Agricultural Crises and the International Transmission of the Great Depression

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This article examines the role of the agricultural crisis in the international transmission of the Great Depression and assesses the direct and indirect macroeconomic effects of the agricultural price decline. Using panel data for 16 countries, it is shown that the decline in agricultural prices adversely affected the general price level, consumption and investment. Furthermore, it is shown that the agricultural price decline was an important vehicle by which the Depression was transmitted internationally.

Recently there has been an increasing consensus among economic historians and macroeconomists, that monetary shocks played an important role in the Depression and that the Depression was transmitted internationally by the gold standard. The sterilization of the large capital inflows to the United States and France forced other countries to pursue deflationary policies in order to adhere to the gold standard.[1] However, by itself the monetarist view fails to fully explain the transmission of the depression and the collapse in nominal income. Currency in circulation increased by 2.1 percent and currency plus deposits decreased by 1.9 percent on average in the high-income countries of the world from 1929 to 1932.[2] These figures indicate that monetary policies alone cannot explain the entire world-wide 25 percent contraction in nominal income.[3] Furthermore, monetary shocks could not alone have been responsible for the international transmission of the Depression from the United States as advocated by Milton Friedman and Anna Schwartz because gold reserves in the rest of the world increased during the first two years of the Depression.[4]

This article argues that the agricultural price decline had significant macroeconomic effects and played a major role in the international transmission of the Depression. The macroeconomic effects were significant because the agri-

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[1] Bernanke, "Macroeconomics"; Eichengreen, *Golden Fetters* and "Origins"; Eichengreen and Sachs, "Exchange Rates"; Friedman and Schwartz, *Monetary History*; Haberler, *World Economy;* Hamilton, "Monetary Factors" and "Role"; and Temin, *Lessons*.

[2] The following 20 countries are included in the estimates: Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and the United States. The average is an unweighted average.

[3] The average is an unweighted average. The data sources for nominal income are not listed in the data appendix, but are available from the author.

[4] Friedman and Schwartz, *Monetary History*; and Fremling, "Did the United States."

cultural decline had spill-over effects to other sectors of the economy and because the agricultural sector played an important role in the total economy at that time. In Western Europe, Japan, and North America 31.2 percent more workers were employed in agriculture than manufacturing in 1930 and 34.2 percent of the total labor force was employed in agriculture.[5] Excluding the United States, the United Kingdom, and Germany from the sample, the corresponding figures were 53.6 percent and 46.1 percent respectively, which suggests that agriculture played a pivotal role in the economies outside these three countries. Cross-country and time-series evidence suggest the collapse in agricultural prices over the period from 1928 to 1932 had important depressing effects on the world-wide decline in aggregated prices and real income.

The declining real prices of agricultural products also resulted in a large redistribution of income within countries away from the agricultural sector, at a time when the agricultural sector was already in serious financial trouble.[6] This redistribution of income had adverse effects on consumption and investment. First, the marginal propensity to spend of those who lost income exceeded the marginal propensity to spend of those who experienced income gains. Second, the redistribution of income resulted in declining real prices of farmland which increased the cost of borrowing for farmers, and thus adversely affected investment and had negative wealth effects on consumption. Third, the declining ability of farmers to honor their debt obligations adversely affected the functioning of the banking sector as a provider of credit and hence had ripple effects throughout the whole economy. For the United States, for instance, William Arthur Lewis argues that the declining agricultural prices, the fall in real estate values, and the bankruptcy of farmers were the most important factors behind the bank failures.[7] Similarly Peter Temin finds that the bank failures in 1930 and 1931 were significantly related to the changes in agricultural conditions.[8]

The agricultural price decline was also an important mechanism whereby the Depression was transmitted internationally. Agricultural prices were determined by world prices of agricultural products in common currency, tariffs, and exchange rates. Hence, the countries that were the first to abandon the gold standard were also the first to recover from the depression, partly because it lead to a recovery in the prices of their agricultural products.

The agricultural crisis has been previously mentioned as a factor that contributed to the contraction by the League of Nations, Vladimir Timoshenko and to some extent also Charles Kindleberger.[9] However, the macroeconomic effects of the agricultural price decline have never been examined extensively and have not been analyzed as a factor that transmit-

[5] The following countries are included in the sample: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[6] League of Nations, *Agricultural Crisis*, pp. 7–8.

[7] Lewis, *Economic Survey*, p. 54.

[8] Temin, *Did Monetary Forces*, p. 90.

[9] League of Nations, *Agricultural Crisis;* Timoshenko, *World Agriculture*; and Kindleberger, *World.*

ted the Depression internationally. Timoshenko suggests that the decline in prices of agricultural products contributed to the Depression; however, via completely different channels than the ones that are identified in this article.[10] Timoshenko argues that the falling commodity prices turned both the terms of trade and the balance of trade against the developing countries at a time when the international capital markets were already strained by developments in the leading industrialized countries, which in turn created an international credit crisis. This crisis worsened after the crop failures in the developing countries in 1929 and 1930 and hence furthered the Depression. When these developing agricultural nations went into a slump, the industrial nations lost major markets for their output. Kindleberger argues along the same lines but notes that it is unclear whether "an independent depression in agriculture helped to cause the stock market crash, the decline in industrial output, and the banking collapse".[11] The agricultural hypothesis has been largely either ignored or swept away in the literature, probably because the arguments focused on the direct trade expenditure effects. Michael Bernstein, for instance, argues that the primary exporting countries were too unimportant for the US market, and presumably also for the European markets, to have had any significant influence on their production.[12] Similarly Lewis states that the continued decline in commodity prices aggravated the Depression, but did not initiate it.[13]

A CASUAL LOOK AT THE DATA

Central to the hypothesis of this article is that the price decline of agricultural products had particularly important implications for the countries that were heavily dependent on agriculture but that the deflationary implications of the price decline were influential for all countries. Consequently the United States, the United Kingdom, and Germany are separated out in the output estimates presented in the next section, because the agricultural sector, in terms of value-added and employment, did not play as major a role in these countries.

Figure 1 presents the unweighted average of commodity prices, deflated by consumer prices, and industrial production of four countries.[14] The figure

[10] Timoshenko, *World Agriculture*.
[11] Kindleberger, *World,* p. 70.
[12] Bernstein, *Great Depression*, p.11.
[13] Lewis, *Economic Survey*, pp. 46 and 56.
[14] The four countries were chosen because their industrial production and real commodity prices are available over the whole period from 1922.1Q to 1936.4Q. The variables are only proxies because data on real agricultural prices and real GDP are not readily available on a quarterly basis. Warren and Pearson (*World Prices*) calculate the commodity price indices on the basis of 40 commodities. They do not present monthly or quarterly agricultural price data, except for the United States. However, the commodity price index is representative for agricultural prices since nonagricultural commodities followed prices of agricultural products very closely. The correlation coefficient between world food prices and non-food commodities was 0.97 in levels and 0.98 in logs using annual data, over the period

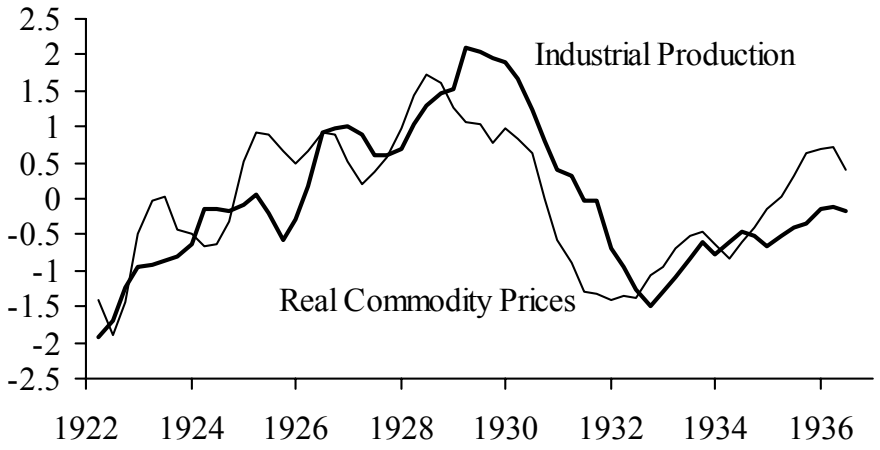

FIGURE 1
INDUSTRIAL PRODUCTION AND REAL COMMODITY PRICES

Notes: Arithmetic averages are shown for the following countries: Belgium, Canada, France, and Japan. The individual series are standardized to have a mean of zero and a variance of one, and the trend is removed from the series. Real commodity prices are calculated as commodity prices divided by consumer prices.

shows that real commodity prices and industrial production were closely correlated for the average country during the Depression and that changes in real commodity prices preceded changes in industrial production.

Figure 1 masks the different developments across countries in the period from 1929 to 1932. By contrast, Figure 2 depicts the 1929–1932 economy-wide change in real GDP and the change in real agricultural prices (the value-added price deflator in agriculture divided by the economy wide value-added price deflator) for 16 countries.[15] The figure shows that the countries that experienced the sharpest decrease in real agricultural prices also encountered the strongest decrease in output.[16] Overall the evidence in

from 1910 to 1936 (Warren and Pearson, *World Prices*, p. 53, table 2). This suggests an almost perfect correlation. The data are exclusive of tariffs.

[15] The United States, the United Kingdom, and Germany are included in the figure for comparative purposes and to show that the relationship between real agricultural prices and output is insensitive to inclusion of these countries.

[16] Least squares regression resulted in the following estimates:

$$\hat{z}_{1929-32} = \underset{(0.09)}{-0.22} + \underset{(6.02)}{0.44}\,\pi^{agr}_{1929-32} + \underset{(3.14)}{20.9}\,D_{Den} \qquad R^2 = 0.74 \qquad N = 16$$

where the numbers in parentheses are absolute *t*-statistics. Here $z_{1929-32}$ is the percentage change in real GDP over the period from 1929 to 1932, $\pi^{agr}_{1929-32}$ is the percentage change in real agricultural prices over the same period, and D_{Den} is a dummy variable for Denmark. The significance of the coefficient of D_{Den} suggests that Denmark is an outlier and therefore does not belong to the population. The null hypothesis that the United States, Canada, and New Zealand are outliers could not be rejected at any conventional significance level (the *t*-statistic is ! 1.44 for the United States, ! 0.84 for Canada, and ! 1.08 for New Zealand). The results are almost identical if relative prices are lagged one year. Furthermore, the estimated coefficient of $\pi^{agr}_{1929-32}$ is 0.49 and its attached *t*-statistic is 4.78, if the United

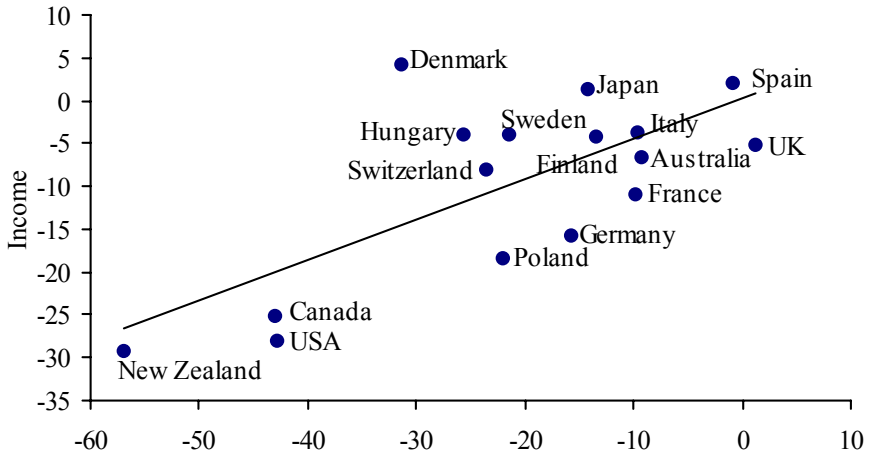

FIGURE 2
PERCENTAGE CHANGE IN REAL GDP FOR THE WHOLE ECONOMY AND REAL AGRICULTURAL PRICES, 1929–1932

Note: Real agricultural prices are computed as the value-added price deflator in agriculture divided by the value-added price deflator for the whole economy.

