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PRICE, QUANTITY AND EXPORT PRODUCT COMPOSITION INDEXES IN DEVELOPING COUNTRIES UNDER STRUCTURAL REFORMS: THE CASE OF PERU, 1993-2004

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Liberal structural reforms associated to changes in the export product composition may affect economic growth, and at the same time, may yield biases in the official standard trade index numbers from developing countries and error measures in the real rate of economic and exports growth. This paper proposes a set of index numbers which incorporates the export product composition in a standard export index in such a way that changes in the current export value can be decomposed into: price changes; quantity changes, and product composition changes. In the applications of those indexes for the Peruvian case, it is found that the estimated overvaluations in the official annual average rate of growth of the real exports value and the GDP, were respectively 3% and 0,6%, for the period 1993-2004.

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INTRODUCTION

Since 1970s, structural and liberal trade reforms have been undertaken in most developing countries with the support of the international organizations (e.g., IMF, WB, and IDB). Among the multiple effects expected from these reforms, emphasized on the development-growth economic literature, is the generation of export product diversification that will spur economic growth in these countries. As pointed out by Batista (2004), Taylor (2003); Berezin and associates (2002), Al-Marhubi (2000), and Piñeres-Ferrantino (1999, 1997), there may be several mechanisms by which outward oriented development processes may induce export product diversification and economic growth: i) through the exploitation of comparative advantage and larger foreign markets coming from new products; ii) the manufacturing processing of traditional primary export products; iii) firms' diversified portfolio of export products (even in primary products) may increase the export returns for domestic firms and may also produce stability on the export earnings and growth; iv) technological diffusion from increase trade and foreign direct investment may stimulate the growth of new sectors and creation of comparative and competitive advantages; and v) externalities and linkages may also generate creation of comparative and competitive advantages.

The changes of the export product structure emerging from these reforms may also affect the standard measures of trade (export and imports) indexes (i.e., prices and quantities). Traditional and modern index numbers[2] decompose the export value in a price and quantity indexes. Thus, changes in the export value due to changes in export product composition when prices and quantities are held constant may yield biases of the price and quantity indexes and error measures of the level and the rate of growth of the real export value. This paper proposes a set of index numbers which take into account the changes in product composition for transitional and developing countries subject to a drastic and long standing structural and trade reforms. This set of index numbers has the property that the changes in the current export value can be decomposed into: price changes; quantity changes, and product diversification changes. Furthermore, these indexes satisfy most of the main axiomatic properties of the standard index numbers including the circularity or chain property. A specific set of index numbers are, then, applied to the Peruvian export data wherein structural and trade reforms began in 1990 (Sheahan, 2000, Tello, 1993). The paper is organized in three sections. Section I, presents the index problem of measuring prices and quantities when there are changes in the product composition in each period[3]. Section II, applies the set of index numbers to the total export sector of the Peruvian economy for the period 1993-2004[4]. The final section summarizes the results.

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[2] A recent survey on index prices and trade indexes are found in Diewert (2001) and Dridi-Zieschang (2004) respectively.

[3] The sources of these changes, among other, may be: the introduction of new products, the entry and exit of established products, market discontinuities, quality changes and seasonal products. In the index price literature 'solutions' of these sources varies and depend upon the type of the source (e.g., Dridi-Zieschang, 2004, Schultze, 2003, Haussman, 2002, Schultze-Mackie, 2002; Greenless, 2000, and Baldwin-Nakamura-Nakamura, 1996). The focus of the proposed index number is not on the sources but rather in the continuous change of the product composition.

[4] An earlier application of the same set of index numbers is provided by Tello (1997) for Nicaraguan trade data.

I. PRODUCT COMPOSITION AND THE EXPORT PRICE AND QUANTITY INDEX NUMBERS

The following Chart No 1 illustrates the problem that generates the introduction of the change of the export product composition. The table contains information for three years for the price (p), quantity (q) and export value (Vt) of three export products. To emphasize the problem caused by the change in product composition it is assumed that all the prices and quantities are identical to one for all years. The base period is 3.

Chart No 1: The Data

Period	Product No 1		Product No 2		Product No 2		Total Value (Vt)	
	p1	Q1	p2	q2	p3	q3	Level	Rate of Change (%)
1	1	1	0	0	0	0	1	
2	1	1	1	1	0	0	2	100
3	1	1	1	1	1	1	3	50

In period 1 only product 1 is exported; in period 2, product 1 and 2 are exported; and in the last period the three products are exported. Even though prices and quantities remains constant export value is increasing in 100% in period 2 and in 50% in period 3. The fixed-base and chained Laspeyres (L and cL); Paasche (P, cP) and Fischer (or Ideal, I and cI) indexes, used as comparison indexes and also because of the official Central Bank of Peru (BCRP), the country case, uses them for the estimation of the trade indices, can be calculated using the following formulation:

$$[1] \quad Lqt = \sum_{i=1}^{nt} (qit/qi_0).si_0 ; \text{ where } si_0 = pi_0qi_0/\left(\sum_{i=1}^{no} pi_0qi_0\right)$$

$$[2] \quad Lpt = \sum_{i=1}^{nt} (pit/pi_0).si_0 ;$$

$$[3] \quad Lq(t-1),t = \sum_{i=1}^{nt} (qi_t/qi_{t-1}).si_{t-1} ; \text{ where } si_{it-1} = pi_{t-1}.qi_{t-1}/\left(\sum_{i=1}^{nt} pi_{t-1}.qi_{t-1}\right)$$

$$[4] \quad cLqt = \prod_{\tau=1}^{t} Lq(\tau-1),\tau ;$$

$$[5] \quad Lp(t-1),t = \sum_{i=1}^{nt} (pi_t/pi_{t-1}).si_{t-1} ; \text{ where } si_{it-1} = pi_{t-1}.qi_{t-1}/\left(\sum_{i=1}^{nt} pi_{t-1}.qi_{t-1}\right)$$

$$[6] \quad cLpt = \prod_{\tau=1}^{t} Lp(\tau-1),\tau ;$$

$$[7] \quad Pqt = \sum_{i=1}^{nt} (qit/qi_0).s'i_0 \text{ , where } s'i_0 = qi_0.pi_t/\left(\sum_{i=1}^{nt} qi_0.pi_t\right)$$

$$[8]\quad Pqt=\sum_{i=1}^{nt}(pit/pi_{t-1}).s''i_0\ ;\ \text{where}\ \ s''i_0=pi_0.qi_t\ /\ (\sum_{i=1}^{nt} pi_0.qi_t)$$

$$[9]\quad Pq(t-1),t=\sum_{i=1}^{nt}(qi_t/qi_{t-1}).s*i_{t-1}\ ;\ \text{where}\quad s*i_{it-1}=qi_{t-1}.pi_t/\ (\sum_{i=1}^{nt} pi_t.qi_{t-1})$$

$$[10]\quad cPqt=\prod_{\tau=1}^{t} Pq(\tau-1),\tau\ ;$$

$$[11]\quad Pp(t-1),t=\sum_{i=1}^{nt}(pi_t/pi_{t-1}).s*'i_{t-1}\ ;\ \text{where}\quad s*'i_{it-1}=pi_{t-1}.qi_t/\ (\sum_{i=1}^{nt} pi_{t-1}.qi_t)$$

$$[12]\quad cPpt=\prod_{\tau=1}^{t} PLp(\tau-1),\tau\ ;$$

$$[13]\quad Iqt=[Lqt.Pqt]^{0.5};$$

$$[14]\quad Ipt=[Lpt.Ppt]^{0.5};$$

$$[13]'\quad cIqt=[cLqt.cPqt]^{0.5};$$

$$[13]'\quad cIpt=[cLpt.cPpt]^{0.5};$$

All these indexes satisfy the product property. That is:

