THEORETICAL BASIS FOR A METHOD OF DISTRIBUTION OF MARKET SHARE CHANGES IN INTERNATIONAL TRADE*

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ABSTRACT Chami's method for calculating how much of an exporter's market share change can be attributed to each competitor has regularly been applied in the literature, but it has not been related to any theory yet. Here, an attempt is made to examine the trade models that can provide the theoretical foundations for the method, clarifying the assumptions underlying its results. It is shown that the method is consistent with most of the main trade models found in the literature.

Key words: trade models; international competition; market share; shift-share analysis

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BASE TEÓRICA PARA UM MÉTODO DE DISTRIBUIÇÃO DE MUDANÇAS DE PARTICIPAÇÕES DE MERCADO NO COMÉRCIO INTERNACIONAL

RESUMO O método desenvolvido por Chami para distribuir as participações de cada país exportador entre seus competidores em um determinado mercado tem sido aplicado na literatura, mas ainda não foi associado a qualquer teoria. Este artigo procura examinar os modelos de comércio que podem oferecer os fundamen-

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tos teóricos para o método, clarificando as suposições necessárias aos seus resultados. Mostra-se que o método é consistente com a maioria dos principais modelos de comércio encontrados na literatura.

Palavras-chave: modelos de comércio; competição internacional; participação de mercado; análise de shift-share

INTRODUCTION

The current method for analysing the distribution of market-share changes in international trade was first presented and applied by Chami Batista (2008a). It has also been applied by other authors, with interesting results.[1] The method fulfills some desirable conditions, but has not been related to any theory yet. Here, an attempt is made to examine the trade models that would provide the theoretical foundations for the method, clarifying the assumptions underlying its results.

The method has been presented using discrete time, with the goal of making it applicable to practical situations.[2] Since our main concern here is with its theoretical basis, Chami's method will be presented using differentials for the first time. Since the method's formulae for analysing the distribution of market share changes in a given sector of international trade is calculated for each individual export good, its theoretical foundation will be developed on the basis of an individual good or product.

However, one of the main advantages of the method is that it may easily apply to any number of goods, allowing the aggregation of gains and losses of revenue of any exporter to specific competitors over a period of time. The result of this aggregation tells us how much of an exporter's gains and losses of competitiveness (competitiveness effect, in the parlance of the Constant Market Share-CMS model) can be attributed to each competitor. But this requires a choice of currency and a base period (initial or final), and is thus subject to some of the well-known criticisms against the CMS model.[3]

If, on the one hand, the method's simplicity allows the analysis of several goods markets, on the other, it entirely ignores the idiosyncratic structure of each good market, the number of firms and countries competing, and whether goods are homogeneous or differentiated by country of origin. As such, the method's results are inaccurate estimates of an exporter's gains and losses in relation to each of its competitors.

1. THE METHOD

Assume that N countries export to a particular import market K.[4] Initially, each exporter's market share of a specific good in value terms, k_H, is given by:

(1) $k_H \equiv \dfrac{X_H}{M}$ for $H \in (1, N)$, where X_H is the export revenue of country H for this specific good, and M is the value of market K imports of the same good from all countries. Changes in the market share are equal to:

(2) $dk_H = k_H\left(\hat{X}_H - \hat{M}\right)$, where the hat at the top of a variable means its rate of growth. Considering that:

(3) $$\sum_{H=1}^{N} dk_H = \sum_{H=1}^{N} k_H\left(\hat{X}_H - \hat{M}\right) = 0,$$

it follows that:

(4) $$\hat{M} = \sum_{H=1}^{N} k_H \cdot \hat{X}_H$$

Substituting (4) in (2), we arrive at:

