Econometric Model of the U.S. Sheep Industry for Policy Analysis

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INTRODUCTION

Sheep were first domesticated in Central Asia about 10,000 years ago (Ensminger and Parker). Their use then was the same as today, to provide two products, meat and wool. Today, sheep production has evolved to include more than 200 breeds worldwide.

In the U.S. two areas dominate sheep production, the range state region and the farm flock region (Anderson, 1994). The range state region includes the 16 Western states and Texas. Commercial production in these states is made up of large concentrations of sheep grazing large areas of the range. In 2002, these states accounted for about 85 percent of the total U.S. sheep flock. The farm flock region includes the rest of the U.S. and accounts for the remaining 15 percent. These flocks generally use more meat-oriented breeds than wool producing breeds (USDA Sheep and Goats).

The U.S. sheep industry is small compared to the rest of the world. In 2002, it accounted for 0.67 percent of the world's sheep inventory with 4.91 million head and about 1.42 percent of the world's wool production with about 41 million pounds of clean fleece (USDA Cotton and Wool Outlook). China is the world's largest sheep producer with 135 million head (in 2002), followed closely by Australia with 119 million head and, in smaller scale, New Zealand, Argentina, Uruguay, and South Africa. In the world's wool production, Australia is the largest producer with 946 million pounds of clean fleece (in 2002), followed by New Zealand, China, Argentina, Uruguay and South Africa. Australia is the world's largest exporter of wool with 406 million pounds of clean fleece followed by New Zealand, Argentina, Uruguay and South Africa. The U.S. is the 8th largest importer of wool with 75 million clean pounds (USDA Cotton and Wool Outlook).

Besides being a small producer of sheep internationally, the U.S. sheep industry has been declining for many years. From 1940 to 2002, the number of stock sheep has declined significantly, from 49 million head in 1942 to 4.1 million head in 2002 (USDA Agricultural Statistics).

Many factors have contributed to the decline of the sheep industry. The per capita consumption of lamb and mutton has fallen from 2.9 pounds in 1970 to 1.2 pounds in 2002 (USDA Livestock, Dairy and Poultry Outlook). During the same period of time, per capita consumption of poultry increased from 34.1 pounds to 93.1 pounds. Two other major factors contributing to the reduction in the U.S. sheep industry are: scarcity of labor and predator losses (Stillman, et al., 1990). Moreover, the growth of manmade fiber is another major factor for this downward trend

In an effort to slow the rate of decline in the U.S. sheep industry, the U.S. Congress passed the Wool Act of 1954. Under the Wool Act, incentive payments were made to producers to encourage wool production (Anderson, 1994). However, in 1993, Congress passed a three-year phase out of the Wool Act incentive payments with the last payments occurring in 1996 (Anderson, 2001). Since that program phase out, a series of ad hoc programs have been passed to support the industry due to a series of setbacks, caused in large part, by events beyond industry control such as strong U.S. dollar which encouraged an increase in imports, and financial difficulties for domestic mills. The 2002 Farm Bill reinstated support for the industry by implementing a marketing loan program, similar to other commodities, with loan rates of $0.40 and $1.00 per pound for un-graded and graded wool, respectively (USDA Cotton and Wool Outlook).

The livestock industry has a large body of research studies in agricultural economics. However, few studies have been performed on the sheep industry, either in the U.S. or the rest of the world. Some of the studies reviewed are: Debertin, et al. (1983) developed a monthly econometric model for the U.S. sheep industry with particular emphasis on the changes in the industry that have taken place during 1964 to1980. Whipple and Menkaus (1989) developed a dynamic supply model of the U.S. sheep industry. Whipple and Menkaus (1990a) estimated a price dependent farm, wholesale, and retail demand for lamb. Anderson (1994) estimated a supply and demand model of the U.S. sheep and mohair industry for policy analysis using annual data from 1973 to 1992.

The objective of this research is to analyze the impacts of different levels of loan rates on the U.S. sheep industry. Two different levels of loan rates will be analyzed: free market (zero loan rate), and an increase of 100 percent ($2.00 /lb) of the actual loan rate. The results of this research will be useful to sheep producers, as well as other stakeholders in the U.S. industry. By analyzing and providing information on the impacts of alternative polices, the industry will be better able to address the impacts of policy alternatives and craft policies to address emerging issues.

In addition, imports and exports of sheep products play a major role in the U.S. sheep industry. Therefore, the econometric sector model developed for this study will concentrate on developing a robust trade component to analyze their effects on U.S. trade with the 7 leading international producers and consumers of sheep: Australia, United Kingdom, South Africa, Argentina, and New Zealand, Canada, and Mexico. Canada and

Mexico, while being smaller markets, are the main recipients of the U.S. lamb and live sheep exports.

MATERIALS AND METHODS

The review of past literature provides important information on how to develop an econometric model of the sheep industry. The conceptual model used in this study builds on the work done by Anderson (1994) and to some extent the studies by Debertin, et al. (1983), and Whipple and Menkhaus (1989 and 1990a). A major expansion to previous studies is that 7 different regions or countries will be modeled in order to better estimate the impacts of exchange rates on trade.

