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INTERNATIONAL TRADE IN MIDDLE PRODUCTS AND THE TRANSFER PROBLEM: A RICARDIAN APPROACH

Hugo Mena*

Abstract. This paper analyzes the effects of international lump-sum transfers within an undistorted two-country model, where consumables are nontraded goods, international trade takes place in intermediates, and technology is Ricardian. The factoral and commodity terms of trade must improve (deteriorate) for the donor (recipient). This secondary effect completely cancels out the primary effect, thereby making the transfer welfare neutral. Jones (1980) obtained an analogous neutrality outcome for a standard two-consumption-good, two-country-model of an exchange economy under the assumption of Leontief utility functions. The duality between these two type of models and neutrality outcomes is examined.

INTRODUCTION

Traditional normative analysis of international transfers in perfectly competitive markets has been conducted in the context of the "neoclassical paradigm": trade takes place in final goods, and technology exhibits smooth and continuous substitution among productive inputs. As is well-known, in this context, welfare effects of transfers depend crucially on each country's marginal propensities to consume traded goods.

This paper constructs an undistorted two-country model, where only nontraded goods are consumed and international trade takes place in "middle products" like Sanyal–Jones *Theory of International Trade in Middle Products* (1982). The nontraded consumption good of a country is produced by labor and the intermediate commodity produced by the other country. Each country's middle product is produced by labor alone. The model assumes a Ricardian production structure in that labor is the only primary factor, which is mobile across sectors, and technology is characterized by Leontief production functions.

The paper's main result is that a lump-sum transfer in this model always improves (deteriorates) the factoral and commodity terms of trade for the donor country (recipient). Such a secondary effect of the transfer is completely

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neutralized by the primary effect. Thus, the effect of transfer is welfare neutral. These results reconfirm Jones (1980), which obtained an analogous neutrality outcome within a pure exhange model in which trade was assumed to take place solely in final consumption goods and there was no substitution in consumption. The duality between these two type of models and neutrality outcomes is examined.

The paper is divided into six sections. Section A specifies the general theoretical framework. Section B presents the structural form of the two-country model. We next examine the determinants of the terms of trade (Section C) and the general equilibrium for the world economy (Section D). Section E analyzes the effects of a lump-sum transfer. The last section emphasizes the formal similarity between our set up and the standard two-consumption-good, two-country international trade model of an exchange economy, whenever preferences are represented by Leontief utility functions.

A. GENERAL FRAMEWORK

Suppose international trade occurs only in "middle products" or intermediate goods.[1] The world economy consists of only two countries: country A and country B. Each country produces two different commodities: a traded good and a nontraded good. Specifically, country A produces one "middle product" X and a final (nontraded) consumption good, Q_N^A. Labor is the only primary factor of production. It is regarded as a domestically mobile and homogeneous factor, and hence is used both in the production of X and in the production of Q_N^A, and the same wage rate prevails in both sectors. Using Sanyal–Jones terminology, the "input-tier" corresponds to the sector producing the traded good (X) and the "output-tier" corresponds to the sector producing the nontraded good (Q_N). Furthermore—and also in the spirit of Sanyal–Jones "middle product approach"—domestic production of exportables requires only labor as input, whereas the production of the final consumption good also requires an imported intermediate good, which we denote as M. Technology is represented by Leontief production functions. Full employment is assumed throughout and the competitive-profit conditions in each sector are binding.

The same scenario is assumed for country B. The final (nontraded) consumption good in country B is denoted by Q_N^B, and the intermediate imported commodity required for the production of this single final good in contry B is commodity X (country A's exported good).

One sector of the economy (the 'input-tier") is connected to the world market at the output level, whereas the other (the "output-tier") has its contact at the

[1] The empirical evidence shows that imports of consumption goods represent barely about 20% of total imports and 10% of private consumption. Intermediate goods represent more than a half of total commodity imports (about 60% on average). These are worldwide patterns with very low variability through time. The author can provide these information for a sample of 52 countries, upon request.

input stage. All consumption goods are nontradeables. Traded goods enter the countries' production functions, nontraded goods enter the utility functions. These are, essentially, the fundamental features of Sanyal–Jones "theory of trade in middle products", which we adopt here.

