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Steel: Price Links between Primary and Scrap Markets

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Abstract:

Steel is used as a case study to decompose the links between primary and secondary markets, in order to examine how prices in the one market influence the prices in the other, and how volatility can be transmitted between them.

Keywords: Steel, Primary Prices, Scrap Prices, Volatility, Correlation, Vector Autoregression

I. Introduction

It is widely recognized that recycled material markets are haunted by high volatility in prices. It is also known that if a secondary (recycled) market exists, there must be a primary market as well. Furthermore, In the case of commodity markets, the primary market is also characterized by price volatility, though to a lesser extent. The objective of this study is to examine the case of steel in order to analyze scrap prices and their connection to primary metal prices. Linkages between primary and scrap steel explain how the prices in the two markets, as well as their fluctuations are dependant on each other, and how their volatilities are correlated. They also can be used to improve forecasting. It should be noted that the main focus of the paper is on the scrap steel market, as it tends to be the most unpredictable. Steel is a metal that has been recycled for many years and has a well - established scrap market. The fact that steel is not sold on market exchanges is the reason it is used in the paper in order to keep things simple. Market exchanges tend to make a market more volatile (Slade, 1991), but this volatility is related to the institutional structure of the market and not the fundamental demand and supply market structure for metal. Thus by analyzing steel we are able to avoid institutional volatility and focus on the relationships between steel and scrap.

This is not the first paper to examine links between primary and secondary markets. Most studies that analyzed such links focused on physical links that exist between the two markets. Other than structural primary and secondary market connections, an important reason for price co-movements is dependence on the same macroeconomic forces, though not as much attention has been given to this. In the present paper this cause of price linkages will be a substantial part of the analysis. The issue in which this study contributes most in relation to past research is the examination of volatility transmission between the two markets. Though volatility connections for different metals have been proven in literature (McMillan and Speight, 2001; Labys et al, 1999), this hypothesis has not been examined for primary and secondary metals.

The method used here is time series analysis that allows us to avoid structural modeling of the markets to demand and supply relationships and to simplify investigations into links expressed through prices. Preliminary correlation analysis is followed by multivariate level time series analysis.

The remainder of the paper is as follows: Section II provides background research related to the issue. In Section III a description of the steel scrap industry is presented. In section IV the relevant economic theory is discussed. In Section V the methodology that is being used is displayed. In Section VI price and variance are analyzed on the basis of statistical tests and models and results are reported. Section VIII concludes the paper.

II. Research Background

Steel has been an industry studied by many researchers and for many years because of its industrial importance. Steel scrap utilization and prices have been analyzed since the beginning of the century (Blackett, 1923; Fowler, 1937). Interest in the steel industry has remained alive and interest in scrap metal has expanded, as recycling has become more important and as technological advances in the industry have made steel production through scrap easier (Crandall, 1996) and have therefore expanded its use. The amount of scrap purchased per ton of steel made in the US rose by 86% during the two decades after 1973-74.

Some of the recent work on steel scrap prices has been by Albertson & Aylen (1996, 1999). Albertson & Aylen (1996) found two elements of price fluctuations in scrap prices: a) a year-to-year cyclical fluctuation and b) seasonal patterns. The cyclical fluctuation is linked to US booms and recessions while seasonal patterns are linked to weather and the rhythm of industrial production. Both these influences are linked to macroeconomic variables. Scrap steel price fluctuations have been found to interact with business cycles from early in the century (Blackett, 1923). Moore (1988) who studied macroeconomic leading inflation influences on metal prices also found these influences on scrap prices in aluminum and copper. The link between steel scrap and macroeconomic influences is indirect and comes from the derived demand for scrap as an input in steel production. End uses for scrap and steel are the same, for this reason both steel and scrap production and prices must be determined by the same underlying factors. Business cycles and macroeconomic data hold an important place in explaining co movements in related and unrelated commodity markets (Labys et al (1999); Pindyck and Rotenberg (1990)), but this element of co movement of scrap with primary metal prices has not been examined till now.