Data

Annual data will be used to construct the models for the U.S. sheep industry. Table 1 contains the data and abbreviations used for all the equations included in the model development and estimation. The data was collected from the U.S. Department of Agriculture, the Livestock Marketing information Center, Food and Agricultural Organization (FAO) and International Monetary Fund (IMF). Since the sheep industry have been declining for roughly the past 50 years, a time trend will have a large impact in the model. Therefore, following Anderson's (1994) approach, shortening the data period to the last 22 years (1980-2002) will show the different structure of the industries while allowing an adequate number of degrees of freedom.

Model Development

Figure 1 shows a flow chart of the U.S. sheep industry. The number of stock sheep (ewes) represents stock breeding ewes in the herd. Ewes are the starting point of the sheep industry and all the other variables will revolve around it. The number of

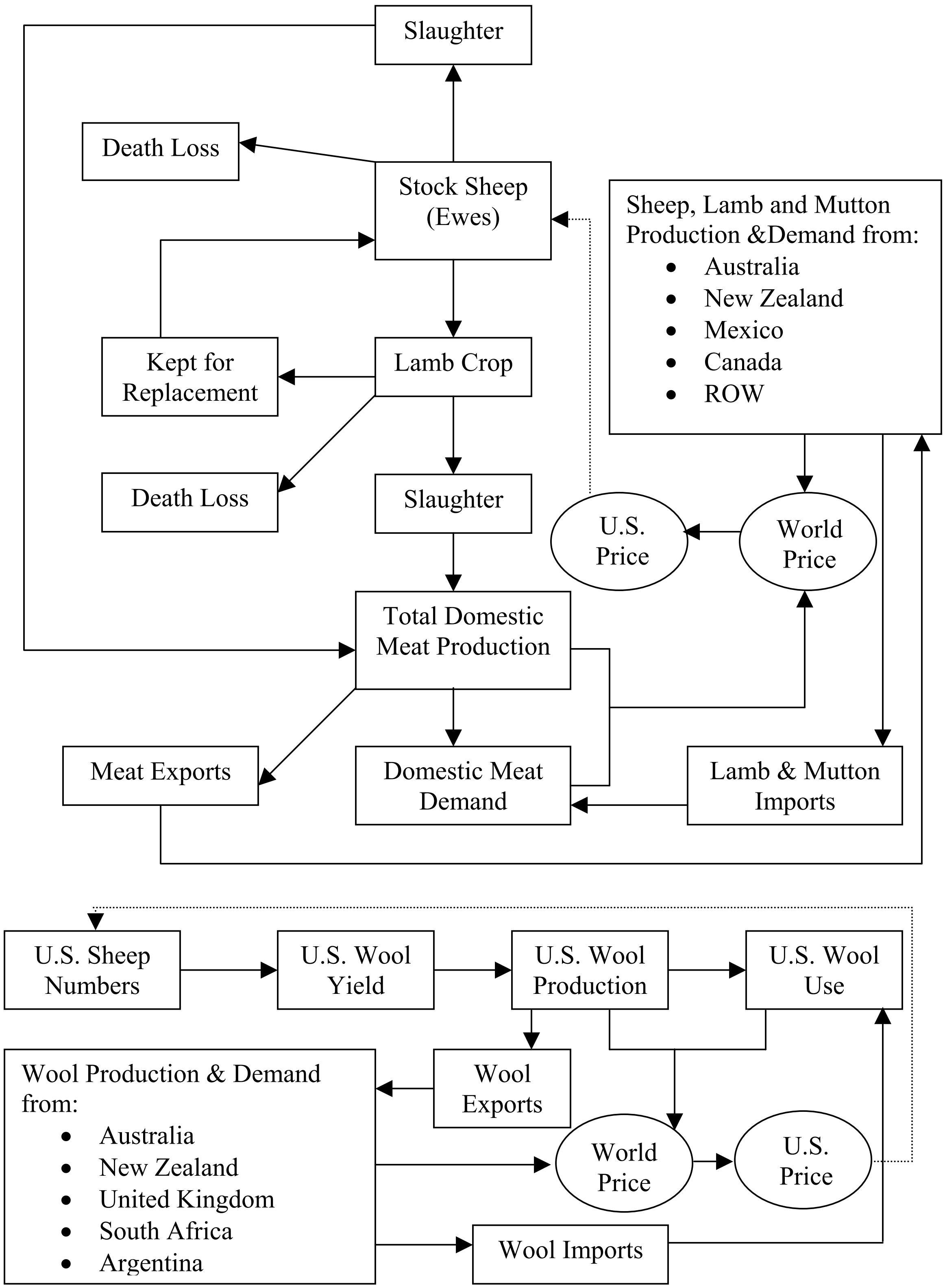
Table 1. Variables for the sheep industry model

