Journal of Economic and Social Research 7(1), 71-97

Estimating Mining Export and Import Structures: Price and Output Elasticities in Turkey

Mustafa Akal*

Abstract. This study attempts to estimate the mining export and import structures and their income and price elasticities in Turkey. The mining export indicated a significantly cubic relationship with respect to the mining terms of trade adjusted U.S. Dollar exchange rates and significantly linear relationships with respect to (i) the world wholesale prices (ii) the mining domestic wholesale prices and (iii) the world output in natural logarithmic terms. However, the mining import indicated a significantly parabolic relationship with respect to the mining terms of trade adjusted U.S. Dollar exchange rates, a significantly cubic relationship with respect to the world wholesale prices and a linear relationship with respect to the domestic output in natural logarithmic terms. The estimated mining import and export models exhibited a long-run relationship in the variables. However, some variables indicated are found contradictory to the theory in causality of directions.

The estimated mining world export demand world output elasticity ranged between 4.6 and 7.66. The estimated mining import domestic output elasticity ranged between 0.8 and 1.34. The mining export was found more income elastic than the mining import. The mining export was found inelastic with respect to the domestic mining prices. The mining export sectoral term of trade adjusted U.S. Dollar exchange rate elasticity indicated a natural logarithmic parabolic function, but the mining import sectoral terms of trade adjusted U.S. Dollar exchange rate elasticity indicated a natural logarithmic linear function, which implies changing elasticities over time, contradicting the constant elasticity assumption in the Neo-Classical Theory.

JEL Classification Codes: C1 ; C12, C13, C5, F1 ; F11, F14
Keywords: Mining, international trade, elasticity, Turkey.

* Assoc. Prof. Dr., Sakarya University, Faculty of Economic and Administrative Sciences, Economics Department, Esentepe Kampusu, Adapazarı, 54187, Turkey. Phone: 90-264-2956341, E-mail: akal@sakarya.edu.tr.

1. Introduction

It is important to estimate both the mining export and import demand structures in a country in order to derive policy implications based on the structural patterns and their estimated elasticities. We need to know the direction of causal relation between mining export or import and price or income variables and their structural of relations based on real data.

There might exist contradictions between data and theory in view of (i) the expected signs (ii) the direction of causalities and (iii) the structures of the relations between endogenous and exogenous variables. Marquez (2002) mentioned contradictory results between data and theory in estimating trade elasticities. Hooper, Karen and Marquez (1998) found the U.S. exports and imports cointegrated with relative prices and real effective exchange rates over the 1960-94 period, but they obtained an incorrect indication for the price elasticity for imports when using an effective exchange rate index. This result implied that a weaker domestic currency associated with greater imports for the U.S.A. economy. Johnston and Chinn (1996) found the evidence of a long-run relationship between U.S. trade flow, income and the real exchange rate over the 1973-93 period. On the other hand, Rose and Yellen (1989) rejected the cointegration hypothesis using the Engle-Granger Procedure in the estimated regression of the general form in trade balance for the monthly data over the 1960-85 period. From these findings, one may conclude that different authors may estimates different statistics in magnitude or in signs basing upon sample periods, magnitude of trade deficits and structure of relations between endogenous and exogenous variables over time. For example, in regarding to the magnitudes of trade elasticities, improvements in trade balance require larger movements in the value of domestic currency under larger trade deficits, which implies low import price elasticity. Turkey has faced large trade deficits for the 1982-2000 period thus having inelastic mining price and sectoral adjusted foreign exchange rate elasticity for the mining sector in the economy.

The earlier studies by Khan (1974), Murray and Ginman (1976), Goldstein and Khan (1978), Haynes and Stone (1983), and Arize (1987), etc., all assumed that both foreign income and relative prices are effective on foreign export demand. They also assumed that both domestic incomes and relative prices of countries influence import demand. They estimated both the relative price and income elasticities of both exports and imports for various countries by assuming log linear models rather than testing whether simultaneity and linearity exist or not in international trading. Tansel and

Togan (1987) followed a similar approach for Turkey. Their approach is called "the traditional approach" in the reports. They choose aggregated exports receipts and imports expenditures as endogenous variables in their models. They all based their models on the assumption of economic theory, which assumes export and import imperfect substitutes for domestic goods or vice versa. In regarding to estimation based on the most tradable goods[1], the estimation of structural forms of relations between endogenous and exogenous variables depending on data analysis the magnitudes of our estimates may differ from their estimates. Hence, the policy derivations based on different models and periods may differ. As a result, it is important to examine broadly and estimate the most appropriate export and import demand price and output elasticities for Turkey, especially after 1980.

Özatay (2000) set up Turkish total export goods as a function of foreign income and real exchange rate. He found significant inelastic real exchange rate elasticity but an insignificant foreign income elasticity effect. Senhadji and Montenegro (1999) emphasized that the higher export demand income elasticity means a more powerful export growth effect as an engine of growth. The higher export price elasticity means more competition in the international market for exports, and thus a more successful real exchange rate devaluation effect on improving export revenues and the balance of trade deficit facing a country. Similar implications can be derived in a mining sector [2].

Arslan and Wijnbergen (1993) concluded that the policies allowing real depreciation of the domestic exchange rate were more effective than export incentives on Turkish export growth. In this tie, we may research a possible effect of the mining terms of trade-adjusted exchange rates on the mining exports and imports. Bahmani-Oskooee and Domac (1995) estimated a long-run equilibrium relationship between export growth and output growth in Turkey during the 1923-90 period. Yiğidim and Köse (1997) found statistically insignificant export effect but the most determinately import effect on the economic growth of Turkey. So the effect of price and income variables on the mining trade tells us something indirectly about the effect of the mining sector on the growth.

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[1] This study considers goods that indicate above two millions U.S. Dollar trading in volume.

[2] However, there is no study to estimate trade structure and elasticities for mining sector.

Özmen and Furtun (1998) rejected the validity of the export-led growth hypothesis for Turkey. They found a bi-directional Granger causality between the export growth and output growth. Bahmani-Oskoode and Latifa (1992) estimated a significantly negative exchange rate effect on Turkish general exports. Sivri and Usta (2001) found that the real exchange rate Granger causes neither exports nor imports by using the VAR model, and it can not be applied to improve the trade balance of Turkey. Bahmani-Oskooee and Brooks (1999) found the evidence of a long-run relationship between both the real GDP and real exchange rate and the U.S. bilateral import and export demand with other G-7 countries. They realized that real depreciation of the dollar improves the USA's bilateral trade balance with four out of six big trading partners because the sum of the price elasticities of U.S. import and export demands in the cases of Japan, United Kingdom, France, and Italy was more than unity but it was less than one in the cases of Canada and Germany. Bahmanı-Oskooee (1998) found the evidence that the estimated trade price elasticities were large enough to support devaluation as a successful policy to improve the trade balance in most of the less developed countries.