The relationship of scrap prices to primary prices was noted early on. Steel scrap and iron prices are correlated but their difference is not constant (Blackett, 1923). Scrap and primary metal price are in correspondence as well, and in some cases there have been discussions of linking scrap prices to primary prices (Blomberg and Hellmer, 2000). Most research relating primary and secondary prices is based on structural demand and supply relationships in the market. For steel, Stollery (1983) modeled the demand and supply relationships, between scrap and primary input and output. In this model the prices of scrap and primary input metal were determined simultaneously as functions of exogenous variables, including industrial activity. Hashimoto's study (1983) followed the tradition of structural analysis of primary metal and scrap, but also introduced the examination of price volatility. Hashimoto argues that price fluctuations and co movements are due to the industry's inherent inelasticities and sensitivity to business cycles. He is able to show through simulations simultaneous price movements that occur in the market. Slade (1989) suggested that recycling might increase the volatility in the primary market, when the recycling sector is large, as is the case for steel. The volatility of scrap prices is assumed higher than that of primary steel markets (Dower, Anderson, 1977). Volatility transmission though has not been examined much up to now for scrap and primary metals, but has been established between different metals (McMillan & Speight, 2001; Brunetti & Gilbert, 1995, 1996; Labys et al, 1999)

III. Scrap Market Description

Iron, including steel, is the most widely used metal. Iron and steel comprise about 95 percent of all the tonnage of metal produced annually in the United States and in the world. On average, iron and steel are by far the least expensive of the world's metals, and steel products are used in many construction and industrial applications. The steel market can be classified into two distinct types of production: a. production in large scale integrated mills that use Basic Oxygen Furnaces and b. production in minimills that use Electric Arc furnaces. For the last decade minimills and integrated mills have each accounted for about half of steel production. Minimills have increased market competition and have made steel prices more representative of market transaction prices. However, the basis of steel marketing remains contract based and producer prices are present. In contrast to non-ferrous metals steel is not traded on metal exchanges. The main reason for this is due to the high differentiation of steel products and the need of utilization of base prices for steel products and extras for specifications.

Recycling steel is technologically possible and economically profitable. In consequence a significant industry has developed to collect old and new scrap. New scrap arises from pre-consumer sources and old is generated from post-consumer sources. New scrap comes from all stages of industrial processing. It is generated within steel mills and foundries (home scrap) or industrial plants (prompt or industrial scrap) while making iron and steel products. The availability of home scrap has been declining as new and more efficient methods of casting have been adopted by the industry. Old scrap, or obsolete scrap, comes from many different products, both consumer and industrial and is composed by objects that no longer have further use. The North American steel industry's overall recycling rate is around 55-60% (USGS, 2001).

Scrap prices react quickly to changes in supply and even more so to changes in demand. The major consumers of scrap are steel mills and ferrous foundries. When demand for steel mill and foundry products is low, demand for scrap is low, and prices fall. Dealers cannot influence sales of scrap if mills and foundries do not need it to charge their furnaces. On the supply side, dealers can hold back some scrap from mills and foundries when prices are low. New scrap produced in industrial plants, however, must be disposed of frequently to make room for more scrap.

Prices are also influenced by technological changes in steel mills and foundries. Steel mills melt scrap in basic-oxygen furnaces (BOF), electric-arc furnaces (EAF), and to a minor extent, in blast furnaces, whose significance, however, has been declining over the years. The proportion of scrap in a BOF is limited to less than 30%, whereas that in an EAF can be as much as 100%.. Blast furnaces' and basic-oxygen furnaces' role has been declining over the years and new, relatively small and technologically simple steel plants (minimills) have been built to produce simple products, such as hot-rolled bars of steel. This new approach to steelmaking has caused record highs in steel production and scrap consumption. Minimills have been able to capture a significant share of the market by setting prices that the previously dominant steel companies were unable to match. They have also allowed scrap to become increasingly important to the steel industry (Albertson & Aylen, 1996).

IV. Theoretical Considerations

The purpose of this study is to: a) analyze the relationship between scrap and steel prices, and b) examine the behavior and the transmission of their volatilities. The main reason for these relationships is that scrap is an input to steel production. Scrap competes with iron in input supply to the steel industry. In Oxygen Furnaces up to 30% of scrap can be used, and in electric furnaces up to 100%, which shows that substitution potential is substantial. Given that scrap is an input to steel production, demand for scrap is derived from the demand for steel, and the same macroeconomic variables influence both primary and scrap steel.

