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Staff Paper 03-01

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Abstract

There were two schools of thought to the roots of the farm depression in the United States during the 1920s. One school argued that there was overcapacity in agriculture and recommended production adjustment programs. Another school argued that the problem of agriculture had to do with financial and monetary chaos in the general economy and advocated better central banking and monetary reform. This paper evaluates arguments and policy recommendations from both schools using a traditional general equilibrium model and a macroeconomic model. Theory and data do not support the former school. There is no evidence of a long-run fall in agriculture's term-of-trade due to oversupply of farm goods. During the 1920s agriculture's declining share in the general economy was due to either slower endowment growth or slower productivity growth relative to the non-farm sector. In this environment production adjustment programs could hasten the decline of the sector. More support is found for the arguments of the latter school. In a fix-flex price environment a shock created by financial and monetary chaos would create the price pattern observed in the data. This latter school however lost in the battle of policy making. The core of the Agricultural Adjustment Act of 1933 was a production adjustment program.

Keywords: Agricultural Policy, Farm Depression of the 1920s, American Agricultural History

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The Shaky Foundation of Farm Policy in the United States - Flawed Analysis, Flawed Policy?[1]

by
Henrik Zobbe and Philip L. Paarlberg[2]

1. Introduction

In 1934, one year after President Franklin D. Roosevelt launched the New Deal which introduced full-scale government intervention in American agriculture, the Secretary of Agriculture Henry A. Wallace wrote:

> "The present program for adjusting productive acreage to market requirements is admittedly but a temporary method of dealing with an emergency. It could not be relied upon as a permanent means of keeping farm production in line with market requirements. From national standpoint it has the disadvantage that it takes out of production both the efficient and inefficient areas. A temporary and varying reduction in the productive acreage seriously disturbs the farm economy" (Henry A. Wallace, 1934 pp. 20-21).

Today nearly 70 years later the agricultural legislation from the 1930s still makes up the foundation for U. S. farm policy[3]. The New Deal, and hence the New Deal for agriculture, were a response to the great depression which struck first and hardest on the farm sector. For farmers and rural America this was the worst economic and social crisis ever experienced in history. Bankruptcy and human tragedy were the order of the day. Realized net income of farm operators in 1932 was less than one-third of what it had been in 1929. Farm prices fell more than 50 percent while prices of goods and services farmers had to buy declined 32 percent (Rasmussen et al., 1976). Addressing Congress before the passing of the legislation Roosevelt said:

> "I tell you frankly that it is a new and unshod path, but I tell you with equal frankness that an unprecedented condition calls for the trial of new means to rescue

[1] Comments to earlier versions of this paper from Luther Tweeten are much appreciated. The authors would like to express special thanks to Don Paarlberg, Professor Emeritus at Purdue University for inspiration for the topic of this paper.

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[3] For a complete overview of the history of U. S. Farm policy see Benedict (1953) for the period from 1790 to 1950, Cochrane and Ryan (1976) for the period from 1948 to 1973, and for the period from 1973 to the current time see Knutson et al. (1998).

> agriculture. If a fair administrative trial of it is made and it does not produce the hoped-for results I shall be the first to acknowledge it and advise you" (Franklin D. Roosevelt, 1933 p. 74).

Following this line of statements the main impression in various circles was that the New Deal was not theoretically founded but a step by step approach (Faulkner, 1964). This is not true in the case of the agricultural policy. According to Paarlberg (1984) there were two schools of thought as to the cause of the farm crisis. One school was led by John D. Black professor of agricultural economics at Harvard University and one school was led by George F. Warren, professor of agricultural economics at Cornell University[4]. The former school believed that though the problems were a mix of factors inside and outside agriculture, the cure for the disease had to be implemented inside the sector. They believed some fundamental forces had the tendency to result in overproduction which translated into persistent low prices, hence low income. The cure for this was government intervention in agriculture. The latter school argued that the problem was general in nature mainly caused by monetary chaos due to failures in both domestic and international monetary policy under the gold standard. These policies resulted in periods with both high deflation and high inflation so important price signals had been useless in the adjustment process. This school argued for government intervention in monetary and fiscal policy.

From an academic point of view this debate is fundamental to understanding the agricultural sector and government intervention and motivates further investigation. The objective of this paper is to explore the debate in more detail and discuss the short and long term consequences of both approaches. Section 2 presents data of the economic situation of agriculture in the period 1910-1932. Section 3 discusses the ideas of the school of thought inspired by John D. Black. Section 4 introduces the ideas and thoughts of George F. Warren and Frank A. Pearson. Section 5 evaluates the arguments advanced by the two schools on both the cause of the farm depression and policy recommendations. The conclusion is in section 6.

2. The Agricultural Situation, 1910-1932

The years 1897-1910 were years of sustained economic recovery for American agriculture from the depression from 1870 to 1896. Farm prices rose steadily every year in this period and they rose relative to non-farm prices. This period is known as the *good times* for American agriculture. One of the most important changes in the period from 1870-1910 was the commercialization and maturation of American agriculture. Developments in internal and external transportation linked farmers to both the domestic and international markets. These good years were followed by what has been referred to as the *golden age* of American agriculture, the period from 1910-1914. This period became later known as the parity period (Benedict, 1963 p. 115). Farm prices were high and stable and the terms of trade were in favor of agriculture (Cochrane, 1993 pp. 99-100). Figure 1 present's indexes of farm and national income from 1910 to 1932 and table 1 presents key agricultural indicators from the same period. With

[4] As seen many times in history disciples interpreted and misinterpreted their prophets. This is more true in the case of John D. Black than of George F. Warren. Black points out that he is not a sponsor of production adjustment programs. He designed the domestic allotment plan because it represents a contribution to the problem and should be considered along with other price raising plans (Black, 1929 p.271; Black, 1937 pp. 486-508).

the outbreak of World War I things changed dramatically. The economic stability was gone. Farm prices increased more than non-farm prices, the terms of trade developed favorably

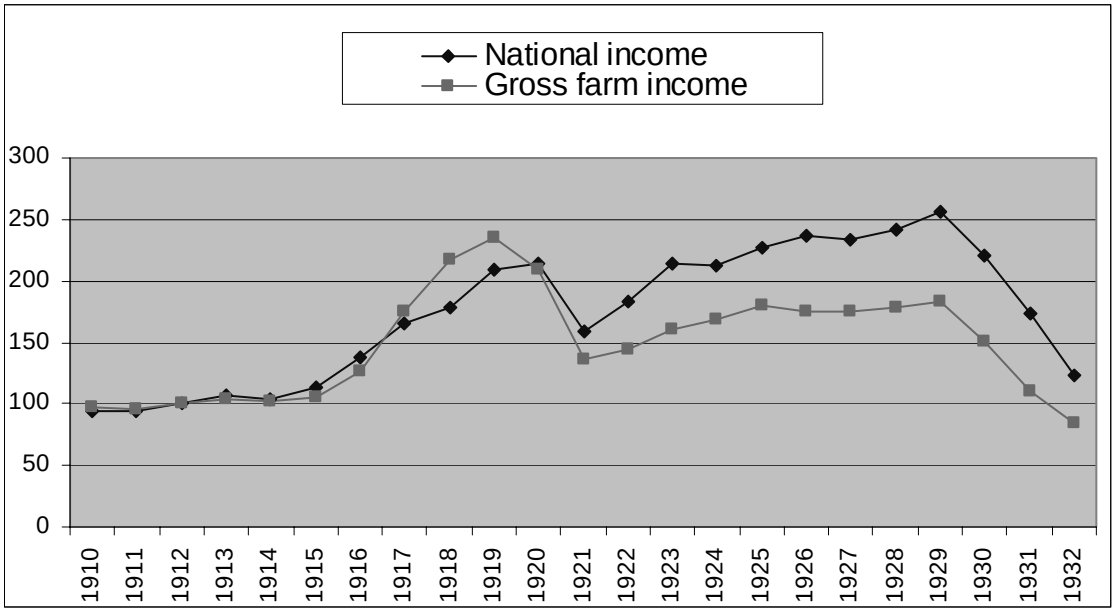

Figure 1 Indexes of farm and national income, 1910-1932 (1910-1914=100)
Source: United States Department of Agriculture (1936)

for agriculture, and gross farm income grew faster than national income (Table 1, Figure 1). The main reason was a sharp increase in export demand because of the war (Table 1). By 1920 farm prices had more than doubled. Farmers responded to the higher prices and to domestic campaigns such as *Food Will Win the War* by increasing production and investment. Land that had been used for grazing was cultivated and several million acres came into crop production and farmers stepped up purchases of machinery (Chandler, 1970 p. 54). From 1910 to 1920 nearly 90 million acres went into cultivation (United States Department of Commerce, 1922). The price of farmland rose by 70 percent on average between 1913 and 1920 and in Iowa farmland prices more than doubled (Cochrane, 1993 p. 100). For the first time farmland becomes a scarce resource in America.

In July 1920 farm prices, hence farm income collapsed. The economic literature offers several reasons for this. The normal explanation of the slump in farm prices was a sudden and catastrophic drop in foreign demand for American farm (Benedict, 1953 p. 169). European agriculture had recovered from the war and European domestic production substituted for imports (Lewis, 1962). During the war America had become a creditor rather than debtor nation with European countries because of wartime credit to its allies. This had a large impact on some Europeans countries abilities to trade. The weakness of foreign demand was accentuated by a 35-40 percent increase in internal freight rates in 1920 (Ingersent and Rayner, 1999 p. 69). Not only did farm prices drop, so too did the general price level. This triggered a decline in domestic demand as incomes fell as well. Another factor that had an effect on the fluctuations of prices in this period is the value of gold (Warren and Pearson, 1933 p. 38). The value of gold and the relationship between gold and prices can be seen in figure 2

Table 1. Indexes of key agriculture indicators of the United States, 1910-1932 (1909-1914=100)

Year	Farm prices Received	Farm prices Paid	Farm prices Ratio	Farm productivity	Gross Farm Income	Ag. Export Value	Ratio of farm income of farm capital
1910	102	98	104	101	98	89	103
1911	95	101	94	98	95	91	103
1912	100	100	100	106	101	97	98
1913	101	101	100	95	104	96	97
1914	101	100	101	101	102	127	98
1915	98	105	93	106	106	131	97
1916	118	124	95	95	127	170	108
1917	175	149	117	101	175	197	139
1918	202	176	115	98	217	309	150
1919	213	202	105	98	235	333	161
1920	211	201	105	103	210	225	115
1921	125	152	82	97	137	166	83
1922	132	149	89	101	145	155	106
1923	142	152	93	103	160	161	122
1924	143	152	94	101	168	197	130
1925	156	157	99	101	180	164	140
1926	145	155	94	103	175	165	134
1927	139	153	91	105	175	157	138
1928	149	155	96	106	179	160	138
1929	146	153	95	103	183	129	128
1930	126	145	87	103	151	89	109
1931	87	124	70	113	110	65	89
1932	65	107	61	113	84	51	82

Source: United States Department of Agriculture (1936) and Nourse et al. (1937)

.The American economy recovered fully in a few years and from 1922-1929, the American economy in general experienced a boom never seen before in history. People believed that this situation was permanent and speculation was the easy way to earn money because of the rapid increase in prices. This period is often referred to as the *great illusion* (Faulkner, 1964 p. 603). Agriculture did not fully recover. Suddenly debt obtained in the high income years had to be paid back in years with low income. Bankruptcy and human tragedy were the order of the day. Thousands of farmers went bankrupt and those who did not went through real hard times (Cochrane, 1993 p. 101). From 1921-1929, farm income lagged behind national income (Figure 1). On the 29th of October 1929, the New York stock exchange collapsed and it was soon clear that the country was in the middle of a deep and persistent depression[5]. One more time in the same decade farm prices and income dropped significantly. With 1910-1914=100, the index of farm prices dropped from 146 in 1929 to 65 in 1932 (Table 1). The index of non-farm prices

[8] For an detailed overview of both the farm crisis of the 1920s and the great depression in the late 1920 and early 1930s see Benedict (1953) for the farm crisis and, Kindleberger (1973) and Galbraith (1979) for the great depression.

dropped from 153 to 107. The agricultural terms-of-trade index between farm and non-farm prices dropped from 95 to 61. The index of gross farm income declined from 183 in 1929 to 83 in 1932. Between 1929 and 1934 land prices fell 30 percent and nearly one million farmers were dispossessed (Benedict, 1953 p. 247).

