Harvests and Business Cycles in Nineteenth-Century America

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Abstract

From the late 1870s to the First World War, the size of the cotton harvest was strongly associated with fluctuations in the next year's industrial output, accounting for most major cyclical peaks and troughs. The relation does not appear to hold for the wheat crop, or for the cotton crop in the antebellum period. We explore a variety of explanations for the pattern, both monetary and "real."

Economists have long been intrigued by the possibility that business cycles are caused by a few types of identifiable, exogenous shocks to the economic system. For the postwar U.S. economy, the most plausible candidate is increases in oil prices, following Hamilton's (1983) observation that (with one exception) the "tendency...for oil price increases to be followed by recessions has in fact characterized every recession in the United States since World War II" (p. 229). This purported pattern has been explained in a variety of ways: some argue that it results from interactions between oil price changes and the monetary system (Bernanke, Gertler, and Watson, 1997); others propose that oil price hikes reduce the productivity of existing capital or directly "disrupt certain categories of spending by consumers and firms" (Hamilton, 2000, p. 35).

Before the 1930s, the most discussed candidate was natural shocks to agricultural output, caused by weather or crop diseases. William Stanley Jevons (1884) famously speculated that sunspots caused variations in British industrial activity through their effect on crop yields in tropical countries. Many economists claimed that an effect of agricultural shocks on industrial output was clearly evident in the United States (Moore, 1914; Robertson, 1915; Pigou, 1927; Timoshenko, 1930; H. Stanley Jevons, 1933). Looking back at U.S. experience from the 1900s, A. Piatt Andrew (1906) claimed that "one cannot review the past forty years without observing that the beginnings of every movement toward business prosperity and the turning-points toward every business decline… were closely connected with the out-turn of crops" (p. 351).

Recent literature has paid little attention to the possible role of harvest shocks as a cause of business cycles (as opposed to the effects on farming of macroeconomic shocks originating elsewhere, discussed by Ardeni and Freebairn [2002]). It is clear that in some countries, for example India, natural events affecting farm output have been an important cause of cyclical-frequency variations in industrial production (Chitre, 2001; Patnaik and Sharma, 2002). But early NBER researchers and most others examining U.S. data from the late nineteenth and twentieth centuries concluded that farm output was entirely unrelated to real activity in other sectors of the economy. In his study of U.S. industrial production in the period between the War Between the States and the First World War, Edwin Frickey (1942) concluded: "The causal relationships between the agricultural and non-agricultural groups certainly did not express themselves in the form of any simple correlation" (p. 229). According to Wesley Mitchell, "In no other great industry for which we have records are the cyclical fluctuations so irregularly related to business cycles as in crop husbandry" (1951, p. 58). Arthur Burns (1951) observed that farm output and employment "undergo cyclical movements, but they have little or no relation to business cycles" (pp. 7-8). Robert A. Gordon (1952) concluded: "It is unlikely that regular cycles in crop production play an important role in business fluctuations," though "Agriculture may have played a more important role than this implies during the nineteenth century, particularly when farm products bulked much larger in American exports than they do now and when agriculture accounted for a much larger share of total economic activity" (p. 386).

In this paper, we re-examine the relation between farm production and American business cycles from the early nineteenth century through the First World War. To indicate business-cycle movements in nonagricultural output, we rely mainly on the annual indexes of industrial production recently developed by Davis (forthcoming), which are significantly better for this purpose than the standard NBER business-cycle reference dates or the output series available for previous studies of business cycles across the whole of the nineteenth century.[1]

Using the Davis index along with other data, we observe some patterns that have escaped the notice of modern economists, including economic historians. In the period from the late 1870s through the First World War, variations in the size of the cotton harvest were strongly associated with fluctuations in the next year's industrial output. The magnitude of the relation is economically, as well as statistically, significant. In various regressions with annual industrial production indices as dependent variables, the addition to the right-hand side of the previous year's cotton crop size, expressed as

[1] Robert Gallman's well-known series on real GNP, used by Temin (1969) and James (1993), was not designed to reveal output movements on a business-cycle frequency (Rhode, 2002). Thomas Berry's annual real GNP series (Berry, 1988) relies on a set of spectacularly heroic assumptions (Calomiris and Hanes, 1994, p. 410). NBER business-cycle reference dates for the antebellum period are unreliable: they were based on movements in money price levels and anecdotal reports of business conditions, especially conditions in financial markets (Moore and Zarnowitz, 1986, pp. 744), which arguably did not bear the same relation to real activity in the antebellum period that they did in later periods (Temin, 1969).

deviation from a long-term trend, boosts the R-squared by about one-fourth. The size of the cotton harvest accounts for most of the cyclical peaks and troughs between the late 1870s and 1913. The relation does *not* appear to hold for the wheat crop, or for the cotton crop in the antebellum period. We explore a variety of explanations for the pattern, both monetary and "real."

In the first section of the paper, we discuss the possible links between agricultural fluctuations and business cycles suggested by old-fashioned and modern economic theories, and the effects attributed to crop fluctuations in some existing accounts of nineteenth-century American business cycles. In the second section, we describe the role of agriculture in the nineteenth-century U.S economy, the nature of markets for cotton and wheat, and natural shocks to crop production. In the third section, we describe the available data from the period, and the ways we define business cycles in industrial production and shocks to crop production. In the fourth section, we present statistical results that indicate the relations between crop shocks and business cycles. We also examine patterns with respect to crop prices, crop revenue, export revenues, interest rates and international specie flows that bear on possible explanations for the apparent relation between postbellum cotton harvests and business cycles.

