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The maxim that free trade leads to maximum social welfare is well-established in neo-classical economics. However it has long been acknowledged that not everyone may directly benefit from a move to free or freer trade. It is the distributive problem that most concerns policymakers and it is also the concern of this paper. Specifically, its aim is to illustrate the possible short-run impact of free trade upon the distribution of farm income in the U. S. grain/livestock sector. To achieve it a comparative static analysis is employed with 1970 as a base year.

A starting point is provided by the projections contained in the Flanigan Report (U. S. Congress) which, although now somewhat dated, contains probably the most detailed assessment of the aggregate impact of free trade in grains and livestock. It presents estimates of the level of net farm income by commodity which would result with a continuation of existing (1970) policies and with free or freer trade.[2/]

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2/Net farm income is synonymous throughout the paper with net returns over variable costs.

Using these figures it is a simple exercise to compute the proportional change in income resulting from free trade. These may then be applied to actual 1970 data (also presented in the report) to produce estimates of the effect of free trade upon income in that year with instantaneous adjustment to the change.

This method is clearly very simplistic and incorporates many assumptions, not least of which is that the estimates in the Flanigan Report are reasonable. While it is always easy to disagree with projections, there is considerable evidence that a serious attempt was made to derive logical and complete forecasts for the grain/livestock sector as a unit and not just for its component parts. This is significant since income changes are truly net, not dependent upon assumed constancy in some closely related activity.

The estimates that are derived (table 1) indicate very considerable gains in the net income of grain/feed producers, even allowing for the loss of government payments that would accompany liberalization. The major reason for this is a large projected increase in world demand for animal products and a parallel increase in the demand for feed. The only net losers appear to be egg and milk producers. While it must be stressed that these estimates are clearly approximate they do provide a useful set of figures for indicative analysis.

A first step in the analysis is to use the data from table 1, in conjunction with statewide production figures for 1970 (USDA), to allocate gains and losses to ten production regions (see appendix). Thus the proportion of total U. S. production of each commodity in each state was calculated and used to apportion the income change. The resulting

Table 1: Estimated Impact of Free Trade by Commodity (1970).

	Returns Over Variable Costs		Change in Gov't Payments	Net Gain/Loss
	Actual	Change with Free Trade		
	million dollars			
Barley	191	+ 115	- 45	+ 70
Corn	2661	+1989	-1228	+ 761
Oats	204	+ 76	0	+ 76
Sorghum	460	+ 354	- 237	+ 117
Soybeans	2970	+2225	0	+2225
Wheat	1006	+ 947	- 871	+ 76
Total Grain/Feed	7492	+5706	-2381	+3325
Beef	1512	+ 442	0	+ 442
Eggs	563	- 160	0	- 160
Milk	1714	- 446	0	- 446
Pork	1880	+ 167	0	+ 167
Poultry	202	+ 21	0	+ 21
Total Livestock and Products	5871	+ 24	0	+ 24
Grand Total	13363	+5730	-2381	+3349

Note: All figures rounded to the nearest million.

Source: Derived from U. S. Senate, Annex 7, Table 6.

quantities were then aggregated and are presented in table 2. These suggest that only one region, the Northeast, would sustain an overall income loss. The Corn Belt, not surprisingly, derives the major share of total gains (some 55 percent). Other regions, most notably the Lake States, lose on the livestock side but gain more heavily in grain/feed such that overall, gains offset losses.

The next step is to employ information from the 1969 Census of Agriculture to distribute gains and losses by economic class of farm (see appendix). Data were compiled by states on the value of marketings (animals and products) or the volume of production (crops) for the appropriate products by economic class of farm. Proportions were derived and employed to distribute gains and losses by state and these were then aggregated regionally. In order to depict the relative impact of free trade average per farm figures were produced using data on 1970 size structure contained in Hottel and Reinsel. The results are presented on the left-hand side of table 3.

The choice of commercial farms alone (census classes Ia to V) reflects the belief that the major impact of free trade would fall upon these and not upon non-commercial farms. A major difficulty in using this census data is that it relates to the year prior to our base year. We are therefore forced to assume that the proportions we use would not differ significantly in the following year. A further problem in the use of a single year's figures is that they could be atypical and misleading. Hottel and Reinsel have observed that data derived from the 1969 census are consistent with those of previous years.

Table 2: Estimated Gains/Losses by Commodity Group and Production Region (1970).