Our Ricardian set up involves the case in which both country A and country B are completely specialized: no domestic production of importables takes place.[2] Comparative advantage and the implied pattern of trade in this Ricardian set up is completely determined by the assumed technological differences between countries. In the current case, we can think of such (exogenous) technological differences as determining the specific bundle of "middle products" to be traded in the world market.

B. THE MODEL: STRUCTURAL FORM

For notational purposes, we use the superscript A to denote country A and the superscript B for country B. The price of nontraded goods is denoted by P, and L stands for labor input (fixed-supply). Furthermore:

a_{Lj} → amount of labor input required per unit of output j

a_i → amount of the imported intermediate input i required per unit of nontraded output

P_X → price of exportable (importable) for country A (country B)

P_M → price of importable (exportable) for country A (country B)

The following are the key equations of the model:

Country A | Country B

Production of Exportables

(1A) $$Q_X = \frac{1}{a_{LX}} L_X$$ (1B) $$Q_M = \frac{1}{a_{LM}} L_M$$

Production of Nontradeables

(2A) $$Q_N^A = \text{Min}\left(\frac{1}{a_{LN}^A} L_N^A, \frac{M}{a_M}\right)$$ (2B) $$Q_N^B = \text{Min}\left(\frac{1}{a_{LN}^B} L_N^B, \frac{X}{a_X}\right)$$

Definition of Real Income

(3A) $$y^A \equiv \frac{W^A}{P^A} L^A$$ (3B) $$y^B \equiv \frac{W^B}{P^B} L^B$$

Equilibrium Condition in the Goods Market

(4A) $$y^A = Q_N^A$$ (4B) $$y^B = Q_N^B$$

[2] Of course, as in any Ricardian model with a nontraded goods sector, complete specialization in terms of traded goods does not imply complete specialization in production.

Full Employment Conditions

(5A) $a_{LX}Q_X + a^A_{LN}Q^A_N = L^A$ (5B) $a_{LM}Q_M + a^B_{LN}Q^B_N = L^B$

(6A) $a_M Q^A_N = M$ (6B) $a_X Q^B_N = X$

Competitive-Profit Conditions

(7A) $a_{LX}W^A = P_X$ (7B) $a_{LM}W^B = P_M$

(8A) $a^A_{LN}W^A + a_M P_M = P^A$ (8B) $a^B_{LN}W^B + a_X P_X = P^B$

C. DETERMINANTS OF THE TERMS OF TRADE

Equations (7A) and (7B) of the model suggest that the factoral terms of trade, W^A/W^B, are a linear function of the commodity terms of trade, P_X/P_M. Under this "middle product approach" the latter corresponds to a relative price between *inputs*. We next derive an equilibrium (reduced-form) expression for the factoral terms of trade.

The competitive-profit conditions in each country represent a system of two equations, each involving two different commodity prices.[3] However, from the standpoint of the world market, we can reduce these four equilibrium conditions to only two. Thus, if we plug equation (7B) into (8A) and (7A) into (8B), we get the following "reduced-form" competitive profit conditions:

(9) $$P^A = a^A_{LN}W^A + a_M(a_{LM}W^B)$$

(10) $$P^B = a^B_{LN}W^B + a_X(a_{LX}W^A)$$

These competitive profit conditions appear formally the same as the ones one would obtain in a typical Ricardian model involving only production of final goods: the price of final consumption goods depends only upon technical coefficients of production and wage rates.

Next, for each country let us substitute the definition of national income (equations (3)) and the equilibrium condition in the goods market (equations (4)) into the full employment condition for the traded input (equations (6)). This allows us to write equations (6A) and (6B) as follows:

(11) $$M = a_M \frac{W^A}{P^A} L^A$$

[3] In Sanyal–Jones (1982) theory, the competitive profit conditions for consumables yield the equilibrium prices for final goods. This may seem awkward, since it suggests that the price *level* emerges as an endogenous variable in what purports to be a real general equilibrium model of trade. In the case of this two-country model, however, equations (8.A) and (8.B) should not be regarded as yielding price levels, but rather the equilibrium *relative* prices of consumption goods in country A vis-a-vis country B. For the appropriate interpretation within the Sanyal–Jones specific set up, see Sanyal–Jones (1982, p. 17).