I. American Agriculture and Business Cycles in Economic Theory and History

The relationship between industry and agriculture in the American economic development has long been a highly contentious issue. A number of studies consider questions about long-term effects and trend growth rates, such as the role of agriculture in nineteenth-century Kuznets cycles or "long swings" (for example Williamson, 1964; North, 1966), and whether agriculture and industry retarded each others' development by competing for labor, or complemented each other through gains from trade between the two sectors.[2]

[2] The authorities – Benjamin Franklin and Alexander Hamilton – that Meyer (2003) identifies with the two positions reflect the high profile of this long dispute. Stressing the competition between the sectors, Franklin observed "Manufactures are founded in poverty…. no man, who can have a piece of land of his own, sufficient by his labor to subsist his family in plenty, is poor enough to… work for a master. Hence while there is land enough in America for our people, there can never be manufactures to any amount or

In this paper, we focus specifically on the relation between agricultural production and the short-term fluctuations in industrial output that are generally referred to as business cycles. Theoretical discussions and historical narratives of U.S. business cycles refer to many ways that natural shocks to crop output could have affected industrial production. Some are essentially monetary, having to do with interactions between harvest shocks and money supplies or interest rates under the gold standard. Others are "real," in the sense that they could operate in an economy with perfectly flexible prices, or, more relevantly, under any monetary regime. These real mechanisms can be viewed in light of the modern "real business cycle" literature, though it is important to keep in mind that weather-related harvest shocks differ from the economy-wide or sector-specific "productivity shocks" that appear in many real-business-cycle models. Sector-specific productivity shocks are assumed to be persistent, affecting expected future factor productivity. Variations in harvests caused by weather affect the outcome of factor inputs applied in the past rather than the productivity of current or future inputs. Thus, there is no reason for a single good harvest to be associated with a transfer of labor or capital into farming, except to the degree that they are needed to bring in a larger crop.[3]

Monetary channels

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value." This position is consistent with a standard trade model where industry and agriculture compete for a given stock of labor and sell their products into large international market.

By way of contrast, Hamilton viewed agriculture and industry as complementary and, indeed, argued their prosperity was "intimately connected." A prosperous agricultural sector encouraged manufacturing by supplying less expensive raw materials as well as food for workers and by providing larger markets for industrial products. Manufacturing development in turn created a larger and more reliable market for agricultural products, one subject to fewer "injurious interruptions" to demand. The role of competition for labor was less problematic in Hamilton's view because manufacturing could employ women and child workers who were underutilized in farming and could attract new migrants from abroad.

Building on Callender and Schmidt, North (1966) offered an approach that bridges these positions. This approach treats the labor markets of the North and South as separate and non-competing. The South possesses such a comparative advantage in cotton production as to preclude local manufacturing. But the South provides a product market for northern manufacturing as well as key raw materials (cotton).

[3] Real business cycle theorists have proposed a wide variety of shocks as causes of business cycles, including rapid changes in the productivity of "home production", (Benhabib, Rogerson and Wright [1991]), but discussions of agricultural shocks are oddly absent from the literature. Da-Rocha and Restuccia (forthcoming) argue that the presence of a large farm sector in an economy amplifies the effects of productivity shocks *outside* agriculture, by increasing the elasticity of labor supply to non-agricultural sectors.

The United States was part of a functioning gold standard system from 1834 (when a revision of the official bimetallic silver-gold exchange ratio left silver undervalued at the mint) through 1860, and again from 1879 through 1914. Under the gold standard, natural shocks to a country's harvest of tradable crops could affect its economy through the relation between foreign trade and relative interest rates, that is the spread between the country's interest rates on liquid assets and interest rates in the rest of the gold-standard world. If international demand for the crop were sufficiently elastic, a good harvest would tend to increase the country's net export revenue for any given levels of domestic prices and relative interest rates. Unless foreign and domestic assets were viewed as perfect substitutes (in which case all adjustments could have taken place through capital flows at the same interest rates), such an exogenous increase in the country's net claims on the rest of the world must tend to decrease the country's relative interest rates through shifts in demand for internationally traded assets, and/or through an inflow (or smaller outflow) of gold; the latter would be an increase in high-powered money supply. The resulting decrease in required returns to domestic assets in general, perhaps including looser standards in credit rationing and long-term credit relationships (like those associated with bank loans), could spur all forms of spending. In the words of Andrew (1906), "in a country where agricultural products form an important factor in foreign commerce, the size of the crops will exert a considerable influence upon the balance of trade and the international movement of gold. The extent of the bank reserves in the great financial centres and the contraction or expansion of general credit may in consequence depend most importantly upon the output of the season's harvests...When the American crops are abundant, our exports very naturally tend to increase, and gold imports are apt to occur. That in turn means large cash holdings in the banks, with, under normal conditions, the accompaniments of expanding credit and buoyant trade" (p. 326).

Historical accounts of nineteenth-century business cycles often refer to monetary effects of harvest shocks. Within the antebellum period, the focus is usually on the policies followed by the Bank of England and their interactions with the fragile U.S. banking system. Harvests in the U.S. and elsewhere are often cited as a factor affecting the British balance of payments and hence the Bank's actions aimed at maintaining its gold reserve (for example Ward-Perkins, 1950; Temin, 1969, p. 175; Hoffman and Lothian, 1984, pp. 467, 469). For the postbellum period, both Fels (1959) and Friedman and Schwartz (1963) refer several times to the relation between the wheat crop, wheat export revenues, and gold inflows. According to Fels, “Crop conditions affected business as a whole primarily through international trade when the United States was on the gold standard. Prior to 1879, the paper currency tended to offset any effect of crop conditions on business generally” (p. 60). When crop export revenues are high, “gold imports are increased (or exports decreased), thus increasing the money supply and bank reserves... Under freely fluctuating exchanges, increased demand for exports merely increases the exchange rate or, in this case, lowers the gold premium” (p. 87). In their *Monetary History of the United States*, Friedman and Schwartz argue that the cyclical expansion from 1879 to 1882 was “powerfully reinforced by accidents of weather that produced two successive years of bumper crops in the United States and unusually short crops elsewhere. The result was an unprecedentedly high level of exports… of crude foodstuffs” causing “a large inflow of gold… In classical gold-standard fashion, the inflow of gold helped produce an expansion in the stock of money and in prices” (pp. 97-98). Through the same mechanism, they assert, the accidental occurence of good grain crops in the U.S. and bad crops abroad was a factor in the upturn from “the mild contraction of 1890-91” (p. 107) and the recovery from a major business cycle after 1896 (pp. 140-141). Neither Fels nor Friedman and Schwartz mention the cotton harvest.

Contemporary descriptions of postbellum financial markets refer to both the cotton and wheat harvests as determinants of money-market conditions, associating big crops with higher export revenues, gold inflows, high reserve ratios in New York banks and lower short-term interest rates. Examples include Monetary Convention (1898, p. 220); Sprague (1903, p. 50; 1915, p. 499).