Price and volatility co movements are accentuated by inelasticities present in the industry. Steel demand is very inelastic (Anderson, 1983). Steel supply is more elastic. Minimills are constrained by their productive capacity, but integrated mills have a lot of potential supply capacity. Scrap supply is also relatively inelastic. The scrap nature of the product, seasonal constraints and the fact that part of the scrap supply is a byproduct of iron, steel and steel products, lead to relative price inelasticity of scrap supply. Demand for scrap is more elastic because of the substitution possibilities that exist with iron, though substitution at some point is constraint by technical requirements in the short term. Steel and scrap prices are expected to be interdependent. Their input-output fundamental relationship in combination with market inelasticities is the major cause of this interdependence. Common dependence on macroeconomic variables is the other reason for price correlations and co-movements. Considering that the end-uses of both scrap and steel are the same, both of them, each to a different degree, are dependent on the same macroeconomic variables. Economic shocks in the steel industry will influence steel and pass through the structural relationships with scrap in simultaneously transmitting the shock in scrap prices as well. Interest rates, GDP, industrial production, are all variables reflecting business cycles that influence steel and scrap prices. The steel market is the main market of the system. Thus the conditions in this market and the demand for steel should heavily influence the instability in scrap prices.

The markets for scrap and primary metal can be represented as in the below recursive system since the data used are monthly which leads to a short term analysis[1]:

$$P_{s,t} = f_1 (\Delta I_t, Z_{sc,}) \quad (1a)$$

$$\Delta I_{s,t} = S_{s,t} - D_{s,t} \quad (2a)$$

[1] The model is drawn from Labys (1973)

$D_{s,t} = f_2 (P_{s,t-k}, Z_{s,t,})$ (3a)

$S_{st,} = f_3 (P_{s,t-k}, P_{p,t,} \ Z_{s,t})$ (4a)

Where D_s is demand for scrap, S_s is scrap supply, $P_{s,t-k}$ is price for scrap at time t-k, and k=1,2,3…, ΔI_t is scrap change in inventory and reflects the flow adjustment process under the conventional equilibrium theory, Z_s is a vector of exogenous variables for scrap. Z_s contains business cycle indicators (BCI), and electricity costs. Scrap supply is also dependant on Pp,t , as new scrap supply is a byproduct of steel production and needs to be expresses as a function of primary steel production or price (Tilton; Vogely 1985).

$P_{p,t}= g_1(\Delta I_{p,t}, Z_{p,t})$ (1b)

$\Delta I_{p,t}=S_{pt}- D_{pt}$ (2b)

$D_{p,t} = g_2 (P_{p,t-k}, Z_{pt})$ (3b)

$S_{p,t} = g_3(P_{p,t-k}, P_{s,t,} \ Z_{pt})$ (4p)

Where $D_{p,t}$ is demand for primary metal, $S_{p,t}$ is steel supply, $P_{p,t-k}$ is price for primary metal at time t-k, where k=1,2,3…, $\Delta I_{p,t}$ is change in primary metal inventory or else excess supply or demand which reflects the flow adjustment process towards equilibrium, Z_{pt} is a vector of exogenous variables for primary metal. Z_{st} is a vector of business cycle indicators (BCI) and electricity costs. $P_{s,t}$ is included in the primary steel supply function as it is one of the main inputs to production.

Substituting (4a) and (3a) into (2a) and (2a) into (1a), and (4b) and (3b) into (2b) and (2b) into (1b), produces the price adjustment expression for primary and secondary prices.

1. $P_{s,t}= f_4 (P_{s,t-k}, P_{p,t,} \ Z_{s,t})$; where t=1,2,3…
2. $P_{p,t}= g_4 (P_{p,,t-k}, P_{s,t} , Z_{p,t})$; where t=1,2,3…

This is a simultaneous equation system. It is solved to provide the reduced forms for primary and scrap steel price. The reduced form model is presented in section V in terms of first differences (changes).

IV. Methodological Framework

The examination of price series for steel and scrap steel leads the study to the use of Time Series Analysis, as is the tradition for time series data. To analyze the relationship between scrap and steel prices the following methodologies are utilized: (1) a preliminary correlation analysis; (2) vector autoregressive analysis. Let us briefly review each of these methods.

Preliminary Correlation Analysis

Preliminary examination of the data to determine the existence of linkages between scrap and steel prices consists of a visual analysis of the two series, a comparison of the descriptive statistics in the two series, and an examination of the correlation and covariance. Covariance and correlation are measures of the extent to which two random variables move together. Correlation analysis is static, so to get a feel of the dynamic linkages it is also important to examine correlations with past lags between the price series.

Correlation does not necessarily imply causality. Correlations can be spurious. Granger (1969) causality testing can examine the relationship between the variables by testing how much of the current y can be explained by past values of y and if adding lagged values of x can improve the explanation. If x helps in the prediction of y, y is said to be Granger caused by x.

