The effect of exchange rates on southern pine exports

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Abstract

Changes in exchange rates affect southern pine exports by changing the cost of southern wood in foreign markets. A strong dollar discourages exports; a weak dollar encourages exports. A simple econometric export market model is developed to determine whether changes in the exchange rates in foreign markets of southern pine products have, in fact, led to significant changes in southern pine exports. The results confirm that exchange rates are important determinants of southern pine exports. Per-capita income in foreign markets and domestic southern pine relative prices are also important determinants of exports. The estimated model can be used to predict the response of southern pine exports to exchange rate movements. The results also indicate that it is not necessary to construct a special southern pine exchange rate index based on southern pine export markets. The Federal Reserve Board broad index serves quite well as a predictor of the effect of exchange rate movements on southern pine exports.

Exchange rates are important determinants of southern wood trade, which, in turn, affect income and employment in the southern wood industry. The behavior of U.S. forest products exports since the adoption of floating exchange rates in the early 1970s demonstrates the impact of exchange rate movements on forest products trade. For example, in response to the sharp appreciation of the dollar in the first half of the 1980s, U.S. forest products exports declined in real terms from $8.3 billion in 1980 to $5.4 billion in 1985, a 35 percent decrease. Forest products exports then responded to a sharp devaluation of the dollar during the years 1986 to 1989, by increasing from $6.3 billion to $10.3 billion, a 70 percent increase (NBER 1997). The subsequent appreciation of the dollar during the 1990s made U.S. wood products more expensive in foreign markets. According to the Federal Reserve Board (FRB) broad index, the value of the dollar increased 15 percent from 1997 to 2000 (FRB 2001). At the same time, southern wood exports declined 24 percent.

Failure to recognize the importance of foreign exchange movements on wood exports could lead a firm to mistakenly attribute, say, an increase in its exports to its export program, where, in fact, the increase may have been a response to the decline in the value of the dollar. Exchange rate fluctuations also influence the optimal location of forest industry. From a firm's perspective, it might appear that exchange rates are of no concern with regard to whether to locate a plant in Alabama or Ohio. A dollar is a dollar. There are, however, differences in the impact of exchange rate movements on wood exports from different regions of the country, because of differences in regional export markets. To the extent firms are export oriented, these differences favor location in regions in which the foreign currencies of export markets strengthen against the dollar and discourages location in regions in which the currencies of export markets weaken against the dollar. The primary objective of this paper is to determine whether exchange rates have a measurable impact on southern pine exports. A simple export market model is constructed and used to measure the impact of exchange rates on southern pine exports and to test the utility of specially constructed wood indexes.

A simple export market model

In this section, we specify a simple export market model designed to measure the relative importance of exchange rates and other key factors believed to influence southern pine exports. Visual comparison of southern pine exports with the FRB broad exchange rate index reveals that southern pine exports exhibit the expected relationship with exchange rates (**Fig. 1**). That is, south-

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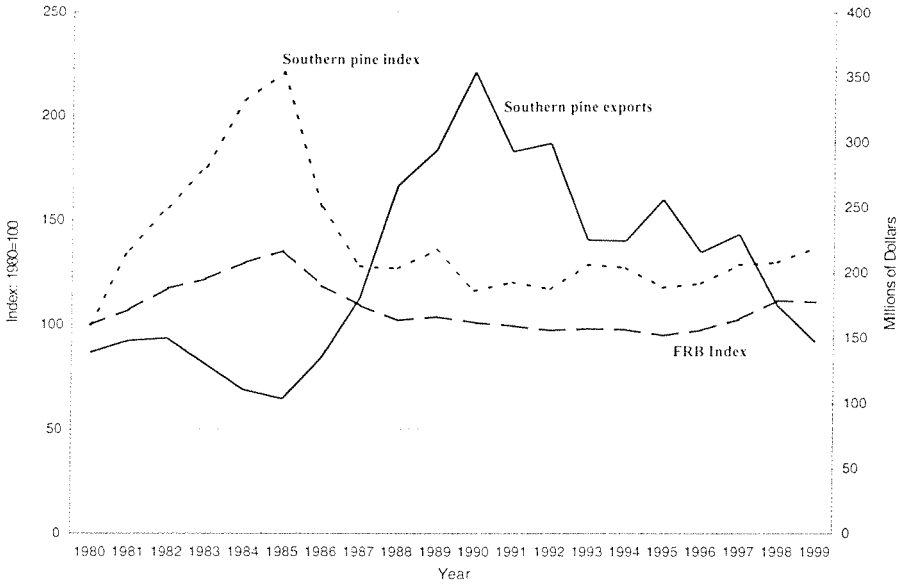

Figure 1. — Comparison of southern pine exports with southern pine and FRB indexes.

ern pine exports tend to increase (decrease) when the dollar depreciates (appreciates).