$$X = a_X \frac{W^B}{P^B} L^B \tag{12}$$

Multiply (11) by P_M and (12) by P_X to obtain:

$$P_M M = \frac{a_M P_M}{P^A} W^A L^A \tag{11'}$$

$$P_X X = \frac{a_X P_X}{P^B} W^B L^B \tag{12'}$$

Equation (11′) corresponds to the value of country A's imports, whereas (12′) stands for the value of country B's imports. Let

$$\theta_M \equiv \frac{a_M P_M}{P^A}; \quad \theta_X \equiv \frac{a_X P_X}{P^B}$$

where the θ's represent the distributive shares of the imported intermediate good in the production of the final consumption good in countries A and B. Then, equations (11′) and (12′) can be rewritten as

$$P_M M = \theta_M W^A L^A \tag{11''}$$

$$P_X X = \theta_X W^B L^B \tag{12''}$$

World market equilibrium implies that trade must be balanced:

$$\theta_M W^A L^A = \theta_X W^B L^B \tag{13}$$

Equation (13) can be solved for the *factoral terms of trade*:

$$\frac{W^A}{W^B} = \frac{\theta_X}{\theta_M} \frac{L^B}{L^A} \tag{14}$$

Thus, the factoral terms of trade are a function of the costs structures for the final (nontraded) consumption good and of labor endowments.

Now recall that the two commodities that are traded in the world market, X and M, represent "pure Ricardian tradeables": in equilibrium, their prices must equal their average labor costs. Hence, using the competitive profit conditions (7A) and (7B), we can link the factoral terms of trade, as appearing in equation (14), to the *commodity terms of trade*, P_X/P_M:

$$\frac{P_X}{P_M} = \frac{a_{LX}}{a_{LM}} \frac{W^A}{W^B} = \frac{a_{LX}}{a_{LM}} \frac{\theta_X}{\theta_M} \frac{L^B}{L^A} \tag{15}$$

The relative price of exportables in terms of importables for country A, P_X/P_M, depends only upon production parameters imbedded in the input-tier of both countries (as summarized by the labor coefficients a_{LX} and a_{LM}), on the cost shares for the imported intermediate good in the output-tier of both countries

(θ_X and θ_M), and on their relative factor endowments of labor, L^B and L^A.

Note that the essential feature displayed by the equilibrium relationship between factoral and commodity terms of trade in a Ricardian model is preserved in this middle-product set up. Lets highlight this by rewriting equation (15) as follows:

$$\frac{W^A}{W^B} = \frac{(1/a_{LX})}{(1/a_{LM})} \frac{P_X}{P_M} \tag{15'}$$

Figure 1 represents equation (15′). It plots a *linear* equilibrium relationship between relative wages in the two countries and the terms of trade, the slope of which is equal to the inter-country ratio of labor productivities in the *production of middle products.*[4] This type of linear relationship is exactly the same that appears in the case in which only final consumption goods are produced and traded in the world market, and in which each country ends up completely specialized[5]. This is precisely the case in the Ricardian model when there is no commodity produced in common by both countries, a situation that is shared with this middle-product set up. Under such circumstances, the factoral terms of trade depend on both the asymmetries in labor productivities in the two countries and on the commodity terms of trade (here, on the relative price of "middle products" in the world market). Since labor productivities are constant, any alteration in the terms of trade will involve a one-to-one change in relative wages, W^A/W^B. Thus, the world redistribution of income associated with any change in the commodity terms of trade—triggered by transfers, for example—affects only workers, since labor is the only primary factor of production considered in this Ricardian model.

Factoral and Commodity Terms of Trade

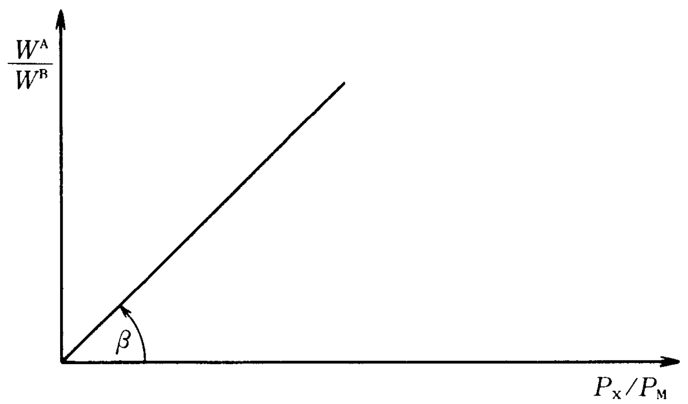

Figure 1.