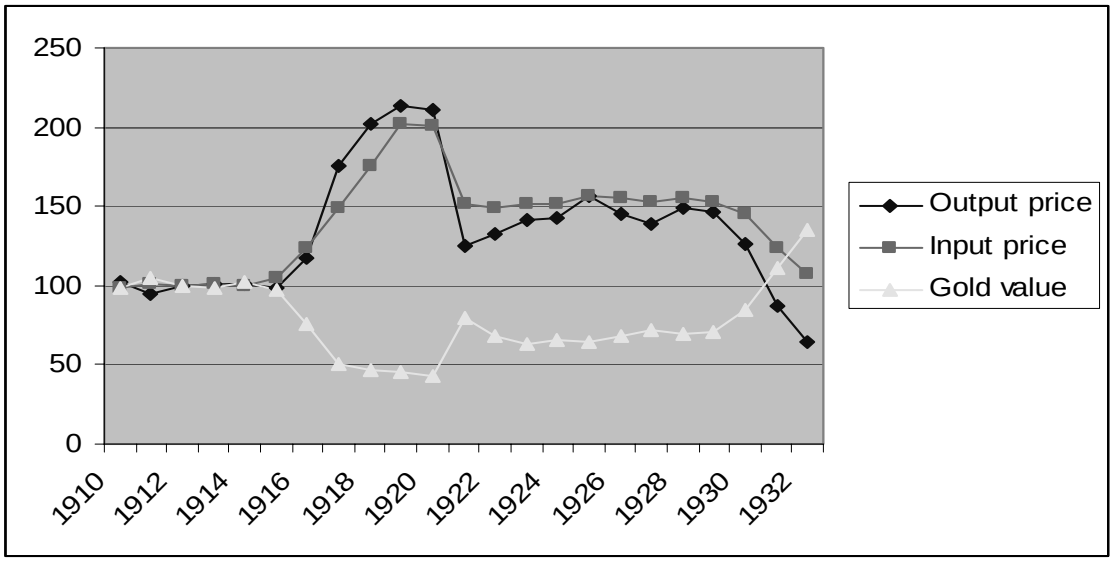

Figure 2. Index numbers for prices received and paid by farmers and gold value, 1910-1932 (1910-1914 = 100). Source: Nourse et al. (1937) and Warren and Pearson (1933)

For farmers the price is exogenous. If prices fall they have to adjust their production to the lower price to keep up income. In retrospect we know that long periods with a decline in the terms-of-trade with the non-farm sector are not unusual (Anderson, 1987). To obtain a reasonable income per farmer under a fixed arable base, the sector response has been to raise productivity and out migration from the rural to the urban sector. To some extent this also happened in the 1920s. The amount of farms declined from 6,448,502 farms in 1920 to 6,288,648 farms in 1930 a reduction of 159,695 or 2.48 percent (United States Department of Agriculture, 1965 p. 431). According to table 1 serious growth in productivity did not take off until the 1930s. From 1920 to 1930 productivity hardly changed. Over that decade the highest value for the productivity index was in 1928 at 106 while the lowest value was 97 in 1921. From 1930 to 1931 the index rose from 101 to 113. The sources of this growth were mainly the spread of tractors and hybrid-corn (Paarlberg and Paarlberg, 2000 p, 23; Cochrane, 1993 p. 109).

3. Production Adjustment Programs

The Agriculture Adjustment Act of May the 12, 1933 embodied sweeping innovations in the government's relationship to the nation's agriculture (Nourse et al., 1937 p. 1). During the 1920s political pressure for government intervention in agricultural markets was building. Various farm groups and politicians from rural areas advocated action such as an active tariff policy, production adjustment programs, and monetary reforms. The mainstream view among farmers, politicians and many agricultural economists was that the core of the farm problem was the low

world market prices for export commodities. The so-called export "surplus" dampened the overall prices for agricultural products (Nourse et al., 1937 p. 4).

In 1924 a two-price plan for agriculture proposed by George N. Peek and Hugh S. Johnson[6] found its way to Washington D. C. This plan became later known as the McNary-Haugen plan[7]. The first version of this plan provided for a price ratio on eight major farm commodities, designed to give producers the same purchasing power they had enjoyed from 1910-1914. An Agricultural Export Cooperation should buy the surplus on the American market at the price ratio and sell it on the world market at whatever price it would bring. To finance this all producers would be charged an equalization fee. The higher domestic price would exceed this fee and there would be a net gain for the farmers (Johnson, 1980 p. 529). The McNary-Haugen plan was put forward with minor adjustments as legislation five times during the late 1920s. The plan was put forward to Congress five times from 1924 to 1928. Congress passed the bill several times. But President Coolidge vetoed the plan every time saying that it was government price fixing, it was a vicious form of taxation, it delegated arbitrary power, it would worsen matters for farmers, and that it was unconstitutional (Johnson, 1980 pp. 527-541).

In the presidential campaign in 1928 the Republicans promised to bring relief to agriculture. President Hoover passed the Agricultural Marketing Act of 1929. The objectives of the act were to set up marketing cooperatives for grain, cotton and wool and to stabilize market prices. To administer this, the Federal Farm Board was established together with a $500 million revolving fund to support it. The idea was that marketing cooperatives with loans from the Farm Board should buy and store commodities in times of temporary market surplus. The Agricultural Marketing Act was basically the remains of the McNary-Haugen plan after the equalization fee was abolished. In retrospect the timing was bad. The world-wide prices collapse was overwhelming for the Farm Board and its $500 million. The revolving fund "revolved once and went out the window" (Paarlberg, 1964 p. 152). In the last report from the Farm Board they made one policy recommendation that would haunt U. S. farm policy for years to come:

> "No measure for improving the price of farm products other than increasing the demand of consumers can be effective over a period of years unless it provides a more definite control of production than has been achieved so far…. For the great staple products the problem still remains for future solution" (Federal Farm Board, 1932 cf. Nourse et al., 1937 p. 11).

In 1929 John D. Black published his book *Agricultural Reform in the United States*. His diagnosis of the problem was consistent with the mainstream view (Zobbe, 2002 pp. 4-9). He believed that though the problems of agriculture were a mix of factors inside and outside the sector the cure for the disease had to be implemented inside agriculture. In his book he strongly advocated government intervention in terms of supply management through an ambiguous plan

[6] This plan first appeared in print without the author's name, early in 1922 in a little pamphlet called "Equality for Agriculture". The second edition appeared in October the same year. This edition is addressed to the American Farm Bureau Federation. This edition carried the names of George N. Peek and Hugh S. Johnson of the Moline Plow Company, Illinois.

[7] The plan became known as the McNary-Haugen plan because it was promoted in Congress by Charles L. NcNary (R) in the senate and in the House of Representatives by Gilbert N. Haugen (R).

called *the domestic allotment plan*. This plan was not entirely Black's own idea. The plan can be traced back to 1926 when W. J. Spillman an agricultural economist employed by USDA published an article on this issue. The basic idea was to ensure a fair price for the part of the production consumed domestically. The price supplement on the domestically consumed product was to be secured by a system of allotments to individual producers of "transferable rights" to sell the domestic part of the crop to the "protected" domestic market. These in turn were to be sold to processors, who were required to have such certificates to cover their entire product sold on the domestic market (Black, 1929 pp. 271-301). In a later version of the plan the idea of transferable rights were removed and a processing tax was introduced to create revenue for a scheme of benefit payments to the farmers (Nourse et al., 1937 p. 13). The domestic allotment plan found its way into Roosevelt's presidential campaign in 1932 and became a year later the foundation of the agricultural legislation under the New Deal.

According to Nourse et al. (1937) the theory of the production adjustment program in the Agricultural Adjustment Act is as follows. *First*, relief was to be brought to the farming population by improvements in income through price enhancement and through use of "benefit payments". That would immediately put in their hands a substantial amount of money so that they might keep their farm properties intact, make necessary outlays for equipment and farm supplies, and finance expenditures for consumption. *Second*, the benefit payments were to be drawn mainly from special excise taxes on the commodity. The theory was that consumers and processors would be forced to pay a "fair exchange value" for the part of the product instead of an abnormally low price, which, it was alleged, had been brought about by the piling up of inordinate stocks because of farmers' inability to limit production to keep in step with the declining effective demand on the market. *Third*, such supplementary income was not to be a *quid pro quo* to those who agreed to participate in a program of controlled production. This control scheme was designed to produce a supply and demand situation which would bring about a level of prices which would be remunerative to farmers. This goal was defined as parity (Nourse et al., 1937 p. 23).

4. The Alternative View: Monetary and Financial Chaos

During the 1920s an alternative approach to the agricultural situation was advocated by two Cornell professors, George F. Warren professor in agricultural economics and Frank A. Pearson professor in price analysis. They both believed strongly that the roots of the agricultural depression were due to serious monetary and financial chaos which had interfered violently with the structural adjustment process of American agriculture. Their analysis of the farm depression and policy recommendations are presented in three books called the *price series*. The books are titled *The Agricultural Situation* from 1924, *Prices* from 1933 and *Gold and Prices* from 1935.

Their point of departure was that American agriculture in the first decades of the 20th Century had moved from self-sufficiency to market oriented. Before that farmers had produced practically all their necessities and most of their luxuries themselves. After being commercialized farmers became specialized, producing certain products with most necessities and all luxuries purchased from other sectors.

> "By specialization, each of us produces so much of something that each of us can have more of everything. The battery that keeps this modern machine running is the medium of exchange – money. When money is stable in value, the machine works well. When inflation occurs, it runs to fast. When deflation occurs it stalls, sales stop, unemployment is common, and there is starvation in the midst of plenty" (George F. Warren and Frank A. Pearson, 1933 p. 2).

The crucial argument is that the value of money plays an important role in the determination of the price for a good because the price for a good is not only determined by the supply and demand of that good but also by the supply and demand of money. For agriculture price signals are very important and therefore it is very important that prices are right. Basically society tells farmers through prices what to produce and more seriously if society wants the farmer to be a farmer or maybe do something else. Agriculture is a slow industry in speed of adjustment because of the lag in production and that the farm, besides being a business, also is the home of the farmer and his family. If price fluctuations are too violent, agriculture is unable to respond correctly.