Real channels

The most obvious real effects of harvest shocks are on output in the specific industries that move crops, or for which farm-produced raw materials make up an important fraction of production cost. Robertson (1915) asserted, “the effect of an increased crop volume is to increase the demand for both land and sea transport, and so indirectly for the products of the iron and steel trades. The general view is that the volume of the United States wheat crop has an important effect upon the gross receipts of the railway companies and upon their orders for new rolling stock and so forth...The effect upon United States railway receipts of variations in the cotton crop (which is carried on the average a much shorter distance) and in the corn crop (of which a very large proportion is consumed on the farm) seems, however, to be considerably less important than that of variations in the wheat crop" (pp. 75-77). After referring to the importance of crop volumes for U.S. railroads, Andrew (1906) also pointed out that "A failure of the wheat crop will obviously depress the milling industry, and a failure of the cotton crop will curtail the earnings of the cotton factories, not only those in the vicinity of the cotton-growing states, but those in New or old England as well. A failure of the corn crop similarly will diminish the profits of cattle raising, may work injury to the packing interests, and to some extent may affect also the distillers of whiskey" (p. 328). According to Haberler (1948), crop variations had direct effects on output in "food and textile industries...A bumper crop will lower the price of the raw material in relation to that of the finished product, till either the manufacturers decide to absorb it all by increased output or the holders decide to keep the surplus in store. In any case, the activity of the later stages will be increased, because the holding of stocks never completely offsets harvest fluctuations" (pp. 158, 159). As Haberler noted, the effects of crop volume on crop-intensive manufacturing is diminished to the degree that stocks of raw or partially-processed crops are carried over from year to year. That depends in turn on the cost of storage and the quality of the capital markets that finance speculation in commodities.

Output in sectors far removed from crop handling can be affected by agricultural shocks if the harvest affects the rate of exchange between their products and other goods and services, that is, the sectoral terms of trade. This mechanism would resemble the response of a country's industries to changes in international terms of trade as described in real business cycle models such as Medoza (1995). If the crop is not exported or foreign demand is inelastic, a bad harvest must hike the relative price of the crop, which is to say it must worsen the rate of exchange between products of domestic nonagricultural sectors and crops or crop-intensive goods such as food. If the crop is exported with sufficiently elastic foreign demand, a bad crop may have little effect on the relative crop price, but it must depress farmers' incomes. Unless capital markets are perfect (in which case farmers could ensure or self-ensure against such transitory income shocks), that may depress farmers' demand for products of domestic industry, especially if farmers are subject to fixed debt payments. Finally, harvest-related shocks to farmers' income could affect nonagricultural sectors through farmers' demand for nonfarm assets: farmers may sell assets (or buy less) when a bad harvest that lowers incomes. That could raise real interest rates and reduce investment in nonfarm capital.

Along these lines, William Stanley Jevons (1884) argued that sunspots could cause variations in British industrial activity because they affected crop yields and real incomes in tropical countries, hence those countries' demand for British exports (p. 219).[4] H. Stanley Jevons (1933) asserted that "The buying power of rural areas, at home and abroad, is the major factor in demand for both production and consumption goods...The income of the agriculturist depends on the quantity harvested of each product and its price" (p. 549). The elasticity of demand for crops might be low, but "When the price does not give the farmer much increase of purchasing power there are other ways in which trade is stimulated by good harvests. The lower cost of food means a distinct increase of purchasing power by the non-agricultural population" (p.550). Pigou (1927) listed "variations in the yield of harvests, enabling industrialists to obtain better or worse

[4] In a series of recent articles and working papers, Solomos Solomou, Weike Wu, and company have used semi-parametric time series techniques to explore the impact of weather variables on agricultural output, consumer price levels, and other macroeconomic variables in the United Kingdom and western Europe over the late 19th and early 20th centuries. They generally found that annual precipitation and temperature (measured over the growing season) have non-linear effects on production and prices. For example, increased precipitation initially increases output (and reduces prices) and then decreases output (increases prices). This is as one might expect, but in the European context, the negative effects of deviating into excessive moisture tended to be greater than those associated with deficient moisture. When explaining price changes in Britain and Germany over the 1880-1913 period, they found that "(i)ncluding weather information improves the fit of the estimated models of inflation by approximately 10 per cent." Solomou and Wu (2002c) p. 10. In models examining the weather sensitivity of British macro-economy in the pre-1914 period, they concluded that weather effects accounted for about "50 per cent of the variation in aggregate agricultural output(,)… 6 per cent of the annual growth rate variations of the construction sector output (, and) 15 per cent of the variations in the growth of domestic coal demand." Solomou and Wu. (2002a) p 18. For Western Europe as a whole, they found weather shocks "account for approximately one third to two thirds of variations in agricultural production." Solomou and Wu (2002b) p 10.

terms for their products from the agricultural community," among the possible "real" causes of business cycles (others were changes in the taste for leisure and variations in the rate of technological innovation): when crops are especially good, "agriculturalists... will offer a larger demand in terms of agricultural produce – will raise their real demand schedule – for the products of industry" (p. 41). Andrew (1906) made similar points, adding "the very solvency of a large part of the agricultural population, and of those connected by business relations with them, depends to a considerable degree upon the outcome of the year's harvest. Whether or not the farmer will be able to repay loans which he has contracted, whether or not he will be able to settle his bills with tradesmen and dealers, and whether or not he can pay for his agricultural machinery and farm improvements, will in many cases be decided by the size of the crop" (p. 326). Surveying these arguments, Haberler (1946) judged that "in many or most cases, an increase in the crop of one country, unaccompanied by any change in the crops of other countries, will result in an increase in the money receipts of the agriculturalists in the country concerned...This initial increase in the receipts and incomes of the country which has been blessed by a good crop will provide an inflationary stimulus to the industry of that country" (p. 163).

Historical studies of nineteenth-century business cycles do not mention real effects of harvest shocks as often as monetary effects, but Temin (1969) argued that unexpected falls in cotton prices contributed to financial crises "because a large part of the antebellum financial system used cotton for security" (p. 176).[5] Fels (1959) asserted that good crop exports spurred the economy not only by inducing gold inflows but also because "prices and incomes in the export trades go up, with multiplier effects" (p. 87); "larger exports of crops meant more spending by farmers on American products" (p. 127, footnote 47). Fels also argued that the effects of crop volume on railroad revenues were very important: "Good crops meant business for railroads, giving them both means and need to buy railroad equipment and encouraging them to build more road; and this in turn

[5] Temin (1969) focuses on such international forces in accounting for the financial difficulties of the late 1830s. See Rousseau (2002) for a treatment highlighting the role of domestic policies (specifically the 1836 Specie Circular and interbank transfers of government balances).

meant business for iron and steel. Moreover, since poor crops could have a serious effect, assurance that crops were not poor helped confidence" (p. 138).