This study inductively analyses Turkish data and estimates mining exports and imports models more conveniently than the traditional approach[3]. In addition, this study uses (i) the weighted exports and import quantity indexes which obtain traded mining goods above two millions USD in volume rather than aggregates (ii) the mining terms of trade adjusted American Dollar exchange rate (iii) foresees a mathematical form based on data analysis (iv) estimates the directions of causalities and thus tests the theoretical causal assumptions between variables (v) tests whether the simultaneity exists between the endogenous variables which are assumed in some traditional models. Based on these differences, we estimate the most appropriate mathematical form between the mining export or the mining import and their explanatory variables to estimate the mining foreign trade elasticities.

Karluk (2003:66-69, Salvatore, 1990:179-88 and 219-229) discuss how the changes in the terms of trade, tariff rates and devaluations affect countries' offer curves. Theoretically, Turkey's mining offer curve shifts

[3] Conventional estimates including traditional neoclassical approach follows deductive approach. Here, we do not tell that we do not consider deductive approach, but we test it inductively by estimating structures and causality of directions between theoretically stated endogenous and exogenous variables by the help of the theory.

outwards as a result of (i) devaluation of domestic currency (ii) the mining terms of trade deteriotion and (iii) reductions in tariff rates. In other words, the mining import is assumed to increase as a result of increases in the mining terms of trade due to decreases of import prices relative to export prices, or domestic currency revaluation, or tariff reductions. This means that the mining export quantity offer (or foreign import demand) per mining import demand increases. It is assumed that Turkey has the potential to increase exportable mining production after its mining export prices are reduced and a large mining import market is matched after tariff reductions on mining import goods. In other words, there exists room to increase mining imports with increasing mining export quantity at the expansion of offer curves as a result of trade liberalization policies since 1980. Consequently, the mining production is assumed to increase and the effect of the mining sector on growth is expected to be higher.

2. Data and Variables

Mining export and import quantity and price indexes are obtained from *Statistical Indicators (2002)*, *Turkish Statistical Institution*, and other variables are obtained from the *International Financial Statistics Yearbook* (*1997,2001), IMF.* The variables are symbolized as follows:

LQXMI= Ln (Mining export quantity indexes),
LPXMI= Ln (Mining export price indexes),
LQMMI=Ln (Mining import quantity indexes),
LPMMI=Ln (Mining import price indexes),
LMIEXC=Ln ((Turkish Liras per U.S. dollar)/(Mining export price indexes/Mining import price indexes)), or
Ln (Mining Terms of Trade adjusted U.S. Dollar in terms of Turkish Liras).
LWPIMI= Ln (Turkish mining wholesale price indexes),
LWWPI= Ln (World wholesale price indexes),
LWPI= Ln (Turkish wholesale price indexes),
LTGDP=Ln (GDP Volume indexes of Turkey),
LWGDP= Ln (GDP Volume indexes of World),
WWPX= World general export price indexes),
LWWPM= Ln (World general import price indexes),
Δ=the first order differences operator.

All indexes series are based on the 1994 principle year. Depending on natural logarithmic forms of the variables, we need to estimate the mathematical form between mining trade quantity variables and the mining terms of trade adjusted U.S. Dollar exchange rate, the prices and the output level[4].

3. Correlations and Directions of Causalities

We researched the degree of linear correlations between variables, especially for the mining trade quantity variables and the others to show the applicability of these variables in regression models. Except for output variables that indicated unambiguously natural log linearity, all other variables were raised to the second and the third upper power forms as seen in the fourth, fifth, seventh, eighth, tenth, eleventh, fifteenth and sixteenth columns of Table 1 to estimate both simple (See Table 1) and partial correlation (See Table 4) coefficients that measures the partial effect of a variable and finally to estimate multiple correlation ratios (See Table 3) that measure the effect of all variables in a model. The probability level of the simple correlation coefficients indicated significant simple linear relation only between the mining export and the world wholesale prices, and domestic mining wholesale prices as seen in Table 1. However, insignificant simple correlation coefficient might indicate significant partial correlations coefficients when they are used with some other variables in mining export and import multiple regression models. On the other hand, the simple correlation coefficients between LQMMI and all other variables are highly significant at least 1 % level.

Table 2 shows us the direction of Granger causality of the relations between both the mining export and mining imports and the other variables. The direction of the relationship between two variables is tested by Granger methodology (1969). To define direction between two variables we need to

[4] We also analyzed data graphically. The graphical analysis indicated a cubic relationship between the mining export and the mining terms of trade adjusted exchange rate, and between the mining import and the world wholesale prices, and a parabolic relationship between the mining import and the mining terms of trade adjusted exchange rate, and a linear relationship between the mining export and the mining domestic wholesale prices, and between the mining export and the world wholesale prices.

estimate four equations[5]. For example, for the examination of whether LQMMI Granger causes LQXMI (LQMMI→LQXMI) at lag "p" Null Hypothesis is set as

$H_0: \sum_{j=1}^{p} \beta_j = 0$ and alternative hypothesis is set as $H_a: \sum_{j=1}^{p} \beta_j \neq 0$ for the following two equations:

$$LQXMI_t = \mu_x + \sum_{j=1}^{p} \alpha_j LQXMI_{t-j} + \epsilon_t \qquad (1)$$

$$LQXMI_t = \mu_x + \sum_{j=1}^{p} \alpha_j LQXMI_{t-j} + \sum_{j=1}^{p} \beta_j LQMMI_{t-j} + \epsilon_t \qquad (2)$$

where ϵ_t is the stochastic term, p is the symbol showing the degree of significantly estimated lagged influential autoregressive factors of a variable. Acceptance of Alternative Hypothesis would mean "LQMMI → LQXMI"; LQMMI Granger causes LQXMI.

Similarly; to examine Whether LQXMI causes LQMMI, the contribution of lagged values of LQXMI to the explanation of LQMMI is examined. To test whether LQXMI Granger causes LQMMI at lag "p" Null Hypothesis is set as

$H_0: \sum_{j=1}^{p} \delta_j = 0$ and Alternative Hypothesis is set as $H_a: \sum_{j=1}^{p} \delta_j \neq 0$ for the following equations:

[5] For example, to test the direction of causality between LQXMI and LQMMI, four dynamic regressions are needed. The Granger test utilizes F-statistics to examine whether lagged values of, for example, LQMMI, contribute significantly to the explanation of LQXMI, or lagged values of LQXMI contribute significantly to the explanation of LQMMI, or both explain each other. The test consists of running regression of LQXMI itself lagged and on a set of lagged LQMMI values; if the lagged values of LQMMI do not contribute a statistically significant explanation then LQMMI does not Granger-cause LQXMI. Similarly, to examine if LQXMI causes LQMMI the regression of LQXMI on itself lagged and a set of lagged LQMMI values is run for LQMMI values. For the examination of each type of direction two regressions are run (Darnell, 1994:42).

$$LQMMI_t = \mu_m + \sum_{j=1}^{p} \gamma_j LQMMI_{t-j} + \epsilon_t \quad (3)$$

$$LQMMI_t = \mu_m + \sum_{j=1}^{p} \gamma_j LQMMI_{t-j} + \sum_{j=1}^{p} \delta_j LQXMI_{t-j} + \epsilon_t \quad (4)$$