(5) $$dk_H = k_H \hat{X}_H - k_H \sum_{J=1}^{N} k_J \hat{X}_J = k_H \hat{X}_H - k_H k_H \hat{X}_H - k_H \sum_{J \neq H}^{N} k_J \hat{X}_J \rightarrow$$

$$\rightarrow dk_H = k_H\left(\hat{X}_H - k_H \hat{X}_H\right) - k_H \sum_{J=1}^{N} k_J \hat{X}_J = k_H\left[\hat{X}_H (1 - k_H)\right] - k_H \sum_{J \neq H}^{N} k_J \hat{X}_J \rightarrow$$

$$\rightarrow dk_H = k_H \hat{X}_H \sum_{J \neq H}^{N} k_J - k_H \sum_{J \neq H}^{N} k_J \hat{X}_J \rightarrow$$

(6) $$dk_H = \sum_{J \neq H}^{N} k_H k_J \left(\hat{X}_H - \hat{X}_J\right).$$

But given that country H does not gain or lose to itself, it must gain from and lose to the other J exporters competing in the same market. Therefore, it may be written that:

(7) $$dk_H \equiv \sum_{J \neq H}^{N} dk_{H,J} = \sum_{J \neq H}^{N} k_H k_J \left(\hat{X}_H - \hat{X}_J\right),$$

where dk_{HJ} is country H's gain from or loss to country J.

So far, the exposition is quite general, as it applies to any model of competition among N exporters in market K. However, equation (7) requires that the product variety from any exporter H competes with the product varieties from all the other $N - 1$ exporting countries.[5] If the product varieties of some countries do not compete with the product variety of country

H, they must be classified in a different product market. After all, if product varieties from the countries they originate from do not compete with each other, these countries cannot gain from or lose to each other.

Chami's method for analysing the distribution of a particular exporter's gains and losses in relation to its competitors simply assumes that the gain (loss) of country *H* from (to) country J is equal to the difference between the growth rate of exports of countries *H* and *J* weighed by the product of the initial market shares of both countries. Formally:

$$(8)\ dk_{H,J} = k_H k_J \left(\hat{X}_H - \hat{X}_J\right)$$

From equation (8), it follows that a country does not gain or lose to itself, $dk_{H,H} = 0$, and the part of *H*'s gain (loss) attributed to *J* must be equal to the part of *J*'s loss (gain) attributed to *H*, $dk_{H,J} = -dk_{J,H}$. These are desirable properties in any method of distributing countries' gains and losses. However, since equation (8) does not follow from (7), it needs to be justified by some economic theory. More specifically, it is necessary to state under what theoretical assumptions or conditions the method may be applied in practice. Inspecting equations (7) and (8), it is evident that the latter will follow from the former if the export growth rate difference in each pair of countries does not depend on factors related to the sales of other countries in *K*. Each $dk_{H,J}$ in equation (7) can then be easily identified and separated as in equation (8).

2. DOMESTIC SUPPLIERS IN THE IMPORTING MARKET

Before analysing the theoretical models that may lend support to the method, it is important to point out that, if there are domestic suppliers in importing market *K*, the method should include them as competing country *K* in the market. Ignoring the existence of domestic suppliers[6] and focussing only on exporters to the *K* market will make equation (7) invalid.[7] However, a sufficient condition for the method to be applied — considering only exporters to market *K* — is to assume that the market share of domestic supply (k_K^D) remains constant between the initial and final periods.

The proof can easily be shown. Redefining the market share of any country H, taking into account the domestic supply (X_K), we have:

$$k_H^D \equiv \frac{X_H}{M + X_K} \equiv \frac{X_H}{D} \,,$$

where D is the total demand of market K.

Equation (2) is now rewritten as:

$$dk_H^D = k_H^D\left(\hat{X}_H - \hat{D}\right)$$

And equation (7) turns into:

$$dk_H^D \equiv \sum_{J \neq H}^{N+1} dk_{HJ}^D = \sum_{J \neq H}^{N+1} k_H^D k_J^D\left(\hat{X}_H - \hat{X}_J\right) = k_H^D k_K^D\left(\hat{X}_H - \hat{X}_K\right) + \sum_{J \neq H \, and J \neq K}^{N} k_H^D k_J^D\left(\hat{X}_H - \hat{X}_J\right)$$