According to Warren and Pearson the agricultural depression of the 1920s is purely a price problem of high inflation followed by rapid deflation caused by financial and monetary chaos. This argument will be explored in detail below. They recognize that there were a few other minor factors that influenced the situation. These other factors were *first*, the United States loaned large sums of money to European countries. Much of this money was used to buy farm products in advance of current needs. Many countries were worried about food supplies and wanted to build up stocks for the future. This stimulated production and because it raised prices, checked consumption. After the price drop from 1920 to 1921 most of these stocks were dumped on the market, so that an abnormal supply appeared. *Second*, foreign currency was scarce in Europe after the war and many countries tried to substitute for food imports by raising the domestic production of food products (Warren and Pearson, 1924 pp. 19-21).

In respect to financial and monetary chaos the argument was that the violent changes both up and down in prices was caused by changes in the change in supply and demand for money, hence gold, rather than because of changes in supply and demand for agricultural products. Figure 2 above compares indexes for prices received and paid by farmers and indexes for the value of gold from 1910 to 1932. Warren and Pearson argue that there was a close relationship between the behavior of the Federal Reserve System and the financial and monetary chaos. December 23, 1913 the Federal Reserve Act was signed by President Wilson. During the fall of 1914 World War I broke out and the Federal Reserve Banks began operation. Exports from Europe declined and they had to pay for their imports by returning stocks and bonds, by shipping gold, and by borrowing from American investors (Warren and Pearson, 1924 p. 6). Many European countries left the gold standard during the war and paid little attention to gold movements. Gold moved to the few places where there was a market for it. This reduced demand for gold made it cheap or made price rise in those countries still on the gold standard (Warren and Pearson, 1933 p. 114). From 1914 to 1917 the United States changed from the world's greatest borrower to the world's greatest lender. The results of this were an increase in prices in America (Warren and Pearson, 1924 p. 6).

After the United States entered the war in April 1917, the governmental focus was to win the war. The government therefore encouraged increased production of essential goods in both industry and agriculture mainly though raising credit. The Federal Reserve System helped the Treasury in this task by issuing government obligations upon which the member banks could borrow from the Federal Reserve Banks at low rates of interest. This policy fuelled inflation and investment both rural and urban. From April 21 to May 10, 1919, the Victory Loan was floated. Nearly 90 percent of the bonds were sold on credit. This triggered the post-war inflation and the further rise of prices. After the war the expectation was deflation. When inflation occurred the optimism generated a feeling that prices would stay high forever. This secondary period of inflation was largely responsible for the rise in land values, which laid the foundation of the farm problem. Prices of plow land rose relatively little before that time. The increase from 1916 to 1918 was from $58 to $68 per acre, but from 1918 to 1920 land rose from $68 to $90 per acre. The situation got so intense in general that wholesale merchants experienced a sudden increase of unusual proportion in their orders. Orders were duplicated. Some merchants gave purchasers only a certain percentage of their orders. Consequently, buyers often placed several orders for the same product with different dealers. The result was a runaway market. No action was taken to stop this mania until December 1919, when the discount rate was raised a little. "The Federal Reserve System realized that they had to make a radical advance in the discount rate in order to save themselves" (Warren and Pearson, 1924 p. 14). The larger Federal Reserve banks raised their rates to 7 percent in June 1920 (Warren and Pearson, 1924 pp. 14-16). From this time on prices started to drop. This drop continued for thirteen month. Prices of basic commodities responded more promptly and more violently than prices of other goods. Industries like agriculture that could not liquidate promptly were most injured. Corporations with long records of dividend payments skipped payments, and many were compelled to reorganize. There was a failure to buy and the primary reason for this was the belief that prices would be lower to tomorrow. The fact that large hoards were on hand made delays in purchases possible. Unemployment and the inability to sell made it impossible to buy (Warren and Pearson, 1933 pp. 359-360).

> "Inability of unemployed persons to buy allows stocks of goods to accumulate and results in the illusion of over-production. Exaggerated statements of capacity to produce are made and efforts are put forth to find means to permanently curtail production, under the childish assumption that if each of us produces less, each of us can have more" (George F. Warren and Frank A. Pearson, 1933 p. 5).

Warren and Pearson's diagnosis of the agricultural depression of the 1920s made them come up with two policy recommendations. The *first* was better central banking by the Federal Reserve System. The argument is that from the beginning of operation and until 1920 the discount policy of the Federal Reserve System was shaped not in accordance with money market conditions – not with the idea of using reserve bank rates as an instrument of effective control the money market – but with the primary purpose of assisting the Department of Treasury in floating its great bond issues and its short-term certificate issues (Warren and Pearson, 1924 pp. 8-9). The *second* policy recommendation was connected with the first. Warren and Pearson argued for the stabilization of the price level. To achieve this goal the gold standard should have been abolished. During the time of the gold standard the United States went through the worst depression in its history. The basic problem was that gold is just another commodity where price

is determined by the supply and demand. When the amount of gold in a dollar was fixed the fluctuations in gold value spilled over to the price level. The target for monetary policy according to Warren and Pearson should be stabilizing some sort of wholesale price index (Warren and Pearson, 1935 pp. 267-296).

The arguments never had any real impact on the policy makers. According to Paarlberg (1984) neither farmers nor politicians understood the complexity of central banking. On the other hand the diagnosis that agriculture was suffering from overproduction was credible to both farmers and politicians. They knew that excessive production meant low prices and reasoned that with prices low there must be excess production (Paarlberg, 1984 p. 6).

5. Analysis of Arguments of the Harvard and Cornell Schools

The Harvard and Cornell schools provide much different explanations for the causes of the problems facing agriculture in the 1920s and come to much different policy recommendations. To evaluate the arguments advanced by the two schools results from theoretical models are used. These models are based on standard economic theory and provide comparative static impacts of various forces at work during the period. They link the observed changes in prices to changes in inputs, economic conditions generated by the First World War, and policies. Comparison of the model results with data checks the consistency of the arguments advanced and aids evaluation of the arguments made.

Two basic types of models are used. One model is the traditional general equilibrium model of international trade. The model gives the comparative static price changes that can be tied to the Stopler-Samuelson and Rybczynski results of the Heckscher-Ohlin model and the Ricardo-Viner (Specific Factors) model. The arguments offered by the Cornell School center on macroeconomic forces in the context of the Gold Standard so the results of a macroeconomic model are presented that can be linked to the general equilibrium results.

5.1 Price Impacts in a Global Model

The Harvard School argued that the farm problem of the 1920s was tied to a falling terms-of-trade to agriculture, with falling returns to assets, which forced the migration of factors of production (farmers) out of agriculture. One source of these changes was the export boom-export bust of the First World War that had pulled resources into agricultural production. Another contributor was technical change in agriculture that helped supply outstrip an income inelastic demand. Their policy recommendation was that adjusting supply via land retirement could boost prices and factor returns as well as slowing or halting to outflow of factors of production.

To understand the farm problem faced in the 1920s and the consequences of proposed remedies, a global general equilibrium model is necessary because the adjustment in world price is required. The model is constructed using duality theory and provides a simple algebraic means to determine changes in the world price. This style of model is developed in Dixit and Norman (1980) and a detailed presentation appears in the appendix. The major complication introduced is in the interpretation of the results through normalization.

The model assumes two countries, the United States and the Rest-of-the-World, where the latter region is denoted by superscript *. Each country has an expenditure function which is the minimum expenditure necessary to achieve a specified level of utility given by a well-defined national utility function. Let U be the level of national utility and P be the normalized price. The expenditure function for the United States is E(1, **P**, U) and that for the Rest-of-the-World is $E^*(1, \mathbf{P}^*, U^*)$ where letters in bold indicate vectors or matrices and letters not in bold indicate scalar values. The value of national production is given by a revenue function which maximizes the value of national output subject to resource constraints indicated by **V** and $\mathbf{V}^*$. Thus, the revenue function for the United States is R(1, **P**, **V**) and that for the Rest-of-the-World is $R^*(1, \mathbf{P}^*, \mathbf{V}^*)$. Expenditure and revenue functions have known properties (Dixit and Norman, 1980). The first derivatives of the expenditure function with respect to price, $\mathbf{E_p}$, give the Hicksian demand functions and the second derivatives, $\mathbf{E_{pp}}$, the response of consumption to price or the pure substitution effects. The first derivatives of the revenue function with respect to price, $\mathbf{R_p}$, give the output supply. The first derivatives of the revenue function with respect to endowments, $\mathbf{R_V}$, give the factor prices. The second derivatives of the revenue function with respect to price, $\mathbf{R_{pp}}$, are the supply responses to price while the second derivatives, $\mathbf{R_{pv}}$, measure the response of outputs to endowment changes.

Equilibrium is determined by four equations. Two equations describe the national income – expenditure identities that require national expenditure to equal national income. The third equation requires global demand to equal global supply as given by the first derivatives of the expenditure and revenue functions. The final equation links price in the two regions.

This formulation allows for the introduction of tariffs since during the early decades of the 20th century tariffs were the main instrument of agricultural protection. During the 1920s the United States as well as other nations raised the level of tariffs and it is helpful to include this effect.

Solving for the price changes in response to endowment changes, d**V** and d$\mathbf{V}^*$, and any change in the vector of tariffs gives:

$$(1)\ d\mathbf{P} = \mathbf{D}^{-1}\{[\mathbf{R_{pv}} - \mathbf{R_V}\mathbf{C_y}]d\mathbf{V} + [\mathbf{R_{pv}}^* - \mathbf{R_v}^*\mathbf{C_y}^*]d\mathbf{V}^* + [(\mathbf{E_{pp}}^* - \mathbf{R_{pp}}^*) + \mathbf{M}(\mathbf{C_y}^* - \mathbf{C_y})]d\mathbf{T}\},$$

where $\mathbf{D} = \mathbf{S} + \mathbf{M}(\mathbf{C_y}^* - \mathbf{C_y})$, $\mathbf{S} = \mathbf{E_{pp}} - \mathbf{R_{pp}} + \mathbf{E_{pp}}^* - \mathbf{R_{pp}}^*$, $\mathbf{M} = \mathbf{E_p} - \mathbf{R_p}$, $\mathbf{M}^* = \mathbf{E_p}^* - \mathbf{R_p}^*$. The matrix **S** gives the substitution effects in both demand and supply. The vectors **M** and $\mathbf{M}^*$ are the vectors of imports while $\mathbf{C_y}$ and $\mathbf{C_y}^*$ are the responsiveness of consumption to changes in income.

To facilitate interpretation of expression (1) it is assumed that there are two goods, a composite agricultural good and a composite non-agricultural good. This means that S becomes a negative scalar, $S < 0$. Interpreting the results can be tricky because both prices and quantities are normalized. When the numeraire good is the U.S. export good – the agricultural good -- the relative price, P, is the price of non-agricultural goods relative to agricultural goods, and trade, M, is a positive value, $M > 0$. The endowments, **V** and $\mathbf{V}^*$, are also defined normalized on agriculture.

Given the assumptions, expression (1) can be interpreted. The term D consists of the substitution effects and the difference in the income effects in the two regions. The substitution effects are negative. In general, the marginal propensity to consume an import good exceeds that for an export good. This means that when $M > 0$, the agricultural good is the numeraire, then $\mathbf{C_y} > \mathbf{C_y}^*$ so the effect is negative and $D < 0$. Thus, $D < 0$, so the Marshall-Learner condition is satisfied and the system is stable.