The acceptance of Null Hypothesis as a result of equations three and four would mean "LQXMI doesn't Granger cause LQMMI", which would be shown as "Not LQXMI → LQMMI". On the other hand, the acceptance of the Alternative Hypothesis would mean "LQXMI Granger causes LQMMI", which will be shown as "LQXMI → LQMMI". If we accept Alternative Hypothesis in both, then the simultaneous causality will be the case, which implies a simultaneous model to explain the exports and imports, and to

Table 1: Estimates of Pearson Correlation Coefficients

Variable	Lqmmi	Lmiexc	$Lmiexc^2$	$Lmiexc^3$	Lwwpi	$Lwwpi^2$	$Lwwpi^3$	Lwpi	$Lwpi^2$	$Lwpi^3$	Lwgdp	Ltgdp	Lwpimi	$Lwpimi^2$	$Lwpimi^3$
Lqxmi	-.131 .59	-.364 .13	-.349 .14	-.321 .18	-.374 .11	-.405 .09	-.427 .07	-.316 .19	-. 332 .16	.-.261 .28	-.285 .24	-.274 .26	-.333 .16	-.342 .15	-.264 .28
Lqmmi	1	.879	.847	.813	.909	.904	.897	.922	.817	.748 .0002	.933	.947	.877	.795	.738
Lmiexc		1	.994	.978	.948	.964	.976	.976	.968	.929	.979	.950	.986	.971	.930
$Lmiexc^2$			1	.995	.910	.932	.950	.961	.986	.962	.957	.918	.974	.989	.964
$.Lmiexc^3$				1	.886	.892	.915	.938	.991	.983	.929	.881	.954	.995	.984
Lwwpi					1	.998	.991	.952	.850	.772	.982	.983	.945	.847	.771
$Lwwpi^2$						1	.998	.961	.878	.805	.985	.980	.959	.877	.804
$Lwwpi^3$							1	.966	.902	.835	.985	.975	.969	.903	.834
Lwpı								1	.948	.891	.982	.971	.959	.925	.880
$Lwpi^2$									1	.987	.918	.875	.942	.992	.982
$Lwpi^3$										1	.862	.806	.899	.985	.998
Lwgdp											1	.989	.968	.911	.858
Ltgdp												1	.944	.862	.799
Lwpimi													1	.954	.902
$Lwpimi^2$														1	.987
Prob.	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001

Table 2: Direction of Causality in Estimated Mining Export and Import Models

LQXMI					LQMMI				
H_a versus H_o Hypothesis	Lag (t-m)	Comparison of Calculated and Critical F Ratios	Decision	Direction of Causality	H_a versus H_o Hypothesis	Lag (t-m)	Comparison of Calculated and Critical F Ratios	Decision	Direction of Causality
LMIEXC→LQXMI	t-1~2	$1.02<3.07=F_{1, 15, .10}$	Accept H_o	no	LMIEXC→LQMMI	t-1	$46.55>8.68=F_{1,15, .01}$	Accept H_a	→
LQXMI→LMIEXC		$.10<3.07=F_{1, 15, .10}$	Accept H_o	no	LQMMI→LMIEXC		$.104<3.07=F_{1, 15, .10}$	Accept H_o	
LMIEXC→LQXMI	t-3	$1.06<2.81=F_{3, 9, .10}$	Accept H_o						
LQXMI→LMIEXC		$4.08>3.86=F_{3,9, .05}$	Accept H_a	→					
LWWPI→LQXMI	t-1	$4.65>4.54=F_{1, 15, .05}$	Accept H_a	→	LWWPI→LQMMI	t-1	$15.02>8.68=F_{1,15, .01}$	Accept H_a	→
LQXMI→LWWPI		$4.39>3.07=F_{1,15, .10}$	Accept H_a		LQMMI→LWWPI		$6.81>4.54=F_{1,15. .05}$	Accept H_a	
LWWPI→LQXMI	t-2	$2.89>2.81=F_{2,12, .10}$	Accept H_a	→	LWWPI→LQMMI	t-2	$1.63<2.81=F_{2,12, .10}$	Accept H_o	no
LQXMI→LWWPI		$1.13<2.81=F_{2,12, .10}$	Accept H_o		LQMMI→LWWPI		$1.08<2.81=F_{2,12, .10}$	Accept H_o	no
LWPI→LQXMI	t-1~2	$.75<3.07=F_{1,15, .10}$	Accept H_o	no	LWPI→LQMMI	t-2	$3.93>3.89=F_{2,12, .05}$	Accept H_a	→
LQXMI→LWPI		$2.02<3.07=F_{1,15, .10}$	Accept H_o	no	LQMMI→LWPI		$.83<2.81=F_{2,12, .10}$	Accept H_o	
LWPIMI→LQXMI	t-2	$1.47<2.81=F_{2,12, .10}$	Accept H_o	no	LWPIMI→LQMMI	t-2	$.19<2.81=F_{2,12, .10}$	Accept H_o	
LQXMI→LWPIMI		$1.69<2.81=F_{2,12, .05}$	Accept H_o	no	LQMMI→LWPIMI		$4.71>3.89=F_{2,12, .05}$	Accept H_a	→
LWPIMI→LQXMI	t-1	$2.02<3.07=F_{1,15, .10}$	Accept H_o		LWPIMI→LQMMI	t-3	$1.7<2.81=F_{3,9, .10}$	Accept H_o	
LQXMI→LWPIMI		$4.57>4.54=F_{1,15,.05}$	Accept H_a	→	LQMMI→LWPIMI		$6.55>3.86=F_{3,9, ..05}$	Accept H_a	→
LWGDP→LQXMI	t-1	$2.08<3.07=F_{1,15, .10}$	Accept H_o	no	LWGDP→LQMMI	t-1	$44.8> 8.68= F_{1,15, .01}$	Accept H_a	→
LQXMI→LWGDP		$1.95<3.07=F_{1,15, .10}$	Accept H_o	no	LQMMI→LWGDP		$1.92< 3.07= F_{1,15,..10}$	Accept H_o	
LWGDP→LQXMI	t-2	$1.15<2.81=F_{2,12, .10}$	Accept H_o						
LQXMI→LWGDP		$4.47>3.89=F_{2,12, .05}$	Accept H_a	→					
LTGDP→LQXMI	t-1	$.18<3.07=F_{1,15, .10}$	Accept H_o	no	LTGDP→LQMMI	t-2	$2.14<2.81= F_{2,12, .10}$	Accept H_o	no
LQXMI→LTGDP		$.38<3.07=F_{1,15,. 10}$	Accept H_o	no	LQMMI→LTGDP		$1.65<2.81= F_{2,12, .10}$	Accept H_o	no
LQMMI→LQXMI	t-1~2	$.33<2.81=F_{2,12,. 10}$	Accept H_o	no	LQXMI→LQMMI	t-1~2	$.28<2.81=F_{2,12, .10}$	Accept H_o	no

Note: The first values are the calculated F ratios and the second ones are the critical F ratios at the rows in columns three and eight.

estimate price and income elasticities of both exports and imports. Granger Causality test for LQMMI and LQXMI pair series resulted no Granger-simultaneity as seen in the last row (fifth and tenth columns) of Table 2. Therefore, LQXMI and LQMMI models can be set up independently. In addition, there is no Granger causality between LQXMI and LMIEXC at lags up to three as seen in the first and second rows (fifth column) in Table 2. But there exist causality relations from LQXMI towards (i) LMIEXC at lag three in the fourth row (ii) LWPIMI at lag one as seen in the fourteenth row but not at lag two as seen in the twelfth row (iii) LWGDP at lag two as seen in the eighteenth row but not at lag one as seen in the sixteenth row in the fifth column of Table 2, which all contradict the theoretical causality statements in affecting foreign export demand except for the world wholesale prices. In conclusion, we see that LQXMI Granger causes LMIEXC, LWPIMI and LWGDP. This would mean that the changes in mining exports would be effective on determining the world output, wholesale prices, and the mining domestic wholesale prices. All these oppose the theory.