Data	Variable Name	Data	Variable Name
Ewes	SEWE	Income	INC
Lamb Crop	LCROP	Population	POP
Replacements	EWEL	Beef Price	BP
Rams & Wethers	RAMS	Pork Price	PP
Death Loss	SDIE & LDIE	Chicken Price	CP
Ewe Slaughter	SSLTR	Incentive Price	INCPR
Lamb Slaughter	LSLTR	Lamb Consumption	LAMBCONS
Carcass Weight	DWT	Wool Exports	WEXP
Wool Production	WOOLPROD	Wool Imports	WIMP
Fleece Weight	FLEECE	U.S. Mill Use	WMILL
Dressed Weight	WEIGHT	Wool Stocks	WSTK
Lamb Price	LAMBPR	Palmer Drought Index	PDI
Sheep Price	EWEPR	Feed Concentrate Cost	FEED
Wool Price	WOOLPR	Australia Lamb Production	AUSL
Wool Incentive Price	WSPTR	Nez Zealand Lamb Production	NZL
Mexico Domestic Demand	MEXDD	South Africa Wool Prodcution	SAW
Mexico Exchange Rate	MEXEXCH	United Kingdom Wool Production	UKW
Australia Exchange Rate	AUSEXCH	Argentina Wool Production	ARGW
Canada Exchange Rate	CANEXCH	Polyster Price	POLYPR
Australian Wool Production	AUSW	Cotton Price	COTPR
New Zealand Wool Production	NZW	Acrylic Price	ACRPR
Live Sheep Export	SHPEXP	Live Sheep Import	SHPIMP
Canada Sheep Production	CANPRD		

stock sheep is reduced by death loss, slaughter, and lamb crop. Replacements and imports increase the number of ewes. Ewe and lamb slaughter, along with lamb and mutton imports make up the total domestic meat production. Total sheep numbers times wool yield gives the total wool production and adding the wool imports gives the total wool use.

The models for the sheep industry will use single econometric equations and biological identities. As mentioned above, data from 7 different countries will be included to provide estimates of the impacts of exchange rates on imports and exports. The 7 different countries will be Australia, United Kingdom, South Africa,

Figure 1. Flow Chart of the U.S. Sheep Industry Model



New Zealand, Argentina, Canada, and Mexico. Three stage least squares (3SLS) will be the estimation procedure. The model will be validated through historical simulation. The equations used for this study are presented in Table 2**.**

Equation 1 is an identity and it represents the herd inventory. The number of breeding ewes is equal to the number of breeding ewes in the last period minus death loss, slaughter and exports, plus imports and replacement.

Equation 2 represents the death loss of ewes and is a function of number of breeding ewes, Palmer Drought Index (PDI), price of lamb, sheep and wool, and time. Historical weighted PDIs for the months of June, July, and August were used as a proxy of drought ranging from 2.88, mild to moderate wetness, to –3.41, severe drought. PDI is hypothesized to have a negative effect to death loss ewes, as well as prices. Ewe slaughter (3) is a function of number of ewes, and prices of lamb, sheep and wool. Higher sheep prices will increase the number of ewe slaughtered, while higher prices for lamb and wool are hypothesized to have a negative effect since producers try to build up the herd to increase lamb and wool production.

The number of live sheep exported (4) is assumed to be a function of number of ewes, prices, and Mexican exchange rate ($Mex/1$US) since most of the live sheep are exported to Mexico. Lower lamb, sheep and wool prices will encourage herd liquidation, and exports. A strong dollar is hypothesized to reduce export levels. Live sheep imports (5) is a function of Canadian sheep production since Canada is the main exporter to the U.S. in live sheep, exchange rate ($Can/1$US), and lamb and sheep prices. Higher Canada sheep production and/or higher lamb and sheep prices is hypothesized to increase live sheep imports. A strong U.S. dollar is expected to increase U.S. import levels.

Table 2. Equations and identities for sheep industry model.

1. $Ewes_t = Ewes_{t-1}$ – $Death\ Loss_{t-1}$ – $Slaughter_{t-1}$ – $Exports_{t-1}$ + $Imports_{t-1}$ + Replacements
2. Ewe Death $Loss_t$ = f($Ewes_t$, PDI_t, Lamb $Price_{t-1}$, Sheep $Price_{t-1}$, Wool $Price_{t-1}$, $Time_t$)
3. Ewe $Slaughter_t$ = f($Ewes_t$, Lamb $Price_{t-1}$, Sheep $Price_{t-1}$, Wool $Price_{t-1}$)
4. $Exports_t$ (live) = f($Ewes_t$, Lamb $Price_{t-1}$, Sheep $Price_{t-1}$, Wool $Price_{t-1}$, Mexico $X\text{-}Rate_t$)
5. $Imports_t$ (live) = f(Canada $Production_t$, Canada $X\text{-}Rate_t$, Sheep $Price_t$, Lamb $Price_t$)
6. Lamb $Crop_t$ = f($Ewes_t$, PDI_t, $Time_t$)
7. $Replacements_t$ = f(Lamb $Crop_t$, $Ewes_t$, Lamb $Price_{t-1}$, Sheep $Price_{t-1}$, Wool $Price_{t-1}$)
8. Lamb $Death_t$ = f(Lamb $Crop_t$, PDI_t, $Time_t$)
9. Lamb $Slaughter_t$ = f(Lamb $Crop_t$, $Ewes_t$, Lamb $Price_{t-1}$, Sheep $Price_{t-1}$, Wool $Price_{t-1}$, Sub $Price_{t-1}$)
10. Lamb $Production_t$ (meat) = Lamb $Slaughter_t$ * Carcass $Weight_t$
11. Carcass $Weight_t$ = f($Time_t$, Lamb $Price_{t-1}$, Feed Concentrate $Cost_{t-1)}$)
12. Total Raw Wool $Prod_t$ = Total $Sheep_t$ * Fleece $Yield_t$
13. Fleece $Yield_t$ = f($Time_t$, PDI_t, Wool $Price_{t-1}$, Lamb $Price_{t-1}$, Fleece $Yield_{t-1}$)
14. Lamb $Imports_t$ (meat) = f(Australia $Prod_t$, New Zealand $Prod_t$, Lamb $Price_t$, Australia $X\text{-}Rate_t$)
15. Wool $Imports_t$ (raw) = f(Big 5 Wool $Production_t$, Wool $Price_t$, Australia $X\text{-}Rate_t$)
16. Lamb Domestic $Demand_t$ = f(Lamb $Price_t$, $Income_t$, Sub $Price_t$, $time_t$)
17. Lamb $Exports_t$ = f(Lamb $Price_t$, Mexico $X\text{-}Rate_t$, Mexico Domestic $Demand_t$)
18. Wool $Demand_t$ = f(Wool $Price_t$, $Income_t$, Cotton $Price_t$, Polyester $Price_t$, Acrylic $Price_t$)
19. Wool $Exports_t$ = f(Wool $Price_t$, Australia $X\text{-}Rate_t$)
20. Wool $Stocks_t$ = f(Wool $Price_t$, $Income_t$, Big 5 Wool $Production_t$)