Bearing in mind that $k_H^D \equiv \frac{X_H}{M}\frac{M}{D} \equiv k_H k_M^D$, it follows that:

$$k_H^D\left(\hat{X}_H - \hat{D}\right) - k_H^D k_K^D\left(\hat{X}_H - \hat{X}_K\right) = k_M^D k_M^D \sum_{J \neq H \, and \, J \neq K}^{N} k_H k_J\left(\hat{X}_H - \hat{X}_J\right)$$

Assuming $dk_K^D = 0$, it follows that: $\hat{X}_K = \hat{M} = \hat{D}$, and

$$k_H^D\left(\hat{X}_H - \hat{M}\right)\left(1 - k_K^D\right) = k_M^D k_H\left(\hat{X}_H - \hat{M}\right) k_M^D = k_M^D k_M^D \sum_{J \neq H \, and \, J \neq K}^{N} k_H k_J\left(\hat{X}_H - \hat{X}_J\right),$$

which leads back to equation (7):

$$dk_H \equiv \sum_{J \neq H}^{N} dk_{H,J} = k_H\left(\hat{X}_H - \hat{M}\right) = \sum_{J \neq H}^{N} k_H k_J\left(\hat{X}_H - \hat{X}_J\right) .$$

Therefore, the assumption $dk_K^D = 0$ is a sufficient condition for applying the method without taking into account the existence of domestic suppliers. Although this will never be rigorously true (the probability of $dk_K^D = 0$ is zero), it may be a good approximation, depending on the chosen initial and final periods.

3. THEORETICAL MODELS THAT UNDERPIN THE METHOD

There are essentially two main categories of competition in trade models. The first category assumes that the traded good is homogeneous, and that destination price is the same irrespective of country of origin. The second assumes that the traded good is differentiated, and that destination price may not be the same according to the country of origin.

3.1 Trade models with homogeneous products

These models assume that homogeneous products are sold for a single price at each destination, regardless of the volume being purchased by any individual consumer.[8] This requires that consumers not be segmented (resale cannot be controlled, and both sale and resale are costless), and that they have perfect information about the prices being charged by any vendor. Intra-firm trade is ruled out.[9] As products are identical and prices are the same, consumers should be indifferent as to the origin (country) of products, and changes in the market share of each supplying country are then driven by cost conditions in these countries.[10]

However, in order to apply the method ignoring the domestic supply in *K*, it is necessary to assume that consumers' preference is a Cobb-Douglas function between the domestic and the imported product, which are then seen as differentiated products. In this case, the share of domestic supply in K's total demand will be constant and, as already seen, this is a sufficient condition for harmlessly ignoring domestic supply.

3.1.1 Perfect competition

Assume there are many firms and consumers, and they both act as price takers. Prices change as a result of changes in aggregate supply or demand. Ignoring domestic trade costs in *K*, aggregate demand $Q_D\,(p)$ is equal to aggregate supply $Q_S\,(p)$ in short-run equilibrium, and p is the single destination price in market *K*. In this model, profit-maximizing-heterogeneous firms equate their marginal costs to price, leading to:

$$(9)\ p_H = p(Q) \cdot E_H = mc_{iH}(q_{iH}),$$

where p_H is the domestic price of the product in country *H*; $p\,(Q)$ is the inverse aggregate demand function; Q is the total quantity sold in market *K*; E_H is the exchange rate of country *H*'s currency with respect to the currency of market *K*; mc_{iH} is the marginal cost of firm $i \in (1, n_H)$ located in exporting country $H \in (1, N)$; the supply of country *H* is the horizontal sum of the supply (marginal cost function) of each firm i: $q_H(\overline{p_H}) = \sum_i^{nH} q_{iH}(\overline{p_H})$; and the aggregate supply is the horizontal sum of the supply (marginal cost) of each country: $Q_s(\overline{p_H}, \overline{E_H}) = \sum_1^N q_H(\overline{p_H})$

Export revenue of exporting country *H*, where there are n_H firms, is given by:

(10) $X_H = p \cdot q_H(p_H) = p \cdot \sum_i^{nH} q_{iH}(p_H)$

In this model, changes in exporters' market shares take place as a result of changes in marginal cost schedules or in exchange rates. Considering a depreciation of the exchange rate in country *H*, the effect on its export revenue will be:

(11) $dX_H = p \cdot dq_H + q_H . dp = p \cdot q'_H . dp_H + q_H \cdot dp$, but

(12) $dp_H = p \cdot dE_H + E_H . dp$,

which combined with (11) leads to:

(13) $dX_H = p . q'_H . p \cdot dE_H + p . q'_H . E_H . dp + q_H . dp$, and

(14) $\hat{X}_H = \dfrac{p . q'_H . p . dE_H}{p \cdot q_H} + \dfrac{p . q'_H . E_H . dp}{p \cdot q_H} + \dfrac{q_H . dp}{p \cdot q_H}$, then

(15) $\hat{X}_H = \dfrac{q'_H \cdot p_H \cdot dE_H}{q_H \cdot E_H} + \dfrac{q'_H \cdot p_H \cdot dp}{q_H \cdot p} + \dfrac{dp}{p}$, then

(16) $\hat{X}_H = \varepsilon_H \cdot \hat{E}_H + (1 + \varepsilon_H) \cdot \hat{p}$,

where $\varepsilon_H > 0$ is the supply price elasticity of exporting country *H*.

The difference between export revenues of countries *H* and *J* can then be calculated as:

(17) $\hat{X}_H - \hat{X}_J = (\varepsilon_H - \varepsilon_J) \cdot \hat{p} + \varepsilon_H \cdot \hat{E}_H - \varepsilon_J \cdot \hat{E}_J = \varepsilon_H \cdot \hat{p}_H - \varepsilon_J \cdot \hat{p}_J$, bearing in mind that $\hat{p}_H = \hat{p} + \hat{E}_H$.

It should be noted that changes in aggregate demand will change destination price, and the market shares of exporting countries will generally change due to their different price elasticities of supply. Changes in market shares may also take place as a result of shifts in exchange rates. As a result, it is easy to show that equation (8) will follow from equation (7), since changes in the market share of *H* that are due to *J* depend only on variables related to *H* and *J*:

$$(18)\ \sum_{J\neq H}^{N} dk_{H,J} = \sum_{J\neq H}^{N} k_H k_J \left[\left(\varepsilon_H - \varepsilon_J\right) . \hat{p} + \varepsilon_H . \hat{E}_H - \varepsilon_J . \hat{E}_J \right] \rightarrow$$

$$(19)\ dk_{H,J} = k_H \cdot k_J \cdot \left[\left(\varepsilon_H - \varepsilon_J\right) \cdot \hat{p} + \varepsilon_H \cdot \hat{E}_H - \varepsilon_J \cdot \hat{E}_J \right] = k_H \cdot k_J \cdot \left(\varepsilon_H \cdot \hat{p}_H - \varepsilon_J \cdot \hat{p}_J\right)$$ for any country *H* and *J*.

3.1.2 Oligopoly in Cournot equilibrium[11]

Firms are no longer price takers, and it is assumed that *n* of them are spread over at least three different countries. Export revenue of country *H* is:

$$(20)\ X_H = \frac{p_H\left(q_H\right)}{E_H} \cdot q_H$$

Profit maximizing firms will equate marginal revenue to marginal cost:

$$(21)\ p\left(Q\right) . \left[1 - \frac{s_H}{\eta\left(Q\right)} \right] = mc_H\left(q_H\right),$$

where s_H is the market share of country *H*, $mc_H\left(q_H\right)$ is the marginal cost of the firm in country H, and $\eta\ (Q)$ is the price elasticity of aggregate demand. Thus:

$$(22)\ s_H = \left[1 - \frac{mc_H\left(q_H\right)}{p\left(Q\right)} \right] \eta\left(Q\right)$$