The terms-of-trade data presented earlier show stability until 1917, then an improvement for agriculture, followed by a deterioration in 1921. The years 1922 to 1925 saw a recovery in agriculture's terms-of-trade. Consider what that pattern says about changes in **V**. The relative price change, dP, depends on two effects. One effect, $D^{-1}\mathbf{R_v}$, represents the change in income from changes in endowments. When endowments increase, this effect is associated with a price increase. The second effect, $D^{-1}\ \mathbf{R}_{pv}$, gives the impact of the larger endowments on the relative output of the non-agricultural good (normalized on the agricultural good). The sign of this term is ambiguous.

Symmetry, Young's theorem, shows that $\mathbf{R_{pv}} = \mathbf{R_{vp}}$ where $\mathbf{R_{vp}}$ leads to the Stopler-Samuelson results. In a Specific Factors model the Stolper-Samuelson effects are always positive so there is a conflict between the price increasing effect from an increase in income due to an endowment increase and a price reducing effect from more output of the non-numeraire good. For an increase in the mobile factor the first term in brackets in expression (1) can be reduced to the difference between the Stolper-Samuelson effect and the marginal propensity to consume the non-numeraire good:

(2) $[\partial \ln W/\partial \ln P] - P[\partial C/\partial Y]$,

where W denotes the price of the mobile factor, C represents demand for the non-numeraire good, and Y is national expenditure. For the specific factor, the expression is:

(3) $[\partial \ln Z_n/\partial \ln P] - P[\partial C/\partial Y]$,

where Z_n is the price of the factor specific to the non-agricultural sector. The two terms conflict. The Stolper-Samuelson results demonstrate that the change in the specific factor price, Z_n, exceeds the change in the price while the change in the mobile factor's price is dampened. Thus, while it is likely that increases in the endowment of either factor will lower the relative price of the non-agricultural good, an increase in the endowment of the specific factor is very likely to create a situation where the income expansion is insufficient to counter the effect of expanded output.

In contrast, the Heckscher-Ohlin model shows the Stolper-Samuelson effects to be opposite in sign. If the endowment increase occurs for the factor used intensively in the non-agricultural sector, the Stolper-Samuelson effect is positive and the above conclusions hold. If, however, the endowment increase occurs for the factor used intensively in the agricultural sector, the Stolper-Samuelson effect is negative and the relative price of the non-agricultural good will rise because the larger output expansion occurs for the agricultural good is combined with the income effect.

The same stories hold if the system is normalized on the non-agricultural good and increases in endowments are considered. Increases in endowments specific to agriculture or which are used intensively in agriculture will generally cause the relative price of agricultural goods to fall because they will expand agricultural output more than can be absorbed by the associated income expansion.

The Harvard School argued that one driver of the farm price story was oversupply in agriculture as increases in farm output outran increases in demand. Expression (1) indicates a more complex relationship is needed. Consider only the income side. Assuming that demand for farm commodities is more income inelastic than demand for non-agricultural goods, the wartime expansion would boost demand for farm goods less. The post war contraction would cut demand for food less. This would not generate the improved agricultural terms-of-trade during the war nor would it explain the post war terms-of-trade decline.

Thus, consideration of the supply side is needed to produce the observed price pattern. The relative price change is determined by relative changes in supply. The price pattern must reflect that the relative output expansion was slower for agriculture during the war and the relative output reduction for agriculture was slower after the war. There are two issues. One way for the observed price pattern to be generated was that resources (endowments) specific to agriculture or used intensively by agriculture were relatively slow to expand. Another way to get the pattern was that agricultural output was less responsive to endowment increases than was the output of non-agricultural goods. There is evidence of such a situation. The inherent time dynamics of agricultural production would tend to reduce its ability to respond and that would be reflected in an improved terms-of-trade during the war and a deterioration afterwards. Wheat area expanded from 45 million acres in 1917 to 75 million in 1919. Also important is that the 1916 wheat crop was low while later crops experienced large yields (Current, Williams, and Freidel, 1975 p. 617). The corn crop was also reduced which caused hog output to fall in 1917 and the prices of both commodities rose sharply (Culver and Hyde, 2000 pp. 47-48).

Another aspect of the Harvard School's argument was that a declining terms-of-trade for agriculture was a long run trend. That is, oversupply of farm products was persistent and not just a short-run post-war adjustment. Policy should be directed at restoring the agricultural terms-of-trade through balancing supply with demand by retiring land. Expression (1) indicates that occurs when there is comparatively faster growth in agricultural specific or agricultural intensive factors. Since changes in technology can be treated like increases in endowments, another force could be agriculture experiencing faster technical change than non-agricultural goods. The data on technical change in agriculture in Table 1 indicate that agriculture saw little technical change until the 1930s. In contrast, other sectors experienced much technical change associated with industrialization, particularly in the automotive and related industries. Non-agricultural sectors experienced growth in factor endowments, largely capital, in the late 19th and early 20th centuries as the nation continued to industrialize. This period was also one when the labor force expanded rapidly via immigration and births. Another force was the change in the land endowment. Until the early 20th century the land base expanded but since has remained mostly constant. Cultivated land expanded greatly during the war, but land was removed from production after the war and the land base returned to roughly pre-war levels. These trends are not consistent with a story where there is a long-run deterioration in agriculture's terms-of-trade. The price data from 1910

until the Great Depression presented in table 1 show a stable terms-of-trade with the exception of the few years during and after World War I.

Yet, the terms-of-trade argument is not necessary for the relative importance of agriculture in the U.S. economy to contract. The Rybczynksi results show that even with a constant relative price output mix and factor shares shift. The Rybczynski results in the Heckscher-Ohlin model are clear. If the factor used intensively in the non-agricultural sector expands relative to that used intensively by agriculture, the relative importance of agriculture falls. The Rybczynski results in the Specific Factors model are strictly ambiguous but do show tendencies. An increase in the endowment of the factor specific to the non-agricultural sector tends to expand that sector relative to agriculture since the direct output effect tends to dominate. This suggests that more rapid growth in non-agricultural endowments boosts non-agricultural output more, lowers the share of agriculture in U.S. output and pulls resources out of agriculture as factors move to greater returns outside of agriculture.

Tariffs also changed in this period. Expression (1) shows that an increase in the tariff for the non-numeraire good raises its relative price. The Fordney-McCumber Act of 1922 boosted tariffs on agricultural goods, chemicals, and manufactured goods (Current, Williams, and Freidel, 1975 p. 645). With agriculture being primarily an export industry – grains and cotton -- the impact of the 1922 tariff can be seen as a relative price increase for the composite non-agricultural good. The mix of output shifts towards non-agricultural goods with returns to factors specific to agriculture or used intensively in agriculture falling. It is interesting that in the price data presented in table 1 the agricultural terms-of-trade improved after 1922 and by 1925 parity with the non-agricultural sector was restored. The analysis suggests that tariff of 1922 actually slowed that terms-of-trade improvement.

Another force at work in the period was the First World War, its effect on European agriculture, and the recovery of European agriculture after the war. The clearest indication of the impact of the war is found in German data. Although only one major battle was fought on German territory during the First World War, the production data show sharp declines in crop area and yields as inputs were diverted from agriculture. From 1914 to 1919 German wheat area fell from 2,265 thousand hectares to 1,431 thousand hectares. Wheat yield declined from 1.99 tons per hectare to 1.68 tons per hectare. Agriculture recovered quickly after the war. In 1921 the wheat yield had risen to 2.05 tons per hectare. The 1922 wheat yield was low, but from 1923 on, yields were back to pre-war levels (Germany, *Statistisches Jahrbuch für das Deutsche Reich, various issues*).

The effect of changes in European endowments can be evaluated using expression (1) normalized on the non-agricultural good where $d\mathbf{V}^*$ is negative during the war years and the immediate post-war years and is positive in the early 1920s. Again there is conflict between the income effect and the output effect. Following the earlier arguments, the most plausible argument is that the output effect dominates so the European agricultural endowment contraction raised the relative price of agricultural goods during the war, but lowered it with the post-war recovery. This is consistent with the idea that agriculture experienced a wartime boom that improved its terms-of-trade and a post-war bust that lowered its terms-of-trade.

One policy recommendation advanced by the Harvard school was to retire land – reduce the agriculture specific factor. Expression (1) can be solved to find the reduction in the U.S. endowment given an increase in the Rest-of-the-World endowment such that there is no term-of-trade change:

(4) $dV = -[(R_{pv}^{*} - R_v^{*}C_y^{*})/(R_{pv} - R_vC_y)]dV^{*}$.

Expression (4) shows that to remove land from U.S. agriculture to maintain agriculture's terms-of-trade when the Rest-of-the-World's endowment increases policy makers must balance the U.S. income loss against the income gain in the Rest-of-the-World as well as the net effect on global output. If the Rest-of-the-World's income gain exceeds the U.S. income loss, then the U.S. output reduction can be smaller than the Rest-of-the-World output gain. This is the direct foreign direct investment problem with no profit repatriation (Dixit and Norman, 1980). The United States adjusts output to offset the net demand change plus the increase in foreign output. As discussed above a stable terms-of-trade is insufficient to prevent agriculture's role in the economy from shrinking if the non-agricultural sector is growing faster. Reducing the endowment of an agricultural specific factor might even hasten that decline.

5.2 Macroeconomic Forces and the Gold Standard

Warren and Pearson at Cornell University took a much different view of the farm problem of the 1920s and its origin. They argued that the problems facing agriculture were macroeconomic in origin, arising due to policies by the Federal Reserve and the Gold Standard.

The First World War generated several interdependent macroeconomic shocks in the United States. *First*, the U.S. Government increased military spending. *Second*, some of the goods produced with the military build up were exported to allied nations so a large trade surplus emerged. *Third*, payment for the exported military supplies was in the form of loans to be re-paid following the war and the United States shifted from and international debtor nation to a creditor nation. Further, the Federal Reserve maintained low interest rates during the war as well as in the immediate post war years. A deflationary policy was adopted in the early 1920s. The result was that during the war the United States had expansionary monetary and fiscal policies with a fixed exchange rate. The end effect was inflation with the U.S. price level doubling between 1914 and 1918. That inflationary pressure continued after the war until policy reversed.

Modeling of the macroeconomic effects is complicated by the conflict between the Keynesian and neo-classical schools. The simple Keynesian story treats price level as fixed and determines real income and the interest rate. The neo-classical model treats output as pre-determined and solves for the price level and the interest rate.

To give a complete picture of the macroeconomic forces at work, both must be considered (the models are presented in the appendix). This presentation assumes there are two countries, the United States and the Rest-of-the-World. The exchange rate is treated as fixed so that external imbalances are adjusted via changes in reserves.

The neo-classical model assumes that outputs, Y and Y^*, are pre-determined and prices are perfectly flexible. Solving gives the comparative static results for the aggregate price level, P, and interest rate, r, given changes in the money supply, M_s, and government spending, G:

(5) $\partial P/\partial M_s > 0$; $\partial P^*/\partial M_s > 0$;

(6) $\partial r/\partial M_s < 0$; $\partial r^*/\partial M_s < 0$;

(7) $\partial P/\partial G > 0$; $\partial P^*/\partial G > 0$;

(8) $\partial r/\partial G > 0$; $\partial r^*/\partial G > 0$.