PDI = Palmer Drought Index
Sub Price = Beef Price, Pork Price, and Chicken Price
Big 5 = Australia, United Kingdom, South Africa, New Zealand, and Argentina

Lamb crop (6) is a function of ewes, PDI and time. Drought is hypothesized to lower lamb crop and time is set to capture any change in technology. Lamb crop has three possible destinations: ewe replacement, lamb death, and lamb slaughter. Ewe replacement (7) is a function of lamb crop, number of ewes, and prices. Higher prices of lamb and wool are hypothesized to have a positive effect on replacement numbers, while higher sheep prices should have a negative impact. Death loss of lamb (8) is a function of lamb crop, PDI and time. Lamb slaughter (9) is assumed to be a function of lamb crop, number of ewes, and prices of lamb sheep and wool, as well as prices of beef, pork and chicken, lagged one period. Higher lamb prices are hypothesized to have a positive effect on the number of lamb slaughtered.

Total domestic lamb production (10) is an identity and is calculated as total lamb slaughtered times its carcass weight. Carcass weight (11) is hypothesized to be a function of time, lamb price, and feed concentrate cost. Feed concentrate cost is the cost of feed too finish the lambs that are going to be slaughtered and is expected to have a negative relationship with carcass weight. Total raw wool production (12) is an identity calculated as the total number of sheep times the estimated fleece weight per sheep. Fleece yield (13) is modeled as a function of PDI, time, wool and lamb prices, and itself lagged one period.

Lamb imports (14) are modeled as a function of lamb price, Australia exchange rate ($Aus/1$US), and Australia and New Zealand production. A strong dollar and/or higher lamb production by Australia and New Zealand is hypothesized to increase imports. Wool imports (15) are a function of wool production of the Big 5 (Australia, United Kingdom, South Africa, New Zealand, and Argentina), wool price, and Australia exchange rate.

Domestic demand for lamb (16) is assumed to be a function of lamb, beef, pork and chicken prices and Income. Economic theory tells us that as the price of lamb increases, its demand will decrease and as the price of substitutes, beef, pork and chicken, increase the demand for lamb will increase. Lamb exports (17) are a function of lamb price and Mexican domestic demand and exchange rate.

Wool demand (18) is a function of wool price, income, and cotton, polyester and acrylic prices. Income is hypothesized to have a positive effect on demand because wool is expected to be a normal or luxury good. Wool exports (19) are a function of wool price and exchange rate and wool stocks (20) are set to be a function of wool price, income, world stocks and wool production by the Big5.

Solving Supply and Demand

The supply and selected demand system will be solved simultaneously to determine the market-clearing price. It involves iterating on the price that equates the supply and demand model. The market clearing equation is:

$$\text{Supply} - \text{Demand} = 0$$

The estimated parameters will be used with the EViews© "Solver" routine to solve this nonlinear optimization. The routine then solves the equation, supply – demand = 0, and yields the market, or equation solving, price. Industry parameters and price will be projected as a baseline to compare policy alternatives.

RESULTS AND DISCUSSION

The econometric estimation results for each equation are presented in Table 3. Each equation was evaluated for goodness-of-fit during the estimation process. Adjusted R^2 statistics and p-values were the primary measure of goodness-of-fit. Variables, based upon economic theory, were retained if they were statistically significant at least at the 95 percent confidence level.

Lamb crop (LCROP) was estimated as a function of number of stock ewes, DPI and trend. All variables were statistically significant at the 99 percent confidence level as shown by their p-values lower than 0.01 and the adjusted R^2 is very high, 0.9841. As expected, the number of ewes was the most important determinant of the size of lamb crop. PDI was also important in the lamb crop equation, but yielded the opposite sign. We would expected a positive relationship between lamb crop and PDI since as PDI goes up means that the level of drought was reduced

Replacement numbers (EWEL) yielded a high adjusted R^2 (0.9825). Number of stock ewes yielded a positive sign, as expected, because some ewes must be replaced each year due to age or usefulness. However, the sign for lamb crop and sheep price are contrary to expectations. As lamb crop and sheep price increases we would expect an increase in the number of replacement in order to build the herd.