Total differentiating the log of equation (22) leads to:

$$\hat{s}_H = \frac{\eta(Q)}{s_H} \left[\frac{mc_H\left(q_H\right) . \frac{\partial p}{\partial Q} . \frac{p}{Q} . \frac{dQ}{Q}}{p(Q)} - \frac{\frac{\partial mc_H}{\partial q_H} . \frac{q_H}{mc_H} . \frac{dq_H}{q_H} . mc_H}{p(Q)} \right] + \hat{\eta}\left(Q\right)$$

$$\hat{s}_H = \frac{\eta(Q).mc_H\left(q_H\right)}{s_H.p(Q)}.\left[\frac{-Q}{\eta(Q)} - \frac{q_H}{\varepsilon_H\left(q_H\right)}\right] + \hat{\eta}\left(Q\right),$$

where $\varepsilon_H\left(q_H\right)$ is H's elasticity of supply.

$$(23)\ \hat{s}_H = \left(\frac{\eta(Q)}{s_H} - 1\right).\left[\frac{-\hat{Q}}{\eta(Q)} - \frac{\hat{q}_H}{\varepsilon_H\left(q_H\right)}\right] + \hat{\eta}\left(Q\right), \text{ and:}$$

$$(24)\ \hat{s}_H - \hat{s}_J = \frac{\hat{q}_H}{\varepsilon_H\left(q_H\right)} - \frac{\hat{q}_J}{\varepsilon_J\left(q_J\right)} - \hat{Q}.\left(\frac{s_J - s_H}{s_H.s_J}\right) - \eta(Q).\left(\frac{\hat{q}_H}{s_H.\varepsilon_H\left(q_H\right)} - \frac{\hat{q}_J}{s_J.\varepsilon_J\left(q_J\right)}\right)$$

Bearing in mind that $\hat{X}_H - \hat{X}_J = \hat{s}_H - \hat{s}_J$, equation (8) will follow again from (7), as all variables in equation (24) are either related to countries *H* and *J* or to the whole import market *K*, making it easy to identify the gains and losses by the pair of countries.

Therefore, trade models with homogeneous products under perfect competition or under Cournot Oligopoly provide full theoretical support for Chami's method.

3.2 Trade models with differentiated products

There are basically three types of trade models with differentiated products: monopolistic competition models in the vein of Krugman (1981), Armington's (1969) model of demand for products by country of origin, and vertical differentiation models as in Grossman and Helpman (1991).

3.2.1 Krugman's model

Krugman's model of monopolistic competition is based on a love of variety utility function developed in Dixit and Stiglitz (1977), in which utility rises with the number of varieties available.[12] Furthermore, the utility function takes the form of a symmetrical constant elasticity function, so that every pair of varieties is equally well substitutable for each other, and their degree of substitutability does not depend on the level of consumption of any variety. The symmetry of the model leads all available varieties to be equally priced and consumed in equal quantities.

The distinctive characteristic of Krugman's model is that the number of varieties can vary, as there is free entry and exit of firms. But for a given number of firms, the share of aggregate spending of any country allocated to a particular variety only depends on the price level. Since price and quantities per firm are the same, countries will gain market share in a free trade world if their relative number of firms or varieties rise.[13] Thus, the export revenue growthrate will be equal to the growth rate of the number of firms:

$$(25)\ \left(\hat{X}_H - \hat{X}_J\right) = \left(\hat{n}_H - \hat{n}_J\right) \rightarrow dk_H = k_H k_J \left(\hat{n}_H - \hat{n}_J\right) + k_H k_N \left(\hat{n}_H - \hat{n}_N\right).$$

Hence,

$$(26)\ dk_{H,J} = k_H k_J \left(\hat{n}_H - \hat{n}_J\right) \text{and}\ dk_{H,N} = k_H k_N \left(\hat{n}_H - \hat{n}_N\right).$$

Therefore, Chami's method is perfectly consistent with Krugman's monopolistic competition model.