[4] Recall that, since the Ricardian model uses linear production functions, the output-elasticity of labor is unity: average and marginal products of labor are the same.

[5] This occurs when the commodity terms of trade settle *strictly in between* each country's cost ratios.

D. WORLD PRODUCTION OF FINAL CONSUMPTION GOODS

Conditions (3) and (4) of the model together imply that the outcome of a lump-sum transfer will depend only on whether equilibrium outputs of nontraded goods are affected by the transfer, and if so, in which direction. This is the only consideration that matters here, since the utility levels (real income) depend only on the amounts of the single consumption (nontraded) good available within each country. The marginal propensity to consume nontraded goods is equal to one in both countries, and the marginal propensity to consume traded goods is equal to zero in both countries. Thus, given the structure of the model, a comparison of taste patterns accross countries is irrelevant for the outcome of a transfer.

Since the utility levels of the two countries involved in the transfer depend only on the amount of final (and nontraded) consumption goods available, it will prove convenient to infer from the general equilibrium conditions for the world market whether production of final consumption goods in each country is affected by a transfer payment.

Walras Law implies that the world equilibrium can be represented either by the equilibrium condition for the nontraded goods markets (equations (4A) and (4B)) or by the balance of payments equilibrium condition (equation (13)). Here we will focus on the former equilibrium condition.

For equilibrium in the final (nontraded) goods markets to prevail, the full employment conditions for factors of production (both labor and intermediates) need to be satisfied. These can be stated as supply-equals-demand conditions for the two internationally traded inputs, plus the market clearing condition for the internal labor market in each country. These four equilibrium conditions are presented below:

(16) $$Q_X^S = a_X Q_N^B$$

(17) $$Q_M^S = a_M Q_N^A$$

(18) $$L^A = a_{LX} Q_X + a_{LN}^A Q_N^A$$

(19) $$L^B = a_{LM} Q_M + a_{LN}^B Q_N^B$$

Equation (16) states that country A's supply of commodity X must be equal to country B's demand for commodity X. Equation (17) represents the equality between country B's supply of commodity M and country A's demand for M. These demands are, of course, input demands. Equation (18) is the same as our previous equation (5A), and equation (19) reproduces equation (5B). General equilibrium requires these four conditions to be simultaneously satisfied.

These four market-clearing conditions can be reduced to only two by plugging (16) and (17) into (18) and (19). This yields

(20) $$L^A = a_{LX} a_X Q_N^B + a_{LN}^A Q_N^A$$

(21) $$L^B = a_{LM}a_M Q_N^A + a_{LN}^B Q_N^B$$

Equations (20) and (21) summarize all the relevant information that we require to solve for the equilibrium levels of production of final commodities in the world market. They represent a system of two linear equations in two unknowns (Q_N^B, Q_N^A), which has to have a unique (and positive) solution in order for the assumed patterns of specialization be internally consistent (the conditions for stable and unique equilibria are addressed in Section F). This solution is:

(22) $$(Q_N^B)^* = \frac{a_{LM}a_M L^A - a_{LN}^A L^B}{a_{LX}a_X a_{LM}a_M - a_{LN}^A a_{LN}^B}$$

(23) $$(Q_N^A)^* = \frac{a_{LX}a_X L^B - a_{LN}^B L^A}{a_{LX}a_X a_{LM}a_M - a_{LN}^A a_{LN}^B}$$

Hence, the equilibrium level of production in the output-tier of both countries can be expressed solely as a function of exogenous variables: technical coefficients of production and labor endowments. This is a key result for the outcome of the transfer, which we discuss in the next section.

E. THE EFFECTS OF A LUMP-SUM TRANSFER

The existence of transfer payments among countries makes produced income different from national income,[6] and the balance of trade different from the current account of the balance of payments.[7] Those differences are equal to the amount of the transfer.

We will first discuss the effects of a transfer payment on the real incomes of countries A and B. This requires to consider the impact of the transfer on real wages in both countries. The underlying equilibrium changes in the (factoral and commodity) terms of trade will be then addressed.