Linkages between variables can also be discovered by examining the Johansen (1991, 1995) cointegration tests. Cointegration implies a common stochastic trend and a long-run equilibrium for time series that are non-stationary., in identifying the cointegrating (long-run equilibrium) relationships.

VAR Analysis

To further examine the correlation in the data we develop and analyze a VAR model, as well as the impulse response functions and the variance decomposition of the system. Vector Autoregression (VAR) is commonly used for examining the links of interrelated time series. In this study exogenous business factors indicators are included as explanatory variables, which transforms the analysis to a VARX model. Impulse response functions and the variance decomposition serve to examine volatility correlations and transmissions. Impulse response functions are used for analyzing the dynamic impact of random disturbances in an endogenous variable on each variable of the system, and variance decomposition decomposes the variation in the forecast error of an endogenous variable into the component shocks to the variables in the VAR. The variance decomposition provides information about the relative importance of each random innovation to the variables in the VAR.

The VAR analysis avoids the need for structural modeling by modeling every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The estimated coefficients show the influence of each variable on the endogenous variables, and the impulse response functions and variance decomposition provide information about the relative importance of each random innovation to VAR system and its variances. The VAR system is always examined under the perspective of forecasting. The mathematical form of a VARX is given below:

$$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \beta X_t + \varepsilon_t$$

where Y_t is a k vector of endogenous variables, X_t is a d vector of exogenous variables, $A_1,\ldots,A_p$ and β are matrices of coefficients to be estimated, and ε_t is a vector of errors that may be contemporaneously correlated.

V. Model Estimation and Results

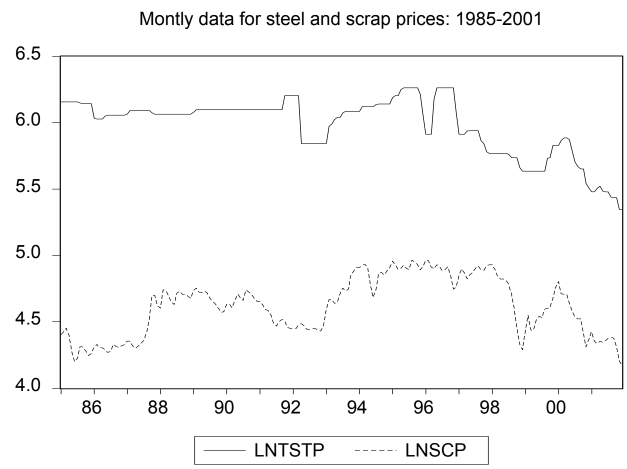
Data Description

The data set is composed by monthly nominal steel (midwest prices of hot-rolled sheet) and scrap steel prices (No.1 Heavy melting Steel Scrap price composite), monthly industrial production, monthly 90-day commercial paper financial interest rate, monthly unemployment rate, electricity price and monthly Wholesale Price Index (WPI)*. The period of analysis is 1985-2001.

Preliminary Correlation Analysis

The preliminary analysis for scrap and steel prices does not give us conclusive results. The prices are examined after they have been transformed to logarithms. The optical examination of the series implies a relationship in the fluctuation of the two price series.

Graph 1: Primary and Secondary Steel Prices



The correlation and covariance that is found indicates dependence between the two series. LNTSTP is the logarithm for steel price and LNSCP is the logarithm for steel scrap price. Cross correlations also show a relationship over time.

-Table1-

Standard deviations (0.2167 for lnpp and 0.2181 for lnps) seem to be of the same magnitude. After testing for equality of the variances we cannot reject equality. This means that volatility in scrap is not really higher than in primary steel and implies some relationship between the variance of the two series.

-Table 2-

* For further details on the data see Appendix 2

We further investigate the relationship between primary and scrap steel prices by performing a Granger (1969) causality test. Pairwise Granger Causality tests do show that causality exists for the two series. With a confidence of ninety percent scrap price seems to granger cause primary steel price. Though not presented in the text the probability that primary steel granger causes scrap reaches 87% when only one lag is used in the granger causality test.

-Table 3-

To test for a common stochastic trend, co integration analysis is performed. For cointegration to exist the price series need to be independently non-stationary, which is the case for both the series. The cointegration test that is performed does not sustain that a long-run relationship between the variables exists.

-Table 4-

Examination of the data suggests that no deterministic trend is present in both series; therefore simple differencing of the logarithmic prices can ensure price series stationary. These differences that correspond to percentage changes in prices will be used in the ensuing analysis.