Figure 2 reinforces the time-series evidence in Figure 1 showing that the decline in real agricultural prices had potentially large output effects.

Why did relative prices of agricultural products have such an important impact on real incomes? Since a large part of the total workforce relied on income from the agricultural sector in most nations, the decrease in the relative prices of agricultural products reduced the real purchasing power of a large proportion of the population without having symmetric effects for those who gained from the decline. Even for economies that were less dependent on agriculture such as the United States, the United Kingdom, and Germany, the agricultural price decline also had important income effects via channels that are examined later. Furthermore, the tariffs on imports were increased to such an extent that they absorbed a large proportion of the terms-of-trade gain of the United States, the United Kingdom, and Germany over the period from 1929 to 1932. After accommodating the effects of the tariffs, the average terms-of-trade gains of these countries were reduced from 23.3 percent to 10.3 percent.[17] Hence, the terms-of-trade gains only injected an extra 1.5 percent purchasing power into these economies over this period, given that the average openness was approximately 15 percent for these countries.

States, the United Kingdom, and Germany are excluded from the estimates, which suggests that the results are not affected by the observations for these countries.

[17] Note that tariffs are not included in export and import unit values. Tariff rates are computed as total tariff income to governments divided by import value.

FIGURE 3
REAL NET FARM INCOME

Note: Net farm income is shown for Canada, Denmark, the Netherlands, and New Zealand, deflated by consumer prices.

Figure 3 shows the net farm income (gross income from sales minus expenses to wages, raw materials, interests, depreciations, taxes, and rent) deflated by consumer prices as an unweighted average for four countries for which the data are available over the period from 1922 to 1936 (excluding the United States, the United Kingdom, and Germany): Canada, Denmark, the Netherlands, and New Zealand. The figure shows that real net farm income fell drastically from 1928 to 1931. The decline was detrimental for agriculture because its net real income had already fallen about 50 percent from its World War I level, on average over the 1920s. Although the World War I period was unusually prosperous for agriculture, many farms changed owners immediately after the war and the mortgages for many farms consequently reflected World War I earnings.[18] Furthermore, downwardly sticky wages of agricultural workers implied that their earnings during the 1920s partly reflected agricultural prices in the World War I period.[19] Both of these factors resulted in a substantial increase in real farm costs as compared to the *pre*-World War I period and the rapid decrease in real agricultural prices from 1928 was consequently devastating for the agricultural sector.

Declining farm income had the further effect of decreasing the real value of farmland as shown in Figure 4 for Canada and the United States. (Unfortunately, the data on farmland prices are not readily available for other countries.) From 1928 to 1930 real farmland prices decreased by approximately

[18] League of Nations, *Agricultural Crisis*, p. 176; and Eichengreen, "Political Economy," p. 8.
[19] League of Nations, *Agricultural Crisis*, p. 13.

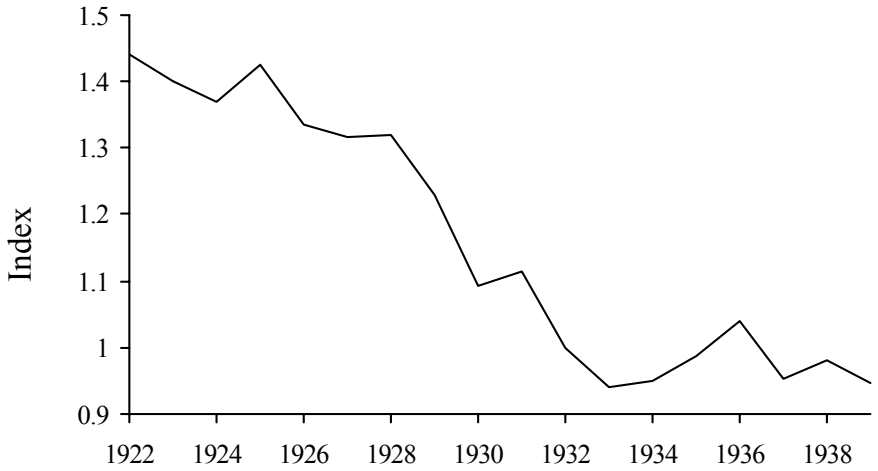

FIGURE 4
AVERAGE REAL VALUE OF FARMLAND IN CANADA AND THE UNITED STATES

Notes: The figure shows the value of farmland deflated by consumer prices and normalized to the index of one over the period from 1930 to 1939. U.S. land prices are linearly interpolated between the years 1922, 1929, 1933, and 1939. Canada's prices comprise the average of Hudson's Bay Company's price index of farmland (1925–1939) and the price index of the Canadian Northern Land Department (1930–1939).

25 percent and a further 15 percent from 1930 to 1933. The decrease had negative wealth effects on farm consumption and furthered the decrease in the agricultural sector's expenditure. Moreover, the increasing real value of debt aggravated the balance-sheet position of farmers. This contributed further to the decline in agricultural expenditures, and made it increasingly difficult for farmers to honor their debts, thus contributing to bank failures and hence decreasing economy-wide liquidity in some countries, especially the United States.[20]

Declining agricultural prices also had important indirect macroeconomic effects because they contributed to the world-wide deflation from 1929 to 1932. Figure 5 displays the path of consumer prices and wholesale prices of agricultural products and other commodities for four countries. The casual evidence in Figure 5 indicates a strong positive relationship between consumer and commodity prices and shows that changes in commodity prices preceded changes in consumer price by one to three quarters during the Depression.

The deflation, which followed from the decrease in agricultural prices, had severe consequences for output and employment. There are several demand-side channels through which deflation affected output. First, Ben Bernanke and Harold James find that the deflation caused a series of bank

[20] Lewis, *Economic Survey*, p. 54.

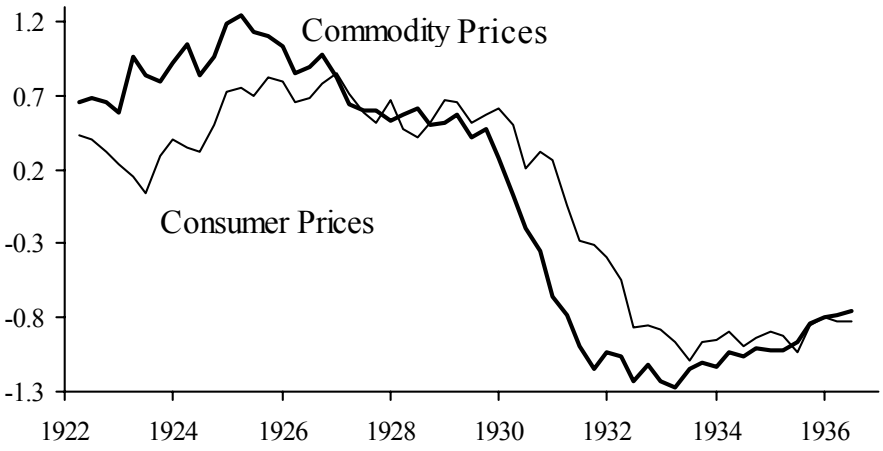

FIGURE 5
CONSUMER AND COMMODITY PRICES

Notes: Arithmetic averages are shown for the following countries: Belgium, Canada, France, and Japan. The individual series are standardized to have a mean of zero and a variance of one.

panics in some countries that hampered the provision of credit in the beginning of the 1930s.[21] Second, Irving Fisher stresses the debt-deflation effect: because the nominal interest rate cannot be negative, unexpected deflation increases the real payment on debt, thus redistributing real income and wealth from debtors to creditors.[22] Because the marginal propensity to spend is higher for debtors than creditors, the unanticipated deflation curbed aggregate spending. Third, increasing *ex ante* real interest rates adversely influenced employment and output as it increased the cost of investment in capital and workers.[23] Fourth, James Tobin and Bradford De Long and Lawrence Summers show that expected deflation is contractionary, and may even be destabilizing, because it causes firms and consumers to postpone fixed investment and expenditures on consumer durables in the belief that the prices of these products will decrease even further.[24]

The deflation also affected supply-side channels; it resulted in increasing real wages because nominal wages were sticky. Using time-series and cross-country data Barry Eichengreen and Jeffrey Sachs and Ben Bernanke and Kevin Carey find that real wages were driven up substantially by the deflation and therefore had adverse supply effects.[25] Furthermore, tariff rates were automatically forced up by the deflation because a large share of import duties

[21] Bernanke and James, "Gold Standard."
[22] Fisher, "Debt-Deflation Theory."
[23] See Newell and Symons, "Macroeconomics," for empirical evidence.
[24] Tobin, "Keynesian Models"; and De Long and Summers, "Is Increased Price."
[25] Eichengreen and Sachs, "Exchange Rates"; and Bernanke and Carey, "Nominal Wage Stickiness."

were specific and therefore denominated in fixed nominal values.[26] For the United States, Douglas Irwin finds that declining import prices contributed more to the increase in the average tariff rate than the discretionary increases in tariffs during the Depression.[27] If it is furthermore taken into account that the discretionary tariff-rate increases were to a large extent sparked by the agricultural crisis, then the income effects of the increasing tariff rates can, to a large extent, be attributed to the decrease in the agricultural prices.[28] Although the literature disagrees on the real economic effects of the increasing tariff rates, most studies find that the increasing tariff rates contributed to the Depression.[29]

REAL AGRICULTURAL PRICES AND OUTPUT

The casual evidence in the previous section indicated a close association between real agricultural prices and output. To further investigate the time series relationship between agricultural prices and output, the following equation is estimated using annual data for a panel of 15 and 12 countries over the period from 1929 to 1936 (the data start in 1924 to allow for lagged adjustment, first differences, and lagged instruments)

$$\begin{aligned}\Delta y_{it} &= \phi_0 + \phi_1 \Delta y_{i,t-1} + \phi_2 \Delta (p_{it}^{va,a} - p_{it}^{va}) + \phi_3 \Delta (p_{i,t-1}^{va,a} - p_{i,t-1}^{va}) + \phi_4 \Delta g_{it} + \phi_5 \Delta g_{i,t-1} \\ &+ \phi_6 \Delta (m_{it} - p_{it}^{va}) + \phi_7 \Delta (m_{i,t-1} - p_{i,t-1}^{va}) + \phi_8 \Delta p_{it}^{va} + \phi_9 \Delta p_{i,t-1}^{va} + \varepsilon_{it}\end{aligned} \quad (1)$$

where y is the log of the economy-wide real GDP, $p^{va,a}$ is the log of the value-added price deflator in agriculture, p^{va} is the log of the economy-wide GDP deflator, g is the log of real government expenditure, m is the log of monetary stock, the subscript i signifies country i, and ε is an identically and independently distributed disturbance term.

Equation 1 depicts aggregate demand as a function of money, government spending, real agricultural prices, and changes in prices to allow for the contractionary effects of the deflation. The equation represents a reduced form IS-LM model where the consumption and investment functions are augmented to allow for the influence of real agricultural prices and the change in prices.[30] Δp^{va} is included in the equation to allow for expected and

[26] Liepmann, *Tariff Levels.*

[27] Irwin, "Smoot-Hawley Tariff."

[28] Kindleberger ("Commercial Policy," p. 170) argues that "the Hawley-Smoot tariff began as a response to the decline in agricultural prices." A similar view is found in Eichengreen, "Political Economy," pp. 6–8. Furthermore, Svenska Handelsbanken ("Great Trade War," p. 3) notes that "the trade barriers have, it should have been remembered, been tending to increase for several years, some of the most important restrictive measures being the increase in agricultural protection in certain European countries during 1928–29".