The comparative static results should not be a surprise. An expansionary monetary policy pushes the home country (United States) aggregate price level higher and has spillover effects that raise the price level in the Rest-of-the-World, expression (5). In other words, an expansionary monetary policy causes inflation at home and abroad. Associated with the expansionary monetary policy is a fall in the interest rates in the two regions, expression (6). Expansionary fiscal policy via an increase in government spending boosts the aggregate price levels, expression (7) as well as raising interest rates, expression (8).

Because the neo-classical model treats output as pre-determined it is important to examine a model where output, Y, changes using a simple Keynesian model. That model assumes that resources are not fully employed so output can be adjusted at no cost. The implication is that the aggregate price levels are fixed. The Keynesian model solves for changes in outputs (real income) and the interest rates. Solving gives:

(9) $\partial Y/\partial M_s > 0$; $\partial Y^*/\partial M_s > 0$;

(10) $\partial r/\partial M_s < 0$ (usually); $\partial r^*/\partial M_s$ ambiguous;

(11) $\partial Y/\partial G > 0$; $\partial Y^*/\partial G > 0$;

(12) $\partial r/\partial G > 0$; $\partial r^*/\partial G > 0$.

Expansion in the money supply with a fixed exchange rate causes both economies to expand, expression (9). The spillover to the Rest-of-the-World is the "locomotive effect." A monetary expansion has an ambiguous impact on the interest rates. In the United States a monetary expansion has three effects. One effect is the direct impact of increasing the money supply which lowers the interest rate. A secondary effect occurs via the expansion in aggregate demand in the United States and this adds upward pressure on the interest rate. The third effect is the expansion in the economy of the Rest-of-the-World which adds to U.S. currency reserves as purchases from the United States expands. Usually the two negative effects dominate and the interest rate in the United States falls. In the Rest-of-the-World the expansion of the U.S. economy raises reserves so acts like a monetary expansion in the Rest-of-the-World which acts to lower the interest rate. At the same time the Rest-of-the-World economy expands and that puts upward pressure on the interest rate. Increases in government spending raise aggregate

demand in both regions. This increases real income (output), expression (11), and interest rates, expression (12).

For the agricultural sector the critical issue is how these macroeconomic changes affect the sector. Initially it is assumed that money is neutral and that prices are Hicksian flex prices. This means the change in the aggregate price level does not affect the relative price. Its impact enters via a real wealth effect on consumption.

To think about how the change in income affects the terms-of-trade, expression (1) giving the relative price shift in response to an endowment change, can be used. Increased wartime growth is interpreted as an increase in all endowments for the U.S economy while the post-war economic downturn is viewed as a reduction in the endowments as industries contract and release factors of production.

Two terms are critical. One term is the income effect generated by the change in each endowment on consumption of each composite good. As resources flow into the economy, income rises which generates added consumption determined by the income effects putting upward pressure on prices. With agriculture having a lower income elasticity of demand than non-agricultural goods, income expansion would generate a greater increase in consumption and the relative price for non-agricultural goods. The opposite would occur during the post-war slump. That is, when income falls agriculture would experience a terms-of-trade gain since agricultural prices fall less.

The second effect in expression (1) recognizes the impact of changes in input use on outputs. Generally agricultural goods are thought to be relatively unresponsive to price and factor usage changes due to the lags in production. If non-agricultural goods are more responsive to changes in economic activity, then when the economy grows non-agricultural output expands relative to agricultural output. That moderates the rise in the price of non-agricultural goods generated by the demand expansion. When the economy declines, the pattern is reversed.

Expression (1) can also be used to understand the impact of the change in the interest rate. Here dV represents changes in endowments that drive the interest rate lower. The same effects appear. Lower interest rates raise consumption depending on the income effects. Food consumption is not very sensitive to interest rate changes. Although as Chambers (1984) points out, commodity stocks are reduced in response to increases in the interest rate, on balance it is plausible that the interest rate effect for agricultural goods is low. Consumption of non-agricultural goods is more sensitive to changes in the interest rate. The relative price change mostly hinges on the effect of the interest rate change on outputs. Agriculture in the early decades of the 20th century was different than modern agriculture. Most land was owner operated and use of purchased inputs was limited. Outside financing of purchase inputs was limited, but land, purchased on credit, was relatively more important. Thus, R_{pv} for agriculture could exceed R_{pv} for the non-agricultural good with rC_y for the agricultural good less than rC_y for the non-agricultural good. That would create a pattern where the change in agricultural prices, dP_a, is larger than the change in non-agricultural prices, dP_n.

Thus, changes in both income growth and interest rates can alter relative prices. The relative price changes are governed by differences in income effects and output effects. Another reason why agricultural prices might show more adjustment relates to industry structure and pricing. The previous model assumes prices of both the composite agricultural good and the composite non-agricultural good instantly and fully adjust to shocks. That is, both goods are modeled as Hicksian flex-price goods.

For the World War I period that assumption seems appropriate for the price of the composite agricultural good since there was no farm commodity price support and these commodities were bought and sold in open markets with many participants. During the war the administrator of the Food Administration established by the Lever Act of August 10, 1917, Herbert Hoover, opposed retail price fixing. One exception was that the Food Administration did guarantee purchase of the entire 1917 wheat crop at $2.20 per bushel (Current, Williams, and Freidel, 1975 p.617). Also in a statement Hoover appeared to guarantee a minimum price for hogs relative to corn at a 13:1 ratio, but did not explicitly state that position. In any case there was no intervention to support the price of hogs until September 1918 when a minimum hog price of $17.50 per cwt was announced. That price was the level prevailing in the spring of 1918 and represented a 10.8:1 ratio with the corn price (Culver and Hyde, 2000 pp. 45-51).

The assumption that the non-agricultural composite good is a Hicksian flex-price good is suspect. Many of these goods were produced by imperfectly competitive industries and sold under contracts. During the war some critical goods, like coal, were subject to Federal price setting. Activities, like interstate commerce, had controlled rates even before the war. Thus, the composite non-agricultural good should probably be considered a Hicksian fix-price good that adjusts slowly to shocks.

When the agricultural price is assumed to be a Hicksian flex-price good and the non-agricultural good is assumed to be a Hicksian fix-price good two important dimensions are introduced. *First*, the initial change in the terms-of-trade is known. The wartime increase in the aggregate price level would cause the prices of agricultural goods to rise faster than prices of non-agricultural goods. After the war agricultural prices would be quicker to fall when deflation begins. The *second* aspect is that there could be overshooting in agricultural prices (Stamoulis and Rausser, 1988). Overshooting can be illustrated by thinking of the aggregate price level as a convex combination of the composite agricultural price and the composite non-agricultural price. Logarithmic differentiation gives:

(13) $dlnP_a = [dlnP - \theta_{np} dlnP_n]/\theta_{ap}$,

where θ_{ap} and θ_{np} are the shares of the agricultural good and the non-agricultural good in the aggregate price. Given a change in the aggregate price, if the price of the non-agricultural good cannot adjust, the price of the agricultural good adjusts more. As the non-agricultural good's price adjusts through time, the change in the price of the agricultural good becomes less and the agricultural price rises back to the equilibrium level.

The changes in the three macroeconomic variables alone could have generated the observed changes in the agricultural terms-of-trade. Increases in U.S. economic activity during the war

and demobilization could have changed relative agricultural prices if agricultural output responds more sluggishly. Interest rate decreases could also have caused greater agricultural price adjustment if agricultural output is more sensitive to the interest rate changes than is non-agricultural output. Agriculture can be viewed as a flex-price industry while the non-agricultural sector had price rigidities. That means terms-of-trade shifts and implies overshooting by agricultural prices.

Inserting the results from the macroeconomic analysis into the Stolper-Samuelson Effects indicates how factor returns were affected. During the First World War the agricultural prices rose sooner and by more than non-agricultural prices. This would indicate than the prices of factors that are mobile between the sectors rise but by less than the relative price change. Returns to factors specific to agriculture -- land, buildings, farm equipment, farmers – increased by more than the relative price increase. Nominal returns to factors specific to non-agricultural industries increased, but decreased in real terms. Because the agricultural price overshoots when non-agricultural prices are slower to adjust, returns to agricultural specific factors overshoot as well. In a dynamic situation this would induce an excess inflow with over investment in agriculture. The risk of overshooting was increased by government exhortations to boost farm output and the dangers were publicized by editorials in *Wallaces' Farmer* (Culver and Hyde, 2000 pp. 45-47).

The monetary contraction after the war lowered the aggregate price level, slowed economic growth, and boosted the interest rate. These changes translated into a decline in agricultural prices that was stronger than the decline in non-agricultural prices and appeared sooner. The Stolper-Samuelson results indicate that prices of mobile factors fall, but by less that the relative price decline. Returns to agricultural specific factors fall by more than the relative price decline. Return to factors specific to non-agricultural industries fall, but rise in real terms. Again there is overshooting indicating that the initial fall in returns to agricultural specific factors of production is excessive.

The policy recommendations offered by Warren and Pearson are vague. One clear message is a criticism of the behavior of the Federal Reserve which pursued an expansionary monetary policy during the war and immediate post-war years. An expansionary policy followed by a sharp contraction would alter relative prices and lead to overshooting by farm prices with impacts on agricultural resource values and factor use. Another criticism is the tie to the Gold Standard, although they do not explicitly call for flexible exchange rates. How a flexible exchange rate would have behaved in the war and post war years is hard to say. Inflation and expansionary fiscal policy is usually associated with a depreciating currency. That would reinforce the rising U.S. prices as exports expand and imports are more costly. Yet, there was an inflow of capital from loans and the United States offered a safe haven for European money. These forces would tend to appreciate the dollar and would push U.S. prices lower.

6. Conclusion

Combining the results of the models allows an assessment of the arguments advanced by the two schools and of the policy recommendations made. Both sets of arguments can be supported

during the war and the immediate post-war years. Indeed, Black, Wallace, and others linked to the Harvard School recognized the role played by monetary policies.

One common link is that for both models to generate the observed changes in the terms-of-trade during the World War I period, agricultural output needs to be less responsive than non-agricultural output to equal changes in factor endowments. That relationship seems plausible given the lags in agricultural production due to inherent biological processes. Further, the observed price pattern can result from a situation where agricultural endowments change less than do non-agricultural endowments. The extent to which this happened is unclear. Both agricultural and non-agricultural endowments increased during the war and both were given encouragement in government campaigns. It takes time to convert land from pasture to crop production, but it also takes time to convert manufacturing capital from civilian good production to arms production.

Agriculture experiencing slower changes in output helps explain the wartime terms-of-trade shifts, but does not mesh with the hypothesis offered by the Harvard School of a long-run fall in agriculture's terms-of-trade due to persistent oversupply of farm goods. For that to occur, agriculture would need to have been experiencing faster rates of endowment growth and technical change than the non-agricultural sector. Data prior to 1930 do not support that view and there is no evidence of a declining terms-of-trade for agriculture. Another complication is the 1922 tariff that increases the relative price of the non-agricultural good. With the agricultural terms-of-trade rising after 1922, the model suggests that the rise would have been stronger without the tariff.