Note that our system of equations formed by (20) and (21) does not depend on whether or not the trade balance is identically equal to the current account in any country. Therefore, the equilibrium conditions (22) and (23) are unchanged by a transfer payment among countries. Thus, production of nontradeables in each country will be unaffected by the transfer.

As indicated by equations (4A) and (4B), in equilibrium, production of nontradeables must be equal to real income in each country. In turn, real national income equals real factor payments plus the net income from the transfer.

[6] As a corollary, spending is less (greater) than produced income for the donor (receiver) country.

[7] Under a transfer T, condition (13) must be replaced by the equilibrium for the current account ($\theta_M W^A L^A = \theta_X W^B L^B + T$), and hence the factoral terms of trade become a function of the transfer: $W^A/W^B = \theta_X/\theta_M L^B/L^A + (1/\theta_M L^A)\tau$, where τ stands for the value of the transfer expressed in units of wage income of country B.

Let country B be the donor. Given these qualifications, the relevant equilibrium conditions for the purpose of determining the impact of the transfer are therefore:

$$(Q_N^A)^* = \frac{W^A}{P^A} L^A + \tau \tag{24}$$

$$(Q_N^B)^* = \frac{W^B}{P^B} L^B - \tau \tag{25}$$

where $(Q_N^A)^*$ and $(Q_N^B)^*$ are the *equilibrium* output levels for nontraded goods (as given by equations (22) and (23)).

A transfer from country B to country A will alter only the *right-hand side* of (24) and (25). National income in country A will increase initially by τ and country B's national income will decline by the same amount. However, as Q_N^A and Q_N^B are unchanged, and so are L^A and L^B, the only outcome of the transfer that is consistent with equilibrium is to alter the *composition* of national income in both countries, leaving their levels unchanged. The adjustment mechanism is as follows. At unchanged prices, a transfer from country B to A tends to increase the demand for nontradeables in country A. An excess supply of labor would thus appear in country A. Consequently, wages must fall. The opposite takes place in country B. Since the labor market clears only when production of nontradeables equals $(Q_N^A)^*$ and $(Q_N^B)^*$ in countries A and B, respectively, real wages must fall (rise) in A (B) exactly in proportion to the transfer, thus neutralizing its effect. Since labor is the only primary factor of production here, the above illustrates the "secondary effect" of a transfer: the donor's real income experiences a "secondary blessing" via the terms of trade effect. The "anti-orthodox outcome" of the transfer takes place.

What is the movement in the terms of trade that underlies this secondary effect of the transfer? Consider the (reduced form) competitive-profit conditions: equations (9) and (10) of the model. Take any of these, say, equation (9). Divide through by P^A and get:

$$1 = a_{LN}^A \frac{W^A}{P^A} + a_M a_{LM} \frac{W^B}{P^A}$$

We showed that the outcome of the transfer involves a reduction in W^A/P^A. Hence, in equilibrium, W^B/P^A must increase (since the a_{ij}'s are constant). On the other hand, the factoral terms of trade can be written as:

$$\frac{W^A}{W^B} \equiv \left(\frac{W^A}{P^A}\right)\left(\frac{P^A}{W^B}\right)$$

Both right-hand-side terms decline. Therefore, the factoral terms of trade (W^A/W^B) decline too. The outcome of the transfer thus involves the factoral terms of trade deteriorating for country A (receiver) and improving for country

B (donor). Since there exists a one-to-one correspondance between factoral and commodity terms of trade (see equation (15′)), commodity terms of trade also deteriorate for country A (receiver) and improve for country B (donor).

Summarizing, we have (as usual) two different effects as an outcome of a lump-sum transfer: a *primary* effect and a *secondary* effect. The primary effect reduces (increases) real income for the donor (receiver), at *given* terms of trade. The secondary effect, in this set up, increases (reduces) real income for the donor (receiver): the donor country (recipient) experiences a "secondary blessing" (secondary burden) due to the improvement (deterioration) in the terms of trade induced by the transfer. As production levels in the output-tiers of countries A and B are unaffected by the transfer, the primary (direct) effect of the transfer is exactly cancelled by the secondary effect on the terms of trade. Thus, although the *value* of imports and exports have been affected, the *quantities* have remained unchanged in each country. This is enough to freeze the output of consumables: labor endowments are given. The offsetting impacts of primary and secondary effects implies that the transfer payment is *welfare neutral.* Hence, no redistribution of world income is obtained as a final equilibrium outcome.