[29] See Irwin, "Smoot-Hawley Tariff," and references therein.

[30] Equation 1 can also be derived from an optimizing intertemporal framework as shown by Clarida et al., "Science," which is also consistent with the equations that are used below for investment and consumption. The only principal difference is that expected income is an extra explanatory variable in the IS curve in the intertemporal optimization framework.

unexpected price effects. Monetary stock is measured by M1. Real currency in circulation and the real *ex post* interest rates were used as alternative measures of monetary policy, but their estimated coefficients were insignificant at any conventional significance level.

Because equation 1 is estimated with only eight time-series observations for each country, it is estimated using the generalized method of moments (GMM) for panels, which is devised by Manuel Arellano and Stephen Bond.[31] Following their recommendation, equation 1 is estimated in first differences using all the orthogonality conditions that exist between lagged values of the endogenous variables and the disturbances. More formally, it deploys the orthogonal condition as follows

$$E(y_{is}\varepsilon_{it}) = 0 \qquad s < t \;!\; 1$$

This orthogonal condition for country *i* is satisfied for the following instrument set

$$W_i = \begin{bmatrix} y_{i1} & 0 & \cdots & 0 \\ 0 & y_{i1}, y_{i2} & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & (y_{i1},\ldots..,y_{i,T-2}) \end{bmatrix} \tag{2}$$

Then, the matrix of instruments is $W = (W_1^{'},\ldots., W_N^{'})^{'}$ and the moment condition $E(W_i^{'}\vartheta_{is}) = 0$, where $\vartheta_{is} = [\varepsilon_{i3}, \varepsilon_{i4}, \cdots, \varepsilon_{iT-2}]$, is satisfied. For the initial data period in 1929 $y_{i,1924}$, $y_{i,1925}$, $y_{i,1926}$, $y_{i,1927}$, and $y_{i,1928}$ are used as instruments. The same instruments plus $y_{i,1929}$ are used for 1930, and so forth. Hence, the list of instrumental variables is not the same for each equation because the list of variables uncorrelated with the disturbance terms changes each period. Log first differences of currency in circulation and government expenditure at periods *t* and *t* ! 1, deflated by the value-added price deflator, are added to the instrument set. Fixed-effect country dummies were initially included in the estimates, and in all the estimates that follow, but were deleted because they were jointly insignificant, even at the 5 percent level.

The results of estimating the restricted version of equation 1 are reported in Table 1. Variables whose estimated coefficients are insignificant at the 5-percent level are deleted. The estimates suggest that real agricultural prices were very influential for real economic activity, noting that the estimates do not involve feedback from income to real agricultural prices, because instru-

[31] Arellano and Bond show that their estimator is the most efficient within the class of panel data instrumental variable estimators that use lagged values of the dependent variable as instruments for all regressors. Arellano and Bond, "Some Tests."

TABLE 1
PARAMETER ESTIMATES OF OUTPUT EQUATION

	All Countries		Excluding United States, United Kingdom, and Germany	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant	0.00	0.27	0.01	1.85
$)y_{t!1}$	0.33	2.67	0.48	7.02
$\Delta(p_t^{agr} - p_t^{va})$	0.29	3.90	0.32	6.83
$)m_{t!1}$	0.41	4.22	0.29	2.45
Δp_{t-1}^{va}	0.57	4.41	0.38	2.45
Sargan(36)	42.5			
Sargan(22)			21.1	
SC(1)	!1.50		!1.91	
SC(2)	!0.87		0.36	
N	15		12	
Observations	118		94	

Notes: The absolute asymptotic *t*-statistics presented are robust to heteroscedasticity. The GMM estimation method is used. See the text for instruments. Sargan(*j*) is the Sargan instrument validity test, which is distributed as $\chi^2(j)$ under the null hypothesis of instrument validity, SC(*i*) is a LM test for *i*'th order serial correlation, which is robust to general cross-section and time series heteroscedasticity, and is distributed asymptotically as N(0,1) under the null of serial uncorrelated errors. The countries that are included in the sample are Australia, Canada, Denmark, Finland, France, Germany, Hungary, Italy, Japan, New Zealand, Spain (1929–1935), Sweden, Switzerland, the United Kingdom, and the United States. The estimation period is 1929–1936. The data period commences in 1924.

ments are used for real agricultural prices.[32] The estimated coefficient of real agricultural prices is statistically highly significant and the diagnostic tests do not give evidence against the model specification. The estimated coefficient of real agricultural prices is slightly higher for the sample that excludes the United States, the United Kingdom, and Germany, which indicates that the agricultural decline was more influential in the economies that were more heavily dependent on agriculture than others, as one would expect. The estimates also suggest that growth in real M1 was also influential for the income growth path. However, since M1 increased from 1929 to 1932 for most countries it did not contribute to the decline in income for these countries. Finally, the statistical and economical significance of the estimated coefficients of p^{va} suggests that price changes were also influential for the income path during the Depression.

Allowing for the lagged effects in the estimates of the equation involving all 15 countries, simulations of the model indicate that the 21 percent de-

[32] Because Figure 2 indicates that the decrease in output and real agricultural prices was particularly pronounced for New Zealand, Canada, and the United States, it is important to test whether the results in this section are predominantly driven by the observations for these countries. However, the null hypothesis that New Zealand, Canada, and the United States belong to the sample cannot be rejected at any conventional significance level. An *F*-test of equality of the coefficients between the samples that include and exclude Canada, New Zealand, and the United States yields a statistic of 2.23 (distributed as $F(5,109)$ under the null of coefficient equality). The test is based on OLS estimates.

crease in real agricultural prices from 1929 to 1932 for the average country resulted in a 10 percent decrease in real GDP, which is close to the actual decrease of 9.7 percent. In the upturn from 1933 to 1936 the model predicts that the 22.8 percent increase in real agricultural prices resulted in a 10.9 percent increase in real GDP, which is more than half of the actual increase of 17.9 percent. These results suggest that the path of real agricultural prices was influential for the decline in income, but only partially influential for the recovery.

The estimates and simulations suggest that changes in real agricultural prices were potentially important for the cyclical movements in output. Although instruments are used to compensate for the potential of a joint determination of the dependent and independent variables, regression analysis is only suggestive in regard to causality. That real agricultural prices precede output, as shown in the previous section, does not necessarily uncover an economic law, because a third factor may have been responsible for the relationship. The same problem applies to Granger-Sims tests of causality as discussed by Kevin Hoover.[33] Although the multicountry nature of this study does not guarantee that a causal relationship has been uncovered it nevertheless greatly reduces the possibility that the results arise because of spurious relationships. Furthermore, three important channels whereby the declining agricultural prices transmitted to output are identified in the next three sections to reinforce the results of the output estimates.[34]

A MODEL OF DEFLATION DURING THE DEPRESSION

In this section a simple general-equilibrium model is derived to test the extent to which monetary forces and declining agricultural prices contributed to the deflation during the first years of the Depression. A dynamic aggregate supply side is derived in the first step and dynamic aggregate demand is incorporated into the supply side in the next step. Consider the changes in the log of the economy-wide value-added price deflator

$$\Delta p_t^{va} = \gamma \Delta p_t^{va,m} + (1-\gamma)\Delta p_t^{va,a} \tag{3}$$

[33] Hoover, "Causal Direction." Based on the analysis of Simon's, *Causal Ordering,* Hoover suggests an econometric framework for causality testing that does not involve testing for precedence. Hoover investigates stability of the conditional and marginal distributions in alternative partitions to give information about the causal order in the data-generating process. Unfortunately the method requires the identification to interventions in the data-generating process which are unlikely to be available for the demand variables considered in this study. Furthermore, the limited number of observations effectively makes it impossible to implement the Hoover method.

[34] As suggested by a referee the equations that are considered in this article could be estimated simultaneously using the VAR framework. Holtz-Eakin, Newey, and Rosen, "Estimating Vector Autoregressions," devise a method for estimating VAR models for panels. However, the limited number of available observations renders the overparameterization a serious issue. Furthermore, the moment conditions, which are used in the GLS estimator of Holtz-Eakin *et al* are used in the GMM estimates in this article.

where $p^{va,m}$ and $p^{va,a}$ are the log of the value-added price deflator in manufacturing and agriculture, and γ is share of manufacturing in the total value-added price deflator. Next assume that the manufacturing value-added price deflator is mark-ups on marginal or average costs

$$\Delta p_t^{va,m} = \lambda_1 \Delta ulc_t + \lambda_2 \Delta (y_t - y_t^*) \tag{4}$$

where *ulc* is the log of unit labor costs (hourly labor costs divided by labor productivity), and y^* is the log of potential GDP.

Unit labor costs are determined by the following augmented Phillips curve

$$\Delta w_t = \alpha_1 \Delta p_{t+1}^{e,va} + \alpha_2 (y_t - y_t^*) + \alpha_3 \Delta pr_t + \alpha_4 \Delta p_t^{im}$$

where w is the log of hourly labor costs, $p_{t+1}^{e,va}$ is the log of expected value-added price deflator at period $t + 1$, pr is the log of labor productivity, p^{im} is the log of the price of imported materials. Okun's law has been used to convert unemployment to income. Import prices represent the wedge between consumer prices, which is the relevant deflator for workers, and the value-added price deflator, which is the relevant deflator for firms. Assuming productivity homogeneity ($\alpha_3 = 1$), that inflation expectations are adaptive, $\Delta p_{t+1}^{e,cpi} = \Delta p_t^{cpi}$, and noting that $\Delta ulc = \Delta w - \Delta pr$, then equations 3 and 4 and the Phillips curve can be solved to yield

$$\Delta p_t^{va} = \beta_1 \Delta p_{t+1}^{va,a} + \beta_2 \Delta p_t^{im} + \beta_3 (y_t - y_t^*) + \beta_4 \Delta (y_t - y_t^*) \tag{5}$$

where $\beta_1 = (1 - \gamma)\Omega$, $\beta_2 = \gamma\lambda_1\alpha_4\Omega$, $\beta_3 = \gamma\lambda_1\alpha_2\Omega$, $\beta_4 = \gamma\lambda_2\Omega$ and $\Omega = [1 - \gamma\lambda_1\alpha_1]^{-1}$. This equation is the dynamic aggregate supply schedule, where inflation is driven by the excess demand in the goods and labor markets, prices of imports and agricultural prices. Cyclical income ($y - y^*$) is assumed to have both level and change effects. The level effect is the traditional Phillips curve effect whereby disequilibrium in the labor market puts continuous downward pressure on wage inflation and hence price inflation, whereas the change effect allows demand shifts to have only one-off effects on inflation. Note that $\Delta(y - y^*)$ was negative over the period from 1929 to 1932, and positive over the period from 1933 to 1936, whereas $(y - y^*)$ was negative over the period from 1929 to 1936, for most countries. This implies that real income was below potential over the entire period between 1929 and 1936 but that between 1929 and 1933, income was falling, whereas between 1933 and 1936, it was increasing.