Goldstein and Khan (1985) provide a theoretically rigorous structural export market model. The relevant equations from the Goldstein and Khan theoretical model are:

$$X_i^d = f(Y^* e, PX_i, P^* e)$$
$$X_i^s = g(PX_i, P_i)$$

where:

X_i^d = the quantity of country i's exports demanded by rest of the world

X_i^s = the quantity of exports supplied from country i to rest of the world

PX_i = the domestic currency prices received by exporters in country i

P_i = the quantity of exports supplied from country i to rest of the world

P^* = the price of all goods in rest of the world

Y^* = nominal income in rest of the world

e = the exchange rate expressed in units of country i's currency as a percent of the rest of the world's currency

The absence of a reliable and sufficiently long time series for the price of exports, PX_i, is a major barrier to solving the structural model. For this reason, the reduced-form equation is often resorted to (Goldstein and Khan 1986). Belongia (1986) provides a reduced-form estimating equation for the Goldstein and Khan model. Their model suits our needs well, because our concern is with the full impact of exchange rate movements on southern pine exports (that is, the sum of demand and supply effects). The coefficients of the reduced-form equation provide this information. Accordingly, we adopt Belongia's market-clearing reduced-form equation:

$$\ln AGX = a + b\ln FGNP + c\ln USAGP/USCPI + d\ln RTWER + e$$

where:

AGX = the volume of U.S. agricultural exports in 1972 dollars

$FGNP$ = the trade-weighted index of foreign real GNP

$USAGP$ = the price index of U.S. agricultural exports

$USCPI$ = the U.S. consumer price index

$RTWER$ = the real trade-weighted index of the foreign exchange value of the U.S. dollar

ln = the natural logarithm

Export demand is assumed to depend on just two factors: the level of real economic activity in foreign markets and U.S. prices relative to prices in major U.S. export markets. An exchange rate index represents the latter variable. The higher the level of real economic activity in foreign markets, other things equal, the larger would be the foreign demand for U.S. exports. The higher the price of U.S. exports relative to domestic substitutes in foreign markets, other things being equal, the smaller would be the demand for U.S.exports.

On the other side of the market, the supply of U.S. exports is expressed as a function of the prices of U.S. exports relative to the prices of all U.S. goods and services, and exogenous factors, such as trade barriers. Other things equal, the higher the prices of U.S. exports relative to prices of other goods, the larger the production of commodities for export. Adapting Belagio's equation to our purposes, we have:

$$\ln(SPEXP_t) = a + b\ln(\mathrm{TWER}_t) - c\ln(FGDP_t) + d\ln(RELPRICE_t) + e_t$$

where:

$SPEXP_t$ = real value of southern pine exports in year t

$TWER_t$ = the trade-weighted exchange index in year t

$FGDP_t$ = trade-weighted foreign gross domestic product in year t

$RELPRICE_t$ = wood price index/ all commodities price index in year t

e_t = a random error term in year t

ln = natural logarithm

The $TWER$ and $FGNP$ variables are of particular importance because they measure the relative importance of real exchange rates and economic activity in export markets.

Description of variables

The dependent variable

The dependent variable, $SPEXP$, is the real value of annual southern pine exports for the years 1980 to 2000. Southern pine export data for the years 1980 to 1988 are taken from the National Bureau of Economic Research (NBER) trade database (NBER 1997). Data for the years 1989 to 2000 are taken from the U.S. International Trade Commission (USITC) interactive tariff and trade dataweb (USITC 2001). The foreign exchange rates, consumer price indexes, and gross domestic product (GDP) data were taken from the International Monetary Fund's (IMF) International Finan-

Table 1. — Weights assigned to each country included in the southern pine exchange rate index and the FRB index.

	Southern pine		FRB index
Country	1989	1995	1995
Belgium	18.5	9.1	1.5
Denmark	8.3	3.9	--
Germany	4.8	19.3	5.6
[illegible]	3.5	6.1	0.6
[illegible]	2.0	3.4	2.5
Japan	--	3.5	16.6
Korea	--	--	4.4
Netherlands	12.9	27.1	1.5
Spain	--	--	0.9
Taiwan	--	--	4.9
United Kingdom	50.0	27.7	4.2
Other	--	--	58.0
Total	100.0	100.0	100.0

cial Statistics for the years 1980 through 2000 (IMF 2001).