3.2.2 Armington's model

In Armington's (1969) trade model[14] of differentiated products by country of origin, the number of countries or products is fixed, and changes in market shares are due to price competition. He assumes that a commodity produced by one country is an imperfect substitute in demand for the "same" commodity produced by another country. Following Armington's convention, I refer to these commodities as *goods* and to the good produced by a particular country as a *product.*

In order to simplify his analysis, Armington makes the so-called assumption of independence, by which the marginal rates of substitution between any two products of the same good must be independent of the quantities of the products of all other goods. He also assumes that the quantity index functions are linear and homogeneous, which implies that market shares must depend only on the relative prices of the products in the market and not on the size of the market. Hence, it can be written that:

$$(27)\ X_H = p_H \cdot q_H\left(Q, \frac{p_H}{p_J}, \frac{p_H}{p_N}\right),$$

where P_H is the destination price of country H's product, q_H is the quantity exported by country H, X_H is country H's export revenue, Q is the quantity index, and P_N is the general price level of the products from all sources other than *H* and *J*. It follows from (27) that:

(28) $\hat{X}_H = \hat{p}_H + \hat{q}_H$, and

(29) $\hat{q}_H = \hat{Q} + \eta_{HPJ} \cdot (\hat{p}_H - \hat{p}_J) + \eta_{HPN} \cdot (\hat{p}_H - \hat{p}_N)$,

where η_{HPJ} is the elasticity of q_H with respect to the relative price of country *H* to country *J*, and η_{HPN} is the elasticity of q_H with respect to the relative price of country *H* to country *N*. Note that the elasticity of q_H with respect to *Q* is equal to one, since q_H is assumed to be homogenous of degree one in the quantity index function.

Combining (28) and (29) leads to:

(30) $\hat{X}_H = \hat{p}_H + \hat{Q} + \eta_{HPJ} \cdot (\hat{p}_H - \hat{p}_J) + \eta_{HPN} \cdot (\hat{p}_H - \hat{p}_N)$.

Analogously, the rates of growth of country *J*'s and *N*'s exports can be derived, leading to the following expressions for the differences between the rates of growth of exports:

(31) $\hat{X}_H - \hat{X}_J = (1 + \eta_{HPJ} + \eta_{JPH} + \eta_{HPN}) \cdot \hat{p}_H - (1 + \eta_{HPJ} + \eta_{JPH} + \eta_{JPN}) \cdot \hat{p}_J - (\eta_{HPN} - \eta_{JPN}) \cdot \hat{p}_N$

(32) $\hat{X}_H - \hat{X}_N = (1 + \eta_{HPJ} + \eta_{NPH} + \eta_{HPN}) \cdot \hat{p}_H - (1 + \eta_{NPJ} + \eta_{NPH} + \eta_{HPN}) \cdot \hat{p}_N - (\eta_{HPJ} - \eta_{NPJ}) \cdot \hat{p}_J$

(33) $\hat{X}_N - \hat{X}_J = (1 + \eta_{NPJ} + \eta_{JPN} + \eta_{NPH}) \cdot \hat{p}_N - (1 + \eta_{NPJ} + \eta_{JPN} + \eta_{JPH}) \cdot \hat{p}_J - (\eta_{NPH} - \eta_{JPH}) \cdot \hat{p}_H$

Inspecting equations (31) to (33), it should be clear that equation (8) will follow from (7) if, and only if:

(34) $\eta_{HPN} = \eta_{JPN}; \eta_{HPJ} = \eta_{NPJ}; \, and \, \eta_{NPH} = \eta_{JPH}$

Thus, the cross-price elasticities are required to be equalized. Condition (34) is necessary because, for equation (8) to follow from (7), the growth differentials between any pair of products must not be determined by any third price product. From equation (34), it follows that:

(35) $\hat{X}_H - \hat{X}_J = (1+\alpha) \cdot \hat{p}_H - (1+\alpha) \cdot \hat{p}_J = (1+\alpha) \cdot (\hat{p}_H - \hat{p}_J)$

(36) $\hat{X}_H - \hat{X}_N = (1+\alpha) \cdot \hat{p}_H - (1+\alpha) \cdot \hat{p}_N = (1+\alpha) \cdot (\hat{p}_H - \hat{p}_N)$