To incorporate the demand-side into the model, consider the following quantity theory of money equation

$$y_t = m_t - p_t^{va} + v_t \tag{6}$$

where m is the log of money stock and v is the log of the velocity of money. This model has Keynesian features. Keynes propounds that inflation, in

addition to the speed of response of wages to prices and unemployment, depends on the degree of excess capacity and that monetary policy transmits to excess demand via the interest rate.[35]

Substituting equation 6 into equation 5 yields

$$\Delta p_t^{va} = \beta_1 \Delta p_{t+1}^{va,a} + \beta_2 \Delta p_t^{im} + \beta_3 (m_t + v_t - p_t^{va} - y_t^*) + \beta_4 \Delta (m_t + v_t - p_t^{va} - y_t^*)$$

To simplify this equation it is assumed that the velocity of money is constant. This assumption is relaxed in the empirical estimates. Furthermore, y^* is assumed to grow at a constant rate over time. Hence, the equation simplifies to

$$\Delta p_t^{va} = \varphi_0 + \varphi_1 \Delta p_{t+1}^{va,a} + \varphi_2 \Delta p_t^{im} + \varphi_3 \Delta m_t + \varphi_4 m_t^x \tag{7}$$

where $\varphi_0 = -\beta_3 \Delta y^* \Sigma$, $\varphi_1 = \beta_1 \Sigma$, $\varphi_2 = \beta_2 \Sigma$, $\varphi_3 = \beta_4 \Sigma$, $\varphi_4 = \beta_3 \Sigma$, and $\Sigma = [1 - \beta_4]^{-1}$. The term $m^x = m - p^{va} + v - y^*$ measures the degree to which the money market is in disequilibrium. This term can be interpreted as an error-correction term in the sense that it assumes that inflation gravitates towards the long-run equilibrium in the money market.

Equation 7 says that inflation gravitates towards the growth in money supply in the long run, but deviates from this equilibrium on a cyclical basis owing to supply shocks. The model embeds the monetarist premise of the existence of a stable relationship between growth in money and inflation.[36] The disequilibrium term is also of monetarist spirit in the sense that the price level gravitates towards the equilibrium in the money market as in the p-star model of Jeffrey Hallman, Richard Porter, and David Small.[37]

Empirical Estimates

Equation 7 is stochastically specified as

$$\begin{aligned}\Delta p_{it}^{va} = {} & a_0 + a_1 \Delta p_{i,t-1}^{va} + a_2 \Delta p_{it}^{va,a} + a_3 \Delta p_{i,t-1}^{va,a} + a_4 \Delta m_{it} + a_5 \Delta m_{i,t-1} \\ & + a_6 \Delta p_{it}^{im} + a_7 \Delta p_{i,t-1}^{im} + a_8 m_{it}^x + \varepsilon_{it,2}\end{aligned} \tag{8}$$

All coefficients are expected to be positive. p^{im} is measured as the log of import unit values for total imports multiplied by $(1 + TR^{im})$, where TR^{im} is the average import tariff rate, and m^x is estimated as the residual from regressing the equation; $m_t - p_t^{va} = k_0 + k_1 \hat{y}_t + m_t^x$, for each country over the entire interwar period (1920–1939), where $\hat{y}$ is the predicted value from regressing the log of real GDP on a time trend and a squared time trend. Since $m_t - p_t^{va} = k_0 + k_1 \hat{y}_t + m_t^x$ is estimated for each individual

[35] Keynes, *General Theory*, pp. 304–06.
[36] See for instance Stockton and Struckmeyer, "Tests."
[37] Hallman, Porter, and Small, "Is the Price Level."

country, the velocity of money is allowed to vary across countries and is captured by the constant term k_0, for each individual country.[38]

To check for the sensitivity of the results to different measures of monetary stock, m is measured both as the log of notes in circulation and as the log of M1. It is not straightforward whether deposits should be included in the monetary measure. Since the value of deposits were significantly affected by the banking panics, as stressed by Bernanke and James, among several others, the potential effects of changes in deposits on inflation should not automatically be attributed to money supply.[39] If the banking panics were predominantly caused by monetary factors, as advocated by Friedman and Schwartz, then one can argue that M1 is the correct measure of monetary stock.[40] If, on the other hand, it was the agricultural crisis, as argued by Temin, or other nonmonetary factors that predominantly caused the banking panics, then M1 is not the appropriate measure of the monetary stock in the inflation equation but notes in circulation.[41] Finally, equation 8 is estimated using GMM for 13 countries over the period 1929 to 1936 (the data period commences in 1924). Log first differences of real government spending in periods t and $t!1$ are used as instruments in addition to the instruments which are presented in equation 2.

The results of estimating a restricted version of Equation 8 are shown in Table 2. The estimated coefficients of import prices, money growth and disequilibrium in the money market were insignificant at the 5-percent level, and were consequently restricted to zero. The monetary variables were insignificant regardless of whether monetary stock was measured by M1 or currency in circulation.[42] The insignificance of the monetary terms suggests that the deflation during the first years of the Depression was neither caused nor influenced by monetary stock. This finding is consistent with the fact that monetary stock, particularly currency in circulation increased from 1929 to 1932 in many countries and yet their price levels decreased over the same period.[43]

The estimated coefficients of agricultural prices are statistically and economically quite significant. The long-run elasticity is 0.34, which implies that the 45-percent decrease in prices of agricultural products from 1928 to 1932 explains the 16 percent decrease in consumer prices from 1929 to 1932, for the countries considered in Table 2. Simulations of the model

[38] Note that the fixed effect dummies capture potential cross-country differences in velocity stemming from the term $\Delta(m_t - p_t^{cpi} + v_t - y_t^*)$. However, the fixed effect dummies were insignificant.

[39] Bernanke and James, "Gold Standard."

[40] Friedman and Schwartz, *A Monetary History*.

[41] Temin, *Did Monetary Forces*, p. 90.

[42] If consumer prices are used instead of the economy-wide value-added price deflator, then the estimated coefficient of monetary stock is slightly significant when monetary stock is measured by M1.

[43] For the country sample considered in the estimates, currency in circulation increased for five countries, decreased for six countries and was almost unaltered for two countries, over the period from 1929 to 1932.

TABLE 2
PARAMETER ESTIMATES OF THE INFLATION EQUATION
(dependent variable = $\Delta\hat{p}_t^{va}$)

	Estimates			
	Coefficients	*t*-Statistics	Tests	
Constant	! 0.01	2.94	Sargan(29)	26.7
$\Delta p_t^{va,a}$	0.19	3.47	SC(1)	1.63
$\Delta p_{t-1}^{va,a}$	0.15	2.33	SC(2)	0.16
			N	13
			Observations	99

Notes: See the notes to Table 1. The GMM instrumental variable estimator is used. See the text for instruments. The countries, which are included in the sample, are Australia, Canada, Finland, France, Germany, Italy (1929–1934), Japan, New Zealand, Spain (1929–1935), Sweden, Switzerland, the United Kingdom, and the United States. The estimation period is 1929–1936. The data period commences in 1924.

indicate that the model predicts a 15 percent decrease in consumer prices from 1929 to 1932 on average.

The velocity of money has been assumed constant, but allowed to vary for each individual country, in the estimates above. Several combinations of dummy variables were experimented with to allow for shifts in the velocity of money including dummies taking the value of one after 1931, the dummies for banking panics from Bernanke and James, and gold standard dummies.[44] However, they were insignificant in all cases and the other coefficient estimates were unaffected by their inclusion. It is therefore unlikely that changes in velocity had much bearing on the deflation during the Depression.

From this evidence, however, one should not *a priory* discount the possibility that another factor has been responsible for the decrease in commodity prices, which preceded the decline in consumer prices from the end of 1929 to the end of 1932. Suppose that a world-wide decrease in money supply causes a world-wide contraction in nominal demand. Since prices of commodities were more flexible than prices of consumer goods,[45] such a demand shock would lead to a decrease in prices of commodities which preceded consumer prices. To investigate this possibility, the estimates in Table 2 were augmented with world total money supply in either domestic or common currency (USD). The coefficients of world money were not significant in any of the estimates regardless of whether money was measured in domestic or common currency and whether money was measured as notes in circulation or notes in circulation plus deposits.[46] This evidence further reinforces the finding above that money was not important for the

[44] Bernanke and James, "Gold Standard."
[45] Berle and Means, *Modern Corporation*; and Burns, *Decline*, pp. 250–54.
[46] The estimates are presented in an earlier version of the paper which is available from the author.

international price path during the Depression.[47] Since real agricultural prices were highly positively correlated with consumer prices during the Depression, the agricultural price collapse had significant indirect real economic consequences.

Overall the estimates in this section have shown that the decline in agricultural prices were to a large extent responsible for the deflation and that money played only a minor role in the world-wide deflation. Money was not influential for the path of the value-added price deflator during the Depression. Hence, the output consequences of the deflation can to a large degree be attributed to the decline in prices of agricultural products. In the next two sections it is shown that the decline in real agricultural prices also had significant effects on aggregate consumption and investment.

PRIVATE CONSUMER SPENDING AND ASYMMETRIC INCOME SHOCKS

To assess the effects of the agricultural decline on aggregate consumption, consider the permanent income hypothesis. The life-cycle permanent income hypothesis (LC-PIH) predicts that temporary income changes do not affect private consumption of nondurables. It follows from LC-PIH that if the income redistributional consequences of the agricultural crisis were perceived to be temporary, then the aggregated consumption would have remained unaffected. However, if consumers do not have free access to credit, then they cannot smooth out their consumption and the empirical counterpart of the LC-PIH consequently breaks down, as shown by Tullio Japelli and Marco Pagano, among others.[48]

The very sparse statistics on consumption that are available from the interwar period suggest that consumers in the agricultural sector did not lower their savings in periods of financial distress to overcome temporary income falls and therefore did not behave as predicted by the LC-PIH. In the years of prosperity from 1919 to 1921 persons in the agricultural sector in the United States had a negative savings of $1,560 million per year on average.[49] Thereafter the numbers fluctuated around zero, but were positive from 1930 to 1933, on average $70 million per year. This suggests that credit markets prevented consumers who were dependent on income from agricultural production from smoothing out their consumption. Therefore, farmers and agricultural workers only had one option under economic distress, namely to lower their consumption. By contrast, those who gained from the lower real agricultural prices did not increase their consumption because they perceived the real income gain to be temporary. James Hamilton, for instance, analyses the futures prices of some agricultural commodities and

[47] Quarterly estimates are presented in an earlier version of the paper which is available from the author. The estimates show that commodity prices preceded consumer prices.

[48] Jappelli and Pagano, "Consumption."

[49] U.S. Department of Commerce, *Historical Statistics*, table F 540-551.

finds that they were mostly expected to increase throughout the Depression.[50] If consumers' expectations were in line with the futures markets' expectations, then they perceived the price fall of agricultural products to be temporary and would therefore not increase consumption because their permanent income was unaltered. This implies that consumption may be sensitive to the income redistributional consequences of the agricultural crisis, even if the LC-PIH holds.

Another reason to believe that the agricultural price decline did not have symmetrical expenditure effects was that the sharp decline in the real value of agricultural property was not counterbalanced by an increase in real wealth elsewhere in the economy. Furthermore, the economy-wide deflation, which to a large extent was a result of the decline in prices of agricultural products, lead to an increase in the real value of consumers' debt. This suggests that there were spill-over effects from the agricultural sector to consumers elsewhere in the economy. Frederic Mishkin's study suggests that the decline in the real value of households' assets and the increase in the real value of debt led to the collapse in durable spending in the United States during the Depression.[51] The collapse in agricultural prices increased farmers' real value of debt substantially, especially when it is taken into account that the relevant deflator for farmers' debt is not consumer prices but the price deflator of agricultural products. Furthermore, the declining prices of agricultural products lowered the real value of farmland as shown in Figure 4. According to the Mishkin model, this increased the likelihood of financial distress that was associated with not being able to meet debt obligations, and consequently lowered expenditures on durables goods and investment in housing.