[P1] Lqt.Ppt=Lpt.Pqt=Iqt.Ipt=Vt/Vo; Vt is the export value at the period t

[P2] cLqt.cPpt=cLpt.cLqt=cIqt.cIpt= Vt/Vt-1

The Chart No 2 shows the computations of these indices using the data from Chart No 1. The comparison of these indices at each period t, yields[5]:

[15] Ipt< Lpt <Ppt=cLpt≤ cIpt≤cPpt and Iqt <Lqt<Pqt=cLqt≤cIqt≤cPqt;

Although the Paasche and the chained Laspeyres indexes measure appropriately the prices and quantities, these indexes cannot be used to satisfy the export value product property and therefore they cannot explain the changes in the export value. The rest of the indexes, either underestimate or overestimate the real indexes of prices and quantities.

Chart No 2: Computing The Index Numbers

Period	Laspeyres Index				Paasche Index				Fisher/Ideal Index				Ideal Adj.		Diver. Index		
	Lp	Lq	cLp	cLq	Pp	Pq	cPp	cPq	Ip	Iq	cIp	cIq	Iap	Iaq	Kp	kq	kn
1	1/3	1/3	1	1	1	1	1	1	$(1/3)^{0.5}$	$(1/3)^{0.5}$	1	1	1	1	$(3)^{0.5}$	$(3)^{0.5}$	1/3
2	2/3	2/3	1	1	1	1	2	2	$(2/3)^{0.5}$	$(2/3)^{0.5}$	$(2)^{0.5}$	$(2)^{0.5}$	1	1	$(3/2)^{0.5}$	$(3/2)^{0.5}$	2/3
3	1	1	1	1	1	1	3	3	1	1	$(3)^{0.5}$	$(3)^{0.5}$	1	1	1	1	1

[5] The results in [15] are held regardless of the selected base period.

The set of index numbers, that it is proposed follows the one formulated by Yan Aw and Roberts (1988) who provide a Tornqvist index number to solve the same problem for the case of different import bundle of goods to the US. The set of alternative index numbers proposed here is called the adjusted Fischer's ideal index numbers. The factors of adjustment are called the product composition factors. The general formula for the set of index numbers is the following:

[16] $Iapt=Ipt.kpt$; [17] $Iaqt=Iqt.kqt$;

Wherein, kqt and kpt are the quantity and price product composition factors respectively. These factors have the role to transform the ratios of unequal product composition for each period incorporated in the Fischer's ideal index numbers formulas to ratios of equal product composition. As long as this transformation is made, a family of index numbers could be created according to the definition of product composition factors. The one that it is proposed here although complex, it satisfies most of the properties of the index numbers including the circularity or chain property. The formulas for kp and kq (wherein the index 'i' is omitted in the sum of these formulas) are:

$$[16]' \quad kpt=\{[(\Sigma p_t.qm)/(\Sigma pm.qm)].[(\Sigma p_0.q_t)/(\Sigma pm.q_t)].[(\Sigma q_0.pm)/(\Sigma q_0.p_t)].[(\Sigma pm.\,qm)/(\Sigma qm.p_0)]\}^{1/2}$$
$$nt \qquad nt \qquad nt \qquad nt \qquad no \qquad nt \qquad no \qquad no$$

$$[17]' \quad kqt=\{[(\Sigma q_t.pm)/(\Sigma qm.pm)].[(\Sigma q_0.p_{ti})/(\Sigma qm.p_t)].[(\Sigma p_0.qm)/(\Sigma p_0.q_t)].[(\Sigma qm.\,pm)/(\Sigma pm.q_0)]\}^{1/2}$$
$$nt \qquad nt \qquad nt \qquad nt \qquad no \qquad nt \qquad no \qquad no$$

$$[18] \quad pmi=\sum_{t}^{T} pit/T; \text{ y } qmi=\sum_{t}^{T} qit/T;$$

Wherein, nt is the number of products composition in period t; no is the number of the products composition in a fixed base period, 'o'; T is the number of periods considered in the analysis; pmi and qmi are the average price and quantity for each product (tariff line), 'i', for the T periods[6].

In Chart No 2 the adjusted Fischer's ideal index numbers and the kp and kq factors have been computed. These indexes remains constant for the period considered. That is: $Iaqt=Iapt=1.0$, for $t=1,2,3$. In the case that the products composition does not change throughout the period of the analysis then, it can be shown that: $kq=kp^{-1}$ and $kn=1$. That is, the product composition index, kn, does not change throughout the period[7]. The analysis of the properties of the proposed set of index numbers follows the

[6] An alternative family of index numbers is given by the following definition of kp and kq:

$$kq=[(\Sigma p_{0i}.qmi)/(\Sigma p_{0i}.qmi)]^{1/2}; \quad qmi=\sum_{t} qit/T; \qquad kp=[(\Sigma q_{0i}.pmi)/(\Sigma q_{0i}.pmi)]^{1/2}; \quad pmi=\sum_{t} pit/T;$$
$$no \qquad nt \qquad\qquad no \qquad nt$$

The notation is similar to the adjusted ideal index numbers proposed in this paper. Both set of index numbers satisfy practically the same properties except that the one proposed satisfy the chain property. When the number of products is equal for all the time periods, this family set of index numbers is transformed to the ideal index numbers given that $kp=kq=kn=1$. Tello (1996) applies this set of index numbers to the analysis of export subsidies in Nicaragua.

[7] In the alternative set of index numbers proposed, $kp=kq=1$.

so called axiomatic or test approach suggested by Fischer (1922) rather than the economic theory approach of the index number (e.g., Konus, 1939; Allen, 1949; Diewert, 1993, 1995 and Balk-Fare-Grosskopf, 2004) and its application to external trade indicators (prices an quantities, e.g., Dridi-zieschang, 2004; and Kohli, 1978).

The first property (or Fischer's tests, 1922, and Eichhorn-Voeller, 1976) that the proposed adjusted ideal price (and quantity) index satisfies is *monotonicity*. Suppose that the vector of prices at period t is greater (lower) than the respective vector at base period 'zero' (pt> po or or pt<po) for all t. It can be shown that $Ip_t.kp_t=Iap_t > 1$ (or $Iap_t < 1$) as long as periods t and 0 belongs to set of periods of the sample of T[8] periods.