Based on the hypothesis that oversupply of farm goods contributed to driving down agriculture's terms-of-trade, the Harvard School promoted a policy to counteract oversupply by restricting agricultural production. In the competition for ideas, the advocates of production control prevailed over those arguing for reform of monetary policy. The United States started down a path that continued until production controls were abolished in the 1996 farm legislation. Even so, production controls continue to have advocates. With little evidence of forces causing a long-run decline in agriculture's terms-of-trade before 1930, in hindsight, this policy recommendation appears flawed.

The declining share of agriculture in the economy does not rely on a declining terms-of-trade. Rather it is tied to relative changes in endowments where agricultural endowments grow more slowly or where technical change in agriculture is slower. Real returns to factors used intensively by or specific to agriculture fall. Mobile factors of production move out of agriculture and toward higher returns in non-agricultural industries. That situation seems correct for the early 20th century. If that is the case an agricultural oriented policy of taking endowments out of the sector does not slow the agricultural sector decline and may even hasten it.

Overall the macroeconomic stories offered by the Cornell School seem to provide more consistency between an economic model and the data. Expansionary fiscal and monetary policies cause terms-of-trade changes that match the observed pattern. Fixed and Flex pricing also changes the terms-of-trade while generating overshooting for agricultural prices that appears in the data. When overshooting occurs, agricultural resource values will be affected. They will

rise too much in response to price increases and fall too much when the relative agricultural price falls. The criticism of the Federal Reserve to increase the money supply during the war and to contract it in the early 1920s appears correct. A policy recommendation not made would have been to promote price flexibility in non-agricultural sectors to reduce the overshooting of agricultural prices.

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APPENDIX: CONCEPTUAL MODELS USED IN THE ANALYSIS

To evaluate the arguments for the U.S. farm problem of the 1920s advanced by the two schools theoretical models are developed. These models are based on standard economic theory and are designed to provide comparative static impacts of various forces at work during the period. Propositions about the impacts of different shocks to the models can be confronted with data from the period. This allows evaluations of the arguments advanced by the two schools as well as an assessment of their respective proposals to treat farm problems.

The presentation begins with the two traditional general equilibrium models of international trade, the Heckscher-Ohlin model and the Ricardo-Viner or Specific Factors model. The discussion focuses on two sets of effects. One set are the so called "Stolper-Samuelson" results which link factor price changes to output price changes. The other set are the "Rybczynski" results that tie output changes to changes in endowments. The next section develops a full global model using duality theory that examines the impact of changes in factor endowments and technology on prices. This model is used because the Heckscher-Ohlin and Specific Factors models become cumbersome to work with in a "large country" equilibrium. The model gives the comparative static price changes that can be tied to the Stopler-Samuelson results of the previous models. The arguments offered by the Cornell School center on macroeconomic forces in the context of the Gold Standard so the third section presents macroeconomic models that can be linked to the general equilibrium results developed in the first section.

Stopler-Samuelson and Rybczynksi Effects in Standard Trade Models

A central aspect of the farm problem of the 1920s is the nature of adjustment to internal and external shocks being experienced at that time. Traditional trade theory provides a means for linking output price and factor endowment shocks to changes in factor prices and outputs. Yet, despite very similar structures, the Heckscher-Ohlin and Specific Factors models give different stories linked to the ability of factors of production to flow among sectors. It is important to understand these differences.

Both models share many basic assumptions. In addition, some further simplifying common assumptions are made to keep the results tractable. One assumption is that there are two tradeable goods, a composite agricultural good denoted by subscript a, and a composite non-agricultural good denoted by subscript n. The world is divided into two nations. Variables for the United States have no superscript while those for the Rest-of-the-World have superscript *. Neither country completely specializes in the production of one good and factors of production are assumed to be fully employed. Producers are price taking agents using two factors of production to produce each good with constant returns to scale technologies. Technology is described by the per unit use of factor i in the production of good j, a_{ij} , which only depends on the factor prices. Free entry and exit by firms is assumed. Thus, perfect competition prevails. Factors of production are in fixed supply and are non-traded. Demands are assumed to be identical and homothetic.

Heckscher-Ohlin

The critical feature that distinguishes the Heckscher-Ohlin model is that all factors of production are perfectly mobile between the sectors. This means that factors move to equalize rates of return. Often the Heckscher-Ohlin model is viewed as representing a long-run equilibrium that allows factor use adjustment.

In the Heckscher-Ohlin world perfectly competitive farms produce agricultural goods, Q_a, using factors, L, and K, that are paid W and Z, respectively. Agricultural output is priced at P_a. With perfect competition, under the above assumptions, farms earn zero profits as described by the complementary condition:

(1) $a_{La}(W,Z)W + a_{Ka}(W,Z)Z = P_a$.

The non-agricultural industry operates in the same environment so satisfies the zero profit condition:

(2) $a_{Ln}(W,Z)W + a_{Kn}(W,Z)Z = P_n$.

Factor markets clear with full employment. Since both factors are perfectly mobile there are two factor market clearing complementary conditions that sum factor use in each sector:

(3) $a_{La}(W,Z)Q_a + a_{Ln}(W,Z)Q_n = L$;
(4) $a_{Ka}(W,Z)Q_a + a_{Kn}(W,Z)Q_n = K$.

The first left hand side terms in equations (3) and (4) give factor use in agriculture while the second terms give factor use in production of the composite non-agricultural good.

Equations (1)-(4) are the well-known description of a Heckscher-Ohlin economy and when logarithmic differentiation is applied describe how that economy responds (Jones, 1981). The critical drivers of the responses include unit cost shares for factors i in the output of goods j , θ_{ij}, the factor shares of factors i in industries j, λ_{ij}, and the elasticity of substitution, σ_j. Solving for the percent changes gives:

(5) $$dlnW = \frac{[\theta_{Kn}(dlnP_a) - \theta_{Ka}(dlnP_n)]}{\theta_{Kn} - \theta_{Ka}}$$

(6) $$dlnZ = \frac{[\theta_{La}(dlnP_n) - \theta_{Ln}(dlnP_a)]}{\theta_{La} - \theta_{Ln}}$$

$$(7)\ dlnQ_a = \frac{[\lambda_{Kn}(dlnL) - \lambda_{Ln}(dlnK)]}{\theta_{Kn} - \theta_{Ka}}$$

$$+ \frac{[\lambda_{Kn}(\lambda_{La}\theta_{Ka}\sigma_a + \lambda_{Ln}\theta_{Kn}\sigma_n) + \lambda_{Ln}(\lambda_{Ka}\theta_{La}\sigma_a + \lambda_{Kn}\theta_{Ln}\sigma_n)]}{\theta_{Kn} - \theta_{Ka}} (dlnW - dlnZ)$$

$$(8)\ dlnQ_n = \frac{[\lambda_{La}(dlnK) - \lambda_{Ka}(dlnL)]}{\theta_{Kn} - \theta_{Ka}}$$

$$- \frac{[\lambda_{La}(\lambda_{Ka}\theta_{La}\sigma_a + \lambda_{Kn}\theta_{Ln}\sigma_n) + \lambda_{Ka}(\lambda_{La}\theta_{Ka}\sigma_a + \lambda_{Ln}\theta_{Kn}\sigma_n)]}{\theta_{Kn} - \theta_{Ka}} (dlnW - dlnZ)$$

The signs of the impacts from exogenous shocks due to changes in endowments or output prices depend on the relative factor intensities of the industries. Assume that agriculture is relatively intensive in factor K due to its use of land, buildings, and machinery. That means $\theta_{Kn} - \theta_{Ka} = \theta_{La} - \theta_{Ln} < 0$.

Once the factor intensity is established interpretation of the Stopler-Samuelson results and Rybczynski results is straightforward. If the price of the agricultural good rises, the price of the factor used intensively in agricultural production, factor K in this case, rises as shown by expression (6). Further, since the unit cost shares are less than one, the rise in the return to factor K (dlnZ) exceeds the price change ($dlnP_a$). That is the agricultural price change is magnified. The return to the factor used intensively in the non-agricultural sector, dlnW, falls – expression (5). The same pattern holds for a change in the non-agricultural price. If $dlnP_n > 0$ and $dlnP_a = 0$, then the return to the factor used intensively by the non-agricultural sector, dlnW, rises in a magnified fashion and the return to the factor used intensively by agriculture falls.

The structure of the Heckscher-Ohlin model gives a result where changes in factor prices, the Stopler-Samuelson results, are uniquely determined by changes in output prices. This is how factor price equalization emerges in the model when international trade equalizes the prices of traded commodities. The model is separable in the sense that output prices uniquely determine factor prices. Changes in outputs, the Rybczynski results given by expressions (7) and (8), depend on changes in endowments and factor prices (output) prices. With output prices constant, an increase in the endowment of the factor used intensively in the non-agricultural industry, L, increases the output of the composite non-agricultural good in a magnified fashion since the factor shares are less than one, and lowers the output of the composite agricultural good. With output prices constant, an increase in the endowment of the factor used intensively by the agricultural good causes a magnified increase in agricultural output and a decrease in the output of the non-agricultural good.

A critical result is that changes in endowments do not affect factor prices except if the resulting output changes world prices. That is, for factor prices to change following a change in resource endowments, the country must be large enough to affect world prices.

Technical change can be introduced (Jones, 1981). Product augmenting technical change where more output is obtained for the same level of inputs is introduced as an effective price increase for the good experiencing technical change. The Stolper-Samuelson results above indicate that the return to the factor used intensively in the sector undergoing the technical change rises while the return to the factor used intensively in the other sector falls. Thus, if agriculture has a rate of product augmenting technical change greater than the non-agricultural sector, the return to the factor used intensively in agriculture will rise. Conversely, if the non-agricultural sector has a more rapid rate of technical change, the return to the factor used intensively in agriculture falls. Factor augmenting technical change is equivalent to an increase in an endowment so the critical issue for changes in factor prices is the impact on output prices.

Specific Factor (Ricardo-Viner) Model

An alternative model is the Specific Factors model which assumes that each sector uses a factor that cannot be shifted to the other sector. Often this model is viewed as a short-run description of an economy in contrast to the long-run view of the Heckscher-Ohlin model.

Both models appear similar with subtle differences in assumptions about factors. Assume each industry uses two factors of production. One factor, denoted L, is mobile between the sectors and is paid W. The other factor, K_j j = a,n, is specific to each sector and cannot move. It receives a payment Z_j. Thus, the key feature of this model is the competition of the two sectors for the mobile factor.

The zero profit conditions now appear as:

(9) $a_{La}(W, Z_a)W + a_{Ka}(W, Z_a)Z_a = P_a$
(10) $a_{Ln}(W, Z_n)W + a_{Kn}(W, Z_n)Z_n = P_n$.

Because of the immobility of the specific factor there are two specific factor prices and one, common, price for the mobile factor, but only two zero profit conditions. Thus, there is no unique solution for factor prices from only the output prices. Unlike the Heckscher-Ohlin model, the levels of the endowments affect factor prices.

The factor market clearing conditions are structured to reflect the immobility of the specific factors. For the mobile factor market clearing is given by:

(11) $a_{La}(W, Z_a)Q_a + a_{Ln}(W, Z_n)Q_n = L$.