The possibility of expenditure effects flowing on from the declining agricultural prices has received some attention in the literature. Kindleberger points out that the fall in the price of agricultural products decreased the income of farmers and raised income in the industrial sector.[52] But while farmers reacted quickly to the decrease in income by cutting expenditures, those in the industrial sector reacted much more slowly to the rise in their real income, due in part to money illusion.[53] By contrast Temin argues that "the net effect of the initial fall in commodity prices in the United States therefore probably was positive, since there were many more consumers than producers of these commodities in the United States."[54] In other words, the declining agricultural prices stimulated the U.S. economy because it enjoyed a terms of trade improvement. However, as most of the terms of trade improvement was absorbed by higher tariffs it only had marginal effects on the U.S. economy as shown earlier.

[50] Hamilton, "Monetary Factors" and "Was the Deflation."
[51] Mishkin, "Household Balance Sheet."
[52] Kindleberger, *World*.
[53] Kindleberger, *World*, p. 91.
[54] Temin, *Lessons*, pp. 55–56.

To test the income redistributional effects of the agricultural crisis on consumption, the following consumption function is estimated

$$\Delta c_{it} = \kappa_0 + \kappa_1 \Delta c_{i,t-1} + \kappa_2 \Delta (p_{it}^{va,a} - p_{it}^{va}) + \kappa_3 \Delta (p_{i,t-1}^{va,a} - p_{i,t-1}^{va}) + \kappa_4 \Delta y_{it}^{d} + \kappa_5 \Delta y_{i,t-1}^{d} + \varepsilon_{it,3} \quad (9)$$

where c is the log of real private consumer expenditure, and y^d is the log of real disposable income. Real disposable income is measured by real GDP. Since direct taxes and governmental transfers were only a low proportion of GDP in the interwar period, real GDP is likely to be closely related to real disposable income.

Equation 9 looks almost like an augmented traditional Keynesian consumption function. However, the equation also nests the rational expectational LC-PIH of Robert Hall, which is augmented to allow for a fraction of consumers whose actions do not support the LC-PIH.[55] In Hall's model, consumption in the previous period is the only variable that contains information that can help to predict consumption today. In other words consumption in period $t - 1$ contains all the information about permanent income that is needed to predict consumption in period t. Hence, this model predicts that consumption is uncorrelated with present and past income. However, John Campbell and Gregory Mankiw have shown that a fraction of consumers do not obey the rational expectational LC-PIH and therefore that the change in consumption is correlated with the change in current income.[56] Because the asymmetric effects of the agricultural decline are not accommodated in the income-augmented Hall consumption function, the error term will be correlated with real agricultural prices. Hence, real agricultural prices become an important regressor in the consumption function.

Equation 9 is estimated using the generalized instrumental-variable estimator of Jan Kmenta over the period from 1927 to 1938 for nine countries.[57] The Kmenta estimator is used because of the low number of countries in the panel, particularly the panel that excludes the United States, the United Kingdom, and Germany. Estimates where the United States, United Kingdom, and Germany are excluded from the sample are also reported to determine the extent to which the effects of real agricultural prices depended on the importance of the agricultural sector for the overall economic activity. Because the data are available for only a few countries, the time span is extended beyond the Depression years of 1929 to 1936 to gain efficiency. Instruments are used for real disposable income and real agricultural prices. For the log first differences in real disposable income the following instruments are used: consumption at period $t - 1$, real income at period $t - 1$, and

[55] Hall, "Stochastic Implications."
[56] Campbell and Mankiw, "Response."
[57] See Kmenta, *Elements*, chap. 12.

TABLE 3
PARAMETER ESTIMATES OF THE CONSUMPTION FUNCTION
(dependent variable = $\Delta\hat{c}_t$)

	All Countries		Excluding United States, United Kingdom, and Germany	
	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic
Constant	0.00	2.13	0.01	2.48
$\Delta(p_t^{va,a} - p_t^{va})$			0.08	2.15
$\Delta(p_{t-1}^{va,a} - p_{t-1}^{va})$	0.13	6.98	0.10	3.41
Δy_t^d	0.58	13.1	0.47	6.61
SC(1)	0.06		0.02	
SC(2)	0.32		0.42	
R^2	0.82		0.67	
N	9		6	
Observations	108		72	

Notes: See the notes to Table 1. The Kmenta instrumental variable estimator is used. See the text for instruments. R^2 is Buse's raw moment R^2. Data for the following countries are included in the estimates: Australia, Denmark, Finland, Germany, Italy, Japan, Sweden, the United Kingdom, and the United States. The estimation period is 1927–1938. The data period commences in 1924.

real currency in circulation and real government expenditure at period t and t ! 1. For the log first differences of real agricultural prices the following instruments are used: real agricultural prices at period t ! 1, real currency in circulation and real government expenditure at periods t and t ! 1. All instruments are measured in log first differences.

The results of estimating a restricted version of Equation 9 are presented in Table 3. In the equation that includes data for all the countries, the estimated coefficients of contemporaneous real agricultural prices and lagged income were insignificant, even at the 10-percent level, and consequently restricted to zero. The coefficient of real income is 0.6 and 0.5 if the United States, the United Kingdom, and Germany are excluded from the estimates. Consequently, the simple Keynesian closed-economy expenditure multiplier exceeded one and demand shocks were consequently amplified by consumption. The coefficient of real agricultural prices is highly significant, both economically and statistically, and has the expected positive sign. This indicates that the marginal propensity to consume for those who lost income significantly exceeded the marginal propensity to consume for those who gained income. Even though the direct income effects of the decline in agricultural prices are accommodated in the income term, the estimates suggest that the effects of the decreasing real agricultural prices alone contributed to a 2.7 percent decrease in consumption from 1929 to 1932, for the average country. The estimated long-run coefficient of real agricultural prices is larger in the estimates that exclude the United States, United Kingdom, and Germany, as would be expected.

Additional effects of the decline in real agricultural prices on consumption are the indirect income effects of deflation on consumption and investment that can be attributed to the decline in agricultural prices. If half of the 10-percent decline in real income was a result of the price decline of agricultural products, then a further 2.9 percent decline in consumption can be attributed to the agricultural decline. A significant portion of the 6.2 percent decline in consumption, measured across the sample countries, can therefore be explained by the decrease in relative agricultural prices, especially for countries that were strongly dependent on agriculture.

SPILLOVER EFFECTS ON INVESTMENT EXPENDITURES

Whereas consumption declined by 6.2 percent, investment declined by 52 percent on average over the period from 1929 to 1932. This suggests that the collapse in investment was a more important factor than consumption in shaping the Depression, even if their relative shares in total GDP are accounted for. This underscores the importance of examining investment effects of the agricultural price decline.[58]

There are various reasons as to why the decline in prices in agricultural products adversely affected nonresidential investment. The decline in the value of farmland and the shortage of liquidity in the agricultural sector made lenders less willing to lend, without having symmetrical effects on the manufacturing sector. Investment in the agricultural sector was severely hampered by the decline in the real value of farmland, as demonstrated by Glenn Hubbard and Anil Kashyap for the United States.[59] Using a model of asymmetric information they show that the decrease in the net worth of farmland reduces lenders' overall willingness to lend. Furthermore, the significant decrease in the agricultural value-added price deflator resulted in real cost of funding in agriculture that reached prohibitively high levels. Finally, the poor and uncertain prospects of farming, and the limited ability of farmers to self-finance their investment projects, contributed to a further decline in investment.

The price decline in the agriculture sector had further negative spillover effects on manufacturing investment due to the Keynes-Tobin effect. James Tobin and Bradford De Long and Lawrence Summers show that expected deflation is contractionary, and may even be destabilizing, because it causes firms and consumers to postpone fixed investment and expenditures on consumer durables in the belief that the prices of these products will decrease even further.[60] Furthermore, the deflation lowered the real net worth

[58] The literature on the United States has traditionally focused on the collapse in consumption. However, using the new revised consumption data of Lebergott, *Consumer Expenditures*, the decline in GDP from 1929 to 1932 which can be attributed to investment, is about the same as can be attributed to consumption.

[59] Hubbard and Kashyap, "Internal Net Worth."

[60] Tobin, "Keynesian Models"; and De Long and Summers, "Is Increased Price."

of firms by increasing the real value of their liabilities without a corresponding increase in the real value of assets, and thereby reducing banks' willingness to lend. Finally, banks' heavy losses on loans to the agricultural sector had negative spillover effects for lending to manufacturing, because the losses made banks very restrictive in their lending policies. Ben Bernanke shows that the disruption to banking reduced the effectiveness of the banking sector as a provider of credit, and played a key role in the propagation of the Depression in the United States.[61]

One may argue that the agricultural price decline lowered input prices for the manufacturing sector, thus stimulating manufacturing investment due to higher profits. However, this argument does not rest on optimizing behavior for competitive and noncompetitive firms. The perfectly competitive firm would have passed the lower input prices on to consumers and not changed its investment plans. The imperfectly competitive firm would take advantage of the lower agricultural prices by increasing their mark-up, but then the investment demand schedule would have shifted down because the required return to investment would have been higher, and investment would consequently have been reduced.

To test the empirical implications of the agricultural decline on investment consider the following neoclassical investment function. From the first-order condition that the real cost of capital equals the marginal productivity of labor it follows that the desired capital stock is a positive function of income and a negative function of the cost of funds in the following log-linear relationship[62]

$$k_t^* = b_0 + b_1 y_t + b_2 RR_t + \upsilon_{1t} \tag{10}$$

where k^* is the log of the desired stock of capital, RR is the real interest rate, and υ is a disturbance term. The discussion above suggests that the error term in equation 10 is correlated with real agricultural prices. Incorporating real agricultural prices into the maintained model yields

$$k_t^* = c_0 + c_1 y_t + c_2 (p_t^{agr} - p_t^{va}) + c_3 RR_t + \upsilon_{2t} \tag{11}$$

Capital stock is assumed to adjust towards it desired level according to the adjustment mechanism

$$k_t - k_{t-1} = \theta(k_t^* - k_{t-1}) \tag{12}$$

[61] Bernanke, "Nonmonetary Effects."

[62] Consider the production function $Y = F(L,K)$ where K is capital stock, and L is labor. This can be rewritten as $L = G(K,Y)$, where $G_K' > 0$ and $G_Y' < 0$. Substituting this expression into the first order condition for profit maximization, $MP_K(K,L) = R/P^{va}$, yields $MP_K(K,G(Y,K)) = R/P^{va}$, or $K = Z(Y, R/P^{va})$, where R is the nominal cost of capital, P^{va} is the value added price-deflator, $Z_Y' > 0$, and $Z_{R/P^{va}}' < 0$. Log-linearizing the latter expression yields the stochastic counterpart given by equation 10.

where θ is the adjustment rate, and k is the actual capital stock. The stock of capital equals investment plus the stock of capital in the previous period minus depreciation, which can be rewritten as

$$i_t = \delta k_{t-1} + (k_t - k_{t-1}) \tag{13}$$

where δ is the rate of depreciation, and i is the log of nonresidential investment. Combining equations 11, 12, and 13 yields

$$i_t = \delta c_0 + \delta c_1 y_t + \delta c_2 RR_t + \delta c_3 (p_t^{agr} - p_t^{va}) + (\delta - \theta) k_{t-1} + \upsilon_{3t} \tag{14}$$

This equation can, in principle, be used to test the implications of the agricultural decline on investment. However, because k is likely to be integrated of an order higher than the other variables contained in the equation, an AR or MA process is introduced in the residuals; thus the test statistics will not follow standard normal distributions. A simple solution to this problem is to substitute $k_{t!1}$ out of the equation using lagged investment, because the stock is composed of lagged investment according to the following formula

$$k_{t-1} = \sum_{i=0}^{\infty} (1-\delta)^i i_{t-i-1} \tag{15}$$

Combining equations 14 and 15 and allowing for adjustment lags yields the following stochastic specification of the investment equation

$$\begin{aligned} \Delta i_{it} = {} & d_0 + d_1 \Delta i_{i,t-1} + d_2 \Delta (p_{it}^{agr} - p_{it}^{va}) + d_3 \Delta (p_{i,t-1}^{agr} - p_{i,t-1}^{va}) + d_4 \Delta y_{it} \\ & + d_5 \Delta y_{i,t-1} + d_6 \Delta RR_{it} + d_7 \Delta RR_{i,t-1} + \varepsilon_{it,4} \end{aligned} \tag{16}$$

where RR is measured as the nominal interest rate on a long-term government bond minus the growth in the economy-wide value-added price-deflator in decimal points.