Sheep death loss (SDIE) was estimated as a function of number of stock ewes, PDI, lamb price, sheep price and trend. All variables are statistically significant and the model yielded a high adjusted R^2, 0.9257. All variables have the expected signs except for lamb price that have the opposite sign. Lamb death loss (LDIE) is a function of PDI and trend. Both variables are statistically significant and yielded a low adjusted R^2, 0.6548. However, PDI has an opposite sign than expected.

Lamb slaughter (LSLTR) estimated results show that all variables in the equation are statistically significant at least at the 95 percent level and all signs agree with economic theory. Sheep prices lagged ($EWEPR_{t-1}$) has a negative sign since the producer will want to reduce slaughter increase the herd size. Beef price lagged (BP_{t-1}) also has a negative relationship as expected since beef is considered substitute for lamb. The dummy variable D01 accounts for the years that the wool subsidies were terminated in 1996 and reinstated in 2002.

Table 3. Regression equations for sheep industry model estimated over 1980-2002

	Adjusted R^2
$LCROP_t$ = 2443.6 + 0.56963($SEWE_t$) – 31.6940(PDI_t) –36.2685(TIME)	0.9841
(0.000) (0.016) (0.002)	
$EWEL_t$ = -679.7 + 0.3648($SEWE_t$) – 0.1804($LCROP_t$) – 7.47($EWEPR_t$)	0.9825
(0.000) (0.000) (0.000)	
$SDIE_t$ = 0.0682($SEWE_t$) – 6.6147(PDI_t) + 2.5217($LAMBPR_{t-1}$) – 4.408($EWEPR_{t-1}$) – 4.8104($TIME_t$)	0.9257
(0.000) (0.0210) (0.000) (0.000) (0.000)	
$LDIE_t$ = - 40.755($TIME_t$) + 94.651(PDI_t)	0.6548
(0.000) (0.0495)	
$LSLTR_t$ = 2068.2 + 0.628($LCROP_t$) – 24.61($EWEPR_{t-1}$) – 7.418(BP_t)– 258.172(D01)	0.9604
(0.000) (0.000) (0.000) (0.014) (0.000)	
$SSLTR_t$ = 176.56 + 0.0398($SEWE_t$) – 4.5538($EWEPR_t$) + 25.182($WOOLPR_t$)	0.9049
(0.000) (0.000) (0.000) (0.004)	
DWT_t = 43.8157 + 0.0437($LAMBPR_{t-1}$) + 4.4409$(TIME)^2$	0.9147
(0.000) (0.004) (0.000)	
$FLEECE_t$ = 1.89 + 0.7418($FLEECE_{t-1}$) + 0.1018($WOOLPR_{t-1}$) – 0.0226(PDI_t)	0.7880
(2.84) (1.56) (1.70)	
$SHPEXT_t$ = 7.5031($MEXDD_t$) – 0.3066(D01)	0.2552
(0.000) (0.000)	
$SHPIMP_t$ = - 235.417 + 6.9208($CANPRD_t$) + 0.5898($LAMBPR_t$) + 51.871($CANEXCH_t$)	0.6294
(0.000) (0.000) (0.000) (0.002)	
$LMIMP_t$ = -39.05 + 0.236($AUSL_t$) - 10.59(NZL) + 57.7($AUSEXCH_t$) + 19.2166(D01)	0.8283
(0.001) (0.000) (0.020) (0.000)	
$LMEXP_t$ = 12.4042 – 0.1107($LAMBPR_t$) + 0.0384($MEXDD_t$)	0.7670
(0.001) (0.000) (0.050)	
$WMILL_t$ = – 0.006($WOOLPR_t$) + 65.3($COTPR_t$) - 269.6($POLYPR_t$) + 60.82($INCPR_t$)	0.6879
(0.008) (0.000) (0.000) (0.025)	
$WIMP_t$ = 0.782(NZW_t) +0.512(UKW_t) + 27.456($WOOLPR_t$) - 44.15($INCPR_t$) + 65.048(D01)	0.7993
(0.000) (0.000) (0.000) (0.000) (0.000)	
$LAMBCONS_t$ = 312.7 – 0.019($LAMBPR_t$) + 0.007(INC_t) – 6.168($TIME_t$) + 0.26($LAMBCONS_{t-1}$)	0.6686
(0.000) (0.000) (0.020) (0.000) (0.000)	
$WEXP_t$ = 23.451 – 1.7952($WOOLPR_t$) + 6.2215($INCPR_t$) – 13.626(D01)	0.6484
(0.000) (0.021) (0.000) (0.000)	

Variables are defined in Table 1.
Values in parenthesis are p-values

Sheep slaughter (SSLTR) estimated results shows that all variables in the equation are statistically significant at least at the 0.01 level and all signs agree with economic theory except for wool price. As wool price increases we would expect sheep slaughter to decrease since they will be kept to produce more wool.