II. Agriculture in the Nineteenth-Century American Economy

The relative importance of agriculture in the American economy, as a share of employment, output value, or exports, was much greater in the late nineteenth century than in the twentieth century, and greater still in the antebellum period. Figure 1 shows labor force shares from 1800 through 1920 for agriculture and industry (mining and manufacturing) derived from Lebergott's numbers (U.S. Bureau of the Census, 1975, p. 139, series D 167, 170, 172, 174). The figure also displays the more recent estimates of the agricultural labor force share based on the careful work of Thomas Weiss (as cited in Margo (2000), p. 213). It is generally accepted that Weiss' numbers better capture the trends, especially in the first half of the nineteenth century. In 1800, agriculture employed about three-quarters of the labor force and manufacturing/mining was virtually non-existent. (The remainder of the labor force was primarily engaged in construction, transportation, trade and other services.) With the emergence of modern economic growth, the agricultural share declined, falling to just over one-half of the labor force by 1870, and the manufacturing/mining share rose, reaching about 20 percent by that date. These trends accelerated after 1900 and by 1920, the labor force share in manufacturing/mining exceeded that in agriculture. The 1910s were a watershed decade in another important respect. They represented the first period when the national agricultural labor force fell in absolute terms. (Prior to 1910, the relative decline of agriculture was still associated with expansion in absolute size of its labor force.)

Table 1 shows the distribution of GNP in the agriculture and manufacturing-mining sectors over the 1840 to 1900 period (Gallman, 2000, p. 50). The income data reveal that the same pattern of a rising industrial share and a declining agricultural share. As one would expect from the findings of Simon Kuznets regarding the development gap, industry passed agriculture earlier in terms of income – the 1880s—than in terms of the labor force – the 1910s.

Given the nature of America's comparative advantage, agriculture continued to play much larger role in U.S. trade. Figure 2 graphs the shares of three key crops – cotton, tobacco, and wheat—in the total value of U.S. merchandise exports from 1800 to 1915. Except briefly in times of war, cotton was the nation's number one export commodity. This staple accounted on average for over one-half of total revenue during the 1825-60 period and for over one-quarter of revenues during the 1880-1915 period. Rising exports of wheat (and flour) offset some of the decline, growing to make up almost one-fifth of revenues over the middle years (1875-93) of the postbellum period. Over this period, farm products comprised over three-quarters of all exports and even on the eve of the Great War, they still made up over one-half of the total. This fraction obviously was much larger than the sectors' share of the labor force or income.

Our empirical analysis focuses on the two great cash crops, cotton and wheat. These two commodities, as the series in Figure 3 indicate, made up roughly comparable shares of national product over the late nineteenth century. However, a far larger share of the cotton crop was exported, and the U.S. position in the cotton trade was far more dominant than its place in the wheat market, as shown by figures 4 and 5. Over 1900-1913, the U.S. produced about one-fifth of the world's wheat and three-fifths of the world's cotton. Russia had attained rough parity with the U.S. in grain production, but there were no close contenders for cotton. Figure 6 charts the sources of supply for cotton consumption in Europe and America by five-year periods from 1821 to 1894 (Ellison, 1968, p. 99 and U.S. Treasury, 1895, p. 305). The U.S. dominance of the market for its cotton was even greater than Figure 6 suggests, because raw cotton is not a homogeneous product. The U.S. fiber was an imperfect substitute for the foreign fibers. Egyptian and Brazilian cottons, which possessed long staple lengths, sold at a premium compared with the US, medium-staple upland cottons. Indian cottons, which were short staple, traded at a 20-30 percent discount. The available evidence on price differentials between types of wheat sold in leading European markets suggests the grain products of various nations were closer substitutes.

What was the elasticity of demand for these crops over the nineteenth century, at the year-to-year frequency that would govern the response of crop prices to harvest shocks? Unfortunately, the voluminous empirical literature on the cotton and wheat markets, beginning with the birth of econometrics as a field of analysis, has failed to generate much consensus about the magnitude of these parameters.[6] However, most imply a smaller elasticity for wheat than for cotton in the postbellum period, despite the smaller U.S. share of the world wheat market. Table 2 shows a sample of estimates. For cotton, Wright's estimates "put the elasticity of demand at roughly 1.0 during 1830-1860, 1.5 for the period 1866-1895, but back to 1.0 for 1879-1913." (Wright, 1979, p. 102-3).[7] For wheat, the net elasticity facing US producers would combine the effects of the elasticity of demand from importers and the elasticity of supply from other exporters.[8]

The structure of the cotton market was different from that of the wheat market, and the postbellum cotton market differed from the antebellum market. Before the War Between the States, cotton moved from plantation to mill through a series of spot markets, with no futures or consignment contracts: the planter sold his crop outright at a seaport or river town, and broker sold to broker until final sale to millowners, who held very small stocks (Hammond, 1897, pp. 288-291). At each step preceding final sale to the mill, the buyer bore the risk that the price would be less than expected when he was able to sell his cotton, perhaps weeks later. After the war and the establishment of transatlantic telegraph service in 1866, an active futures market developed, along with many publications aimed to inform interested parties about demand, supply, and market prices. Cotton planters appear to have made little use of futures but brokers did, buying and selling contracts with many parties who were simply speculating on cotton prices, rather than arranging for future delivery. Most mills still bought from brokers, but brokers had

[6]Pioneering econometricians such as Henry Moore, Holbrook Working, and Henry Schultz developed many of the basic techniques examining the wheat and cotton markets (Christ, 1985). The variety of results suggests that researchers have mainly found it possible to identify specifications and approaches that confirm their priors. This is too negative but it does temper one's impulse to believe everyone would come around if one did it right.

[7] Schultz (1938) p. 321 reports a similar pattern: "the effect on an increase on 1 per cent in the (deflated) price of cotton was to decrease the annual per capita consumption by approximately 0.51 percent in the first period [1875-95], by 0.25 per cent in the second [1896-1913], and by 0.12 per cent in the third [1914-29]."