Equation 16 is estimated using the generalized instrumental variable estimator of Kmenta over the period from 1927 to 1938 for ten countries and seven countries that exclude the United States, United Kingdom, and Germany. The following instruments are used for all regressors at period t: the log first differences of real currency in circulation and real government expenditure, at periods t and t ! 1. The following instruments are additionally used. For RR_{it}: $RR_{i,t!1}$; for $(p_{it}^{agr} - p_{it}^{va})$: $(p_{i,t-1}^{agr} - p_{i,t-1}^{va})$;and for y_{it}: $y_{i,t!1}$.

The results of estimating equation 16 are presented in Table 4. The coefficients that are insignificant at the 5-percent level were restricted to zero. Real agricultural prices, the real interest rate, and income are all highly significant and have their expected signs. The estimated coefficients of real agricultural prices are, as expected, highest for the sample that excludes the United States, the United Kingdom, and Germany. For the estimates that include the United States, the United Kingdom, and Germany, the estimated long-run elasticity of real agricultural prices is 0.73, which implies that the

TABLE 4
PARAMETER ESTIMATES OF THE INVESTMENT FUNCTION
(dependent variable is $\Delta\hat{i}_t$)

	All Countries		Excluding United States, United Kingdom, and Germany	
	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic
Constant	!0.04	11.5	!0.04	5.11
Δi_{t-1}	0.19	7.28	0.17	2.93
$\Delta(p_t^{va,a} - p_t^{va})$	0.31	8.69	0.27	3.18
$\Delta(p_{t-1}^{va,a} - p_{t-1}^{va})$	0.28	9.14	0.44	7.20
Δy_t	1.67	23.6	1.65	8.96
Δy_{t-1}	0.63	9.85	0.64	3.69
ΔRR_t	!0.78	13.4	!0.45	3.36
SC(1)	0.16		0.20	
SC(2)	0.11		0.22	
Het(6)	10.3		6.25	
R^2	0.97		0.91	
N	10		6	
Observations	120		72	

Notes: See the notes to Table 3. Data for the following countries are included in the estimates: Australia, Canada, Denmark, Finland, Germany, Italy, Japan, Sweden, the United Kingdom, and the United States. The estimation period is 1927–1938. The data period commences in 1924.

direct effects of the 21-percent decline in real agricultural prices on average contributed to a 15.3-percent decrease in investment from 1929 to 1932. Furthermore, if just half of the increase in the real interest rate from 1929 to 1932 is attributed to the price decline of agricultural products, then the 5.8 percentage point increase in the real interest rate from 1929 to 1932 contributed to a further 2.3-percent decline in investment in the short run and 2.8 percent in the long run. Finally, if just half of the 10-percent decline in real income is due to the price decline of agricultural products, then a further 11.5-percent decline in investment in the short run and 14.1 percent in the long run, can be attributed to the agricultural decline. These calculations show that regardless of the proportion of the decrease in income and the increase in the real interest rate which is ascribed to the reduction in real agricultural prices, the agricultural price decline contributed significantly to the 52-percent decline in investment over the period from 1929 to 1932.

INTERNATIONAL TRANSMISSION OF THE DEPRESSION

In the previous sections it has been shown that some countries suffered more from the Depression than others because they experienced a more pronounced decrease in nominal and real agricultural prices and because they had a larger agricultural sector. This begs the question why the cross-

country paths of agricultural prices were so different, and how the Depression was transmitted internationally. To examine these issues, the following price equation for agricultural products is estimated

$$\Delta p_{it}^{va,a} = f_0 + f_1 \Delta p_{i,t-1}^{va,a} + f_2 \Delta p_{it}^{w,agr} + f_3 \Delta p_{i,t-1}^{w,agr} + f_4 D_{1933}^{USA} + f_5 D_{1934}^{USA} + f_6 D_{1935}^{USA} + \varepsilon_{it,5} \quad (17)$$

where D_j^{USA} is a dummy for the United States in year j, and $p^{w,agr}$ is the log of world prices of agricultural products in domestic currency and adjusted for tariffs. More precisely $p^{w,agr} = \ln[P^{w,agr,USD} \cdot E(1 + TR) / (1 + TR^w)]$, where $P^{w,agr,USD}$ is world prices of agricultural products in USD exclusive of tariffs, E is the domestic currency price of USD, TR is the average tariff rate on imports in decimal points, and TR^w is the world tariff rate in decimal points.[63] World prices are divided by $(1 + TR^w)$ to allow for the effects of world tariffs on prices of products received by domestic producers. Suppose that the world tariff rates increase. Then domestic farmers have to lower their domestic currency denominated prices proportionally to the tariff increase, in order to remain competitive in their export markets. TR is calculated as total duties received by governments divided by total import values. TR^w is calculated as a weighted average of TR for the most important importers of agricultural products.[64]

The U.S. impulse dummies are included in the equation to accommodate the potential effects on U.S. agricultural prices of the U.S. agricultural scarcity program which aimed at stimulating prices of agricultural products in an attempt to improve the earnings of the depressed agricultural sector. The program gave farmers incentives to curb the effective supply of wheat, cotton, corn-hogs, dairy products, and tobacco by reducing the land under cultivation, among other things.[65] The program, which was administered under the Agricultural Adjustment Administration (AAA), gradually took effect over the period from late 1933 to 1935. The historical record suggests that the AAA-initiated scarcity program effectively curbed the U.S. supply of the products that were covered under the program.[66] However, the question remains as to the extent to which the program was able to increase prices of agricultural products. The factors, which were crucial to the success of the program, were the importance of U.S. agricultural production on the world market and the degree of world-wide competitiveness.

Equation 17 is a standard model of agricultural pricing that encompasses both the theory of the law of one price and the theory of pricing-to-market

[63] The restriction that the coefficients of $P^{w,agr,USD}/(1 + TR^w)$, E, and $(1 + TR)$ are the same cannot be rejected at the 5 percent level ($F(3,177) = 0.38$).

[64] The weights are the following: United Kingdom 25 percent, United States 25 percent, Germany 25 percent, France 15 percent, Sweden 5 percent, and Switzerland 5 percent. The weights are approximations. I was only able to find statistics on imports of agricultural products for the United States, the United Kingdom, Germany, and Switzerland. The numbers for France and Sweden are guestimates. See the data appendix for sources.

[65] Saloutos, *American Farmer*; and Schlesinger, *Coming*.

[66] Saloutos, *American Farmer*, chap. 5; and Schlesinger, *Coming*, chap.4.

where changes in exchange rates, world prices, and tariff rates are only partially passed through.[67] Under the law of one price, domestic currency prices of agricultural products are determined in the world market and only deviate from world prices due to exchange rates, tariffs, and transport costs. Hence, we would expect the coefficient of $p^{w,agr}$ to be close to one. Currency depreciations and increases in domestic import duties result in proportionally higher prices received by farmers in domestic currency. By contrast, domestic producers have to lower their price in an environment of increasing world tariff rates in order to maintain their competitiveness. In an environment of pricing-to-market behavior the coefficient of $p^{w,agr}$ is less than one because importers, exporters, and farmers take advantage of depreciations, for instance, to enhance their earnings.

Equation 17 is estimated using GMM for 15 countries over the period 1929 to 1936 and the data period commences in 1924. Log first differences of real currency in circulation and real government spending in periods t and t ! 1 are used as instruments in addition to the instruments given by equation 2. Equation 17 is additionally estimated without using instruments using GLS to correct for cross-country heteroscedasticity, because the validity of the instruments cannot be maintained, as discussed later.

The results of estimating equation 17 Using GMM are shown in Table 5. The lagged world agricultural price is restricted to zero because its estimated coefficient was insignificant. The Sargan test for instrument validity indicates that the null hypothesis of instrument validity cannot be maintained. Using lagged world prices of agricultural products and further lags of the other instruments improves the instrument validity test. It is therefore useful to compare the GMM results with the GLS results to see whether the results are sensitive to the choice of estimator. The estimated coefficients of world agricultural prices are highly significant and the coefficient estimates are very similar for the GMM and the GLS estimates. A 1-percent increase in world market prices of agricultural products increases domestic prices by 0.6 percent in the first year for both estimates and by 0.84 percent and 0.73 percent in the long run for the GMM and the GLS estimates, respectively. Since we would expect a 100-percent pass-through of world prices to domestic prices in a perfectly competitive market, the coefficient estimates suggest an element of imperfect competition, probably due to changing mark-ups of wholesalers of agricultural products.

The estimated coefficients of the U.S. dummies reveal that the AAA-initiated scarcity program was very effective in increasing prices of agricultural products in the United States. The estimates suggest that the program lead to an increase in the price of U.S. agricultural products over the period from 1933 to 1935 of 31 percent (GMM estimates) or 33 percent (GLS estimates). Hence, the AAA-initiated program played an important role for

[67] See Jabara and Schwartz, "Flexible Exchange Rates."

TABLE 5
PARAMETER ESTIMATES OF AGRICULTURAL PRICES
(dependent variable is $\Delta\hat{p}_t^{va,a}$)

	GMM Estimates		GLS Estimates	
	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic
Constant	0.01	2.69	0.00	0.60
$\Delta p_{t-1}^{va,a}$	0.30	2.53		
$\Delta p_t^{w,agr}$	0.59	6.14	0.55	12.3
$\Delta p_{t-1}^{w,agr}$			0.18	4.06
D_{1933}^{USA}	0.12	2.35	2.64	2.64
D_{1934}^{USA}	0.06	1.35	1.90	1.90
D_{1935}^{USA}	0.13	2.55	1.87	1.87
Sargan(25)	47.9			
SC(1)	!1.42		!0.23	
SC(2)	!2.01		!0.12	
R^2			0.67	
N	15		12	
Observations	144		156	

Notes: See notes to Tables 1 and 3. The GMM estimates: The country sample and the instruments are the same as considered in the estimates in Table 1, and the estimation period is from 1927 to 1936. The data period commences in 1924. GLS estimates: The same countries are included in the sample as the GMM estimates excluding Germany, Hungary, and Spain, and the estimation period is from 1924 to 1936.

the recovery in the U.S. agricultural sector along with the abandonment of the Gold Standard in 1933. Because the United States had a significant share of world agricultural production, the AAA-initiated program also had positive ramifications for farmers outside the United States and had macroeconomic implications, which were quite different from the devaluation of the dollar.[68] Whereas the devaluation of the U.S. dollar was to a large extent beggar-thy-neighbor policy, which will be discussed later, the AAA-initiated program had the opposite effect on the economies outside the United States, and speeded up the necessary adjustment of the acreage under cultivation.

The implications of the estimates in Table 5 for the Depression are profound. Domestic currency prices of agricultural products were determined in the world market on an almost one-to-one basis. This suggests that the decreasing world prices of agricultural products were important in transmitting the Depression internationally. Individual countries had the autonomy to influence their own fates by changing exchange rates and to some extent,

[68] Employment in agriculture can be used as a rough indicator of the importance of United States agricultural production in the world. The United States employed 17 percent of the combined agricultural work force in North America, Western Europe, and Japan. Because the labor productivity in agriculture was probably substantially higher in the United States than elsewhere, the 22 percent underestimates the importance of the United States as a producer of agricultural products in the world economy.

also by changing their tariffs. Tariff policies were beggar-thy-neighbor policies. In response to increasing tariffs by some countries, other countries were forced to lower the prices of their agricultural products, both domestically and internationally. Hence, the tariff war had important redistributional consequences among nations. Countries that were net importers of agricultural products could effectively protect prices of their own agricultural produce from further decline by tariff hikes. Finland, Austria, and Switzerland, for instance, alleviated a full-blown agricultural crisis by increasing their tariff rates significantly from 1927 to 1931.[69] However, net exporters of agricultural products could only protect prices of products sold in the domestic market, not their export prices, unless they were willing to subsidize them.