For the mining import demand the directions of causalities exist toward LQMMI from (i) LMIEXC at lag one as seen in the first row (ii) LWWPI at lag one as seen in the third row (iii) LWPI at lag three as seen in the ninth row in the tenth column of Table 2, which associate with theoretical foundations. On the other hand, a causal relationship exists from LWGDP toward LQMMI as seen in the fifteenth row in the tenth column of Table 2 associating with the theory, and there exists no causal relationship between LTGDP and LQMMI as seen in the nineteenth row in the tenth column of Table 2. A causal relation exists from LQMMI towards LWPIMI as seen in the twelfth row in the tenth column of Table 2, meaning that mining imports affect domestic mining prices but not vice versa. In general, there is no simultaneous causal relation between endogenous and exogenous variables.

However, since data did not allow us to set up mining export and import functions inductively for some variables, one may get help from the theoretical foundations and causalities in specifying functional relationship to estimate the mining trade elasticities. For this, we need to remember the traditional trade theory; functional forms and theoretical expectations about the signs of trade elasticities with its assumptions before estimating them. In conclusion, the mining data do not allow a pure inductive estimation; on the other hand, the data do not purely associate with the theory, which indicates a clear contradiction between data and the theory for some variables. Hence, it appears that deductive studies might contradict the actual causalities indicated by data.

4. Functional Forms and Theoretical Expectations

In this section, the expected signs between Turkish mining export, import and their explanatory variables are discussed theoretically in connection to the correlations coefficients and the direction of causalities.

a. Mining Export Equations

According to the traditional general export and import models, foreign export demand is influenced by export prices relative to foreign prices and by foreign income. The export supply is influenced by the import prices relative to domestic prices and by domestic output. As a result of sample analysis, it is seen that only the world wholesale prices Granger causes the mining export in the fifth row (the fifth column) of Table 2. Other variables are not causal sources for mining export even if they are stated causal theoretically. The LQXMI causes LMIEXC, LWPIMI, and LWGDP but not vice versa. The directions of causalities are estimated in adverse direction as from (i) LMIEXC (ii) LWPIMI (iii) LWGDP towards LQXMI in reality. Therefore, there exists causal contradiction between data and theoretical statements for some variables. But we need to satisfy with theoretical statements for functional demonstrations. Indeed, the foreign export demand function can be stated as

$$LQXMI_t = f\,(LMIEXC_t, LWWPI_t, LWPI_t, LWPIMI_t, LWGDP_t).$$

Theoretically, we expect a positive relation between mining export and sectoral terms of trade adjusted exchange rate, ∂ LQXMI / ∂ LMIEXC > 0. This implies that Turkish mining export quantities increase as mining exports become cheaper relative to the mining imports in terms of both foreign currency and relative prices. In addition, we can subdivide this effect into three parts as

(i) ∂ LQXMI / ∂ LEXC > 0
(ii) (ii) ∂ LQXMI / ∂ LPXMI < 0 and
(iii) (iii) ∂ LQXMI / ∂ LPMMI > 0.

We expect a negative relation between the mining exports and the mining terms of trade, ∂ LQXMI / ∂ Ln (PXMI/PMMI) < 0, in the dominance of mining export unit prices, and negative effect, ∂ LQXMI / ∂ Ln (PXMI/PMMI) > 0 in the dominance of mining import unit prices, *Ceteris Paribus*. This would mean that the foreign mining export demand would increase under the mining TOT deteriotion, *Ceteris paribus,* in U.S. Dollar prices. On the other hand, the mining export demand would increase as domestic currency depreciates, holding TOT and others constant. Mining export would stay the same under the equivalent depreciations of domestic currency to the improvement in TOT, *Ceteris paribus*. However, based on significantly estimated correlation coefficients at upper powers we expect a cubic relation between LQXMI and LMIEXC, such as $LQXMI=d\ LMIEXC^3 + c\ LMIEXC^2 + b\ LMIEXC + a$, where a, b, d >0, c< 0 constants.

Theoretically; we expect that ∂ LQXMI / ∂ LWWPI > 0 If Turkish mining exports are substituted for the world domestic goods, ∂ LQXMI / ∂ LWWPI < 0 when they are complementary goods. The world wholesale price (WWPI) is assumed as the alternative price faced by a prospective buyer of Turkey's mining export goods, measured by the world's wholesale price level, which is used instead of the world export mining price level. And we expect that ∂ LQXMI / ∂ LWPIMI < 0, assuming that Turkish mining exports do not indicate "Giffen Paradox" or dominated Veblen effect. Similarly, we expect that ∂ LQXMI / ∂ LWPI < 0.

In theory, the foreign export demand is positively related to the world's income level pos, therefore, ∂ LQXMI / ∂ LWGDP > 0.

Again, except for LWWPI theoretical causal relationships for mining export function are not supported by the sample. Therefore, we need to rely on theoretical causalities to be able to estimate trade elasticities as stated in functional form.

b. Mining Import Equations

Except for no Granger Causal relation between domestic output and mining import and adversely unidirectional causal relation from mining import towards domestic mining wholesale prices, opposing theoretical causal assumption, the mining import function can be defined inductively as

$$LQMMI_t=f\ (LMIEXC_t,\ LWWPI_t,\ LWPI_t,)$$

by data analysis for mining import model estimations. However, we need to add domestic mining wholesale prices and domestic output variables into the function based on the theoretical causal relation to be able to estimate mining import, domestic mining wholesale price and domestic output elasticities.

Theoretically, we expect that ∂ LQMMI / ∂ LMIEXC < 0. That is, a rise in mining terms of trade adjusted exchange rate would cause a decrease in mining import demand as the mining import becomes more expensive relative to the mining export holding nominal exchange rate constant, *Ceteris paribus*. The appreciation of domestic currency would yield higher imports, *Ceteris paribus*. However, we expect a parabolic relation between the mining import and the mining terms of trade-adjusted exchange rate based on data analysis. We expect that ∂ LQMMI / ∂ LMIEXC > 0, ∂ LQMMI / ∂ $LMIEXC^2$ < 0. In other words, the mining import sectoral TOT adjusted exchange rate elasticity may show a linear form[6].