The second property is *dimensionality*. If all export prices are measured with a different unit, kp and Ipt remains constant and so does Iapt. The same occurs for the third property, the *commensurability* property. If prices and quantities are transformed to other units mutually consistent then, kp and Ipt do not change and therefore Iapt also does not change. The fourth property, the *proportional property* is a special case of the monotonicity property when the product composition is held constant. In this case, the prices at period 't' is a proportion δ of the price at the base period, 'o'. In this case, $kp_t=1$ and Ipt is the equal to the proportion δ, and therefore Iapt is also equal to that proportion.

A modified *product property* (or weak factor reversal test, Fisher, 1922) is satisfied for the adjusted index numbers, which is derived from [16], [17] and [P2]. That is:

[19] $Iapt.Iaqt.knt=Vt/Vo$; and $knt=(kpt.kqt)^{-1}$

Wherein, kn is called the product composition factor. This property implies that changes in the nominal export value are decomposed in three components: a price component (Iapt); a quantity component (Iaqt) and a product composition component (knt). Computed values for knt in Chart No 2 indicate that the changes of export value of the data is only due to change in kn, the increase in the number of export products. From this equation the real value of exports is given by:

[20] $Vrt= Vt/Iapt= Iaqt.kn.Vo$

Thus, the changes of the real export value have two sources: the adjusted quantity index (Iaqt) and the product composition factor or index (kn). The last property that satisfies the adjusted price (and quantity indexes) is the *chain or circularity* property. It can be shown that:

[20] $Iap_{t/s} = Iap_{t/0}/Iap_{s/0}$

Wherein, $Iap_{t/s}$ is the adjusted ideal price index of period t using 's' as the base year; $Iap_{t/0}$ is the adjusted ideal index price for period t using 'o' as the base period; and $Iap_{s/0}$ is the adjusted price index for period 's' using 'o' as the base period. This property means that the base can be changed from 'o' to 's' if we have the information of periods

[8] Note in the alternative set of index numbers, for any given product 'i', pio<pmi<pit (or pit<pmi<pio).

's' and 't' using 'o' as base period. In this case the three periods 's', 't', and 'o' should be included in the number of periods T. The first four properties satisfied by the adjusted ideal indexes imply that this is in fact an index number (Eichhorn and Voeller, 1990). The proposed indexes also satisfy the *identity* property, which states that in the base year the price and quantity indexes are equal to one[9].

II. PRICE AND QUANTITY ADJUSTED INDEXES AND PRODUCT COMPOSITION OF THE PERUVIAN EXPORTS, 1993-2004

In this section, the proposed set of index numbers is applied to the Peruvian export data for the period 1993-2004. Two data sources are used for the computations. One is ADUANET, the Peruvian customs register office that records all the trade flows transactions, using a modified Harmonized 10 digit tariff line system called the NABANDINA classification (used by the Andean Group). The period used from this source is 1993-2004. The other is COMTRADE from the UNCTAD, which reports the trade prices and quantities using the Harmonized classification of 6 digit tariff lines. The period used from this source is 1998-2003. The Central Bank of Reserve of Peru (BCRP) computes the official price and quantity indices for the Peruvian trade flows. The export price is measured through a chained ideal index price and the export quantity is measured through a Laypeyres index using a set of fixed prices of the main traditional export products and from the main trading partners for the rest of export products[10]. The base year is 1994. In computing the adjusted ideal export price and quantity indices, the average export value coverage from ADUANET and COMTRADE were 96,9% and 97,7% respectively out of the total export value from these sources. In both sources, tariff lines were eliminated whenever there was some missing data (price or quantity) for the tariff line and when prices and/or quantities had no credible changes per year. The difference between the total number of tariff lines from both (Np_total) data sources and the number of tariff lines considered in the computations (Np) of the adjusted indices are provided in Table No 3 (for ADUANET) and Table No A3 (for COMTRADE).

Even though the BCRP uses ADUANET as his main data source, the total export value reported by this entity is different than that reported in the ADUANET data. For that matter, is not clear the data 'cleaning' that the BCRP implement in the computations of their indexes. The computations of the adjusted and product composition indexes, using the ADUANET data, are reported in Table No 1, 2 and 3 and their respective Figures No 1, 2 and 3. For comparison purposes the estimated indices of the BCRP are also reported in these tables and figures. In the statistical appendix in Tables No A1, A2 and A3 and Figure A1 and A2 the same indexes are reported using the COMTRADE data. Tables No 4 and 5 provides the export value decomposition using both data sources. The figures in the all these tables indicates:

[9] Two well known properties, from the economic approach to index numbers theory are those of the exact and superlative properties (Diewert, 1976). Our conjecture is that the proposed set of index numbers does not satisfy these properties since it will be needed to find a production (o utility) function that takes account changes in product composition.

[10] The main traditional export products in Peru in this period were: Fishing flour; Fishing oil; Cotton, Sugar, Copper; Zinc; Gold; Refined Silver; Tin; Coffee; Iron; Lead. In average, the account for 63,2% of the total Peruvian export value.

i) Except for one year in the case of the price index (i.e, 1998) and two years in the quantity export index (i.e., 1994 and 1995), the sign of the changes of prices indexes (i.e., the adjusted and the chained ideal indexes) and those of the quantities indexes (i.e., the adjusted ideal and the Laspeyres indexes) are the same. The magnitude, however, are different. The magnitude of the change of the official BCRP's chained ideal export price has been, in average of the period 1994-2004, lower than the respective magnitude of the adjusted ideal export price index. The reverse is true for the export quantities indexes;

ii) In average for the 1999-2003 period and for most of the years in this period, the sign and the magnitude of the rate of changes of the adjusted ideal prices and quantities has been similar for both sources of data, ADUANET and COMTRADE;

iii) The average rate of change of the number of tariff lines included in the adjusted ideal export indexes, using the ADUANET source was 9,2 % for the period 1994-2004 and 4,6% for the 1999-2003 period. The respective changes of the total number of tariff lines were 12,3% and 6,7% for each period[11]. The same averages, using the COMTRADE data were lower than the ADUANET data for the period 1999-2003. This, in part, is explained by the higher level of aggregation of the 6 digit tariff lines of COMTRADE data;

The export value decomposition, due to the introduction of factor composition index is different between the official trade indexes and the adjusted ideal indexes proposed. In average for the 1994-2004, export prices changes explain close to 70% of the total export values changes. Thus, the fact that export value approximately triple from 1994 to 2004, most of this effect was by price effect rather than by quantity effect. Conversely, the official indexes of the BCRP indicate that close to 70% of the total export values changes are explained by changes in the export quantity. According to the proposed index numbers, part of the change of this quantity was due to change in product composition, among other things, explained by the introduction of new export products[12]. The computed adjusted indexes indicate that close to 30% of the total 'quantity change' were due to changes in the product composition.