For the specific factors the market clearing conditions are:

(12) $a_{Ka}(W, Z_a)Q_a = K_a$
(13) $a_{Kn}(W, Z_n)Q_n = K_n$.

As before the impacts of changes in output prices and factor endowments are found by differentiating the model:

$$(14)\ dlnW = \Delta^{-1}[\theta_{Ka}\theta_{Kn}(dlnL - \lambda_{La}(dlnK_a) - \lambda_{Ln}(dlnK_n)) - \theta_{Ka}\lambda_{Ln}\sigma_n(dlnP_n) - \theta_{Kn}\lambda_{La}\sigma_a(dlnP_a)]$$

$$(15)\ dlnZ_a = \Delta^{-1}[\theta_{La}\lambda_{Ln}\sigma_n(dlnP_n) - (\theta_{Kn}\lambda_{La}\sigma_a+\lambda_{Ln}\sigma_n)dlnP_a - \theta_{La}\theta_{Kn}(dlnL - \lambda_{La}(dlnK_a) - \lambda_{Ln}(dlnK_n))]$$

$$(16)\ dlnZ_n = \Delta^{-1}[\theta_{Ln}\lambda_{La}\sigma_a(dlnP_a) - (\theta_{Ka}\lambda_{Ln}\sigma_n+\lambda_{La}\sigma_a)dlnP_n - \theta_{Ka}\theta_{Ln}(dlnL - \lambda_{La}(dlnK_a) - \lambda_{Ln}(dlnK_n))]$$

$$(17)\ dlnQ_a = dlnK_a - \Delta^{-1}\theta_{La}\sigma_a[\lambda_{Ln}\sigma_n(dlnP_a-dlnP_n)+\theta_{Kn}(dlnL-\lambda_{La}(dlnK_a)-\lambda_{Ln}(dlnK_n))]$$

$$(18)\ dlnQ_n = dlnK_n - \Delta^{-1}\theta_{Ln}\sigma_n[\theta_{Ka}(dlnL-\lambda_{La}(dlnK_a)-\lambda_{Ln}(dlnK_n))-\lambda_{La}\sigma_a(dlnP_a-dlnP_n)]$$

where $\Delta = -(\theta_{Ka}\lambda_{Ln}\sigma_n + \theta_{Kn}\lambda_{La}\sigma_a) < 0$.

A number of results are indicated in expressions (14) – (18) so it is best to separate them into price impacts and then endowment changes. To examine the impacts of price changes assume that endowments do not change. Expression (14) shows that if either output price rises, the return to the mobile factor rises, but not by as much. That is, the mobile factor's price change is dampened. This should not be surprising given the structure of the model. Both sectors compete for the mobile factor. If, for example, the price of the non-agricultural good rises relative to the price of the agricultural good, the non-agricultural sector wants to expand output (see expression (18)). To do so it demands the mobile output according to the elasticity of substitution, σ_n. With a given stock of the mobile factor in the economy, the mobile factor must flow out of the agricultural sector. The willingness of the agricultural sector to release the mobile factor is controlled by its elasticity of substitution, σ_a. If the elasticity of substitution in the agricultural sector is 0, agriculture will not release any of the mobile factor and the mobile factor price rise will match the increase in the relative price of the non-agricultural good. If the elasticity of substitution is infinite, the agricultural sector surrenders all the mobile factor required by the non-agricultural sector and the mobile factor's price does not change. Thus, the change in the mobile factor's price for a relative price increase is bounded between 0 and 1. The flow of the mobile factor out of agriculture accounts for the negative impact of an increase in the non-agricultural good's price on agricultural output, expression (17).

Expressions (15) and (16) indicate how the returns to the sector specific factor change. Keeping with the example of a rise in the price of the non-agricultural good, expression (16) shows that the return to the factor specific to the non-agriculture sector rises. Further, the price increase for the specific factor in the non-agricultural industry is magnified since $\theta_{Kn} < 1$. The return to the factor specific to agriculture falls when the non-agricultural price rises. This is logical since the agricultural good's price is unchanged but the mobile factor's price is higher. Thus, the price of the factor specific to agriculture must fall to maintain zero profits.

Summarizing the price story in the model. Given that the non-agricultural price rises relative to the agricultural price, the model predicts the following. One, the non-agricultural sector expands output. Two, this desire to expand bids the mobile factor's price higher to induce it to flow to

the non-agricultural sector. Three, the outflow of the mobile factor induces a decline in agricultural output and the mix of the economy shifts more towards the non-agricultural good. Four, the mobile factor's price increase is less than the relative output price rise so the return to the factor specific to the non-agricultural sector rises by more. Five, because the mobile factor's price is higher and the agricultural good's price is the same, the return to the factor specific to the agricultural sector falls. Six, this process is controlled by the demand for the mobile factor by the non-agricultural sector relative to the agricultural sector's willingness to release the mobile factor.

There are three endowment changes to consider in the model. The impact of a change in the endowment of the mobile factor is easiest to understand because it, in a sense, "eases" the competition of the mobile output. A larger endowment of the mobile factor lowers its price, expression (14). Both sectors can expand output, expressions (17) and (18), with the relative rate of expansion governed by the unit cost shares for the mobile factor and the elasticities of substitution. The sector with the largest unit cost share for the mobile factor and/or the greatest ability to substitute the mobile factor for the specific factor expands the fastest. As the mobile factor price falls, the returns to each specific factor rise.

Increases in endowments for sector specific factors are more difficult to identify because there are two conflicting effects. As an example, assume that the endowment of land, a factor specific to agriculture, expands. The added land endowment has a direct positive effect of agricultural output as shown by the first right hand side term in expression (17). But the change in the land endowment appears a second time in expression (17). This is the indirect effect the land expansion has on factor prices and serves to dampen the increase in agricultural output. The increase in land pushes the mobile factor price higher, expression (14) and with the agricultural price unchanged lowers the return to the specific factor in agriculture, land. Thus, agriculture wants to substitute land for the mobile input so the marginal product of land falls. The decline in the marginal product per unit of land dampens the impact of the initial land expansion so the net rise in agricultural output is less than the increase in the land endowment. The non-agricultural sector fares less well because it does not benefit in any way from the additional endowment of the factor specific to agriculture. The only impact is the negative effect via the changes in factor prices, so an expansion in an agricultural specific factor like land lowers the output of the non-agricultural good.

Price Impacts in a Global Model

The previous models are inadequate to assess the arguments of the two schools because they assume that price changes are exogenous. As shown in the Heckscher-Ohlin model price changes are a critical channel for impacts from changes in endowments and technology. One method is to continue with the models already discussed by adding a second country along with demand and national income components. Doing so would complicate the models and become intractable. Instead a the next model is constructed using duality theory and provides a simple algebraic means to determine changes in the world price. This style of model is developed in Dixit and Norman (1980). The major complication introduced is in the interpretation of the results through normalization.

The model assumes two countries, the United States and the Rest-of-the-World, where the latter region is denoted by superscript *. Each country has an expenditure function which is the minimum expenditure necessary to achieve a specified level of utility given by a well-defined national utility function. Let U be the level of national utility and P be the normalized price. The expenditure function for the United States is E(1, **P**, U) and that for the Rest-of-the-World is $E^*(1, \mathbf{P}^*, U^*)$ where letters in bold indicate vectors or matrices and letters not in bold indicate scalar values. The value of national production is given by a revenue function which maximizes the value of national output subject to resource constraints indicated by **V** and $\mathbf{V}^*$. Thus, the revenue function for the United States is R(1, **P**, **V**) and that for the Rest-of-the-World is $R^*(1, \mathbf{P}^*, \mathbf{V}^*)$. Expenditure and revenue functions have known properties (Dixit and Norman, 1980). The first derivatives of the expenditure function with respect to price, $\mathbf{E_p}$, give the Hicksian demand functions and the second derivatives, $\mathbf{E_{pp}}$, the response of consumption to price or the pure substitution effects. The first derivatives of the revenue function with respect to price, $\mathbf{R_p}$, give the output supply. The first derivatives of the revenue function with respect to endowments, $\mathbf{R_V}$, give the factor prices. The second derivatives of the revenue function with respect to price, $\mathbf{R_{pp}}$, are the supply responses to price while the second derivatives, $\mathbf{R_{pv}}$, measure the response of outputs to endowment changes.

Equilibrium is determined by four equations. Two equations describe the national income – expenditure identities that require national expenditure to equal national income inclusive of tariff revenue $(\mathbf{E_p} - \mathbf{R_p})\mathbf{T}$. For the United States and Rest-of-the-World these are:

(19) $E(1, \mathbf{P}, U) = R(1, \mathbf{P}, \mathbf{V}) + (\mathbf{E_p} - \mathbf{R_p})\mathbf{T}$

(20) $E^*(1, \mathbf{P}^*, U^*) = R^*(1, \mathbf{P}^*, \mathbf{V}^*)$.

The third equation requires global demand to equal global supply as given be the first derivatives of the expenditure and revenue functions:

(21) $\mathbf{E_p} + \mathbf{E_p}^* = \mathbf{R_p} + \mathbf{R_p}^*$.

The final equation links price in the two regions. This model assumes a tariff policy since during the early decades of the 20th century tariffs were the main instrument of agricultural protection and price support. Thus, the international price linkage is:

(22) $\mathbf{P} = \mathbf{P}^* + \mathbf{T}$.

Totally differentiating expressions (19)-(22), assuming the initial tariff is zero, and using expression (22) to replace $d\mathbf{P}^*$ gives a three equation system of differential equations from which all of the comparative static results are obtained:

(23) $\mathbf{M}d\mathbf{P} + E_u dU = \mathbf{R_v}d\mathbf{V} + (\mathbf{E_p} - \mathbf{R_p})d\mathbf{T}$

(24) $\mathbf{M}^* d\mathbf{P} + E_u^* dU^* = \mathbf{R_v}^* d\mathbf{V}^*$

(25) $\mathbf{S}d\mathbf{P} + \mathbf{C_y}E_u dU + \mathbf{C_y}^* E_u^* dU^* = \mathbf{R_{pv}}d\mathbf{V} + \mathbf{R_{pv}}^* d\mathbf{V}^*$

where $\mathbf{S} = \mathbf{E_{pp}} - \mathbf{R_{pp}} + \mathbf{E_{pp}}^* - \mathbf{R_{pp}}^*$, $\mathbf{M} = \mathbf{E_p} - \mathbf{R_p}$, $\mathbf{M}^* = \mathbf{E_p}^* - \mathbf{R_p}^*$, $\mathbf{E_{pu}} = \mathbf{C_y}E_u$, and $\mathbf{E_{pu}}^* = \mathbf{C_y}^*E_u^*$. Thus, the matrix **S** gives the substitution effects in both demand and supply. The vectors **M** and $\mathbf{M}^*$ are the vectors of imports while $\mathbf{C_y}$ and $\mathbf{C_y}^*$ are the responsiveness of consumption to changes in income.

Solving for the price changes in response to endowment changes gives:

(26) $d\mathbf{P} = \mathbf{D}^{-1}\{[\mathbf{R_{pv}} - \mathbf{R_V}\mathbf{C_y}]d\mathbf{V} + [\mathbf{R_{pv}}^* - \mathbf{R_v}^*\mathbf{C_y}^*]d\mathbf{V}^* + [(\mathbf{E_{pp}}^*-\mathbf{R_{pp}}^*)+\mathbf{M}(\mathbf{C_y}^*-\mathbf{C_y})]d\mathbf{T}\}$

where $\mathbf{D} = \mathbf{S} + \mathbf{M}(\mathbf{C_y}^* - \mathbf{C_y})$.