[8] There are several additional complications. One of particular note (Meinken, 1955, pp. 22-25) was that the price of wheat relative to those of competing grains mattered crucially for the use of wheat as livestock feed. In most feed operations, 1 pound of wheat was equivalent to about 1.05 pounds of corn. When the price premium on wheat was large (as was common), little wheat was fed to livestock. The demand elasticity depended primarily on human food consumption and was relatively low. When the price spread fell, use of wheat for feed increased rapidly. Thus, demand became more elastic as prices fell.

developed networks of agents scattered through the south. There was a marked decline in sales of cotton on spot at seaports (pp. 292-300). According to Hammond,

> not the least of the services which the system of future delivery contracts has rendered to the cotton trade, is the greater steadiniess in prices which it has introduced. For long periods the fluctuations are perhaps as marked as they were before the sale of "futures" began, for these variations depend upon actual changes in the demand or supply of cotton. But the changes appear less suddenly, and with a less degree of intensity. Thanks to the telegraph and cable, the effect of such circumstances as an attack upon the cotton plant by the boll worm or cotton worm, or a strike among the spinners at Manchester or Fall River, is foreseen on the cotton market weeks and months before it is felt by the consumer or producer, and a change in the prices of cotton for future months comes about gradually. Spinners and planters, seeing the course that prices are taking, gradually make a change in the own plans, and this tends to restore an equilibrium. (pp. 311-213).

The seasonal pattern in sales of crops, payments to farmworkers and clearing of farm-related debts affected the volume of payments and money demand in the U.S. The public's demand for cash, and banks' demand for reserves, was high during spring sowing in March and April, and again from August (winter wheat harvest began early in that month) through December, when there was another boost to money demand because of Christmas (Goodhart, 1969, p. 38). Meanwhile, foreign payments for American crop exports which were concentrated in the months from October through January (Kemmerer, 1911; Goodhart, p. 38). Short-term rates throughout the gold standard world peaked during fall, from September through January, and fell to annual lows during the summer (Clark, 1986; Miron, 1986).

Production shocks in American agriculture

Agricultural production was subject to myriad random weather shocks. In addition, farmers confronted recurrent and evolving threats from plant diseases and insects. The effects of such pests represent the type of persistent or a cluster of negative shocks to technology assumed in real business cycle (and related) models. (Critics often argue such shocks are implausible and require that economic agents forget how to produce.) In the context of American agriculture, new pests were periodically introduced from outside and other new threats emerged as mono-crop production created conditions favorable to their evolution or extensive reproduction. Over the nineteenth centuries, U.S. farmers repeatedly experienced pest-related shifts to lower production possibility frontiers. They did not forget how to produce, but rather their existing knowledge depreciated as new threats appeared from an inherently unstable biological environment. In one example cited in the literature on business fluctuations, the Hessian fly (together with winter-kill) destroyed much of the American wheat crop in 1836. These negative shocks, following on the heels of a short crop in 1835, induced a "very high price" and reversed the direction of the international wheat trade. The U.S., which was almost always a grain exporter, imported wheat from Britain and northern Europe in 1836/37. This development added to trade balance pressure and, according to the literature, contributed to the financial difficulties of the late 1830s.[9]

The reports complained of winter-kill and attacks by Hessian flies (*Cecidomyia destructor*). Winter kill occurs when severely cold weather damages fall-sown wheat. The Hessian fly, introduced to the U.S. in the 1770s, spread across the continent by little more than a century. It proved a serious scourge to grain growing until farmers learned to change to less susceptible varieties and alter planting date. Other evolving insect threats to wheat include the grain midge (or weevil), introduced in the 1820s, the chinch bug, first observed in the 1780s, and locust. Epidemics of stem and leaf rust, caused by fungi, could also lead to widespread crop failures and periods of temporary abandonment of production. Such shocks tended to be correlated with weather events, but also had

[9] One of the authors (Rhode) would like to thank Kenneth Sokoloff for calling this episode to his attention. Thorp, (1926) p. 122 notes in 1836 there was a "Wheat shortage, due chiefly to the Hessian fly, very high price." This shortage followed a "Wheat crop failure" of unspecified origin in 1835. p. 121. One of Thorp's sources, McGrane, (1965) p. 92 also notes "there was a crop shortage, due to the devastating effect of the Hessian fly." McGrane in turn cites (among other sources) an extensive article in the *Niles' Register*, 23 July 1836, pp. 357-59 on "The Crops" reprinted from the *Baltimore American*. Based on complaints of injuries to the wheat crop by "the severity of the winter, and… the ravages of the Hessian fly…" that when beyond the 'crop-croaking' normal in the period, the *Baltimore American* sent out a circular to postmasters throughout the middle states to survey "enterprising and intelligent citizen(s)" about local conditions. Of the 54 counties covering in the reports, 2 reported the wheat crops were very good, 4 good, 10 average, 14 fair or indifferent, 6 bad, and 18 very bad or failures. Thus the modal response, representing one-third of the reports, was in the lowest category. Pennsylvania, Maryland, and Virginia (which included what is now West Virginia) were the hardest hit. Given that the middle states produced about one-half of the nation's wheat crop circa 1839, crop failures in the regions could have a significant effect. (The Hessian fly did not invade Illinois until 1844, and therefore, could not have reduced crops in that region in the late 1830s.) We also know that country imported, on net, the equivalent of 2.4 million bushels of wheat in 1836/37. This

independent, persistent components (Olmstead and Rhode, 2002 and 2003). The notable bad years for wheat include, besides 1835 and 1836, the harvests of 1854, 1864, 1866, 1876, 1881, 1885, 1888, 1890, 1904, 1910, and 1911. (1904 was associated with a major outbreak of stem rust, 1911 with drought.) Among the years of bumper crops were 1869, 1873, 1874, 1882, 1891, 1892, 1898, 1901, 1905, 1906, 1914, and 1915 (Thorp, 1926).