[11] The large difference between the numbers of tariff lines included in the indexes computations and the total number of tariff lines are explained among other things by: i) missing data in the tariff line; ii) tariff lines with only one year of information; and iii) errors in the values.

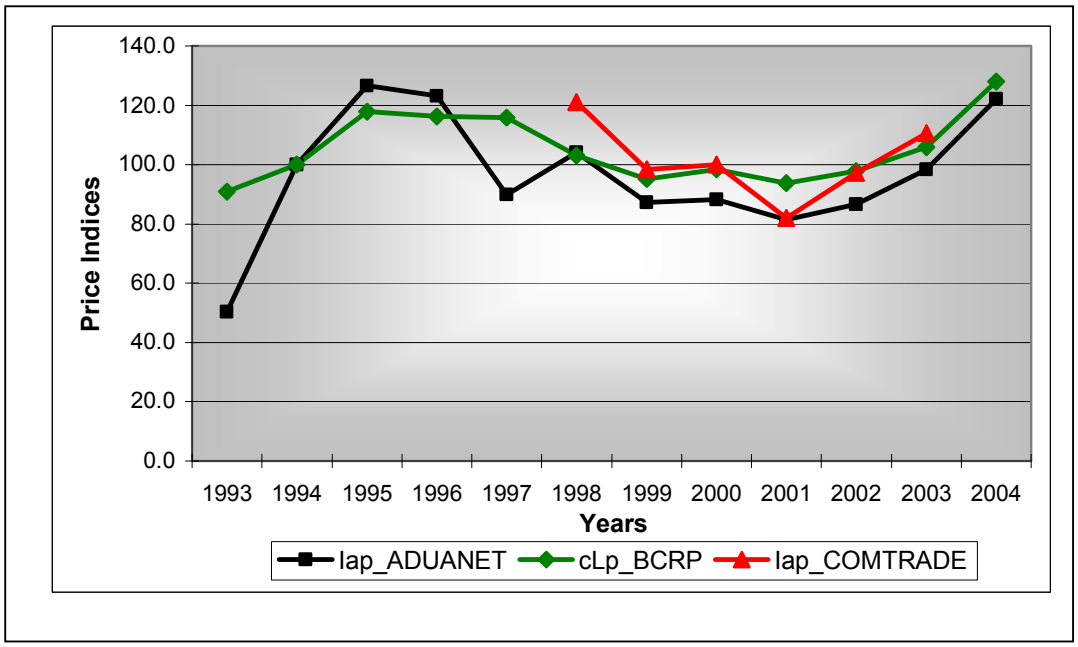
[12] A sample of 'new' export products in Peru is provided in Table No A4.

TABLE No 1
Adjusted and Chained Fischer Export Price Indices of Peru, 1993-2004
(Base =1994)

Year	Iap	Rate of Change.%	clpBCRP	Rate of Change.%	Number of 10 Digit Tariff lines	Rate of Change. %	% Vx
1993	50,4	--	91,0	--	6666	--	96,4
1994	100,0	98,4	100,0	9,9	9184	37,8	95,8
1995	126,7	26,7	117,8	17,8	9049	-1,5	99,0
1996	123,2	-2,7	116,3	-1,3	10196	12,7	98,7
1997	89,9	-27,0	115,9	-0,3	12293	20,6	94,9
1998	104,2	15,8	103,0	-11,1	15595	26,9	94,0
1999	87,2	-16,3	95,1	-7,7	16603	6,5	98,5
2000	88,2	1,2	98,5	3,5	17830	7,4	98,0
2001	81,4	-7,8	93,7	-4,9	17484	-1,9	97,6
2002	86,7	6,5	97,8	4,4	19923	13,9	99,0
2003	98,4	13,6	105,9	8,3	21483	7,8	98,4
2004	122,1	24,0	128,0	20,8	22493	4,7	92,3
Avg[1]		12,0 (-0,6)		3,6 (0,7)		12,3 (6,7)	96,9

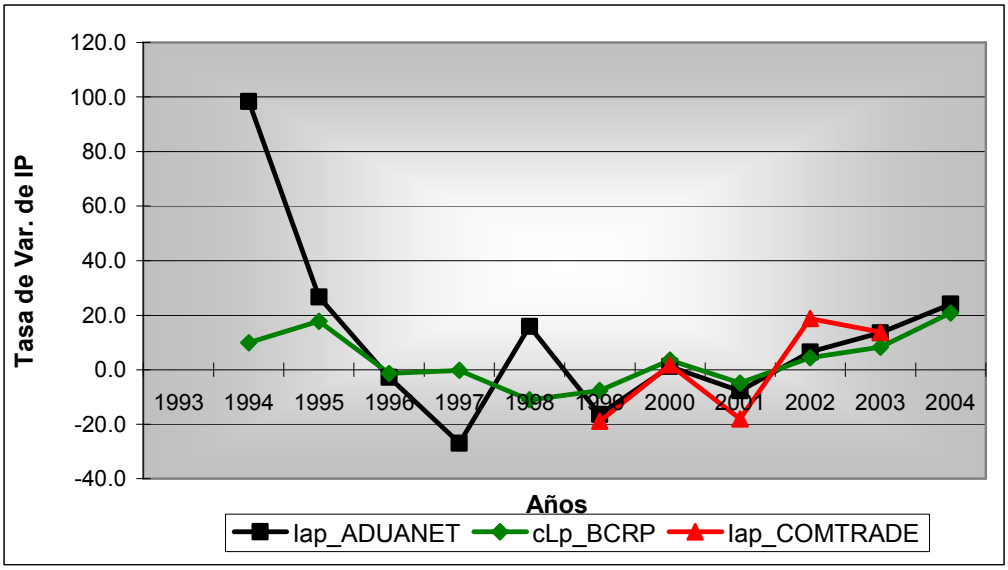
Source: ADUANET, Web-BCRP, Author's estimation, %Vx, Export value sample coverage.
[1] The number in parenthesis are the average rate of change for the 1999-2003 period.