(37) $\hat{X}_N - \hat{X}_J = (1+\alpha) \cdot \hat{p}_N - (1+\alpha) \cdot \hat{p}_J = (1+\alpha) \cdot (\hat{p}_N - \hat{p}_J)$,

where $(1+\alpha)=\left(1+\eta_{HPJ}+\eta_{JPH}+\eta_{HPN}\right)=\left(1+\eta_{HPJ}+\eta_{JPH}+\eta_{JPN}\right)=\left(1+\eta_{HPJ}+\eta_{NPH}+\eta_{HPN}\right)=$

$$=\left(1+\eta_{NPJ}+\eta_{NPH}+\eta_{HPN}\right)=\left(1+\eta_{NPJ}+\eta_{JPN}+\eta_{NPH}\right)=\left(1+\eta_{NPJ}+\eta_{JPN}+\eta_{JPH}\right).$$

Bearing in mind that the elasticity of substitution between product H and J is defined as $\sigma=\dfrac{\hat{q}_H-\hat{q}_J}{\hat{p}_H-\hat{p}_J}$ and $\hat{X}_H=\hat{p}_H+\hat{q}_H$, it follows that $\hat{X}_H-\hat{X}_J=(1+\sigma).(\hat{p}_H-\hat{p}_J)$.

Thus, α in equations (35) to (37) is the constant elasticity of substitution. Indeed, Armington's model also makes the simplifying assumption that "the elasticity of substitution between any two products competing in a market is the same as that between any other pair of products competing in the same market" (Armington 1969, p. 167).

Therefore, Armington's simplifying assumptions are precisely the necessary and sufficient conditions for the validity of the method [equation (8)] when countries gain or lose market shares through price competition.

3.2.3 Quality ladder models

In quality ladder trade models, each firm produces a single variety of the vertically differentiated product. If consumer's preferences are the same everywhere, then only the highest quality variety sells (Grossman and Helpman, 1991), and the distribution of the gains and losses of market shares is pretty obvious. But if consumers are heterogeneous, it is possible that multi-quality varieties sell (Glass, 2001).

Assuming there are two types of consumers with different valuations of the two available varieties, high quality and low quality variety consumers, and a given market size for each type, changes in the market share of an exporting country occur when a firm located in a third country innovates the top quality variety or if there is a change in the market size of one type of consumer.

Assume that country H is the only producer and exporter of the high quality variety, and country J is the only producer and exporter of the low quality variety. The market shares of the high and low quality varieties are k_H and k_J, respectively. If a firm located in a third country N improves the quality of the high quality variety (innovation is stochastic in these family of models), country N gains the market share k_H of country H, and country H gains the market share k_J of country J, according to the model. That is:

$$(38)\ \left\{\begin{array}{l} dk_{H,N} = -k_H \text{ and } dk_{H,J} = k_J \\ dk_{H,J} = -k_J \text{ and } dk_{N,J} = dk_{J,N} = 0 \\ dk_N = k_H ; dk_H = k_J - k_H ; dk_J = -k_J \end{array}\right\}$$

In order to apply Chami's method in this case, one must use the discrete form of it, since the rate of change of country *N*'s exports is infinite. According to this form of the method, the changes in market shares are correctly measured:

(39) $\Delta k_N = k_H ; \Delta k_H = k_J - k_H ; \Delta k_J = -k_J$, but their distribution by competitor is not:

$$(40)\ \left\{\begin{array}{l} \Delta k_{H,N} = \left(\frac{X_N^t \bullet X_H^{t+1}}{M^t \bullet M^{t+1}}\right) - \left(\frac{X_N^{t+1} \bullet X_H^t}{M^t \bullet M^{t+1}}\right) = -k_H \cdot k_H \\ \Delta k_{H,J} = \left(\frac{X_J^t \bullet X_H^{t+1}}{M^t \bullet M^{t+1}}\right) - \left(\frac{X_J^{t+1} \bullet X_H^t}{M^t \bullet M^{t+1}}\right) = k_J \cdot k_J \\ \Delta k_{N,J} = \left(\frac{X_J^t \bullet X_N^{t+1}}{M^t \bullet M^{t+1}}\right) - \left(\frac{X_J^{t+1} \bullet X_N^t}{M^t \bullet M^{t+1}}\right) = k_J \cdot k_H \end{array}\right\}$$

Therefore, in this case, even if the discrete form of the method is applied, its result is inconsistent with the theoretical distribution of gains and losses of any of the exporters.