However, we expect to estimate a linear relation between the mining imports and the mining domestic wholesale prices, and domestic wholesale prices based on data analysis. We expect that ∂ LQMMI / ∂LWPI or ∂ LQMMI / ∂LWPIMI > 0, assuming that the world export goods to Turkey are substituted for domestic goods, *Ceteris paribus.* Otherwise, they are complementary goods, and we expect a cubic structure between the mining imports and LWWPI and thus a parabolic elasticity form[7]. For the world prices we expect ∂ LQMMI / ∂ LWWPI < 0. That is, a rise in the world prices would reduce the mining import demand assuming no Giffen paradox or no dominant Veblen effect, *Ceteris paribus*.

For the domestic output level we expect ∂ LQMMI / ∂ LTGDP>0, assuming that mining imports are normal goods. Mining import increases as domestic country's output increases, *Ceteris paribus*. *On the other hand*, the existence of causality from the world output toward the mining imports has no theoretical meaning in traditional theory.

From Table 1, we understand that all the related variables show insignificant natural log linear simple correlation with the mining export excluding LWWPI and $LWWPI^2$, but all of them indicated highly significant simple linear correlation with the mining import quantities. But their use

[6] It varies according to ∂ LQMMI/∂ LMIEXC=a + 2bLMIEXC pattern, where a>0 and b<0, which are constants.

[7] ∂ LQMMI / ∂ LWWPI=a + 2bLWWPI + $3cLWWPI^2$, where b<0, a and c >0, constants.

with different variables may yield significant coefficient in a model as seen in the fifth row (columns five-seven) of Table 3 or in the fourth row (columns five-seven) of Table 4. However, one may not use all of them significantly in the same model. Therefore, various models are estimated to see the partial effect of each variable on the export and import, in addition to multiple correlation ratios are applied to see model effect whether the relation is linear or not.

5. Estimation of Mining Export and Import Models and Trade Elasticities

Until now, we stated the structures and signs of relations between endogenous and exogenous variables either theoretically or inductively, and estimated the direction of causalities between endogenous and exogenous variables by Granger Methodology. From Table 2 it is seen that there is no simultaneity problem between the endogenous and the exogenous variables that are applied in the models as well as between the mining import and mining export quantities. Therefore, one must set up unidirectional models. Granger Causality Test opposes the simultaneity assumption of some traditional models. Therefore, an inductive approach is important to estimate mathematical structure of export and import equations and to estimate the foreign trade price and income elasticities promptly. Unfortunately, there may exist contradiction between the data and the theory in view of direction of causality and structure.

We also estimated traditional models or adapted them to show whether they were significant if they were estimated. All alternatively estimated theoretical adapted traditional mining export and import models yielded insignificant relative price coefficients as seen on the bottom of Table 3. Only the D9 mining export model indicated significant coefficients for (i) the mining export unit prices (ii) the world wholesale prices (iii) the world output but at a lower level of determination ratio compared with our proposed mining export models through LQXMI 1 – LQXMI 6. However, one may consider LQXMI 1-LQXMI 6 mining export and LQMMI 1, LQMMI 3 - LQMMI 6 import models to derive policy implications. Other models (D1, D2, D3, D4, D5, D6, D7, D8, and D10) indicated insignificant coefficients not to be acceptable. D11, D12 and D13 Models have lack of information in terms of variables. The purpose of each proposed model in column two through thirteen of Table 3 is to show the significance of mathematical forms and to estimate the effect of the

Table 3: Estimates of Mining Export and Import Quantity Models

	Mining Export Models						Mining Import Models					
Variable	Lqxmi 1	Lqxmi 2	Lqxmi 3	Lqxmi 4	Lqxmi 5	Lqxmi 6	Lqmmi 1	Lqmmi 2	Lqmmi 3	Lqmmi 4	Lqmmi 5	Lqmmi 6
Constant	-3.4	-21.95	-25.11	-21.16	-21.7	-22.91	3.11	-3.87	-8.69	0.87	-3.36	-1.175
Std.errors	2.47	4.07***	4.11***	4.86***	4.25***	4.39**	.35***	.087***	3.95**	.30***	1.6**	1.22
$Lmiexc_t$	2.94	1.95	3.23	-0.27	-0.41	2.59	0.242	0.07			0.0669	
Std.errors	.81***	.87**	.85***	.06***	.08***	.08***	.077***	.0096***			.03**	
$Lmiexc_t^2$	-0.32		-0.33			-0.246	-0.009					
Std.errors	.086***	-0.21 .073**	.081***			.077***	.004**					
$Lmiexc_t^3$	0.011	0.0065	0.0096			0.007						
Std.errors	.003***	.0023**	.003***			.002**						
$Lwwpi_t$			-1.28	-1.04	-1.14	-1.54			10			
Std.errors		-1.36 .37***	.374***	.21***	.19***	.39***			3.16***			
$Lwwpi^2_t$									-2.55			-0.022
Std.errors									.83***			.012***
$Lwwpi^3_t$									0.22			
Std.errors									.071***			
$Lwpimi_t$		0.101			0.14							
Std.errors		.055*			.059**							
$Lwpimi^2_t$			0.036									
Std.errors			.018*									
$Lwgdp_t$		5.95	5.71	7.26	7.66	5.67					1.88	
Std.errors		1.21***	1.18***	1.33**	1.17***	1.3***					41***	
$Ltgdp_t$										0.80		1.34
Std.errors										.066***		32***
R^2	.5705	.8785	.8827	.7136	.7957	.844	.8273	.7725	.8936	.89732	.8998	.9134
Adj R^2	.4846	.8177	.8241	.6564	.7374	.784	.8057	.7592	.8723	.8913	.8872	.9026
F	6.64**	14.5***	15***	12.5***	13.63***	14.1***	38.32***	57.74***	41.97***	149***	71.82***	84.37***
DW	.886	1.491	1.361	1.427	1.597	1.763	1.068	.812	1.474	1.014	1.374	1.129
Lower, Upper, .01	.74,1,41	.48,1.96	.48,1.96	.74, 1.41	.65,1.58	.65,1.58	.835,1.265	.93,1.13	.74, 1.41	.93,1.13	.835,1.265	.835,1.265
Lower, Upper, .025	.86, 1.55	.565,209	.565,209	.86, 1.55	.76,1.72	.76,1.72	.96,1.407	1.06,1.28	.86, 1.55	1.06,1.28	.96,1.407	.96,1.407
Lower, Upper, .05	.97,1.68	.65,2.2	.65,2.2	.97,1.68	.86,1.85	.86,1.85	1.074,1.54	1.18,1.4	.97,1.68	1.18,1.4	1.074,1.54	1.074,1.54
Decision	Inc. & + aut..	Inconclusive	Inconclusive	No+ & inc	No+ & inc	No+ & inc	Inc. & + aut..	+ Autocorr.	No+ & inc	Inc. & + aut..	No+ & inc	No+ & inc

***:1%, **:5%, *:10% .

Adapted Traditional Trade Models: D1-D10

$LQXMI_t$=14.99+1.092Ln(PXMI/WWPI)$_t$+4.28 Ln(WGDP)$_t$, R^2=.4813, Adj. R^2=.4165, F=7.4, DW=.827 D.1
(6.16**) (.31***) (1.32)

$LQMMI_t$=.52 + .0068Ln(PMMI/WPIMI)$_t$ + .881 Ln(TGDP)$_t$, R^2=.898, Adj. R^2=.8853, F=70, DW=1.039. D.2
(1.09) (.02) (.24***)