To facilitate interpretation of expression (26) it is assumed that there are only two goods, an agricultural good and a non-agricultural good. This means that the matrix of substitution effects collapses to a negative scalar, $S < 0$. Normalization of the system is the key to interpreting the results, but can be tricky because both prices and quantities are normalized. When the numeraire good is the U.S. export good – the agricultural good -- the relative price, P, is the price of non-agricultural goods relative to agricultural goods, and the vector of trade collapses to a scalar with a positive value, $M > 0$. The endowments, **V** and $\mathbf{V}^*$, are also defined normalized on agriculture. This type of normalization is useful when considering changes in mobile factors or factors specific to the non-agricultural good. When a change in the agricultural specific factor is analyzed, it is more convenient to normalize on the non-agricultural good. Thus, P is then the price of the agricultural good relative to the non-agricultural good and $M < 0$.

Given the above assumptions, expression (26) can be interpreted. First consider the term D that consists of the substitution effects and the difference in the income effects in the two regions. The substitution effects are negative. In general the marginal propensity to consume an import good will exceed that for an export good. This means that when $M > 0$, the agricultural good is the numeraire, then $\mathbf{C_y} > \mathbf{C_y}^*$ so the effect is negative and $D < 0$. When the non-agricultural good is the numeraire, then $M < 0$, but $\mathbf{C_y}^* > \mathbf{C_y}$ so the net is again negative. Thus, $D < 0$, which also means that the Marshall-Learner condition is satisfied and the system is stable.

Consider first the idea of changes in **V**, $d\mathbf{V} > 0$, when the system is normalized on the agricultural good. The relative price change, dP, depends on two effects. One effect, $D^{-1}\mathbf{R_v}$, represents the expansion of income from having larger endowments and contributes to a price increase. The second effect, $D^{-1}\,\mathbf{R}_{pv}$, gives the impact of the larger endowments on output of the non-agricultural good (again normalized on the agricultural good). The intuition is that this term is positive – more endowments, more output – but as shown with the Stopler-Samuelson and Rbyczynski results earlier, expressions (5) – (8) and (14) – (18), that is not always correct. If that is correct, then the impact is to lower the relative price.

Application of the symmetry property, Young's theorem, shows that $\mathbf{R_{pv}} = \mathbf{R_{vp}}$ where $\mathbf{R_{vp}}$ leads to the Stopler-Samuelson results. In a Specific Factors model the normalized Stolper-Samuelson results are always positive so there is always a conflict between the price increasing effect from an increase in income due to an endowment increase and a price reducing effect from more output of the non-numeraire good. For an increase in the mobile factor the term in brackets in

expression (26) can be reduced to the difference between the Stolper-Samuelson results and the marginal propensity to consume the non-numerarie good:

(27) $[\partial \ln W/\partial \ln P] - P[\partial C/\partial Y]$.

For the specific factor, the expression is:

(28) $[\partial \ln Z_n/\partial \ln P] - P[\partial C/\partial Y]$.

The change in the specific factor price, Z_n, exceeds the change in the price while the change in the mobile factor's price is dampened. Thus, increases in the endowment of the specific factor have stronger price depressing effects. While it is likely that increases in the endowment of either factor will lower the relative price of the non-agricultural good, an increase in the endowment of the specific factor is very likely to create a situation where the income expansion is insufficient to counter the effect of expanded output.

In contrast, the Heckscher-Ohlin model shows the Stolper-Samuelson results to be opposite in sign. If the endowment increase occurs for the factor used intensively in the non-agricultural sector, the Stolper-Samuelson result is positive and the above conclusions hold. If, however, the endowment increase occurs for the factor used intensively in the agricultural sector, the Stolper-Samuelson result is negative and the relative price of the non-agricultural good will rise because the larger output expansion occurs for the agricultural good.

The same stories hold if the system is normalized on the non-agricultural good and increases in endowments are considered. Increases in endowments specific to agriculture or which are used intensively in agriculture will generally cause the relative price of agricultural goods to fall because they will expand agricultural output more than can be absorbed by the associated income expansion.

Changes in technology can be treated like increases in endowments. Thus, should produce relative prices shifts consistent with those discussed above.Even an improved terms-of-trade does not imply that agriculture's share of the economy does not decline and that resources do not leave agriculture. That is, the terms-of-trade argument is not necessary for the relative importance of agriculture to contract. Subtracting expression (8) from expression (7) and expression (18) from expression (17) shows that while the result is technically ambiguous, the direct output effect tends to dominate. This suggests a potential that more rapid growth in non-agricultural endowments boosts non-agricultural output more, lowers the share of agriculture in U.S. output and pulls resources out of agriculture as factors move to greater returns outside of agriculture.

Macroeconomic Forces

Warren and Pearson at Cornell University argued that the problems facing agriculture were macroeconomic in origin. This section presents macroeconomic models where shocks alter macroeconomic variables important to agriculture.

Modeling of the macroeconomic effects is complicated by the conflict between the Keynesian and neo-classical schools. The simple Keynesian story treats price level as fixed and determines real income and the interest rate. The neo-classical model treats output as pre-determined as solves for the price level and the interest rate.

To give a complete picture of the macroeconomic forces at work, the stories of both must be considered. Fortunately, there is considerable overlap in the two models. This presentation assumes there are two countries, the United States and the Rest-of-the-World. Under the Gold Standard the exchange rate, e, is fixed so external imbalances are adjusted via changes in reserves, ΔR. The national income identity requires real output, Y, to equal private consumption, C, desired investment, I, government spending, G, and net exports, X-M.

Real consumption is a function of output, the interest rate, r, expected inflation, π, and real wealth of households, W/P. Real wealth is initial nominal wealth defined by initial stocks of money and financial assets divided by the aggregate price level. Thus, real household consumption is:

(29) $C = C(Y, r, \pi, W/P)$.

Macroeconomic theory indicates the sign of the variables (Heller, 1974; Patinkin, 1965). Real consumption rises as real output increases, $\partial C/\partial Y \geq 0$. Real consumption decreases in response to increases in the interest rate, $\partial C/\partial r \leq 0$. Increased inflationary expectations raise current consumption, $\partial C/\partial \pi \geq 0$, as does increased real wealth, $\partial C/\partial (W/P) \geq 0$.

Real desired investment depends on the same set of variables, except for wealth:

(30) $I = I(Y, r, \pi)$

where $\partial I/\partial Y \geq 0$, $\partial I/\partial r \leq 0$, and $\partial I/\partial \pi \geq 0$. Thus, increases in real output and inflationary expectations raise investment while increases in the interest rate lower investment.

Imports are tied to the variables that determine consumption by households and carry the same signs:

(31) $M = M(Y, r, \pi, W/P)$.

The demand for money (M_d/P) depends on real output, the interest rate, inflationary expectations, and real wealth:

(32) $(M_d/P) = L(Y, r, \pi, W/P)$

where $\partial L/\partial Y \geq 0$, $\partial L/\partial r \leq 0$, $\partial L/\partial \pi \geq 0$, $\partial L/\partial (W/P) \geq 0$. To simplify the model residents of a country only hold their own currency so there is no currency substitution.

For each country there are three markets to clear, goods and services, money, and financial assets. By Walras' Law only two of the markets need be in equilibrium so the financial assets

market in each country is omitted. Market clearing for the domestic goods and services market is:

(33) $X - M = Y - C - I - G$.

Market clearing for the domestic money market is:

(34) $(M_s/P) + \Delta R = L(Y, r, \pi, W/P)$

where M_s is the money supply under control of the domestic central bank. The change in reserves in this model equals the trade balance:

(35) $\Delta R = X - M$.

A trade surplus, $X > M$, generates an inflow which raises the reserves and hence the total money supply. With no currency substitution there are two money market clearing equations. The global goods and services market must clear as well. Globally trade clears so any imbalance for the United States is offset by an imbalance for the Rest-of-the-World, adjusted for the exchange rate:

(36) $X - M = e(M^* - X^*)$ so

(37) $\Delta R = - e(\Delta R^*)$.

The differences in the Keynesian and neo-classical models consist of the variables treated as exogenous and the parameters treated as zero. The neo-classical model assumes that Y and Y^* are pre-determined and prices are perfectly flexible. Thus, purchasing power parity is imposed:

(38) $P = eP^*$.

Thus, solving gives the comparative static results:

(39) $\partial P/\partial M_s > 0$; $\partial P^*/\partial M_s > 0$;

(40) $\partial r/\partial M_s < 0$; $\partial r^*/\partial M_s < 0$;

(41) $\partial P/\partial G > 0$; $\partial P^*/\partial G > 0$;

(42) $\partial r/\partial G > 0$; $\partial r^*/\partial G > 0$.

The comparative static results should not be a surprise. An expansionary monetary policy pushes the home country aggregate price level higher and has spillover effects that raise the price level in the Rest-of-the-World, expression (39). An expansionary monetary policy causes inflation at home and abroad. Associated with the expansionary monetary policy is a fall in the interest rates in the two regions, expression (40). Expansionary fiscal policy via an increase in government spending boosts the aggregate price levels, expression (41) as well as raising interest

rates, expression (42). Chambers (1984) analyzed a monetary contraction so the signs reverse as $dM_s < 0$, but comparing the results shows that the results for the home country match in sign. The difference between these results and those of Chambers (1984) is that Chambers allows the exchange rate to change.

Because the neo-classical model treats output as pre-determined it is important to examine a model where output changes. That can be achieved using a simple Keynesian model. That model assumes that resources are not fully employed so output can be adjusted at no cost. The implication is that the aggregate price levels are fixed. This means that there are no wealth effects nor are there inflationary expectations. The Keynesian model solves for changes in outputs (real income) and the interest rates. Solving gives:

(43) $\partial Y/\partial M_s > 0$; $\partial Y^*/\partial M_s > 0$;

(44) $\partial r/\partial M_s < 0$ (usually); $\partial r^*/\partial M_s$ ambiguous;

(45) $\partial Y/\partial G > 0$; $\partial Y^*/\partial G > 0$;

(46) $\partial r/\partial G > 0$; $\partial r^*/\partial G > 0$.

Expansion in the money supply with a fixed exchange rate causes both economies to expand, expression (43). The spillover to the Rest-of-the-World is the "locomotive effect." A monetary expansion has an ambiguous impact on the interest rates. In the United States a monetary expansion has three effects, expression (44). One effect is the direct impact of increasing the money supply which lowers the interest rate. A secondary effect occurs via the expansion in aggregate demand in the United States and this adds upward pressure on the interest rate. The third effect is the expansion in the economy of the Rest-of-the-World which adds to U.S. currency reserves as purchases from the United States expands. Usually the two negative effects dominate and the interest rate in the United States falls. In the Rest-of-the-World the expansion of the U.S. economy raises reserves so acts like a monetary expansion in the Rest-of-the-World which acts to lower the interest rate. At the same time the Rest-of-the-World economy expands and that puts upward pressure on the interest rate. Increases in government spending raise aggregate demand in both regions. This increases real income (output), expression (45), and interest rates, expression (46).