However, if the change in market share distribution is due to a change in the market size of one type of consumer, the method is consistent with the theoretical model. Assume that there are three types of consumers/varieties and three different firms, each located in a different country (*H*, *J*, and *N*), producing and exporting just on type of variety. Suppose the market of *H* expands:

$$(41)\ \Delta k_H = \left(\frac{X_H + \Delta M}{M + \Delta M}\right) - \left(\frac{X_H}{M}\right) = \frac{(M - X_H) \bullet \Delta M}{M\,(M + \Delta M)} = \frac{X_J . \Delta M}{M\,(M + \Delta M)} + \frac{X_N \bullet \Delta M}{M\,(M + \Delta M)} \Rightarrow$$

$$(42)\ \Delta k_{H,J} = \frac{X_J \bullet \Delta M}{M(M + \Delta M)} .$$

And, according to Chami's method:

$$(43)\ \Delta k_{H,J} = \frac{X_J \bullet (X_H + \Delta M)}{M\,(M + \Delta M)} - \frac{X_J \bullet X_H}{M\,(M + \Delta M)} = \frac{X_J \bullet \Delta M}{M\,(M + \Delta M)}$$

Therefore, in this case, the method is perfectly consistent with the theoretical model.

4. CONCLUSIONS

Chami's method for calculating how much of an exporter market share change can be attributed to each competitor is consistent with some of the main trade models, especially when the traded good is homogeneous or horizontally differentiated. But some difficulties may arise even for homogeneous goods if trade is intra-firm. As to horizontally differentiated goods, the key assumption for a consistent application of the method is the constant elasticity of substitution between pairs of products from different countries. Vertically differentiated products are more problematic if the lowest quality exporter is pushed out of the market due to a newcomer at the top of the quality ladder.

If there are domestic suppliers in the importing market but no data on their output values, a sufficient assumption for the method's consistency is that domestic and imported products are differentiated, and their shares in total demand remain constant over the period of analysis.

NOTES

1. See, for instance, Moreira (2007), Jenkins (2008), and Shuquan (2009).
2. Chami Batista (2008a) and (2008b).
3. The competitiveness effect is one of the parts of the Constant Market Share (CMS) decomposition. It is beyond the scope of this article to discuss the theoretical foundations of the CMS model. For an early presentation of the CMS model and criticisms against it, see, for instance, Leamer and Stern (1976). For a recent discussion of the theoretical foundations of the CMS model, see, for instance, Ahmadi-Esfahani (2006).
4. In this section, it is assumed that there are no domestic suppliers within import market *K*. The next section will deal with that.
5. As products are in practice defined according to existing classifications, they do not necessarily fulfill this condition.
6. In practice, if one is using narrowly defined products, it might be hard to find appropriate data for the domestic supply in market *K*.
7. This is generally true if any country competing in the market is not taken into account.
8. See Kreps (1990) for the conditions necessary for linear prices.
9. Although it may be considered that intra-firm trade in a particular good does not compete with the same good produced by other firms in the short-term, cost considerations should be one of the main determinants of multinationals' decisions on plant locations.
10. Classical and neoclassical trade models are examples of models that make such assumptions.
11. For a general discussion of the implications of oligopoly to trade of homogeneous goods using the Cournot approach, see chapter 5 of Helpman and Krugman (1985).

12. See also Helpman and Krugman (1985) for a clear exposition of the utility and demand functions.
13. The number of firms rises with the size of the country if there are fixed output costs (Hummels and Klenow, 2005, p. 708).
14. Armington's model is the basic reference for models designed to estimate the effects of trade agreements, including CGE models of trade liberalization.

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