$LQXMI_t$= .057+1.69Ln(PXMI/WWPX)$_t$ +1.06Ln(WGDP)$_t$, R^2=.1838, Adj. R^2=.0818, F=1.80, DW=.737 D.3
(4.64) (1.19) (.998)

$LQXMI_t$=-.81 + 2.52 Ln(PXMI/WWPM)$_t$ + 1.24 Ln(WGDP)$_t$, R^2=.2754, Adj. R^2=.1848, F=3.04, DW=1.019. D.4
(3.66) (1.22*) (.79)

$LQXMI_t$= 5.68 - .0167 Ln(WPI/WWPI)$_t$ - .15 Ln(WGDP)$_t$, R^2=.083, Adj. R^2=.0316, F=.724, DW=.558. D.5
(4.17) (.088) (.91)

$LQMMI_t$= 1.26 - .01 Ln(WWPI/WPI)$_t$ + .72 Ln(TGDP)$_t$, R^2=.8936, Adj. R^2=.8859, F=71, DW=1.086. D.6
(.92) (.02) (.20***)

$LQMMI_t$= -1.22 + .0284 Ln(WWPI/WPIMI)$_t$ + 1.27 Ln(WGDP)$_t$, R^2=.8796, Adj. R^2=.8645, F=58, DW=1.424. D.7
(1.2) (.03) (.26***)

$LQMMI_t$= .60 + .008 Ln(WWPI/WPIMI)$_t$ + .86 Ln(TGDP)$_t$, R^2=.8965, Adj. R^2=.8858, F=71, DW=1.049. D.8
(.72) (.019) (.16***)

$LQXMI_t$=-18.96+1.67Ln(PXMI)$_t$–1.13Ln(WWPI)$_t$+4.6Ln(WGDP)$_t$,R^2=.5078,Adj.R^2=-.4094,F=5.159,DW=.992 D.9
(7.62**) (.72**) (.32***) (1.38***)

$LQMMI_t$=0.52 - 049Ln(PMMI)$_t$ -.014Ln(WPIMI)$_t$ +.94 Ln(TGDP)$_t$, R^2=.9002, Adj. R^2=.8802, F=45, DW=1.078. D.10
(1.44) (.31) (.02) (.23***)

Other models rather than adapted traditional models:

$LQMMI_t$=4.287 + .067$LWPIMI_t$ R^2=.877, Adj. R^2=.755, F=56, DW=.839 (+ auto) D.11
(.38***) (.003***)

$LQMMI_t$=4.276 + .07$LWPI_t$ R^2=.922, Adj. R^2=.851, F=97, DW=1.429 (no auto) D.12
(.03***) (.007***)

$LQMMI_t$=3.532 + .244$LWWPI_t$ R^2=.909, Adj. R^2=.826, F=80, DW=.982 (inconclusive) . D.13
(.111***) (.027***)

Table 4: Estimates of Partial Correlation Coefficients of Mining Export and Import Quantity Models

	Mining Export Models						Mining Import Models					
Variable	Lqxmi 1	Lqxmi 2	Lqxmi 3	Lqxmi 4	Lqxmi 5	Lqxmi 6	Lqmmi 1	Lqmmi 2	Lqmmi 3	Lqmmi 4	Lqmmi 5	Lqmmi 6
$Lmiexc_t$	.6859	.5442	.7407	-.7571	-.8081	.6383	.6188	.879			.4741	
P values	.002	.043	.002	.0001	.0001	.01	.006	.0001			.047	
$Lmiexc_t^2$	-.6989	-6368	-.7619			-6658	-.4906					
P values	.002	.014	.002			.007	.039					
$Lmiexc_t^3$	.7050	.6332	.7458			.6415						
P values	.002	.015	.002			.01						
$Lwwpi_t$		-.727	-.7044	-.7839	-.8429	-.7382			.633			
P values		.003	.005	.0001	.0001	.002			.006			
$Lwwpi_t^2$									-.6218			-.3956
P values									.008			.104
$Lwwpi_t^3$									.619			
P values									.008			
$Lwpimi_t$		.4692			.5347							
P values		.091			.033							
$Lwpimi_t^2$			.4976									
P values			.07									
$Lwgdp_t$		.8182	.8142	.8165	.8679	.7702					.7479	
P values		.0001	.0001	.0001	.0001	.001					.0001	
$Ltgdp_t$										.947		.7286
P values										.0001		.001

price and income variables on the mining export and import separately and so to estimate the trade elasticities with the use of various variables, because using all the variables in a single model yielded insignificant coefficients. The results are summarized in Table 3[8].

The partial correlations between endogenous and exogenous variables of a model are also estimated and shown in Table 4. For example, the partial correlation ratio between LQXMI and LWGDP in the seventeenth row through Model LQXMI 2-LQXMI 6 columns of Table 4 ranged between .77 and .87. The higher the ratio of partial correlation is, the higher the partial effect of an exogenous variable in explaining endogenous variable in a model.

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[8] Since we use additional variables in the mining export and import models we do not expect variables be consistently significant thorough estimated models based on econometric criteria. In addition, we wanted to see whether existing structures are significant or not in addition to estimating elasticities.

Except for the LQMMI 2 model, all the Durbin-Watson test results of the mining trade models either indicated no autocorrelation problem or ranged between inconclusive regions as they are seen in the row of decision in Table 3. Therefore, all the coefficients of non-autocorrelated mining models are reliable in view of autocorrelation. Among estimated adapted traditional models, the D-W test statistics fell in an inconclusive region for D9 Model. The multicollinearity among variables is avoided in all models by omitting some variables in a model as much as possible. Here we did not need to test structural change because the period is quite homogenous in policies, which is dominated by the export lead industrialization with the trade liberalization policies.

6. Co-integrations and Degree of Integrations of the Variables

Whether a long-run relationship between the endogenous and exogenous variables used in estimated models exists is tested by the Dickey-Fuller methodology (1979) before the interpretation of the results. There exist various forms of DF test equation depending on the significance of trend and constant term, and randomized errors. Accordingly, the critical value varies depending on both the DF test equations and the number of observations. In addition, we need to define the degree of integration for the validity of co-integration level. A co-integrated two series at the levels requires the series to be integrated at the same levels (Engle and Granger, 1991:1-17).

Table 5 presents Ljung-Box autocorrelation test statistics for the randomness of estimated D-F test equation following "the estimated Dickey-Fuller τ_γ" raw. Table 6 presents Ljung-Box autocorrelation test statistics for the randomness of estimated DF test equation for individual series. All the estimated D-F equations showed random disturbances, which are indicated by χ^2. The critical DF "τ " values will be the case of "no constant, no trend" for cointegrating equations in general. If the estimated "τ " value of AR (1) or γ is greater than the critical "τ_γ" with no constant, no trend, a researcher must accept Alternative Hypothesis (H_a) of Co-integration or No Unit Root against Null Hypothesis (H_0) of Non Co-integration or Unit Root Null Hypothesis.