	Grain/Feed	Livestock	Total
	million dollars		
Northeast	+ 64.5	-113.1	- 48.6
Lake States	+ 337.2	- 69.6	+ 267.6
Corn Belt	+1763.2	+ 88.2	+1851.4
Northern Plains	+ 274.2	+ 84.8	+ 359.0
Appalachian	+ 182.6	- 9.9	+ 172.7
Southeast	+ 122.2	- 17.7	+ 104.5
Delta	+ 390.2	- 0.8	+ 389.4
Southern Plains	+ 94.9	+ 50.1	+ 145.0
Mountain	+ 52.6	+ 45.1	+ 97.7
Pacific	+ 43.4	- 32.2	+ 11.2
Total (48 States)	+3325.0	+ 24.9*	+3349.9*

*Totals differ slightly from those in table 1 due to the exclusion of Alaska and Hawaii.

Table 3: Indicators of the Distributive Impact of Free Trade in Grains/Livestock.

	Average Per Farm Gains/Losses							Theil's Inequality Coefficient	
	Ia	Ib	II	III	IV	V	All	Base	Free Trade
	thousand dollars								
Northeast	-3.0	-1.1	-0.7	-0.2	0.2	0.2	-0.4	0.4567	0.4154
Lake States	5.8	3.6	1.7	1.0	0.7	0.5	1.2	0.3364	0.3125
Corn Belt	13.4	9.3	5.8	3.6	1.8	0.9	4.0	0.3965	0.3450
Northern Plains	11.2	3.7	2.0	1.2	0.6	0.3	1.6	0.3135	0.3224
Appalachian	4.7	2.9	1.8	1.0	0.4	0.2	0.8	0.4178	0.4171
Southeast	1.1	2.1	1.5	1.2	0.6	0.3	1.0	0.8625	0.7632
Delta	30.7	10.8	5.7	3.9	1.5	0.6	4.6	0.7328	0.7089
Southern Plains	10.2	1.8	1.1	0.7	0.3	0.1	0.8	0.7063	0.7146
Mountain	8.7	1.5	0.9	0.5	0.3	0.1	1.0	0.6210	0.6312
Pacific	-0.2	0.1	0.3	0.2	0.1	0.0	0.1	0.9460	0.9226
All (48 States)	7.9	4.6	2.7	1.7	0.8	0.4	1.9	--	--
					Between Regions			0.0267	0.0318
					Within Regions			0.5328	0.4919
					Total			0.5594	0.5237

As table 3 demonstrates the greatest impact of free trade falls upon farms in classes Ia to III. Interestingly enough, by virtue of relative product mix, classes IV and V in the Northeast gain, even though farms as a whole in the region lose on the average. A similar situation occurs in the Pacific region where class Ia is the sole loser. In many regions, for example the Lake States and the Corn Belt, the largest gainers (or losers) are the largest farms, and gains per farm decline on a fairly even basis. However, there are interesting exceptions. In the Southeast class Ib rather than Ia has the highest gains. In the Southern Plains and Mountain regions average gains are markedly skewed towards class Ia.

Thus far we have been able to gain some insight into the probable distribution of gains and losses from free trade across farms under 1970 conditions. It would be interesting to determine the effect upon the distribution of net farm income. Specifically, would free trade in grains and livestock lead to more or less income inequality?

The measurement of income inequality is fraught with problems but unfortunately we do not have space to outline the important conceptual and statistical issues (see Sen). One of the most popular devices is the Lorenz curve and the associated gini ratio. A major advantage of the gini is its intuitive plausibility, however its efficiency as an indicator when grouped data are involved is in doubt (Benson). An alternative measure, which has been suggested by Theil, does not suffer from the same limitation but is less easy to conceptualize.

Theil's measure derives from the concept of entropy in information theory (Sen; Theil). Briefly, if an event has the probability x of occurring the information content h(x) of observing that the event has in fact occurred

must be a decreasing function of x. Expressed differently, the more unlikely the event the more interesting to know it has actually happened. One formula that satisfies this property is

$$h(x) = \log \frac{1}{x} \tag{1}$$

When there are n possible events each with a probability $x_i (i=1,n)$ such that $x_i \geq 0$ and $\sum_i^n x_i = 1$ the entropy (expected information content) of the situation can be viewed as the sum of the information content of each event weighted by the respective probabilities

$$H(x) = \sum_i^n x_i h(x_i) = \sum_i^n x_i \log(\frac{1}{x_i}) \tag{2}$$

It is then clear that the closer the n probabilities x_i are to 1/n the greater the entropy. If x_i is re-interpreted as the share of income going to the i^{th} person H(x) looks like a measure of equality. It obtains its maximum value of log n when all x_i's take the same value of 1/n. Subtracting the entropy H(x) of an income distribution from its maximum value we derive Theil's index of inequality

$$T = \log n - H(x) = \sum_i^n x_i \log nx_i \tag{3}$$

Clearly, under a given set of circumstances the higher the value of the index the greater the inequality and vice versa.[3/]