A further implication of the estimates is that the countries that left the gold standard first were the first to experience a recovery in agricultural prices. The depreciation of the currency that followed the abandonment of the gold standard lead to higher domestic prices of agricultural products. This in turn helped arrest the deflationary spiral and increased the purchasing power of the agricultural sector. The countries that devalued their currencies were not nearly as much affected by the Depression as countries that maintained the gold value of their currency at 1929 parity, in the late 1920s and the beginning of the 1930s. Spain stands out as a country that devalued its currency significantly in 1930, 1931, and 1932 and therefore almost completely prevented the domestic prices of their agricultural products from decreasing.

The hypothesis that agricultural price deflation was an important international transmitter of the Depression stands in contrast to the hypothesis that monetary shocks transmitted the Depression internationally by the gold standard. However, this does not imply that monetary shocks were not important for agricultural prices, nor that an earlier abandonment of the gold standard would not have alleviated the agricultural crisis. Currency depreciations were mostly associated with changes in monetary stocks.[70] Furthermore, an early world-wide abandonment of the gold-standard system might have alleviated the world-wide agricultural crisis. A more flexible exchange rate regime would have allowed the countries that were the most severely affected by the agricultural crisis to depreciate the value of their currencies. This possibility was of course limited to small producers on the world market, because the price effects of a currency depreciation would have been counterbalanced by declining world prices for large producers. Kindleberger

[69] Liepmann, *Tariff Levels*, p. 413. Another reason why some countries were less severely affected by the world-wide agricultural crisis than others was that their agricultural production was primarily based on animal produce, for which prices decreased significantly less than prices on nonanimal agricultural products. Countries such as Ireland and the United Kingdom were predominantly producers of animal products and hence escaped the crisis in much better shape than the large wheat producing countries such as Australia, United States, Canada, and Argentina.

[70] Eichengreen and Sachs, "Exchange Rates."

suggests that a route to increase prices was for all countries in the world to simultaneously devalue against the gold.[71] This would not only imply a capital gain on gold, which could be used to stimulate aggregate demand, but also an increase in the money supply which would have enhanced demand even further. This would have required world-wide co-ordination to prevent the widespread beggar-thy-neighbor devaluations of the 1930s, as identified be Eichengreen and Sachs.[72]

To get an impression of the relationship between the recovery and the change in agricultural prices, Figure 6 plots the changes in real GDP against real agricultural prices in the recovery phase from 1933 to 1936. The figure shows a significant positive relationship between increases in real agricultural prices and the income recovery.[73] As in Figure 2, there is a strong positive correlation. The figure indicates that the recovery in the agricultural sector was potentially important for the recovery in the world economy. For the United States, however, it remains an open question the extent to which the recovery in the economy was driven by the agricultural recovery. As the preceding analysis showed, the small size of the agricultural sector in countries such as the United States, made the well being of this sector less influential for the well being of the overall economy. Christina Romer, for instance, has shown that monetary factors were to a large extent responsible for the recovery from the Depression in the United States.[74]

THE ROLE OF DEMAND AND SUPPLY FACTORS IN THE COLLAPSE IN AGRICULTURAL PRICES

It has been advanced by several economic historians that the Depression started in the United States, and perhaps also in Germany, and was transmitted internationally from there.[75] This section discusses how the developments within the U.S. economy influenced and interacted with the world markets for agricultural products and the role played by demand and supply factors. First, the developments in agriculture from World War I are considered.

[71] Kindleberger, *World*, p. 225.

[72] Eichengreen and Sachs, "Exchange Rates," p. 943.

[73] Ordinary least squares regression for the countries considered in Figure 6, resulted in the following estimates

$$\hat{z}_{1933-36} = \underset{(1.23)}{4.87} + \underset{(4.25)}{0.57}\,\pi^{agr}_{1933-36} \qquad R^2 = 0.60 \qquad N = 14$$

where the numbers in parentheses are absolute *t*-statistics. Here $z_{1933\text{-}36}$ is the percentage change in real GDP over the period from 1933 to 1936, and $\pi^{agr}_{1933-36}$ is the percentage change in real agricultural prices over the same period. See Figure 6 for country sample. Spain and Poland are not included in the sample because data are not available for these countries from 1933 to 1936. The null hypothesis that the United States, Canada, and New Zealand are not outliers cannot be rejected at the 10 percent level (the *t*-statistic is 1.30 for the United States, 1.09 for Canada, and 1.55 for New Zealand). Note, that unlike the estimates over the period from 1929 to 1932 in Figure 2, Denmark is not an outlier in Figure 6.

[74] Romer, "What Ended."

[75] See for instance Temin, *Lessons*; Eichengreen, *Golden Fetters* and "Origins"; and Romer, "Nation."

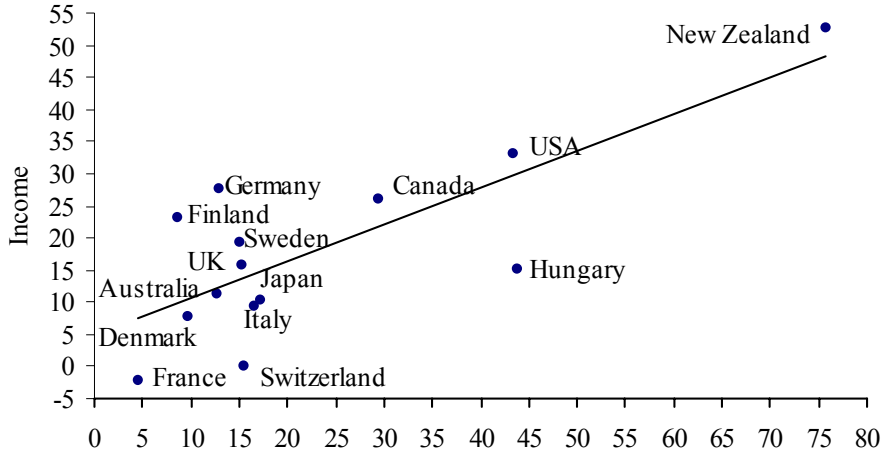

FIGURE 6
PERCENTAGE CHANGE IN REAL GDP FOR THE WHOLE ECONOMY AND REAL AGRICULTURAL PRICES, 1933–1936

Note: Real agricultural prices are computed as the value-added price deflator in agriculture divided by the value-added price deflator for the whole economy.

The causes of the collapse in agricultural prices during the Depression date back to World War I, when the shortage of agricultural products brought their prices up. The high prices resulted in an increase in acreage under cultivation, enabled by foreign loans.[76] The world supply of agricultural products increased further when the agricultural sectors of the nations that were involved in World War I returned to their prewar production levels. Because the growth in demand for food could not keep pace with the growth in supply, the stocks of agricultural products started to mount up from the mid 1920s.[77] By increasing the stocks, the producers of agricultural products prevented any significant reduction in agricultural prices before 1929.

However, the overproduction of agricultural products and the mounting stocks made agricultural prices vulnerable to shocks in demand, international lending, and the international financial system. It was only a matter of time before the bubble burst. The longer the stocks were left to grow the more catastrophic the unavoidable price collapse was destined to be. The combination of a shortage of foreign reserves in some countries and a significant reduction in foreign lending in 1928 and 1929 aggravated the situation during the first years of the Depression. In addition, due to the lack of foreign reserves, the Soviet Union decided to force grain exports, which re-

[76] Eichengreen, *Golden Fetters*, p. 228–29.
[77] League of Nations, *Agricultural Crisis*.

sulted in an increase in grain exported by the Soviet Union from 100,000 metric tons in 1929 to 2,290,000 tons in 1930, and further to 5,220,000 tons in 1931.[78] Similarly the campaign to "Grow Australian" in mid-1929 increased wheat acreage by 22 percent and furthered the price decline of wheat.[79] Moreover, German imports of Australian wool dropped by 19 percent from 1928 to 1929 when Germany stopped borrowing, and contributed to the decline in wool prices.

Overall the discussion here suggests that the agricultural overproduction was the underlying cause of the agricultural crisis but that the shocks to demand and the financial sector triggered the price decline. This is in line with arguments advanced by Temin that "the long-run causes of the agricultural depression . . . were the result of forces within agriculture itself. The timing of the deflation was the result of forces outside this sector."[80] Hence, it was just a matter of time before the decline in prices of agricultural products started to accelerate. The decline in the economy-wide output that started in the United States, and probably also in Germany, led commodity traders to revise their forecasts of demand, and hence prices, downward and to dump stock on the market, thus initiating the price collapse of agricultural products. Furthermore, Kindleberger notes that "as demand for commodity imports in Europe and the United States continued to fall, the heavily indebted nations boosted their commodity exports in a desperate effort to generate the foreign exchange needed to service their debts."[81]

CONCLUSION

This article has argued that the decline in prices of agricultural products was a significant contributor to the decrease in output and the international transmission of the Depression. The decrease in agricultural prices from 1928 to 1932 resulted in a substantial redistribution of income from the agricultural sector to the nonagricultural sector, initiated a deflationary spiral, and had spillover effects to the nonagricultural sector. The estimates, from panel data, in this article indicated that the redistribution of income within countries resulted in a substantial decline in consumption because of asymmetric MPC's among those who gained and those who lost income as a consequence of the change in relative prices of agricultural products. Moreover, nonresidential investment was severely adversely affected by the agricultural crisis, which, due to negative spillover effects, resulted in increasing cost of funding and increasing uncertainty and lowered the willingness of banks to lend. The expenditure effects of the decrease in prices of agricultural products were found to be most pronounced in countries that

[78] Kindleberger, *World*, pp. 80–81.
[79] Kindleberger, *World*, p. 80.
[80] Temin, *Did Monetary Forces*, p. 149.
[81] Kindleberger, *World*, p. 230.

were heavily dependent on agriculture. The effects were lower, but still significant, for the United States, United Kingdom, and Germany, which were less dependent on agriculture than many other countries.

It was furthermore shown that the deflation from 1929 to 1932 was, to a large degree, a result of the decline in agricultural prices and that changes in the monetary stock did not have a significant independent effect on prices. Accommodating both the direct expenditure effects and the indirect deflation-induced expenditure effects of the decreasing agricultural prices, the empirical estimates demonstrated that the agricultural crises had more important macroeconomic effects than has previously been acknowledged in the literature.

The hypothesis that decreasing world prices of agricultural products helped transmit the Depression internationally also gained support from the estimates. Prices of domestic agricultural products were shown to be determined by world prices of agricultural products, exchange rates, and tariffs. Consequently, some countries suffered more from the international agricultural crisis than others because they were late to leave the gold standard, did not increase their tariffs as much as others, or produced agricultural products which declined more in price than other agricultural products. The countries that were late to leave the gold standard forced their own farmers to keep their prices low, and their economies consequently remained depressed. Hence, the burden of the agricultural crisis was to some extent put on the shoulders of countries that were the last to devalue their currencies and were less pushy in their tariff policies. An early abandonment of the gold standard or international co-operation to devalue the currency value of gold and allow countries that were more severely affected by the terms of trade shocks to devalue more than others, might have alleviated a full-blown agricultural crisis. However, it would not have solved the root of the problem, namely the oversupply of agricultural products.