There are several published national trade-weighted exchange rate (*TWER*) indexes. These include the FRB broad index, the Morgan Guaranty index, and indexes developed by Federal Reserve branch banks. The USDA Economic Research Service (ERS) publishes *TWER* indexes for major U.S. agricultural markets, competitors, and suppliers (ERS 2001).

Published indexes usually use total U.S. merchandise trade (exports + imports) in base years to derive the weights applied to each foreign currency in the index. If southern pine export markets differ significantly in relative importance from those of total U.S. trade, then the published indexes may not accurately reflect the impact of foreign exchange movements on southern pine exports. For this reason, we constructed a special southern pine exchange rate index. The countries included in the southern pine index and their corresponding 1989 and 1995 weights are compared with the weights of the FRB broad index in **Table 1**.

Clearly, southern pine export markets differ substantially from total U.S. export markets in their relative importance. The Netherlands, Germany, and Belgium together accounted for 86 percent of southern pine exports in 1995, compared to only 13 percent for all U.S. exports. Conversely, Japan accounted for only 3.5 percent of southern pine exports, but 17 percent of total U.S. exports. Fifty-eight percent of U.S. exports go to countries not included in southern pine export markets.

The exchange rate variable

In view of the considerable differences in southern pine and total U.S. markets, it is reasonable to suspect that a specially constructed exchange rate index would be a better predictor of the effect of exchange rates on southern pine exports than national indexes, such as the FRB broad index, when used as the foreign exchange variable in a southern pine export market model. Accordingly, we use the especially constructed southern pine index as the foreign exchange variable in the southern pine export market model, and compare the result with a similar model estimated with the FRB broad index as the foreign exchange variable.

The expected sign for both versions of the variable are negative. That is, an increase (decrease) in weighted exchange rates increases the cost of U.S. goods in foreign markets, thereby reducing exports.

The foreign markets economic activity variable

The foreign markets economic activity variable, *FGDP*, is the trade-weighted average of gross domestic products in southern pine export markets:

$$FGDP_t = 100 \prod_{i=1}^{n} \left[\left(\frac{GDP_t^i}{P_t^i} \right) / \left(\frac{GDP_B^i}{P_B^i} \right) \right]^{w^i}$$

where:

$FGDP_t$ = the trade-weighted gross domestic product in year t

GDP_t^i = the gross domestic product of country i in year t

P_t^i = the consumer price index of country i in year t

B = the base years (1989 and 1995)

w^i = the trade weight assigned country i based on its share of the total southern pine exports

$\prod_{i=1}^{n}$ = the product of all i through n countries.

Its expected sign is positive. An increase in weighted GDP increases southern pine exports.

The relative price variable

The relative price variable, *RELPRICE*, reflects the relative domestic price of softwood lumber. Its expected sign is negative.

Estimating the models

The model was estimated using the ordinary least squares technique, with the model in log-linear form. The log-linear specification generates estimated coefficients that measure the percentage change in the dependent variable (*SPEXP*) in response to a 1 percent change in one of the independent (right-hand-side) variables, holding all other variables constant.

Discussion of results

Various specifications of the model were tested, using alternatively the southern pine TWER index and the FRB index as the exchange rate variable. Other tested variables were: the softwood producer price and lumber producer price relatives, the trade-weighted foreign gross domestic product (FGDP) index, and the trade-weighted foreign-to-U.S. price ratio. Acceptable estimates were obtained for both the southern pine index and FRB index versions of the model. Both coefficients of determination were acceptable: 78.2 and 89.6 percent for the southern pine index and FRB index, respectively. The substantially higher coefficient of determination for the FRB variable led us to prefer that version of the exchange rate index.

The estimated model is:

$$SPEXP = 9.885 - 2.541FRB + 3.153FGDP - 1.672SP/ALLCOMM - .116DUMMY$$

FRB – (-7.277), [0.000]

$FGDP$ – (6.591), [0.000]

$SP/ALLCOMM$ – (-4.334), [0.000]

$DUMMY$ – (-1.292), [-0.208]

ADJ. r^2 = 89.6; DW = 1.76

where:

$SPEXP$ = real value of southern pine exports in millions of dollars

$SP/ALLCOMM$ = the ratio of U.S. softwood price index to the all commodities price index

All other variables are as before.