The dress weight (DWT) equation showed that both explanatory variables are significant at least at the 0.01 level and their signs agree with expectations, i.e. a higher lamb price is expected to yield a higher dress weight. Fleece weight (FLEECE) estimated parameters agree with economic theory, except for PDI, and it also has a low adjusted R^2, 0.7880.

Live sheep exports (SHPEXT) equation was a function of Mexico domestic demand and the dummy variable (D01). Mexico is the major importer of U.S. sheep. This equation performed very poorly adjusted R^2, 0.2552, although many different variables were used to estimate this equation. Live sheep imports (SHPEXP) yielded also a low adjusted R^2, 0.6294, however, all variables have the expected signs. Canada sheep production has a positive impact on live sheep imports since Canada is the main exporter of live sheep to the U.S. Moreover, Canada exchange rate has a positive effect on live sheep imports since a strong U.S. dollar makes foreign goods relatively cheaper.

Lamb imports (LMIMP) were modeled as a function of Australia and New Zealand lamb production, Australia exchange rate and the dummy D01. The variables are significant at the 99 percent level and the signs agree with economic theory, except for New Zealand lamb production. As Australia and New Zealand lamb production increases, more lamb is imported, however, there is a negative relationship with New Zealand. The effect of the exchange is as expected since a strong U.S. dollar increases imports. Lamb exports (LMEXP) was estimated as a function of lamb price and Mexico domestic demand and all variables were significant at the 95 percent level. In addition, both variables comply with economic theory since as lamb price increases less lamb will be exported, and as Mexico's domestic demand increases, lamb exports increase.

Wool imports (WIMP) was estimated as a function of New Zealand and United Kingdom wool production, price of wool, wool incentive payment and D01. The signs of all the variables were as expected. Positive relationship between wool price, New Zealand and UK wool production on wool imports, and negative relationship with incentive payments.

U.S. mill demand for wool (WMILL) was estimated as a function of wool price, cotton and polyester price, and wool incentive payments. This equation gave an adjusted R^2 of 0.6878 and all of its variables were significant at the 95 percent level. All variables comply with economic theory except for cotton price, which has a positive relationship with mill demand for wool. On the other hand, polyester price have a negative relationship with wool mill demand, as well as wool price. Wool incentive payments have a positive relationship with mill demand for wool since an increase of wool incentive payment will increase supply of wool and consequently lower the price of wool.

Wool export (WEXP) was modeled as a function of wool price, incentive wool price and the dummy D01. This equations yielded a low adjusted R^2 0.6484, but all of is explanatory variables were significant at least at the 95 percent level and comply with economic theory. As wool price increases, wool exports decrease. Also as wool incentive payments increase, wool exports increases.

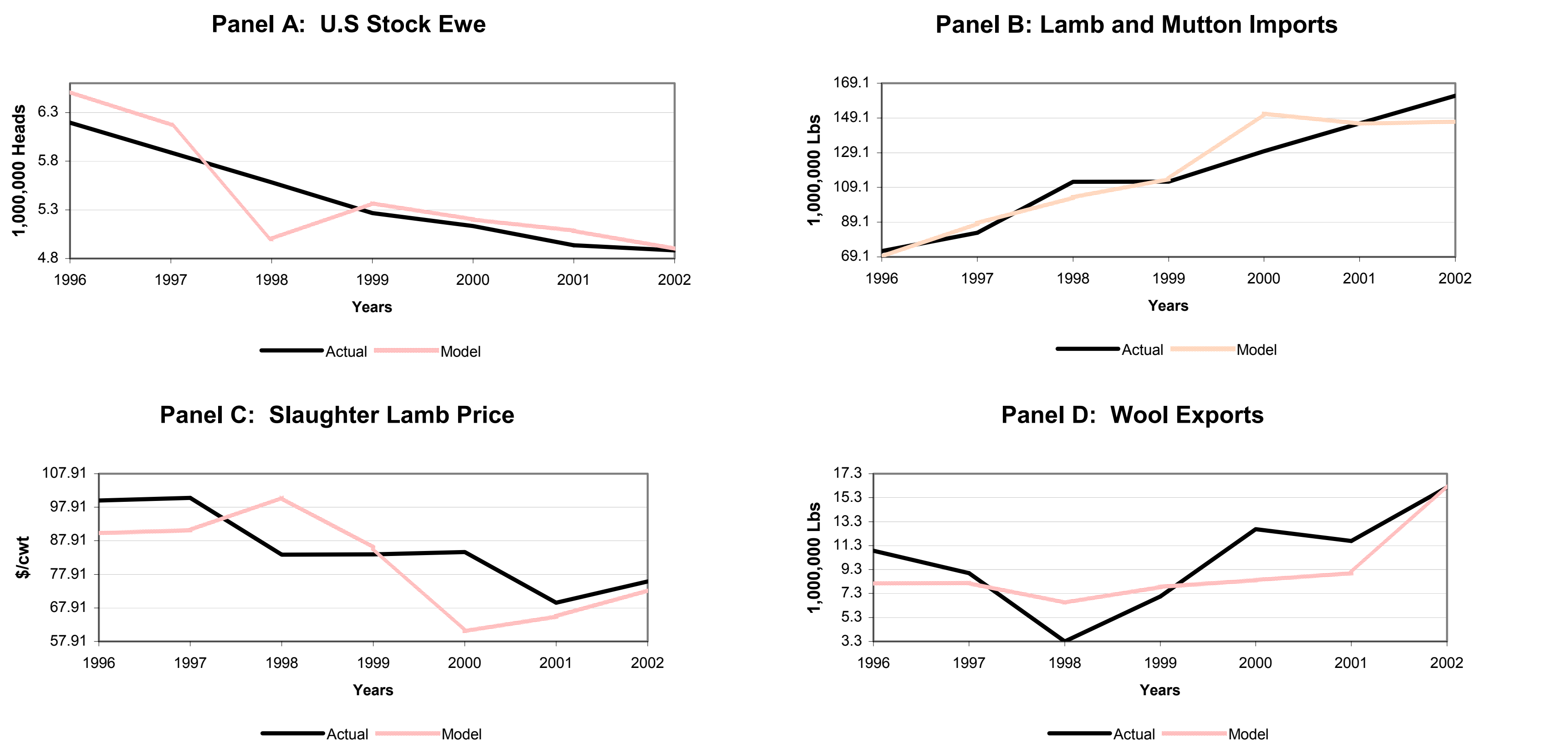
Finally, lamb consumption (LAMBCONS) was modeled as a function of price of lamb, income, trend and lamb consumption lagged one period. All variables were statistically significant at the 95 percent level and their signs agree with economic theory. Lamb price (LAMBPR) has a negative sign meaning that as price of lamb increases, lamb consumption decreases. Moreover, income has a positive sign, which agrees with economic theory for normal or luxury goods.