VAR Analysis

For a further investigation of the links in the primary and secondary price data a VAR model is analyzed. Because of the unit root that exists in the price series we analyze the first differences, the change in the prices from time t-1 to time t, which corresponds to a percentage change because the prices are expressed in logarithmic form. The results that we obtain will not convey the same meanings as those obtained from a price level model. The model that is estimated is presented below:

$$\Delta \ln Ps_t = b_{1k}\Delta \ln Ps_{t-k} + d_{1k}\Delta \ln Pp_{t-k} + n_{1k}\Delta \ln IndPro_{t-k} + z_{1k}\Delta \ln WPI_{t-k} + \theta_{1k}\Delta IR_{t-k} + \delta_{1k}\Delta UR_{t-k} + \varepsilon_{1k}EI_{t-k} + \varepsilon_t$$

$$\Delta \ln Pp_t = b_{2k}\Delta \ln Ps_{t-k} + d_{2k}\Delta \ln Pp_{t-k} + n_{2k}\Delta \ln IndPro_{t-k} + z_{2k}\Delta \ln CPI_{t-k} + \theta_{2k}\Delta IR_{t-k} + \delta_{2k}\Delta UR_{t-k} + \varepsilon_{2k}EI_{t-k} + u_t$$

Where *Psc* is the price for scrap, *Pst* the price for steel, *IP* is industrial production, *WPI* is the wholesale price index *IR* is the interest rate and *UR* is the unemployment rate, El is electricity price and k=1…n.

The best performance according to the Akaike and Schwartz criteria were the three and two lag VAR model respectively. But since the third lags of the change in prices were found to be significant, the model with three lags was chosen. Best results were also found when the independent variables were lagged only one month back.

-Table 5-

The model shows that percentage changes in prices for primary steel are influenced by percentage changes in prices for scrap, but that steel prices do not have an effect of scrap prices. A clear influence is found in primary steel from the price of scrap three months ahead, and some influence is probably exercised by the one month lagged scrap price. Influence from macroeconomic variables is substantial in the case of scrap but insignificant for primary price. The above may seem puzzling if we don't take into account that steel prices are not free market prices, but producer prices, whereas scrap prices are market prices and are able to express the market pulse. The primary producer prices change very infrequently, and changes may not reflect short-term business conditions, but more of a long-term trend. Consequently business cycle indicators influence scrap prices in the short term, but do not influence steel prices. This does not suggest that they do not influence the primary steel market. The instability in the primary steel market takes two forms: in prices it takes the forms of unofficial price discounting which cannot be accounted for in the official published prices, and it also expresses itself in production changes often leading to shortages and excess supply (Tilton, 1981). An increase in demand, for example, will not necessarily increase price in the short run, but will increase production. Scrap price increases and decreases are, as expressed in the theory presented in section III, due to scrap demand changes that represent primary steel demand shifts. The model's results also show that scrap price increases lead to primary steel price increases with lags. This occurs because scrap represents one of the main inputs to metal production, and can be viewed as a barometer of the market by steel producers, since scrap price fluctuates freely to capture demand and supply forces.

Volatility connections and transmission are analyzed through impulse response functions and volatility decomposition. Multivariate Garch Analysis was initially planned to be presented, but Arch testing in the residuals of the primary and scrap price changes, showed that they are not subject to autoregressive conditional heteroskedasticity, and thus cannot be modeled in an M-Garch framework. The impulse response functions show how a shock in one of the endogenous variables influences the system over time. Thus, the dynamic impact of a random disturbance on each variable of the system can be assessed. It is evident that a shock in steel prices directly affects the scrap prices variable and vice versa, as it is transmitted to all the endogenous variables through the dynamic structure of the VAR. The same holds in relation of the influence that innovations of scrap prices have on steel prices. In addition the shock that innovation poses to the system persists over time.

-Graph 2 and Table 6-

The variance decomposition analysis decomposes the error forecast variation in an endogenous variable into the component shocks to the endogenous variables in the VAR. The variance decomposition gives information about the relative importance of each random innovation to the variables in the VAR. The forecasting error in the scrap market is mostly due to its own error variance. The error variance of scrap prices is relatively more important for mis-forcasting steel prices. But this also means that its influence on primary steel is relatively important.