FIGURE No 1
Adjusted and Chain Fischer Export Peruvian Prices Indices, 1993-2004



Source: ADUANET, Web-BCRP, COMTRADE, Table No 1

FIGURE No 1A
Rate of Change of Peruvian Export Prices Indices, 1994-2004



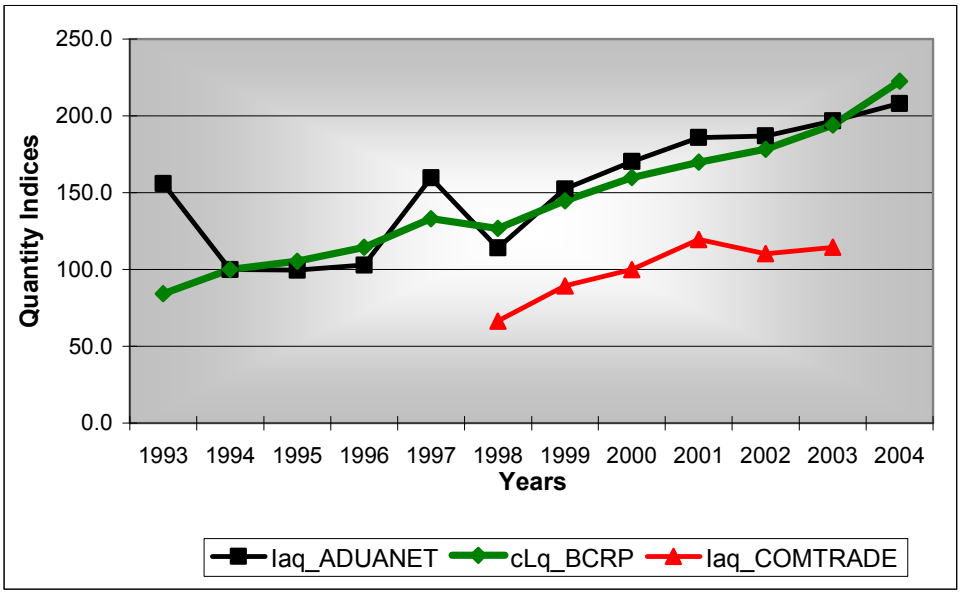
Source: ADUANET, BCRP, COMTRADE, Table No 1

TABLE No 2
Adjusted Fischer and Laspeyres Export Quantity Indices of Peru 1993-2004
(Base =1994)

Year	Iaq	Rate of Change,%	LqBCRP	Rate of Change,%	Number of 10 Digit Tariff lines	Rate of Change,%	% Vx
1993	156,0	--	84,3	--	6666	--	96,4
1994	100,0	-35,9	100,0	18,7	9184	37,8	95,8
1995	99,6	-0,4	105,4	5,4	9049	-1,5	99,0
1996	102,9	3,3	114,5	8,7	10196	12,7	98,7
1997	159,8	55,3	133,1	16,2	12293	20,6	94,9
1998	114,0	-28,6	126,8	-4,7	15595	26,9	94,0
1999	152,4	33,7	144,7	14,1	16603	6,5	98,5
2000	170,3	11,7	159,9	10,5	17830	7,4	98,0
2001	186,0	9,3	169,8	6,2	17484	-1,9	97,6
2002	186,9	0,4	178,2	5,0	19923	13,9	99,0
2003	196,8	5,3	194,0	8,8	21483	7,8	98,4
2004	208,1	5,7	222,6	14,8	22493	4,7	92,3
Avg.[1]		5,4 (12,1)		9,4 (8,9)		12,3 (6,7)	96,9

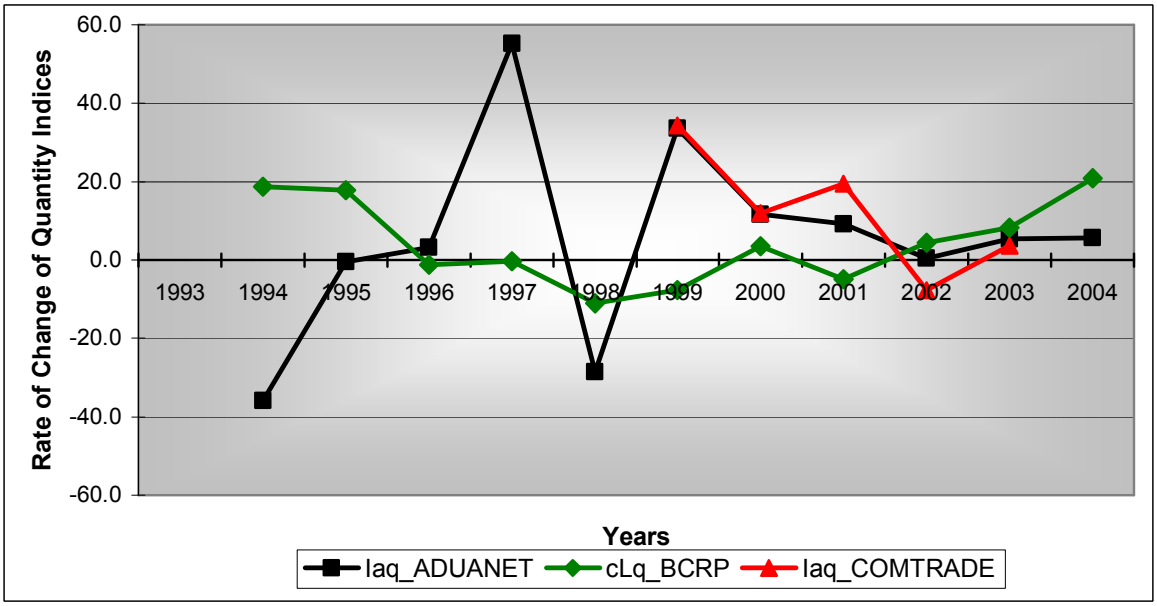
Source: ADUANET, Web-BCRP, Author's estimation, %Vx, Export value sample coverage.
[1] The number in parenthesis are the average rate of change for the 1999-2003 period.

FIGURE No 2
Peruvian Export Quantity Indices, 1993-2004



Source: ADUANTET, BCRP, COMTRADE, Table No 2.

FIGURE No 2A
Rate of Change of Peruvian Export Quantity Indices, 1994-2004



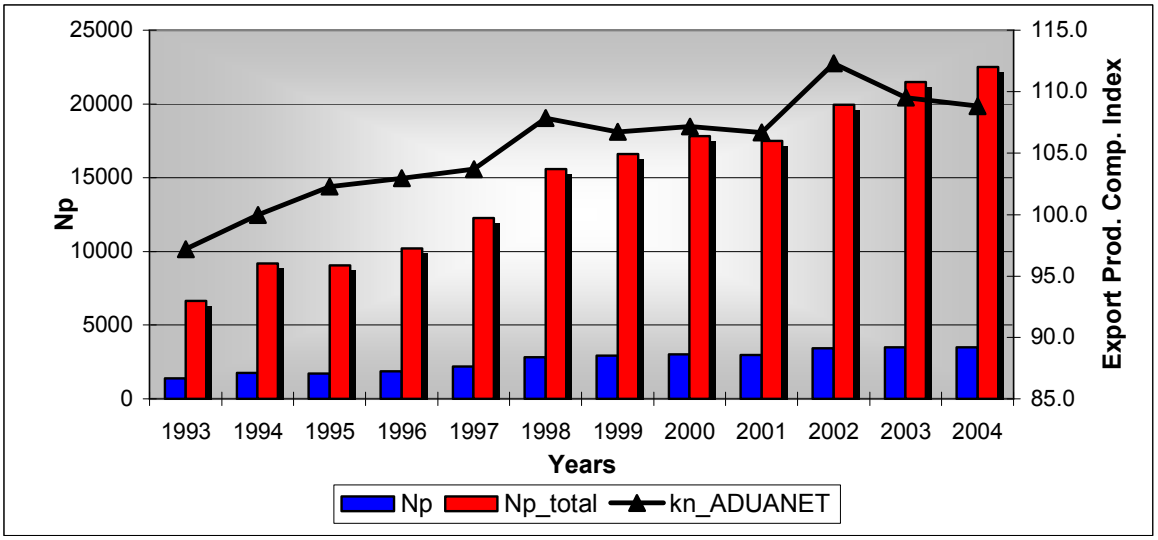
Source: ADUANTE, Web-BCRP, COMTRADE, Table No 2.