Ex-Post Simulation

The model was simulated in EViews© using the "model solver" routine for the 1996-2002 time period and results are presented in Figure 2. Figure 2A contains the actual and simulated stock ewe numbers generated by the model. The model simulates the historical data fairly well, following the trend, but slightly overestimating the ewe numbers all the periods except in 1998 where the simulated model drops sharply below the historical data. The model simulates lamb and mutton imports very well overestimating imports in 1997 and 2000, and underestimating imports in 1998 and 2000 (Figure 2B). Figure 2C shows the actual and ex post simulation of slaughter lamb price. The simulated model seems to move opposite to the historical values. However, for 2001 and 2002 the model follow the movements of the historical lamb prices very well.

Finally, simulated and actual wool exports values are shown in Figure 2D. Again the simulated model seems to move in opposite directions than the actual data, but follow the movements of the actual data for the last couple of years. Moreover, it fails to capture the magnitude of the drastic decrease on wool exports in 1998. In general, the model seem to not follow the actual data in the early years, but tends to recover in the

Figure 2. Ex-Post Simulation for the period 1996-2002



last couple of years of the ex post simulation except for the lamb and mutton imports.

Baseline Analysis (Preliminary Results)

An ex-ante simulation was performed to develop a baseline projection for the 2003-2008 time horizon. The baseline assumptions included:

- No change in the loan rate set at $1 per pound of wool
- Exogenous variables projections were available from the FAPRI January 2004 Baseline and also forecasted using ARIMA and VAR models.

The baseline simulation for stock ewe numbers continue to decline during the entire time horizon reaching about 2.5 million head by 2008 (Figure 3A). Imports of lamb and mutton were projected to increase to about 200 million pounds by 2008 (Figure 3B). Slaughter lamb prices move up and down during the whole time horizon, but a slightly positive trend can be seen (Figure 3C). Finally, wool exports are projected to increase by about 1.2 million pounds in 2003, but tend to decline thereafter (Figure 3D).