The numbers in parentheses to the right of each independent variable are the t-test values. The numbers in brackets are the corresponding probabilities that the associated coefficient would be greater than zero. The equation explains 89.6 percent of the annual variation in southern pine exports. The t-ratios were high for both the exchange rate and GDP variables.

The Durbin-Watson (DW) statistic indicates the presence of autocorrelation. The Hildreth-Lu procedure was applied to correct for autocorrelation. The adjustment did not change the equation significantly. All coefficients, t-values, and the coefficient of determination remained the same to the third decimal point. Accordingly, we chose to proceed with the unadjusted model shown above.

The coefficients attached to the independent variables in a reduced-form equation have a different interpretation than those attached to the variables of the structural demand and supply equations. The coefficients attached to the independent variables in the equation above (exchange rate and income) show the equilibrium impact of a change in that variable on southern pine exports, all other variables held constant. The reduced-form coefficients are sometimes called "impact multipliers" (Wonnacot and Wonnacot 1979).

The reduced-form equation shows explicitly how southern pine exports are jointly dependent on the independent variables and the disturbances of the system (Kmenta 1986). In our case, a 1 percent change in the FRB index produces a 2.5 percent change in the opposite direction in softwood exports. A 1 percent change in the weighted FGDP produces a 3.2 percent change in softwood exports, in the same direction. A 1 percent change in relative price produces a 1.7 percent change in exports. It is clear that exchange rates, economic activity, and relative prices are important determinants of southern softwood exports.

The estimated model can be used to predict the impact of anticipated or realized exchange rate movements on southern pine exports. Individual firms can use the model to predict changes in southern pine exports as long as they keep in mind that it is total southern pine exports that are estimated, not exports by individual firms. A firm could, of course, specify the export model using the firm's exports instead of total southern pine exports as the dependent variable.

How should individual exporters respond to exchange rate uncertainty?

Individual exporters can take actions to reduce the impact of exchange rate movements on their profits. These actions can be price, non-price, or a combination of both. Price actions include adjusting the price markup margin in reponse to a change or expected change in the exchange rate in an export market. The firm's ability to reduce its profit margin depends, of course, on its market power in that market. In a competitive market, the firm's markup will be reduced to or near the minimum acceptable margin over costs. If the firm reduces this margin, it will be operating at an unacceptable level of profit. If, however, the firm enjoys market power, then its markup margin likely will exceed the minimum needed for the firm to stay in the market, granting the firm some degree of pricing flexibility. In this case, the firm can reduce its margin so that the delivered price of the firm's product remains the same in the importing country. A firm might adopt this strategy if it wishes to protect its market share in the foreign market (Knetter 1993).

Non-price actions include the use of forward foreign exchange markets to hedge against exchange rate exposure, and the choice of currency in which to set prices. Forward/future currency contracts are most commonly used to hedge against exchange rate exposure (Friberg 1998). An exporter can also choose among setting price in his own currency, the importer's currency, or a third currency. Friberg (1998) points out that the shape of the demand and cost function, the exporter's risk aversion, and the existence of forward exchange markets will determine which of the three price setting strategies yields the highest profit. The optimum strategy is likely to vary by firm. Selecting the optimal strategy for minimizing the impact of exchange rate uncertainty is a complex topic, and a complete treatment of it is beyond the scope of this paper. Friberg (1998) provides a rigorous analysis of export pricing strategies for different scenarios.

Summary

The high statistical significance of the foreign exchange variables in the southern pine export market model confirms that southern pine exports are very sensitive to changes in exchange rates. Firms that export all or a portion of their production face all of the marketing problems they face in their domestic sales, plus the uncertainty of exchange rates. Exporters must anticipate changes in foreign exchange rates and be able to predict the impact of these changes on their export sales. Failure to recognize the influence of exchange rates on sales can lead them to mistake the reason for changes in their export performance. At the same time, this study has shown that exchange rates are not the only factor influencing southern pine exports. Changes in the level of economic activity in foreign markets and relative prices can also affect exports and should be evaluated along with exchange rate movements.

It does not appear that the cost and effort necessary to construct a special trade-weighted wood products exchange rate index is justified, at least in terms of its performance in trade models. This conclusion is based on the performance of annual indexes. Monthly or quarterly wood products exchange rate indexes may be useful if they exhibit sensitivity to short-term movements in exports not captured in published national indexes.

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