-Graph 3 and Table 7-

VII. Conclusions

The paper examined the relationships between the prices for scrap and steel and found that statistically traceable links exist. Percentage changes in prices for primary are influenced by past percentage changes in prices for scrap, making it clear that price variability in the primary and secondary markets are linked. The importance of the common dependence on macroeconomic data is established, but only for scrap. The influence of macroeconomic variables on scrap prices allows establishing through theory its influence on the primary steel market as well, though this influence is not expressed in the published prices, because of the behavior of an industry based on producer prices. Impulse response examination allowed us to view the affect that incremental shocks in one series have on the other series and understand the links that exist between the variances of the two series. Variance decomposition shows that that the variance of scrap increases the forecasting error for steel. The gist of the paper's examination and results is that the variability of prices in the primary and secondary market cannot be seen independently, and that variability in the primary market carries on to the secondary market and vice versa. The producer price system in the primary steel market weakens the price change influence of steel on scrap and its connection to business indicators. Further analysis will be undertaken with prices of metals that follow the free market system - non-ferrous metals- which are expected to show even higher price connections between primary and secondary prices.

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Appendix 1: Tables

Table 1: Preliminary Correlation Analysis of Primary and Scrap Prices

Correlation Matrix

	LNTSTP	LNSCP
LNTSTP	1.000000	0.322117
LNSCP	0.322117	1.000000

Covariance Matrix

	LNTSTP	LNSCP
LNTSTP	0.046748	0.015155
LNSCP	0.015155	0.047350

Cross Correlogram

i	lag	lead
0	0.3221	0.3221
1	0.3068	0.3099
2	0.2872	0.2986
3	0.2666	0.2899
4	0.2434	0.2781
5	0.2188	0.2634
6	0.1923	0.2524
7	0.1625	0.2442
8	0.1323	0.2383
9	0.1021	0.2337
10	0.0651	0.2298
11	0.0276	0.2246
12	-0.0010	0.2182

Table 2: Test for Equality of Variance between Primary and Scrap Steel Prices

Test for Equality of Variances Between Series

Method	df	Value	Probability
F-test	(203, 203)	1.012883	0.9274
Bartlett	1	0.008295	0.9274
Levene	(1, 406)	0.604860	0.4372
Brown-Forsythe	(1, 406)	3.717351	0.0545

Table 3: Granger Causality Tests for Primary and Scrap Prices

Pairwise Granger Causality Tests
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
LNPS does not Granger Cause LNPP	200	1.92580	0.10775
LNPP does not Granger Cause LNPS		0.69558	0.59587

Table 4: Cointegration Test for Primary and Scrap Prices

Series: LNPP LNPS
Lags interval: No lags

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.025230	6.665234	19.96	24.60	None
0.007253	1.477823	9.24	12.97	At most 1

Test assumption: No deterministic trend in the data
*(**) denotes rejection of the hypothesis at 5%(1%) significance level .
The test rejects any cointegration at 5% significance level.