Cotton production suffered from similar weather and pest shocks. In the early nineteenth century, cotton production was ravaged by anthracnose rot (a disease caused by the fungus *Colletotrichum capsici*). Among the insect pests attacked the crop were cotton worms (aka caterpillars or *Aletia argillacea*) that were allegedly introduced by French cotton planters from the West Indies in 1802, and boll worms, *Helithis armiger* (See Comstock, 1879 and Watkins, 1908). The most serious threat, however, occurred after western expansion pushed U.S. cotton cultivation into contact with the Mexican boll weevil *(Anthonomus grandis*) which crossed into Texas in 1892 and spread across the entire South by 1922. As with wheat, cotton enjoyed readily identifiable periods of good crops (1829, 1837, 1839, 1842, 1857, 1859, 1870, 1897. 1898, 1904, 1911, 1914) and of bad crops (1838, 1846, 1866, 1868, 1871, 1881, 1892, 1895, 1909, 1915). Often the bad years were associated with insect attacks, such as infestations of cotton worms in 1846, 1866, 1968, and the early 1870s, of the boll worm in 1881, and of the boll weevil in 1909 and 1915 (Thorp, 1926).

III. Available data

To examine relations between harvest fluctuations and business cycles, we use annual series for industrial production, crop output and crop yields (crop output per planted acre). To test some possible explanations for the relations we find between industrial production and crop output, we examine data on the crops' relative prices, international gold flows and relative interest rates, export revenues and merchandise trade balances. More extended descriptions of data series and sources are given in an appendix. Here we briefly describe the series we use, and some of their limitations.

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contrasts with net exports averaging 4.3 million bushels over the 1831/32 to 1834/35 period and 7.9 million

U.S. industrial production

For American industrial production, we rely mainly on a new index of industrial production constructed by Joseph Davis (forthcoming) for the period from 1790 to 1915. Davis assembled the index from annual data on physical output or inputs for 43 industries in manufacturing and mining. The goal was to create a series that compares conceptually to the Federal Reserve Board's historical monthly industrial production index available since 1919. Davis selected component series based on two principal criteria advocated by Romer (1991) and Calomiris and Hanes (1994). First, the annual series employed had to pertain either directly to actual output, or to a related physical-quantity proxy. Thus, the index is devoid of nominal data and its changes reflect purely fluctuations in real output. The index's exclusive focus on physical quantities stands in sharp contrast to various late-nineteenth century "business condition" indexes that utilize wholesale prices, equity prices, and other financial variables. Second, the industrial components had to be available annually for sufficiently long periods to preserve index consistency and comparability over time. Thus, Davis omitted existing products whose aggregate coverage did not run at least 30 years before and after the Civil War. Many of the component series are unavailable before 1829. The reliability of the series is greater beginning with 1829, so we will examine movements in industrial production starting with that year.

Two important components of the index are related to agricultural production in a way that is undesirable for the purpose of this study: U.S. consumption of raw cotton, used to indicate cotton textile production; and shipments of barrels of milled wheat flour. To observe the behavior of industrial production in sectors not directly related to agriculture in this way, we constructed for this paper an index *excluding* these components, which we refer to as the index "excluding textiles and flour." Within the postbellum period, results derived from the Davis series can be compared with results using the well-known Frickey index of manufacturing production, which covers years from 1860 through 1914 (Frickey, 1947).

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over the 1838/39 to 1841/42 period. Such a shift represents roughly ten percent of the typical crop.

As our definition of “business cycle” movements in industrial production, we use the deviation of the log of a production index from the Hodrick-Prescott (HP) trend in the series with the conventional parameter of 100 for annual data (described in Kydland and Prescott, 1990). We use this definition because it is common in recent literature and represents a very short-term notion of business cycles, emphasizing the distinction from “long swings:” the HP trend with the conventional parameter is affected by output movements that persist for more than a year or so. Trends were estimated over 1827-1860 and 1868-1914. We will refer to an IP deviation from the HP trend as the “output gap.”

Table 3 shows standard deviations, maximum and minimum values of output gaps over antebellum and postbellum periods, for the Davis IP index including and excluding textiles and flour. By these measures, the overall amplitude of cyclical movements was quite similar in the two periods. The index excluding textiles and flour shows larger fluctuations.

Crop production

Beginning in 1866, the U.S. Department of Agriculture created annual estimates of yields, acreage, and production for each major U.S. crop, including cotton and wheat. USDA statisticians also collected and published annual estimates of cotton production, based on commercial sources, dating back to 1790. Several sources provide annual estimates of wheat production for parts of the antebellum period, but these series require further analysis before we can judge them suitable for this study. By many accounts, 1869 was the first “normal” crop year for cotton following the War Between the States. Thus, our postbellum samples will begin with 1870 when the cotton crop is included with a one-year lag.

We use two definitions of short-term fluctuations in crop output, acreage and yield. One is the deviation of the log of the variable from the HP trend. The other is the deviation of the log from a quadratic time trend. Both are defined over periods 1826-1860 and 1869-1914. The lower portion of Table 3 shows standard deviations, and maximum and minimum values, of crop deviations from trend, on these two definitions. On either definition, the amplitude of cotton crop fluctuations was about the same in the postbellum period as in the antebellum period, and the amplitude of wheat deviations was similar to that of cotton deviations. The quadratic trend gives bigger deviations. We will refer to the crop deviations from trend as "crop deviations."

Were these crop deviations a response to business-cycle phenomena, or exogenous shocks to the economy? Tables 4 and 5 show regressions results that suggest the crop deviations were indeed exogenous to business-cycle phenomena. For Table 4, left-hand side variables were crop harvest deviations. Right-hand side variables included the current and previous years' output gaps in the Davis IP index. For cotton in the antebellum period, the right-hand side also includes the previous year's cotton crop deviation. For cotton and wheat in the postbellum period, the right-hand side includes the current and lagged deviation in the other crop. The lower rows of the table show F-statistics to test the hypothesis that all of the coefficients are equal to zero, and the hypothesis that the coefficients on the output gaps are zero. The associated p-values show the significance levels at which one would fail to reject these hypotheses. For both crops, under either definition of trend, one would fail to reject the hypothesis that the coefficients on the output gaps are zero, at conventional significance levels. Thus, there is no evidence that industrial production affected the crop deviations from trend. For the cotton crop, there is no indication that crop deviations from either trend were related to *any* of the right-hand side variables – at conventional significance levels, one would fail to reject the hypothesis that *all* of the coefficients are zero. For the wheat crop, there is some evidence that the crop deviation was related to the previous year's cotton crop deviation – at the ten percent level or thereabouts, one would reject the hypothesis that the coefficient on the previous year's cotton crop is zero.