For testing purpose we set hypothesis as follows: H_0: γ =0 and H_a: γ <0 in an appropriately chosen

$$\Delta x_t=\gamma\, x_{t-1} + v_t \quad \text{or} \quad \Delta x_t= \gamma\, x_{t-1} + \sum^{p} \Delta x_{t-j} + v_t$$

j=1

Dickey-Fuller Test equation, where v_t is randomly distributed error term, x_t is the series needing to be tested whether exhibiting unit root or not, Δ is the first order differences operator, $\Sigma\Delta x_{t-j}$ is the autoregressive or the stationary part to satisfy randomness of v_t. The D-F test statistics is defined as $\tau_\gamma=\gamma/\sigma_\gamma$. According to the Ljung-Box test statistics for estimated D-F test equations, randomness is satisfied for the estimated model (columns 2-13) in the first row of Table 5. The estimated models showed co-integrated relationships at the levels. And the Ljung-Box test results in rows 6 to 9 (columns 2-13) in Table 6 indicated random distubances and tau statistics indicated that mining export and export series are integrated at zero, and all independent variables are integrated at the level one, I(1) or ΔI(0), implying that the difference between I(0) and I(1) series may cointegrate at the zero levels.

Table 5 : Dickey Fuller Co-integration Test Results for Mining Models

	LQXMI 1	LQXMI 2	LQXMI 3	LQXMI 4	LQXMI 5	LQXMI 6	LQMMI 1	LQMMI 2	LQMMI 3	LQMMI 4	LQMMI 5	LQMMI 6
AR(1),γ	-.47	-.98	-.85	-.83	-.81	-1.18	-.55	-.46	-76	-.52	-.69	-.75
No constant, τ (p)	-2.29 (0)	-4.07 (3)	-3.56 (3)	-3.59 (3)	-3.32 (3)	-5.27 (3)	-2.59 (0)	-2.4 (0)	-3.25 (0)	-2.14 (0)	-2.98 (0)	-2.86 (4)
$\tau_{critical\ (prob)}$	-1.95 (05	-2.66 (01	-2.66 (01	-2.66 (01	-2.66 (01	-2.66 (01	-2.66 (01	-2.66 (01	-2.66 (01	-1.95 (05	-2.66 (01	-2.66 (01
χ^2_{0-6} probability	9.38 .154	5.56 .351	4.93 .424	1.97 .853	2.86 .722	6.02 .304	6.24 .397	4.06 .668	7.28 .296	9.37 .154	7.17 .305	8.53 .110
χ^2_{6-12} probability	14.97 .243	11.49 .503	9.95 .535	9.08 .615	8.12 .702	11.46 .406	8.38 .755	9.31 .677	15.37 .222	12.76 .387	10.04 .612	10.63 .474
Errors Distrib.	random	random	random	random	random	random	random	random	random	random	random	random
Decision	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)	CI(0,0)

Table 6: Estimated Dickey-Fuller τ_γ for Individual Variables for Degree of Integration

	Lqxmi	Lqmmi	Lmiexc	Lmiexc^2	Lmiexc^3	Lwwpi	Lwwpi^2	Lwwpi^3	Lwpimi	Lwpimi^2	Lwgdp	Ltgdp
AR(1), γ	-.2879	-.16	-.898	-.017	-1.08	-.87	-.78	-1.07	-1.42	-1.23	-.95	-1.3
No constant, τ (p, c, t)	-1.78 (0,0,0)	-3.36 (5,c.t)	-3.37 (0,c,0)	-2.87 (1,0,0)	-3.65 (0,c,t)	-3.42 (2,c,0)	-3.07 (2,c,0)	-3.54 (2,0,0)	-3.71 (0,c,t)	-4.73 (0,c,t)	-3.53 (0,c,0)	-5.3 (0,c,0)
τ critical (prob)	-1.61 (.1)	-3.24 (.1)	-3 (.05)	-2.7 (.01	-3.6 (.05)	-3. (.05)	-3 (.05)	-3 (.05)	-3.6 (.05	-4.38 (.01)	-3 (.05)	-3.75 (.01)
χ^2_{0-6} probability	5.66 (.463)	2.49 (.12)	1.73 (.94)	2.18 (.70)	3.02 (.81)	1.09 (.90)	6.59 (.16)	4.39 (.36)	6.22 (.4)	1.09 (.98)	2.05 (..92)	5.75 (.45)
χ^2_{6-12} probability	14.34 (.28)	7.68 (.36)	8.98 (.70)	10 (.57)	7.18 (.85)	9.2 (.53)	14.2 (.16)	8.61 (.57)	10.6 (.53)	5.19 (.95)	7.6 (.82)	9.36 (.67)
Errors distri.	random	random	random	random	random	random	random	random	random	random	random	random
Integrati. level	I(0)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Note 1: t=trend inclusion, c=constant inclusion.
Note 2: I(1) implies that the first differences of the series are integrated at zero level, Δ I(0).
Note 3: Lqxmi series is also integrated at level one by τ =-3.8 at 1% significance level with no constant, no trend.
Source for critical τ: Enders (2004, Table A:Empirical Cumulative Distribution of τ, p.439)

Since all the estimated models indicated a co-integrated relationship between endogenous and exogenous variables of the estimated models, one may evaluate these models and the economic meanings of the estimated coefficients.

7. Interpretation of the Results and Policy Implications

There existed contradictions between the data and theory for some variables in constructing mining export and import models. However, we were able to reach significantly estimated mining export and import models. Proposed models are found significant and more powerful than adapted traditional models in explaining both mining export and import. Mining import is explained highly significantly between 83 % and 91 % and mining export is explained highly significantly between 57 % and 88 %. The mining exports can be explained by the mining terms of the trade-adjusted exchange rate, the world prices and the world output, and the mining domestic wholesale prices. Both the explanatory structural pattern and the direction of causality did not associate with the theoretical assumptions for the mining export models except for the world price variable, which is approximated instead of the world mining prices. In addition, the signs of both the estimated world price and the domestic mining price elasticities contradicted the theory in the estimated export models. Furthermore, not having simultaneity avoids simultaneity bias in elasticities that were mentioned by Tansel and Togan (1987).

The relationship between mining import and its exogenous variables were found natural log linear except for the world wholesale prices. There existed a significantly estimated cubic relation between the mining import and the world wholesale prices, and between mining export and mining TOT adjusted American Dollar exchange rate in terms of the Turkish Lira. The mining imports may be explained by the world wholesale price level wholly, or by the domestic output and the mining terms of trade adjusted foreign exchange rate partially, and by the world wholesale prices and domestic income partially.

The significantly positively estimated foreign income elasticity of the mining export demand and the domestic income elasticity of the mining import demand satisfied our theoretical expectations in the estimated models. This is also the case in adapted traditional models on the bottom of Table 3, but where none of the mining import and mining export models is found significant except for the LQXMI D9 export model. From Table 3 we understand that the mining export demand world income elasticity ranges between 4.6 and 7.66, and the mining import demand domestic income elasticity ranges between 0.80 and 1.34 basing on different specifications. Both are normal goods. The mining foreign export demand is more income elastic than mining import, and the magnitude of mining export income elasticity implies luxuries of export goods. An equivalent percentage increase in the world income to the domestic income improves mining trade balances, and so reduces the mining trade deficit and thus balance of payment deficits of Turkey, *Ceteris Paribus*.