TABLE No 3
Export Product Composition Index of Peru (kn), 1993-2004
(Base =1994)

Year	kn	Rate of Change,%	Np[1]	Rate of Change,%	Np Total[2]	Rate of Change,%
1993	97,2	--	1396	--	6666	
1994	100,0	2,9	1737	24,4	9184	37,8
1995	102,3	2,3	1714	-1,3	9049	-1,5
1996	102,9	0,6	1877	9,5	10196	12,7
1997	103,7	0,8	2187	16,5	12293	20,6
1998	107,9	4,0	2815	28,7	15595	26,9
1999	106,7	-1,1	2930	4,1	16603	6,5
2000	107,2	0,4	3031	3,4	17830	7,4
2001	106,7	-0,5	2971	-2,0	17484	-1,9
2002	112,3	5,3	3429	15,4	19923	13,9
2003	109,5	-2,5	3500	2,1	21483	7,8
2004	108,9	-0,6	3514	0,4	22493	4,7
Avg.[3]		1,1 (0,3)		9,2 (4,6)		12,3 (6,7)

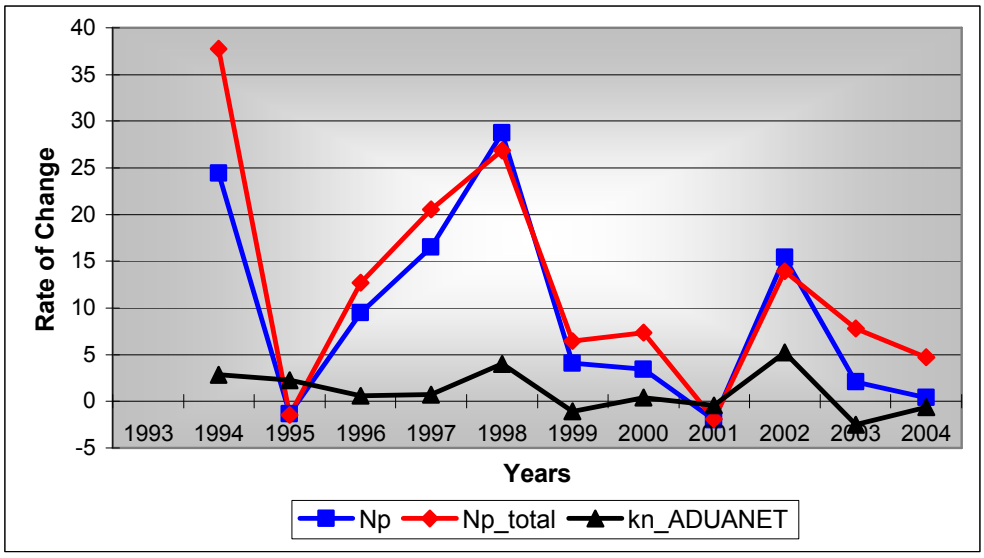
Source: ADUANET, Author's estimation.[1] Number of tariff lines taken in the indices computation. [2] Total number of 10 digit tariff lines of export products at period t. [3] The number in parenthesis are the average rate of change for the 1999-2003 period.

FIGURE No 3
Export Product Composition Index (kn) and Numbers of 10 Digit Tariff Lines, ADUANET Data, 1993-2004



Source: ADUANET, Table No 3, Np, Number of 10 digit tariff lines taken in the indices. Np_total, the total Number of 10 digit tariff lines of export products in Peru.

FIGURE No 3A
Rate of Change of the Product Composition Index (kn) and Number of 10 Digit Tariff Lines, ADUANET, Data, 1993-2004



Source: ADUANET. Author's estimations. Np = Number of 10 digit tariff lines taken in the computations of the indices. Np_total, the total Number of 10 digit tariff lines of export products in Peru

TABLE No 4
Export Nominal Value Decomposition Using ADUANET Data, 1993-2004 (%)

Año	Differential of ln of Export Nominal Value (1)	Differential of ln of Adjusted Ideal Export Price (2)	Differential of ln of Adjusted Ideal Export Quantity (3)	Differential of ln of Product Comp. Index (4)	Ratio (2)/(1)	Ratio (3)/(1)	Ratio (4)/(1)
1993	--	--	--	--	--	--	--
1994	26,8	68,5	-44,5	2,8	255,2	-165,7	10,5
1995	25,6	23,7	-0,4	2,3	92,6	-1,6	9,0
1996	1,0	-2,8	3,2	0,6	-280,0	320,0	60,0
1997	13,3	-31,5	44,0	0,8	-237,8	331,8	6,0
1998	-15,1	14,7	-33,7	3,9	-97,6	223,5	-25,9
1999	10,1	-17,8	29,0	-1,1	-175,9	286,8	-10,9
2000	12,7	1,2	11,1	0,4	9,5	87,3	3,2
2001	0,3	-8,1	8,9	-0,5	-2498,0	2752,2	-154,2
2002	11,9	6,3	0,5	5,1	53,0	4,2	42,8
2003	15,4	12,7	5,2	-2,5	82,4	33,8	-16,2
2004	26,6	21,6	5,6	-0,6	81,2	21,1	-2,3
Avg,	11,6	8,0	2,6	1,0	69,0	22,4	8,6

Source: ADUANET. Author's estimation.

TABLE No 5
Nominal Export Value Decomposition BCRP Data, 1993-2004 (%)

Year	Rate of Change of the Nominal Export Value (1)	Rate of Change of clp_BCRP (2)	Rate of Change of lq_BCRP (3)	Ratio (2)/(1)	Ratio (3)/(1)
1994	30,8	9,9	18,7	32,2	60,8
1995	24,1	17,8	5,4	73,8	22,4
1996	7,0	-1,3	8,7	-18,5	123,7
1997	16,1	-0,3	16,2	-1,9	100,5
1998	-15,6	-11,1	-4,7	70,9	30,0
1999	5,7	-7,7	14,1	-134,0	245,5
2000	14,2	3,5	10,5	24,6	73,7
2001	1,0	-4,9	6,2	-481,3	609,0
2002	9,8	4,4	5,0	44,9	51,0
2003	17,8	8,3	8,8	46,5	49,3
2004	38,8	20,8	14,8	53,6	38,2
Avg.	13,6	3,6	9,4	26,3	69,2

Source: Web-BCRP. Author's estimation.