Appendix 1: Variables

The numbers in parentheses are the time-coverages that differ from the general coverage used in this article. All variables are measured in logs except when noted. The coverage in space and time is (except when noted) 1924–1936 for the following countries: Australia (AUD), Canada (CAN), Denmark (DEN), Finland (FIN), France (FRA), Germany (GER), Hungary (HUN), Italy (ITL), Japan (JAP), New Zealand (NZ), Spain (SPA), Sweden (SWE), Switzerland (SWZ), United Kingdom (United Kingdom), and United States. The coverage for GER is 1927–1936, for HUN is 1926–1936, and for SPA is 1924–1935.

y	Real GDP
$p^{va,a}$	Agricultural value added price-deflator
p^{va}	Economy-wide value added price-deflator
p^{m}	Manufacturing output prices
p^{im}	Import prices of manufactures

ulc	Unit labor cost
p^{raw}	Raw material prices
y^*	Potential output
$h0$	Currency in circulation
$M1$	Currency in circulation plus deposits in savings and commercial banks
w	Hourly labor costs
pr	Labor productivity
m	Monetary stock
v	Velocity of money
m^x	Disequilibrium in the money market
c	Total real consumption—coverage (1924–1936): AUD, DEN, FIN, GER, ITL, JAP, SWE, UK, and US
y^d	Disposable income measured as real GDP
i	Real nonresidential investment—coverage (1924–1936): AUD, CAN, DEN, FIN, GER, ITL, JAP, SWE, UK, and US
RR	Real interest rate—calculated as the nominal interest rate on a long-term government bond minus the growth rate in the value-added price deflator
k	Capital stock
k^*	Desired capital stock
D_j^{USA}	Impulse dummies for the United States in 1933–1935, not in logs
$p^{w,agr}$	World agricultural prices in domestic currency and exclusive of tariffs
$p^{w,agr,USD}$	World agricultural prices in USD including tariffs
E	Exchange rate measured as domestic currency price of USD, not in logs
TR^{im}	Import tariff rate
TR^{w}	World tariff rate

APPENDIX 2: DATA

IMPORTS OF AGRICULTURAL PRODUCTS

United States: United States. Department of the Commerce, Bureau of the Census. *Historical Statistics of the United States: Colonial Times to 1970*. Washington, DC: GPO, 1975.

Germany: Hoffmann, W. G. *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. New York: Springer-Verlag, 1965.

Switzerland: Ritzmann-Blickenstorfer, H. *Historical Statistics of Switzerland*. Zurich: Chronos, 1996.

United Kingdom: Mitchell, B. R. *British Historical Statistics*. Cambridge: Cambridge University Press, 1988.

NET FARM INCOME

Canada: Bellerby, J. R. *Agriculture and Industry Relative Income*. London: Macmillan, 1956.

United States: United States Department of the Commerce, Bureau of the Census. *Historical Statistics of the United States: Colonial Times to 1970*. Washington, DC: GPO, 1975.

New Zealand: Hussey, D. D., and B. P. Philpott. "Productivity and Income of New Zealand Agriculture 1921–1967." Agricultural Research Unit, Lincoln College, Research Report No 59, 1969.

Denmark: Svennilson, I. *Growth and Stagnation in the European Economy.* Geneva: United Nations Economic Commission for Europe, 1954.

Netherlands: Bellerby, J. R. *Agriculture and Industry Relative Income*. London: Macmillan, 1956.

AGRICULTURAL VALUE-ADDED PRICE DEFLATOR

Poland: League of Nations. "Price Index of Agricultural Products." *Money and Banking*, Geneva,1934.

Canada: Leacy, F. H., Ed. *Historical Statistics of Canada*, Ottawa: Statistics Canada, 1983.

United States: United States Department of the Commerce, Bureau of the Census. *Prices of Farm Products Received by the Farmer (All Products)*. Washington, DC: GPO, 1975.

Japan: Ohkawa, K., M. Shinchara, and L. Meissner. *Patterns of Japanese Economic Development: A Quantitative Appraisal*. New Haven, CT: Yale University Press, 1979.

Australia: Vamplew, W., Ed., *Australians: Historical Statistics*. Broadway, N.S.W.: Fairfax, Syme & Weldon Associates, 1987.

New Zealand: Hussey, D. D., and B. P. Philpott. "Productivity and Income of New Zealand Agriculture 1921–1967." Agricultural Research Unit, Lincoln College, Research Report No 59, 1969.

Denmark: Hansen, S. A. *Økonomisk Vækst i Danmark*. København: Akademisk Forlag, 1974.

Finland: Hjerppe, R. *The Finnish Economy, 1860–1985*. Helsinki: Bank of Finland, Government Printing Centre: 1989.

France: Toutain, J.-C. *Le Produit Interieur Brut de la France de 1789 a 1982*. Paris: Economies et Societes, 1987.

Germany: Hoffmann, W. G. *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. New York: Springer-Verlag, 1965.

Hungary: Eckstein, A. "National Income and Capital Formation in Hungary, 1900–1950." In *Income and Wealth*, Series 5, edited by S. Kuznets, 175–96. London: Bowes & Bowes, 1955.

Italy: Fua, G. *Notes on Italian Economic Growth 1861–1964*, Milano: Mvlta Pavcis, 1965.

Spain: Instituto De Estudies Fiscales. *Datos Basicos Para La Historia Financiera De Espana (1850–1975)*. Madrid: Ministerio de Hacienda, 1976.

Sweden: Johansson, O. *The Gross Domestic Product of Sweden and its Composition 1861–1955*, Stockholm: Almqvist and Wiksell, 1967.

Switzerland: Unweighted Average of WPI of Animal and Vegetable Products. Ritzmann-Blickenstorfer, H. *Historical Statistics of Switzerland*. Zurich: Chronos, 1996.

United Kingdom. Mitchell, B. R. *British Historical Statistics*. Cambridge: Cambridge University Press, 1988.

IMPORT PRICES

Import unit values. The same sources as for the agricultural value-added price deflator with the following exceptions:

New Zealand: Muriel, F. L. R. *An Economic History of New Zealand to 1939*, London: Collins, 1970.

France, Italy, and the United Kingdom: Maddison, A. "Growth and Fluctuations in the World Economy, 1870–1960." *Banco Nazionale del Lavoro Quarterly Review* (1962): 127–91.

Spain: Carrearas, A., Ed. *Estsdisticas Historicas De Espana*. Madrid: Fundacion Banco Exterior, 1989.

COMMODITY PRICE INDEX

Warren, G., and F. A. Pearson. *World Prices and the Building Industry*. New York: John Wiley and Sons, 1937. Index for 40 basic commodities, where the same weighting was used for all countries. The weights reflect the importance of the commodity in the world.

WORLD PRICE INDEX OF COMMODITIES AND AGRICULTURAL PRODUCTS

Warren, G., and F. A. Pearson. *World Prices and the Building Industry*. New York: John Wiley and Sons, 1937.

CONSUMER PRICES, NOTES IN CIRCULATION AND DEPOSITS, AND EXCHANGE RATES

League of Nations. *Monthly Bulletin of Statistics*. Geneva: League of Nations, various years.

TARIFF RATES

Import duties divided by total imports. Mitchell, B. R. *European Historical Statistics 1750–1975*. London: Macmillan, 1975, *International Historical Statistics: Americas and Australasia*, London: Macmillan, 1983, and *International Historical Statistics: Asia and Africa*, London: Macmillan, 1982.

INTEREST RATES

League of Nations. *Money and Banking*. Geneva: League of Nations, various years, and *Monthly Bulletin of Statistics*. Geneva: League of Nations, various years.

PRICES OF NONAGRICULTURAL COMMODITIES

Prices of commodities minus the value-added price deflator for agriculture multiplied by a half. Both indexes are standardized to have the same mean in the sample period.

VALUE OF FARMLAND

Canada: Leacy, F. H., Ed. *Historical Statistics of Canada*, Ottawa: Statistics Canada, 1983.

United States: United States. Department of the Commerce, Bureau of the Census. *Historical Statistics of the United States: Colonial Times to 1970*. Washington, DC: GPO, 1975.

WORLD MONETARY STOCK

Sum of USD-denominated notes in circulation and deposits.

REAL GDP

Maddison, A. 1995, *Monitoring the World Economy 1820–1992*. Paris: Development Centre, OECD, 1995; and Mitchell, B. R. *European Historical Statistics 1750–1975*. London: Macmillan, 1975, *International Historical Statistics: Americas and Australasia*, London: Macmillan, 1983, and *International Historical Statistics: Asia and Africa*, London: Macmillan, 1982; except for New Zealand, where the following source has been used: Cjhapple, S. "How Great was the Depression in New Zealand? Neglected Estimates of Interwar Aggregate Income." *New Zealand Economic Papers*, 28 (1994): 195–203.

CONSUMER EXPENDITURE

United States, Japan, and Italy: Liesner, T. *One Hundred Years of Economic Statistics*, Oxford: The Economist, 1989.

Australia: Butlin, M. W. "A Preliminary Annual Database 1900/01 to 1973/74." Research Discussion Paper 7701, The Reserve Bank of Australia, 1977.

Denmark: Hansen, S. A. *Økonomisk Vækst i Danmark*. København: Akademisk Forlag, 1974.

Finland: Hjerppe, R. *The Finnish Economy, 1860–1985*. Helsinki: Bank of Finland, Government Printing Centre: 1989.

Germany: Hoffmann, W. G. *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. New York: Springer-Verlag, 1965.

Sweden: Johansson, O. *The Gross Domestic Product of Sweden and its Composition 1861–1955*, Stockholm: Almqvist and Wiksell, 1967.

NOMINAL GDP

Poland: CPI multiplied by real GDP, League of Nations, *Monthly Bulletin*; and Maddison, A. 1995, *Monitoring the World Economy 1820–1992*. Paris: Development Centre, OECD, 1995.

Canada: Leacy, F. H., Ed. *Historical Statistics of Canada*, Ottawa: Statistics Canada, 1983.

United States: United States Department of the Commerce, Bureau of the Census. *Historical Statistics of the United States: Colonial Times to 1970*. Washington, DC: GPO, 1975.

Japan: Ohkawa, K., M. Shinchara, and L. Meissner. *Patterns of Japanese Economic Development: A Quantitative Appraisal*. New Haven, CT: Yale University Press, 1979.

Australia: Vamplew, W., Ed., *Australians: Historical Statistics*. Fairfax. 1987.
New Zealand: Real GDP multiplied by CPI.
Denmark: Hansen, S. A. *Økonomisk Vækst I Danmark*. København: Akademisk Forlag, 1974.
Finland: Hjerppe, R. *The Finnish Economy, 1860–1985*. Helsinki: Bank of Finland, Government Printing Centre: 1989.
France: Toutan, J.-C. *Le Produit Interieur Brut de la France de 1789 a 1982*. Paris: Economies et Societes, 1987.
Germany: Hoffmann, W. G. *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. New York: Springer-Verlag, 1965.
Hungary: Eckstein, A. "National Income and Capital Formation in Hungary, 1900–1950." In *Income and Wealth*, Series 5, edited by S. Kuznets, pages???. London: Bowes & Bowes, 1955.
Italy: Fua, G. *Notes on Italian Economic Growth 1861–1964*, Milano: Mvlta Pavcis, 1965.
Spain: Instituto De Estudies Fiscales. *Datos Basicos Para La Historia Financiera De Espana (1850–1975)*. Madrid: Ministerio de Hacienda, 1976.
Sweden: Johansson, O. *The Gross Domestic Product of Sweden and its Composition 1861–1955*, Stockholm: Almqvist and Wiksell, 1967.
Switzerland: Ritzmann-Blickenstorfer, H. *Historical Statistics of Switzerland*. Zurich: Chronos, 1996.
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INDUSTRIAL PRODUCTION

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