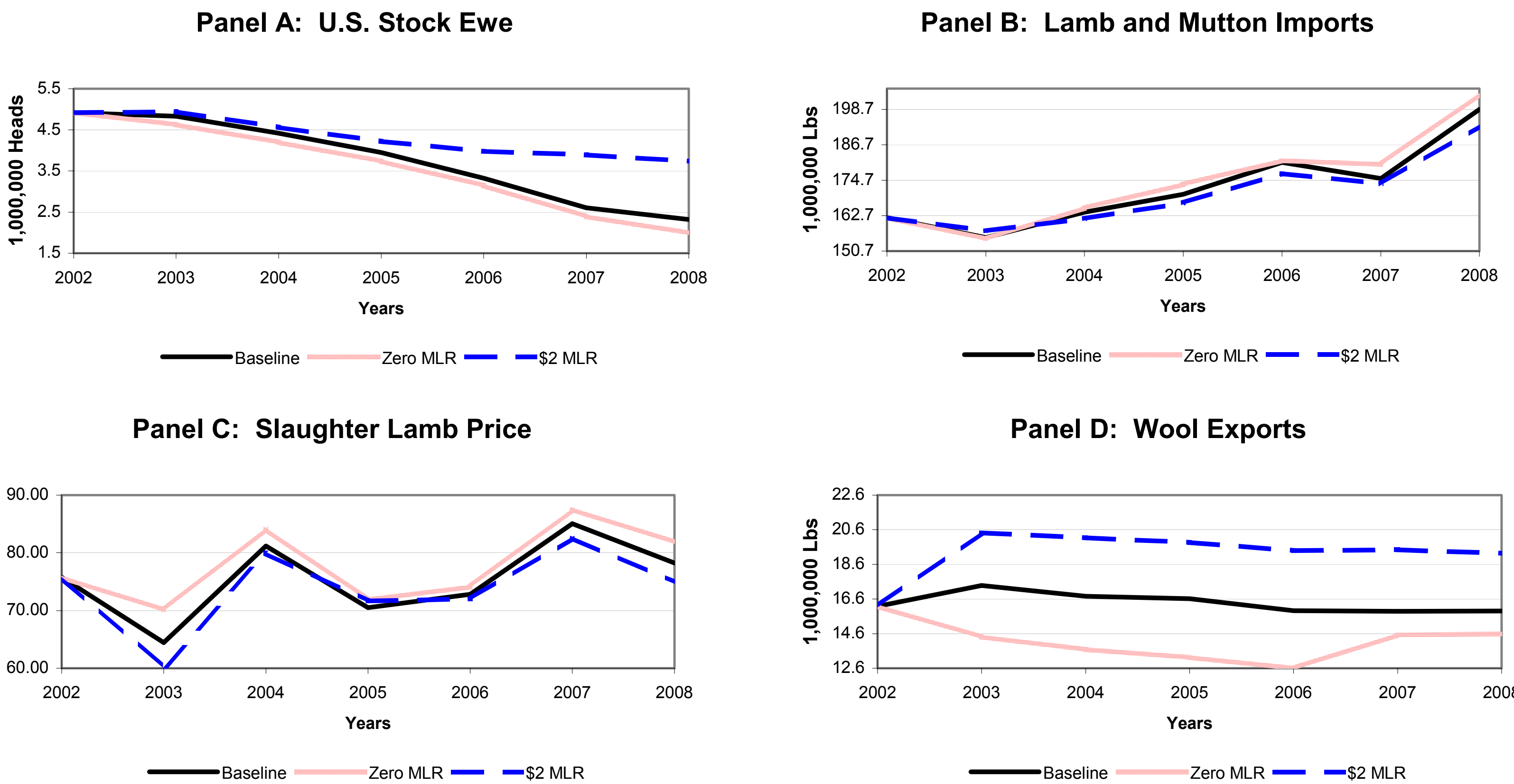
Policy Alternative (Preliminary Results)

The policy alternative analyzed in this study is two levels of wool marketing loan rate: scenario 1 has a zero loan rate, while scenario 2 has a loan rate of $2.00 per pound of wool.

Stock ewe continues its negative trend under both scenarios, but the magnitude of the negative trend is much smaller for scenario 2 compared to scenario 1 and the baseline (Figure 3A). Under scenario 1, stock ewe number reaches about 2 million head in 2008 compared to 3.7 million under scenario 2.

Lamb and mutton imports are also affected under the two scenarios (Figure 3B). The loan rate is hypothesized to have a positive effect on the short run and a negative

Figure 3. Ex ante simulations of baseline and two policy scenarios for 2003-2008



effect on the long run on lamb and mutton imports since a higher loan rate will make the producers increase the replacement number to build the herd. Therefore in the short run, a higher loan rate will increase the number of lamb and mutton imports. The model complies with a priori expectations since under scenario 2 (higher loan rate) lamb and mutton imports increase in 2003 compare to both scenario 1 and baseline. Afterwards, it falls below both scenario 1 and baseline.

Slaughter lamb price also shows an impact under both scenarios (Figure 3C). A higher loan rate is expected to increase slaughtering of lamb that will lead to a decrease in lamb prices, while a lower loan rate will have the opposite effect. Figure 3C shows that lamb prices under scenario 1 are higher than under scenario 2.

Finally, Figure 3D shows the effect that wool exports have due to the two levels of loan rates. As expected a higher loan rate will increase wool production that will lead to and increase in wool exports. The conversely is true for a decrease in loan rate.

SUMMARY AND CONCLUSIONS

The sheep industry has been in a downward trend since the early 1940s. Therefore, producers and their congressmen have been concerned about the industry's survival and programs to aid the industry. Due to the limited number of research studies on the sheep industry, there is a need to develop an econometric model of both industries for policy analysis purposes.

The objective of this research is to analyze the impacts of different levels of loan rates on the U.S. sheep industry. Two different levels of loan rates will be analyzed: free market (zero loan rate), and an increase of 100 percent ($2.00 /lb) of the actual loan rate. For this purpose, an ex-ante simulation was performed to develop a baseline projection for the 2003-2008 time horizon and compared to the simulations under the two policy scenarios. The main assumption of the baseline is that there will be no change in the actual loan rate set at $1 per pound of wool.

Results of the ex ante simulation show that stock ewe numbers will continue its decrease under both scenarios, but the rate of decrease will be lower under a higher loan rate. Under scenario 2, lamb and mutton imports goes from a slightly increase in the first year to a slightly decrease in the following years compared to the baseline and scenario 1. Under scenario 1 slaughter lamb prices will increase while wool exports decreases compared to scenario 2.

Higher marketing loan payment will result in reduced decline in ewe numbers, but will not reverse their downward trend. Raising the marketing loan rate would likely increase the U.S. wool exports. On the other hand, removing the current marketing loan rate will have minimal impact on ewe numbers and raise lamb imports and lamb price very slightly. Moreover, eliminating the marketing loan rate would reduce wool exports slightly.

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