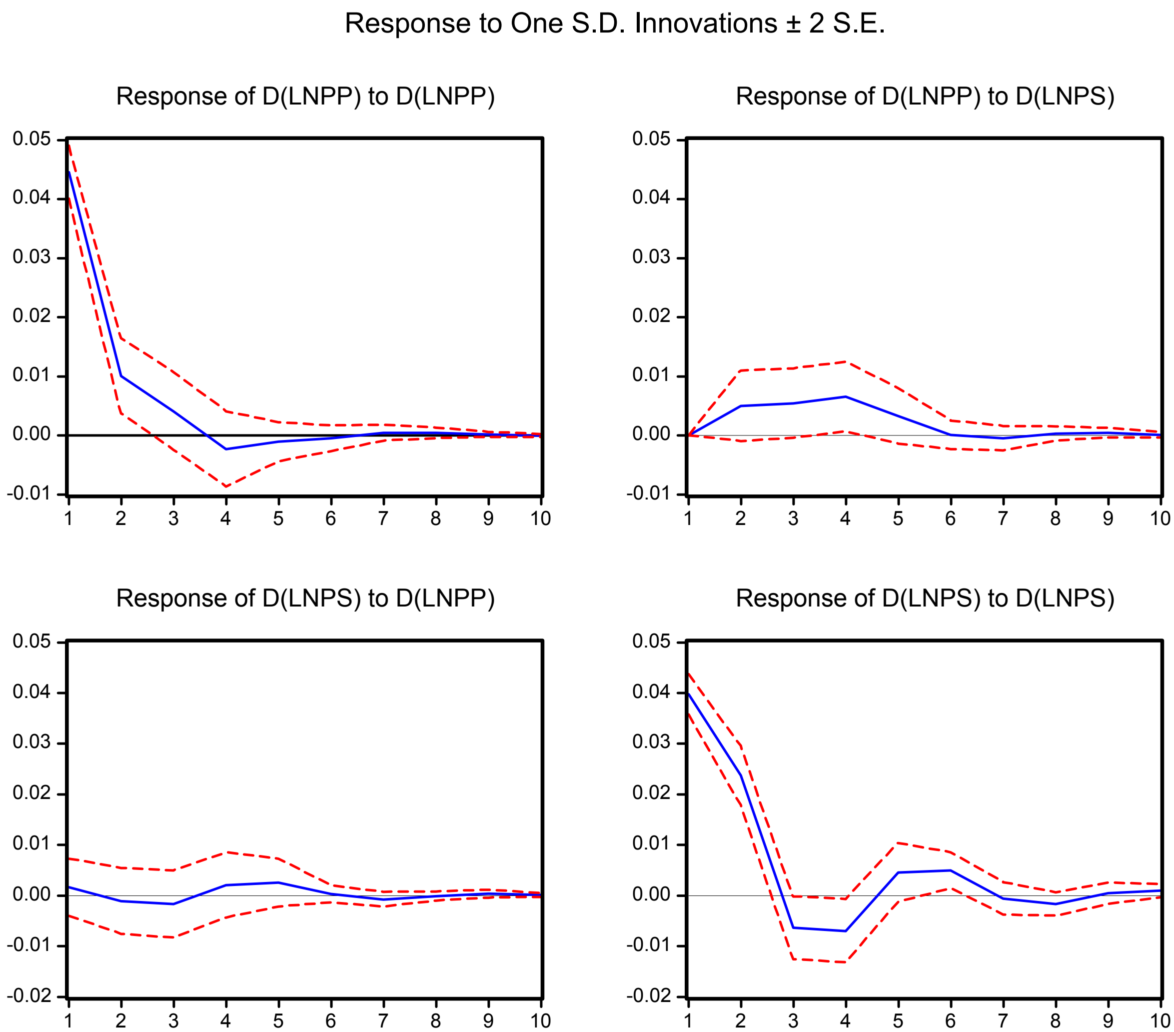
Table 5.Estimation Results of the of the VarX Model for First Differences

	D(LNPP)	D(LNPS)
D(LNPP(-1))	0.221043	-0.046503
	(0.07229)	(0.06459)
	(3.05754)***	(-0.71993)
D(LNPP(-2))	0.043328	0.005329
	(0.07444)	(0.06651)
	(0.58208)	(0.08013)
D(LNPP(-3))	-0.081673	0.051925
	(0.07177)	(0.06412)
	(-1.13799)	(0.80975)
D(LNPS(-1))	0.125089	0.597178
	(0.07722)	(0.06900)
	(1.61988)'	(8.65529)***
D(LNPS(-2))	0.033824	-0.510783
	(0.07906)	(0.07064)
	(0.42781)	(-7.23067)***
D(LNPS(-3))	0.129255	0.230738
	(0.07777)	(0.06948)
	(1.66206)*	(3.32075)***
D(LNWPI(-1))	-0.174254	-0.724238
	(0.52993)	(0.47348)
	(-0.32883)	(-1.52962)'
D(LNEL(-1))	0.216282	0.648778
	(0.24284)	(0.21697)
	(0.89065)	(2.99019)***
D(LNUR(-1))	0.029805	0.027277
	(0.05313)	(0.04747)
	(0.56097)	(0.57459)
D(LNIR(-1))	-0.011595	0.208161
	(0.07324)	(0.06544)
	(-0.15832)	(3.18098)***
D(INDPRO(-1))	0.000849	-0.002740
	(0.00128)	(0.00114)
	(0.66251)	(-2.39285)**

R-squared	0.108600	0.389005
Adj. R-squared	0.061436	0.356677
Sum sq. resids	0.397043	0.316961
S.E. equation	0.045834	0.040952
F-statistic	2.302607	12.03314
Log likelihood	338.4151	360.9417
Akaike AIC	-3.274151	-3.499417
Schwarz SC	-3.092743	-3.318009
Mean dependent	-0.004049	-0.001105
S.D. dependent	0.047310	0.051057
Determinant Residual Covariance		3.14E-06
Log Likelihood		699.5272
Akaike Information Criteria		-6.775272
Schwarz Criteria		-6.412457

Standard errors & t-statistics in parentheses
Standard errors & t-statistics in parentheses
*, **, *** state statistical significance at the 10%,5%, and 1%, respectively