Liberal markets structural reforms, in particular, the trade liberalization reforms, indeed are associated to changes in the export product composition in developing economies, such as the Peruvian economy. However, those changes will also produce biases in the measure of the changes of the quantity and prices of the traditional index numbers such as the chained ideal price index and the Laspeyre quantity index used by the official institution in Peru[13]. As a consequence of these biases, the real export value growth and the real GDP growth may suffers of measurement errors. Table No 6 provides the exports real value estimated using the official and the adjusted export prices indexes.

Whereas the official trade indexes of Peru associate the more than a triple increase in the nominal export between 1993 and 2004 with a close to a triple increase of the real export value, the adjusted ideal indexes yields only an increase of 150% of the total exports real value. This difference produces an overestimation of close to 3% in average per year of the rate of real export growth and, assuming that real exports is 20% of the total GDP, an overestimation of 0,6% of the real growth of the GDP[14]. Moreover, the estimated average contribution of the change in export product composition, in the period 1993-2004, of the total export real value was approximately 6%, being the highest contribution in 2002 of 11% of the total export real value.

[13] The sources of the biases come on the one hand, due to omission of the changes of product export composition. On the other hand, due to that the estimated value of the rate of change of these traditional indexes, in the case of Peru, are dominated by the changes in prices and quantities of the 12 main traditional exports products that account for 63,5% of the total export value. The weighted average of the rate of change of prices and quantities of these 12 products are very similar to the respective rate of change of the official quantity and price indexes. The former are 8,9% and 3.0% respectively, whereas the official are 9,4% and 3,6%.

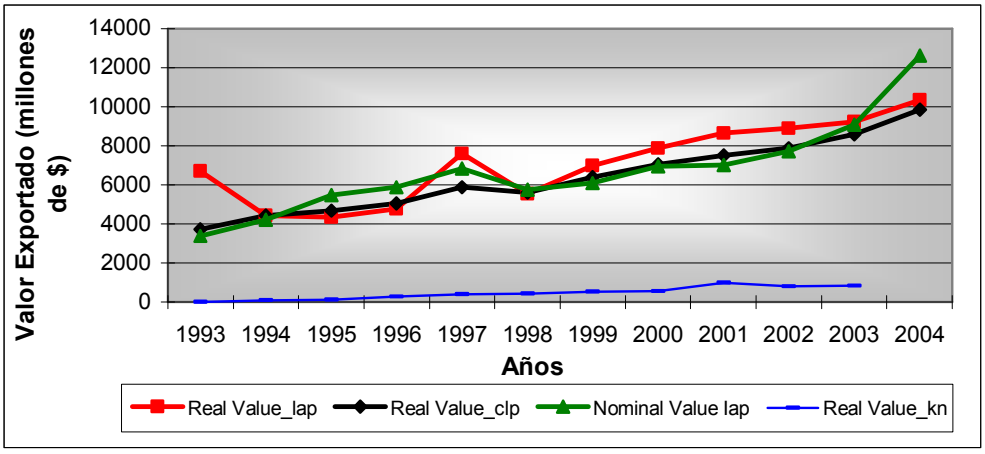
[14] The average rate of change of the Peruvian real GDP growth in this period was 4,4%.

TABLE No 6
Export Real Values Using Nominal Values of the BCRP, 1993-2004
(Constant Millions of Dollars of 1994)

Año	Nominal Export Value	Rate of Change.%	Real Value Using clp (BCRP)	Rate of Change.%	Real Value Using lap	Rate of Change.%	Estimated Real Value Due to Changes in Prod. Comp.
1993	3384,0	--	3718,7	--	6713,3	--	-193,3
1994	4424,8	30,8	4424,8	19,0	4424,8	-34,1	0,0
1995	5491,4	24,1	4661,6	5,4	4334,2	-2,0	97,2
1996	5877,6	7,0	5053,8	8,4	4770,1	10,1	136,2
1997	6824,6	16,1	5888,4	16,5	7589,0	59,1	271,7
1998	5756,8	-15,6	5589,1	-5,1	5525,8	-27,2	402,7
1999	6087,5	5,7	6401,2	14,5	6983,6	26,4	439,3
2000	6954,9	14,2	7060,8	10,3	7885,5	12,9	528,3
2001	7025,7	1,0	7498,1	6,2	8636,0	9,5	541,3
2002	7713,9	9,8	7887,4	5,2	8900,8	3,1	974,7
2003	9090,7	17,8	8584,2	8,8	9235,2	3,8	803,7
2004	12616,9	38,8	9857,0	14,8	10332,9	11,9	840,6
Avg.	6770,7	13,6	6385,4	9,5	7110,9	6,7	403,6

Source: ADUANET. Author's estimation.

FIGURE No 4
Real and Nominal Export Estimated Values, 1993-2004
(Constant Millions of Dollars of 1994)



Source: Table No 4.

III. CONCLUDING REMARKS

Liberal structural reforms, in particular trade reforms, are expected to generate an increase in export product diversification that will affect economic growth in developing countries. However, changes in the export composition may also generate biases in the measure of standard price and quantity trade indexes and may produce overestimations of the real impact of exports growth on the GDP growth. Using the axiomatic approach of the index numbers, this paper have proposed a set of trade indexes that allows for changes in the export composition that may avoid the potential bias on the trade indexes. A singular feature, of the proposed trade indexes is it measures the product composition in the trade (export) sector in such a way that

changes in the current trade (export) value can be decomposed into: price changes; quantity changes, and product composition changes. When the proposed set of export indexes are applied to Peruvian export data, it is estimated, that export product diversification have contributed, in average for the period 1993-2004, in about 6% of the total real export value and close to 9% of the average annual export value growth of the period. At the same time, changes in product composition may have yielded an overestimation of the Central Bank of Peru official figures of 3% in the average annual real rate of export growth and 0,6% of the respective rate of GDP growth for the period. Thus, the triple increase in the real value of the total Peruvian exports estimated for the official figures from 1993 to 2004 is reduced to 150% increase using the proposed export indexes.

Regardless of the shortcomings and advantages of the proposed set of trade indexes, these estimations shows that the size of the bias in the exports figures and their impact on the GDP figure may be very high and may well overstate the economic growth impact of export growth in developing countries, in periods of meaningful changes in the trade product composition in these countries.

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STATISTICAL APPENDIX

TABLE No A1
Adjusted and Chain Fischer Export Price Indices of Peru, 1998-2003 (Base =2000)

Año	Iap	Rate of Change,%	clpBCRP	Rate of Change,%	Np Total[1]	Rate of Change,%	% Vx
1998	121,2	--	103,0	--	16746	--	92,9
1999	98,3	-18,9	95,1	-7,7	17740	5,9	95,9
2000	100,0	1,7	98,5	3,5	18971	6,9	96,5
2001	81,9	-18,1	93,7	-4,9	19019	0,3	96,8
2002	97,3	18,7	97,8	4,4	19712	3,6	99,2
2003	110,6	13,8	105,9	8,3	21116	7,1	99,2
Avg.		-0,6		0,7		4,8	96,7

Source: COMTRADE, Web BCRP, Author's estimation, [1] Number of 6 digit tariff lines.

