tag{A.3}$$

$$x^* - \frac{\beta}{1-\theta^*}(x^* + y^*)^2 = 0, \tag{A.4}$$

$$EP^*(1-\theta^*)x^* = P(1-\theta)y. \tag{A.5}$$

Note $u = \frac{\alpha}{1-\theta}$, $v = \frac{\beta}{1-\theta^*}$, the manipulation of (A.1) and (A.2) gives the following equations:

$$x = \frac{\sqrt{y}}{\sqrt{u}} - y, \tag{A.6}$$

$$y^* = \frac{\sqrt{x^*}}{\sqrt{v}} - x^*. \tag{A.7}$$

In substituting (A.6) and (A.7) into (A.2) and (A.3), we can obtain:

$$y\left(\frac{\sqrt{x^*}}{\sqrt{v}}-x^*\right)-u\frac{\sqrt{y}}{\sqrt{u}}\frac{\sqrt{x^*}}{\sqrt{v}}x^*=0, \tag{A.8}$$

$$x^*\left(\frac{\sqrt{y}}{\sqrt{u}}-y\right)-v\frac{\sqrt{y}}{\sqrt{u}}\frac{\sqrt{x^*}}{\sqrt{v}}y=0. \tag{A.9}$$

we can get after simplification:

$$\sqrt{y}\left(\frac{1}{\sqrt{v}}-\sqrt{x^*}\right)-\frac{\sqrt{u}}{\sqrt{v}}x^*=0, \tag{A.10}$$

$$\sqrt{x^*}\left(\frac{1}{\sqrt{u}}-\sqrt{y}\right)-\frac{\sqrt{v}}{\sqrt{u}}y=0. \tag{A.11}$$

In using (A.10), it follows:

$$\sqrt{y}=\frac{\frac{\sqrt{u}}{\sqrt{v}}x^*}{\frac{1}{\sqrt{v}}-\sqrt{x^*}}. \tag{A.12}$$

In substituting it into the equation (A.11), we obtain:

$$\sqrt{x^*}\left(\frac{1}{\sqrt{u}}-\frac{\frac{\sqrt{u}}{\sqrt{v}}x^*}{\frac{1}{\sqrt{v}}-\sqrt{x^*}}\right)-\frac{\sqrt{v}}{\sqrt{u}}\left(\frac{\frac{\sqrt{u}}{\sqrt{v}}x^*}{\frac{1}{\sqrt{v}}-\sqrt{x^*}}\right)^2=0.$$

With the following transformations:

$$(1-\sqrt{v}\sqrt{x^*})^2-(1-\sqrt{v}\sqrt{x^*})ux^*-u\sqrt{v}\sqrt{x^*}x^*=0,$$

and,

$$1-2\sqrt{v}\sqrt{x^*}+vx^*-ux^*+ux^*\sqrt{v}\sqrt{x^*}-u\sqrt{v}\sqrt{x^*}x^*=0,$$

one gets:

$$(v-u)x^*-2\sqrt{v}\sqrt{x^*}+1=0,$$

which yields:

$$\sqrt{x^*} = \frac{2\sqrt{v} \pm \sqrt{4v - 4v + 4u}}{2(v-u)} = \frac{\sqrt{v} \pm \sqrt{u}}{v-u}$$

i.e.

$$x_1^* = \frac{(\sqrt{v}+\sqrt{u})^2}{(\sqrt{v}+\sqrt{u})^2(\sqrt{v}-\sqrt{u})^2} = \frac{1}{(\sqrt{v}-\sqrt{u})^2},$$

$$x_2^* = \frac{(\sqrt{v}-\sqrt{u})^2}{(\sqrt{v}+\sqrt{u})^2(\sqrt{v}-\sqrt{u})^2} = \frac{1}{(\sqrt{v}+\sqrt{u})^2},$$

Using (A.6), (A.7) and (A.12), we can check easily the only good solution is

$$x^* = y = \frac{1}{(\sqrt{u}+\sqrt{v})^2},$$

$$x = \frac{\sqrt{v}}{\sqrt{u}(\sqrt{u}+\sqrt{v})^2},$$

$$y^* = \frac{\sqrt{u}}{\sqrt{v}(\sqrt{u}+\sqrt{v})^2}.$$

The vector $(x, x^*, y, y^*) = (0,0,0,0)$ is also a solution of the model, but it is trivial compared to the reality of the world economy. In using equations (12-13) and (18), and the above results, the nominal exchange rate is given by:

$$E = \frac{\sqrt{\Omega W(1-\theta)}}{\sqrt{\Omega^* W^* (1-\theta^*)}}.$$

When the VAT rates are zero, i.e. $\theta = \theta^* = 0$, the non trivial solution is:

$$x^* = y = \frac{1}{(\sqrt{\alpha}+\sqrt{\beta})^2},$$

$$x = \frac{\sqrt{\beta}}{\sqrt{\alpha}(\sqrt{\alpha}+\sqrt{\beta})^2},$$

$$y^* = \frac{\sqrt{\alpha}}{\sqrt{\beta}(\sqrt{\alpha}+\sqrt{\beta})^2}.$$

The nominal exchange rate is given in this case by:

$$E = \frac{\sqrt{\Omega W}}{\sqrt{\Omega^* W^*}}.$$

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