For Table 5, left-hand side variables were deviations from HP trends in crop acreage or yield. Right-hand side variables were the previous year's acreage or yield deviation and industrial production deviations. Results using deviations from quadratic trend are not shown because they were essentially identical to these. For cotton, neither acreage nor yield appears related to any of the right-hand side variables. For wheat, acreage appears positively related to the previous year's acreage, but not to output gaps.

Crop prices

For cotton, Cole (1938) presents apparently reliable monthly series of New York prices through 1861. Monthly cotton prices beginning in 1870 can be found in the NBER macro history database, series m04006a. For wheat, we use wholesale prices in Chicago from the NBER macro history database, series m04001a.

As crop prices vary significantly from month to month, farmer's incomes from a given year's crop and materials costs to manufacturers would depend significantly on the relative volumes of trade taking place within each month (in addition to the differences between their transaction prices and the prices in our sources). It is clearly inappropriate to value crops at a price equal to a simple annual average of monthly prices, but there is no way to know month-by-month trade volumes, and crop season average prices weighted by trade volumes are unavailable until 1908. We use October prices, as harvests for both cotton and wheat were well under way or completed by this month.

Other prices

The standard measure of the "price level" over the nineteenth century is the Warren and Pearson wholesale price index for years preceding 1890, and the BLS wholesale price index thereafter. Prices of raw cotton, wheat and wheat flour have considerable weight within these series. We use a price index constructed from the groups within the Warren and Pearson and BLS series that do *not* include raw cotton, wheat and wheat flour (that is, all groups other than "farm products" and "food products" groups). Groups were aggregated with Warren and Pearson's weights (Warren and Pearson, 1932, p. 184).

Export revenues

In 1820, U.S. customs officials began to collect fairly reliable annual data on dollar values of exports by sea (North, 1960, p. 602). Published data, found in standard sources such as U.S. Bureau of the Census (1975), include estimates of export values for specific crops, including cotton, wheat and wheat flour, and for broad classes of goods such as “crude materials,” “crude food” and “manufactured food.” The sum of these three classes should contain cotton, wheat and wheat flour.

For 1842 and earlier years, the figure for a given year refers to trade occurring through the end of September, from the beginning of October of the previous year. For the period from 1844 on, they refer to trade occurring through the end of June, from the beginning of July of the previous year. There are no usable figures for the year 1843. (That year’s figures cover trade from 1 October 1842 of that year to 30 June 1843.)

Gold flows and stocks

Data on imports and exports of specie – gold and silver – were collected along with other import and export data. Annual series for sets of months matching export data are available starting with 1821 (U.S. Bureau of the Census, 1975, series U 197-200). Unfortunately, for years before 1864, gold exports cannot be distinguished from silver exports, and figures do not include exports of bullion until 1895. Monthly data become available in the postbellum period. Annual specie stock in the US in antebellum years beginning with 1829 (a fishy series, but the only one available) is taken from U.S. Comptroller of the Currency, *1906 Annual Report*, Washington, D.C.: GPO, 1906, Pt. 1, pp. 113-15. (This is the series used by Temin [1969] pp. 186-87.) For the postbellum period, we use the gold stock series from *Historical Statistics* (series U197-198).

Relative interest rates

For the postbellum period, we use the spread between the New York three-month commercial paper rate (MacAulay, 1938) and the London open market three-month discount rate (this matches NBER series 13018A).

IV. Relations between Industrial Production and Crops

Effects of harvests on industrial production

Tables 6, 7, and 8 show results of OLS regressions that treat output gaps or log levels of IP series as dependent variables, and current and lagged crop or yield deviations as independent variables. This statistical approach is reasonable to the degree that crop deviations are determined by factors exogenous to the economy system, such as weather and crop diseases. Recall that the results shown in Tables 4 and 5 were consistent with that assumption. All regressions were performed using both definitions of trend for crop deviations. Results using quadratic trends were nearly identical to results using HP trends. We present only the results using HP trends. We use four time periods as samples: the entire antebellum period 1829-1860; the antebellum gold-standard period 1834-1860; the entire postbellum period 1870-1913; and the postbellum gold standard period 1879-1913.

Generally, the results indicate that, within the postbellum periods, deviations in the cotton crop or cotton yield had a strong positive relation to the next year's output gap. Such a relation did *not* hold within the antebellum periods, or for the wheat crop in the postbellum periods.

Table 6 shows results using output gaps in the various industrial production indexes. Right-hand side variables included the crop deviations from the current and previous years, and the output gaps in the previous two years. (Adding more lags of IP to the right-hand side had little effect on the other coefficients, and added no explanatory power to the regressions.) The lower rows of the table show F-statistics and p-values to test the hypothesis that both wheat crop coefficients are zero. For the first set of columns in the table, the IP index was the Davis IP index including textiles and flour. In the antebellum periods, one cannot reject the hypothesis that the coefficients on the cotton crop deviations are zero. In the postbellum periods, one cannot reject the hypothesis that the coefficients on wheat crops and the *current* year's cotton crop are zero. But the coefficient on the previous year's cotton crop is positive and statistically different from zero at the one percent level.

The next set of columns in Table 6 shows results using the Davis IP index excluding textiles and flour. The last set of columns shows results using the Frickey manufacturing index – the alternative IP index for the postbellum period. Results are very similar to those using the Davis IP index including textiles and flour: within the postbellum periods, but not in the antebellum periods, the coefficients on the previous year's cotton crop are positive and different from zero at conventional significance levels.

Table 7 shows results of regressing the log *level* of the Davis IP index on two lags of the index and the same crop deviations from trend used for Table 6 (*not* the log levels of the crops). In the antebellum samples, cotton crop coefficients are not significantly different from zero. In the postbellum samples, the coefficient on the previous year's cotton crop deviation is positive and significantly different from zero at the one percent level. Coefficients on wheat crops are not different from zero.[10]

Figure 7 displays the relation between the Davis IP output gap and the previous year's cotton crop graphically. For the figure, the output gap was regressed on two lags of the output gap over the 1870-1913 sample. The residual from this regression was scattered against the previous year's cotton crop deviation. A positive relation is obvious, at least for observations in the 1879-1913 gold standard period. Arguably, the relation does not hold as well within the 1870-1878 period: the two largest crop deviations within that period are not accompanied by corresponding output gaps. Of course, it is impossible to make any meaningful statistical distinction between eight observations and the rest of the sample.