TABLE No A2
Adjusted Fischer and Laspeyres Export Quantity Indices of Peru, 1998-2003 (Base =2000)

Año	Iaq	Rate of Change,%	LqBCRP	Rate of Change,%	Np Total[1]	Rate of Change,%	% Vx
1998	66,5	--	126,8	--	16746	--	92,9
1999	89,3	34,4	144,7	14,1	17740	5,9	95,9
2000	100,0	11,9	159,9	10,5	18971	6,9	96,5
2001	119,5	19,5	169,8	6,2	19019	0,3	96,8
2002	110,3	-7,6	178,2	5,0	19712	3,6	99,2
2003	114,4	3,7	194,0	8,8	21116	7,1	99,2
Avg.		12,4		8,9		4,8	96,7

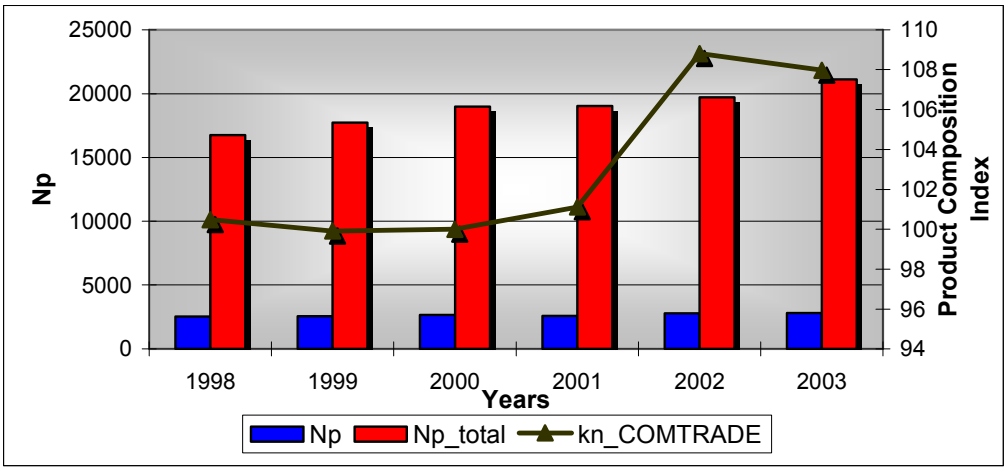
Source: COMTRADE, Author's estimation, [1] Number of 6 digit tariff lines

TABLE No A3
Export Product Composition Index of Peru (kn), 1998-2003 (Base =2000)

Año	kn	Rate of Change,%	Np	Rate of Change,%	Np_Total	Rate of Change,%
1998	100,5	--	2532	--	16746	
1999	99,9	-0,6	2556	0,9	17740	5,9
2000	100,0	0,1	2657	4,0	18971	6,9
2001	101,1	1,1	2573	-3,2	19019	0,3
2002	108,8	7,6	2786	8,3	19712	3,6
2003	108,0	-0,8	2820	1,2	21116	7,1
Avg.		1,5		2,2		4,8

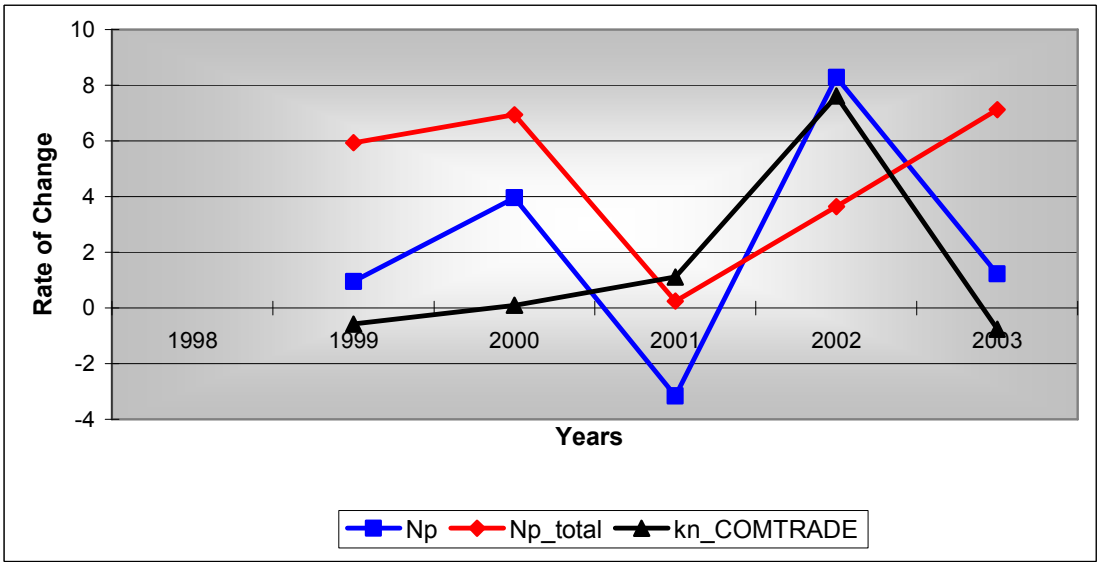
Source: COMTRADE. Author's estimations. [1] Number of six digit tariff lines taken for the adjusted indices computations. [2] Total number of six digit tariff lines.

FIGURE No A1
Product Composition Index (kn) Using and Number of 6 Digit Tariff Lines, Using COMTRADE Data, 1998-2003



Source: COMTRADE. Table No A1.

FIGURE No A2
Rate of Change of the Product Composition Index (kn) Using and Number of 6 Digit Tariff Lines, Using COMTRADE Data, 1998-2003



Source: COMTRADE, Table No A1.

TABLE No A4

A Sample of Peruvian Export Products Out the 500 Main Export Goods, 2004

No	Tariff Line Number	Product Description	Initial Export Year	Export Value, 2004 (Millions of Dollars)
1	6105100052	Knitted Man Color Shirts	1998	17,2
2	7108010000	Asparagus	2002	15,6
3	8030012000	Fresh BANANAS "CAVENDISH VALERY"	1999	10,6
4	6109100032	Women and men Cotton Color "T-SHIRT"	1998	9,6
5	5211420000	Color Cotton Fabrics and Threads	2001	5,3
6	6109100042	Knitted Cotton Color "T-SHIRT"	1998	5,3
7	5606000000	Especial Threads	2003	1,9
8	3042010100	Frozen Hake	2002	4,2
9	1005909010	White Maize	1997	4,0
10	3203001400	Coloring of Vegetable Origin	1997	3,8
11	5509990000	Synthetic Fibers	2000	0,9
	Total (% out of Total Export) Value			78,3 (0,62)