One of the major advantages of this measure from our point of view is that it can be expanded to allow for the decomposition of between and within set inequality for production regions

3/One of the properties of the index is that its upper bound increases with the number of individuals. This may at first seem to be a distinct disadvantage but in fact has much to commend it. As Theil argues, a measure of income inequality should be greater in a society of 2 million people when one person has all the income than in a society of 2 people under the same circumstances.

$$T = \sum_{r=1}^{R} Y_r \log \frac{Y_r}{N_r/N} + \sum_{r=1}^{R} Y_r \left[\sum_{i \in S_r} \frac{y_i}{Y_r} \log \frac{y_i/Y_r}{1/N_r} \right] \qquad (4)$$

where R = number of regions

N = total number of farms

N_r = number of farms in the r^{th} region (r=1,R)

Y_r = income share of the r^{th} region

y_i = income share of the i^{th} farm (i=1,N)

S_i = total set of farms in the r^{th} region

The first term in (4) is the inequality in the distribution of total income between the regions (between set component). The second term is the aggregate inequality within regions (within set component). This is the weighted sum of inequality in each region where the weights are the regional income shares. The unweighted components of this term can therefore be used to summarize distributional impact region-by-region.

In order to apply (4) the net income figures by economic class of farm contained in Hottel and Reinsel were used as the base (without free trade) situation. The total gains and losses used in the derivation of first part of table 3 were added to these to give the free trade case.[4/] Unfortunately this produced two sets of data both of which had negative income figures for class V farms in the Northeast and Pacific regions. Since (4) is clearly restricted to non-negative income shares classes IV and V in these regions were aggregated.

A further problem is created by the fact that these regional data are grouped. We are forced to treat every individual farm within each economic class as though it realized the same (mean) income. The level

4/It is assumed that free trade in grains/livestock would have a negligible impact on income derived from other products.

of total inequality is therefore reduced by grouping. On the assumption that the degree of inequality within each group does not change markedly as the result of free trade our indicator of its effect remains appropriate.

The results of applying (4) to the data are presented on the right-hand side of table 3. Interestingly, the impact of free trade upon the majority of the regions is to decrease income inequality. Thus the losses incurred by larger Northeastern farms lead to a decline in the regional index, as do the large but evenly spread gains in the Corn Belt. In three of the regions (Northern Plains, Southern Plains and Mountain), where average gains are heavily concentrated in class Ia, inequality increases. For the continental U. S. as a whole income inequality between regions increases, which is perhaps only to be expected given the uneven geographical distribution of gains and losses. This increase is, however, more than offset by the decline in aggregate inequality within regions. The net effect is a decrease in total inequality.

These results are clearly interesting. We could certainly expect from table 2 that the increase in inter-regional inequality was likely but the decrease in aggregate intra-regional inequality could not be forecast, nor could the overall impact of free trade in grains and livestock.

In conclusion it should be stressed that many stones have been left unturned in this brief analysis. It has been limited to the very short-run. A longer-run approach would certainly have to adopt more sophisticated methods and concentrate upon factor shares to develop acceptable distributional estimates (for example, Gardner and Hoover).

It has omitted many important crops such as cotton, peanuts, sugar and tobacco for which free trade might have significant and interesting effects. It has only considered effects upon producers and has ignored gains and losses that might be incurred by other groups. Furthermore it has been limited to direct changes in income, indirect or "trickle-down" effects have been ignored. Finally, it must be emphasized that these results are of extremely limited relevance for an assessment of current or future distributive impacts of freer or more restricted trade. Conditions have changed so drastically since 1970 that extrapolation would be totally unjustified.

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Appendix

A. Composition of the Regions.

1. Northeast - Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
2. Lake States - Michigan, Minnesota, Wisconsin.
3. Corn Belt - Illinois, Indiana, Iowa, Missouri, Ohio.
4. Northern Plains - Kansas, Nebraska, North Dakota, South Dakota.
5. Appalachian - Kentucky, North Carolina, Tennessee, Virginia, West Virginia.
6. Southeast - Alabama, Florida, Georgia, South Carolina.
7. Delta - Arkansas, Louisiana, Mississippi.
8. Southern Plains - Oklahoma, Texas.
9. Mountain - Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming.
10. Pacific - California, Oregon, Washington.

B. Definition of Economic Classes of Farms.

Economic Class	Gross Farm Sales
Ia	$100,000 and over
Ib	$ 40,000 - $99,999
II	$ 20,000 - $39,999
III	$ 10,000 - $19,999
IV	$ 5,000 - $ 9,999
V	$ 2,500 - $ 4,999