Graph 2 and Table 6: Impulse Response Functions for Primary and Scrap Price Changes

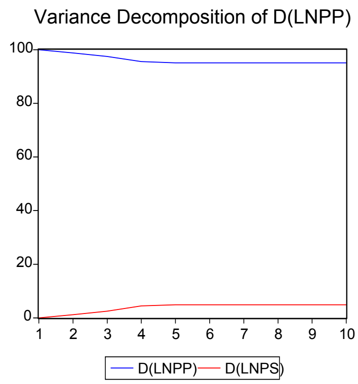


Period	Response of D(LNPP): D(LNPP)	D(LNPS)
1	0.044556	0.000000
2	0.010054	0.004976
3	0.004072	0.005416
4	-0.002343	0.006561
5	-0.001101	0.003261
6	-0.000513	7.25E-05
7	0.000422	-0.000505
8	0.000405	0.000305
9	0.000152	0.000454
10	-3.77E-05	7.70E-05

Period	Response of D(LNPS): D(LNPP)	D(LNPS)
1	0.001643	0.039776
2	-0.001091	0.023753
3	-0.001721	-0.006363
4	0.002086	-0.006980
5	0.002526	0.004545
6	0.000296	0.004976
7	-0.000736	-0.000606
8	-8.72E-05	-0.001662
9	0.000349	0.000452
10	0.000100	0.000933

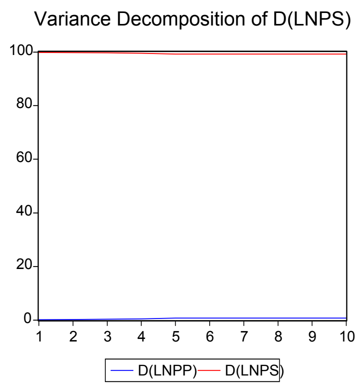
Ordering: D(LNPP) D(LNPS)

Graph 3 and Table 7: Variance Decomposition for Primary and Scrap Price Changes



Variance Decomposition for D(ILNTSTP)

Period	S.E.	D(LNPP)	D(LNPS)
1	0.044556	100.0000	0.000000
2	0.045946	98.82733	1.172667
3	0.046443	97.49216	2.507844
4	0.046963	95.59529	4.404713
5	0.047089	95.13937	4.860625
6	0.047092	95.13973	4.860274
7	0.047096	95.12919	4.870809
8	0.047099	95.12556	4.874443
9	0.047102	95.11675	4.883248
10	0.047102	95.11650	4.883499



Variance Decomposition for D(LNSCP)

Period	S.E.	D(LNPP)	D(LNPS)
1	0.039810	0.170362	99.82964
2	0.046370	0.180893	99.81911
3	0.046837	0.312290	99.68771
4	0.047400	0.498672	99.50133
5	0.047684	0.773359	99.22664
6	0.047944	0.768807	99.23119
7	0.047953	0.792047	99.20795
8	0.047982	0.791425	99.20858
9	0.047986	0.796595	99.20340
10	0.047995	0.796725	99.20327

Appendix 2: Data Sources

Psc. The prices for scrap steel are the prices for No.1 Heavy melting Steel Scrap price composite that were reported in the Metal Statistics year book published by AMM. The dates of publication that where used were 2001, 1995, and 1992.
Pst. The prices for steel are the midwest prices of hot-rolled sheet that were reported in the Metal Statistics year book published by AMM. The dates of publication that where used were 2001, 1995, and 1992.
UR. The unemployment rate is found from the Minnesota Department of Economic Security Research and Statistics Office at http://www.mnworkforcecenter.org/ui/. The data is non-seasonally adjusted, as are the other series.
IR. The interest rate used is the monthly commercial paper financial 90-day found in the Federal Reserve Statistical Release. The interest rates are nominal, just like the Steel nad Scrap Prices.
WPI. This is the most general wholesale price index that can be found. For the purposes of this study it corresponds to the BLS all commodity PPI WPU00000000 series beginning 01/1913.
INDPRO. The Industrial Production Index data begin in 01/1889 with the NBER series 01001, The Babson Index of Physical Volume of Business. They are then updated from 1919.01 using the Federal Reserve Total Index, B50001: Industrial Production: Market and Industry Aggregates. This series was compiled by Walter C. Labys on Oct. 10, 2002.
EL. Price of Electricity per 500 KWH. Average price data, U.S. city average. BLS item number: APU000072621 (not seasonally adjusted).