F. DUALITY BETWEEN THE EXCHANGE AND RICARDIAN SET UPS

The neutrality of transfers obtained here reconfirm Jones (1980), which obtained an analogous neutrality outcome within a pure exchange model. In Jones' model, trade takes place in final consumption goods and the indifference curves are assumed to be right-angled, thus displaying no substitution in consumption. Our model shows that indeed the same result can be obtained if, instead, no substitution in production is assumed and international trade takes place in middle products. The formal similarity between these two set ups is emphasized next.

Suppose that the utility functions are of the Leontief type in the standard two-consumption-good, two-country international trade model of an exchange

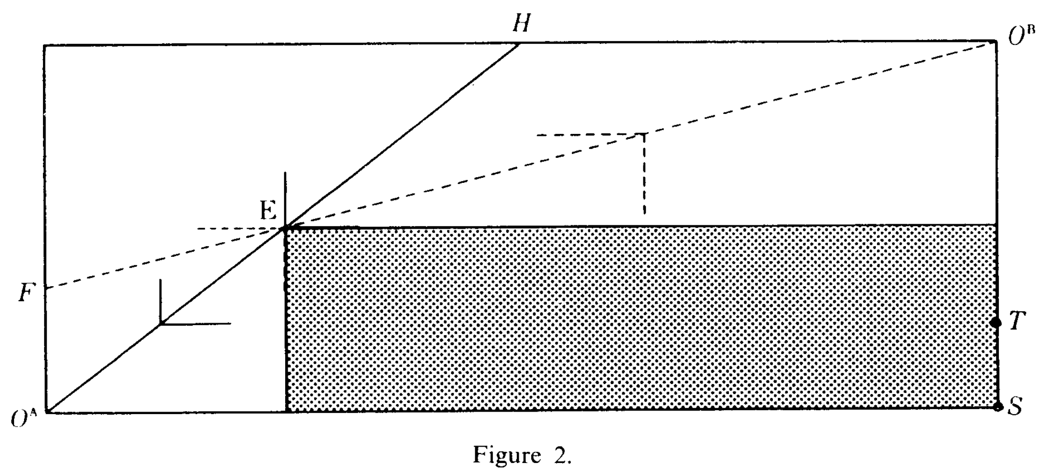

Figure 2.

economy. Figure 2 illustrates such a world with the Edgeworth box diagram. The axes represent the two consumption goods. The solid and dashed lines represent the system of indifference curves of countries A and B, respectively. The expansion path for country A (O^AH) intersects the one for country B (O^BF) at point E. As shown in Jones (1980), only endowment points that belong to the shaded region in figure 2 can support simultaneously *stable* and *unique* equilibria. Let point S represent the initial endowment. The corresponding market equilibrium is reached at E. If country B transfers some of the initial endowment of the second good to country A, and the endowment point shifts to T, the new equilibrium is again attained at E. A transfer, therefore, does not change the utility level of either country if substitutability in utility functions is not allowed.

Now, let us use the same figure 2 to analyze the effect of a lump-sum transfer within the Ricardian model we have presented in this paper. Consider the reduced form system of equations (20) and (21) in our model, in which Q_N^A and Q_N^B represent the output levels of the nontraded goods in respective countries, and L^A and L^B the labor endowments in respective countries. The middle product structure of the model implies that labor services are indirectly traded in this model: in each country production of final goods (nontradeables) requires an intermediate good which the other country produces with its labor input (in fixed proportions). Figure 2 can now be viewed as a production Edgeworth box for the world economy, with the axes representing L^A and L^B, and the solid and dashed lines respectively representing the isoquants of the nontradeables of countries A and B. If the initial endowment S is shifted to T, the equilibrium output point and hence the consumption levels of the two countries remain at point E.

A general principle thus applies: lack of substitution—either in consumption or in production—makes lump-sum transfer payments welfare neutral. The anti-orthodox outcome is the only consistent with equilibrium, and the primary and secondary effects of the transfer exactly offset each other. Although it is still the case that "it is never better to give than to receive", it turns out that both situations are equivalent under these circumstances.

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