In addition, the mining foreign export demand world price elasticity looks elastic, and its magnitude is more than mining demand world price elasticity. On the other side, the mining foreign export mining TOT adjusted exchange rate elasticity is higher than the mining import demand mining TOT adjusted exchange rate elasticity in absolute values in the estimated models. A percentage increase in domestic mining prices yields 0.101 and 0.14 percentage increases in mining export, assuming theoretical causality between LQXMI and LWPIMI, *Ceteris Paribus*. LQXMI D9 model indicates 1.67 mining foreign export demand mining export price elasticity, *Ceteris Paribus*. This is the indication of the Veblen effect in mining foreign export demand. The lower mining TOT adjusted exchange rate in terms of Turkish Lira yields higher mining export and lower mining import in comparing LQXMI 4 and LQXMI 5 with LQMMI models. This implies that mining trade balance might be improved by sectoral devaluation, or by either sectoral TOT deteriotion or devaluing domestic currency against the American Dollar on the average. Furthermore, the foreign export demand mining TOT adjusted exchange rate elasticity is a parabolic function in LQXMI 1, LQXMI 2 and LQXMI 3, and in LQXMI 6 models. Its value depends on the value of LMIEXC at a point. For example, it is "2.94-0.64LMIEXC+0.033LMIEXC^{2}" in LQXMI 1 model, and its value depend on the "2.59-.492LMIEXC+0.021LMIEXC^{2}" in LQXMI 6 model, where LMIEXC ranges between 5.68 and 13.88. Both functions indicate decreasing elasticity for LMIEXC values under 9.69, which is before 1994 and increasing elasticity for LMIEXC values above 11.71, which is after 1996. On the other hand, the mining import demand mining TOT adjusted exchange rate indicated a linear elasticity function only in LQMMI 1 model, which is "0.242-0.018LMIEXC". As a result, the mining foreign export demand is more elastic than the mining import demand with respect to the changes in sectoral TOT adjusted exchange rate.

Foreign mining export demand increases as domestic mining and mining export prices increase, and as the world prices decreases, *Ceteris Paribus*. It increases as sectoral TOT adjusted US Dollar exchange rate decreases. On the other hand, the mining import demand increases as sectoral TOT adjusted US Dollar exchange rate increases as it is seen in LQMMI 1 and LQMMI 2 models.

The magnitude of mining import demand world price elasticity depends on the value of "10-5.1LWWPI+0.66LWWPI^{2}", *Ceteris Paribus,* where LWWPI ranges between 2.73 and 4.96. Its value is –2.12 for LWWPI equals 2.73, and 12.02 for LWWI equals 4.96. On the other hand, the mining import demand world price elasticity ranges between –1.54 and –1.04, *Ceteris Paribus*, in estimated LQMMI 3 an LQMI 6 models.

Both the insignificantly estimated negative signs of LPMMI and LWPIMI in D10 mining import model, and the significantly estimated negative sign of LWWPI in D9 mining export model[9] imply that all foreign goods are complementary to domestic mining goods[10].

Tansel and Togan (1987:532) found the best export demand price elasticity equals -2.53, and that of foreign income 2.18 in simultaneity of the general export demand and supply equilibrium. They estimated the best import price elasticity about –0.56 and income elasticity about 1.65. They also estimated the foreign export demand and the import structural equations in disequilibria. They estimated the export demand relative price elasticity equals -0.93, and the export demand income elasticity equals 1.51. The import demand relative price elasticity was found about -0.47, and the income elasticity was found about 1.42 over the period of 1960-1983, largely for the import substitution period. Khan (1974:687-689) found the general export price and the income elasticities by –1.41 and 1.619 respectively in equilibrium, and -0.743 and 0.056 in disequilibria. He found the Turkish import price and income elasticities by -2.175 and 0.554 respectively in equilibrium, and -2.293 and 0.501 in disequilibria over the period of 1951-1969. Their elasticities are found constant based on the log linear equations. But, as result, there may be changes in the trade elasticities depending on the period or the estimated structural form and context of traded goods. Except for the LQXMI D9 model our estimated traditional mining export and import models were found insignificant as they are seen at the end of Table 3. However, our estimated mining foreign export demand world income elasticity tends to be higher than earlier authors' findings about general export world income elasticity. Our traditional mining import models yield lower domestic income elasticity than Tansel and Togan's findings but higher than Khan's general import income elasticity estimates for the economy of Turkey.

8. Conclusion

There existed contradiction between the mining export and its theoretical exogenous variables in direction of causality except for world prices. Data indicated association with theoretical causality relations between the mining import and its explanatory variables except for domestic mining prices.

[9] It shall be remembered that the world prices of goods also cover the prices of Turkish mining import goods not to have world goods to be exact complementary even the sign of mining export price (LPXMI) is positive due to Veblen effect.

[10] Two goods are gross complements (substitutes) if a rise in the price of one good causes less (more) of the other good to be bought (Nicholson, 1989:165).

However, data indicated no causality between the mining import and domestic output.

There existed a highly significant natural log linear relation between the mining import and the price and the output variables. There existed a natural logarithmic parabolic elasticity function between the mining export and the sectoral terms of trade adjusted American Dollar exchange rate in term of Turkish Liras. The mining import indicated significantly a cubic relation with respect to the world wholesale prices. However, both mining export and import indicated constant elasticites with respect to incomes and domestic mining prices.

The mining export is explained by between 51 % and 88 % while the mining import is explained by between 77 % and 91 % through estimated models. The adapted traditional disequilibria relative price models were found insignificant to explain mining trade.

The mining export terms of trade adjusted U.S. Dollar exchange rate elasticity indicated a parabolic elasticity function. The mining export sectoral TOT adjusted exchange rate elasticity was estimated lower than the mining import sectoral TOT adjusted exchange rate elasticity most of the time. Both the mining export unit prices and the world wholesale prices were found significantly effective as the world income on the mining export. Both the estimated mining import unit price and domestic mining wholesale price elasticities were found insignificant while domestic output elasticity was estimated significantly in adapted traditional models.

According to the estimated models there is an implication of the mining import and domestic mining goods to be complementary goods, a Veblen effect existed on foreign mining export demand.

The positively estimated mining export demand world income elasticity was estimated higher than the positively estimated mining import demand domestic income elasticity. The foreign mining export demand world output elasticity ranged between 4.6 and 7.66, and the mining import demand domestic output elasticity ranged between 0.8 and 1.34 in the estimated models. As a result, the mining export goods are found more elastic than the mining import goods.

There is room to improve mining trade balance as a result of devaluation and to improve mining export more than mining import as a result of the same percentage increase in both domestic and world output at the same time. There existed long-run relations between endogenous and exogenous variables in estimated models supported by data even if the directions of relations differed from the theoretical statements, and data never supported theoretical causality relation for some variables at all.

Estimated co-integrated models imply co-movements of both endogenous mining import and export with exogenous variables and no suspicious regression model over the 1982-2000 period. That means estimated models are meaningful.

However, one might be interested in bi-country mining trade structures and elasticities for the economy, and setting mining export relative to mining imports with respect to the relative prices.

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