Table 8 compares the effect on the Davis IP output gap of variations in the cotton crop, cotton yield, and cotton acreage. (Recall there are no data on acreage from the antebellum period.) In specification (1), right-hand side variables were lagged output gaps and the previous year's cotton crop deviation. In (2), the crop deviation was replaced with the deviation from HP trend in the cotton yield. For (3), the crop was replaced with deviation from the HP trend in cotton acreage. For (4), the right-hand side includes both the cotton crop deviation and the cotton acreage deviation. (Recall that the yield is the ratio of the crop to acreage, so it should not be on the right-hand side along with either the crop or acreage.) In (2), the coefficient on the yield is significantly different from zero and larger in magnitude than the coefficient on the crop. In (3), the coefficient on acreage is also positive and significantly different from zero. In (4), the

[10] To check the robustness of these results, we have also employed filter using the approximate pass-band approach suggested in Baxter-King (1995). Again, in the postbellum period, cotton production had a significant effect on next year's industrial product whereas wheat production did not.

coefficient on the crop is positive and significant; the coefficient on acreage is not significantly different from zero at conventional levels. These results indicate that the variable fundamentally related to industrial production was not cotton acreage *per se* – the measurable input to cotton production – but the size of the cotton crop itself, as affected by both yield and acreage.

What was the relative importance of the cotton crop as a determinant of postbellum business cycles? One way to judge is by comparing the R-squared of regression (1) with that of regression (5), which omits the cotton crop deviation from the right-hand side. This reduces the R-squared by more than 25 percent. Thus, one could say that cotton crop variations account for about one-fourth of business cycle movements as defined to be deviations from trend in industrial production.

Figure 8 provides another way to judge. The figure plots the Davis index output gap along with the value of the output gap implied by the previous year's cotton crop deviation and the coefficients from Table 8 regression (1) on the 1879-1913 sample. Values for lagged output gaps, as determinants of later year's output gaps, were not the true values, but the forecast values, rolled forward (starting from the true value for 1869). Observe that the cotton harvest accounts very well for the 1881 peak in the Davis series (the NBER reference cycle peak is 1882), the downturn and upturn around the 1885 trough (also an NBER trough), and the downturns and upturns of the 1890s, including the short-lived upturn and downturn around 1895. The cotton harvest fails to account for the downturn from 1903 or the depth of the 1907 trough, but it does account for the upturn from 1904 and the 1911 trough. Within the 1870-1878 period, the cotton harvest does not appear to explain much: it does not account for the 1873 downturn or the 1878 trough.

What explains the relation between the cotton harvest and industrial production?

How can we explain the apparent relation between the cotton crop and the following year's industrial production in the postbellum period, along with the absence of a relation between industrial production and the wheat crop, and the absence of a relation between cotton and industrial production before the War? The theories and historical accounts discussed above suggest a number of possibilities.

Recall that a monetary channel from harvest shocks to industrial output, in gold standard periods, would be through the effect of the harvest on U.S. interest rates. That argument has implications we can easily test, as long as crop deviations are indeed exogenous to the economic system. First, in the postbellum period the cotton harvest should be positively related to U.S. industrial output, but not to industrial output in other gold-standard countries. Table 9 shows regression results bearing on this point. In specification (1), the Davis IP output gap was regressed on the previous year's cotton deviation and the deviation from the HP trend in an index of British industrial production (the Hoffman [1955] index excluding building). In all periods, the coefficients on British IP are positive and significantly different from zero; in the postbellum period, so is the coefficient on the lagged cotton crop. In specification (2), the two country's output gaps were reversed: the British output gap was regressed on the cotton crop and the American output gap. In these regressions, the coefficients on the cotton crop are far from significant in the postbellum period, and not strongly significant in the antebellum period. Thus, the cotton crop deviation appears to have been positively associated with American output but not British output in the postbellum period.

An explanation based on the monetary channel would also imply that cotton crop deviations are negatively associated with U.S. interest rates on liquid assets, relative to rates in the rest of the gold-standard world. These patterns should not hold for the postbellum wheat crop, or for the cotton crop in the antebellum period. Also recall, however, that agricultural production had a strong effect on money and reserve *demand* in the spring and from August through January, while international payments for fall's crops continued through the following January. To look for the effects consistent with the monetary channel, it is important to distinguish the effects of the harvest on asset or gold *supply* from the effects of harvests on money *demand*. Thus, we will examine the behavior of average interest rates for June and July.

Tables 10 and 11 show results indicating the relation between crops and interest rates in the postbellum periods. For Table 10, the left-hand side variable is the deviation from the HP trend in the U.S. commercial paper rate *less* the London open-market three-month rate, as described above. For Table 11, the left-hand side variable is the deviation from HP trend in the level of the U.S. rate. For specification (1), right-hand side variables are the previous year's deviations from trend in crops and relative interest rates, or U.S. interest rate level. For (2), the right-hand side also includes the current year's deviation from trend in the Davis IP index. In all specifications, the coefficient on the cotton crop deviation is negative and significantly different from zero. The coefficient on the wheat crop deviation is not significantly different from zero.

What about gold flows? Table 12 shows results of regressions with net imports of gold (in postbellum periods) or specie (in antebellum periods), as a percent of the previous year's domestic stock of gold or specie, on the left-hand side. Recall that through 1841 these are flows through October; thereafter they are flows through June. Right-hand side variables include quadratic time terms, in addition to the variables listed on the table. In the antebellum period, coefficients on the previous year's cotton crop are not significantly different from zero. In the postbellum 1879-1914 period, coefficients on cotton are positive and significantly different from zero at the five per cent level. Cofficients on the wheat crop are of similar magnitude to cotton coefficients, but have greater standard errors. When last year's output gap is included on the right-hand side, the coefficient on the wheat harvest is significant at the seven percent level.

Why would cotton deviations be associated with specie inflow in the postbellum period, but not in the antebellum period? In the postbellum period, why would the relation between the harvest, interest rates and gold flows be stronger for cotton than for wheat? Tables 13-16 present results bearing on those questions.

For Table 13, the log of a year's crop value at the October price was regressed on crop deviations, the log of the WPI (excluding farm and food prices) and quadratic time trends. In the postbellum periods, both cotton and wheat revenue are positively related to current crop deviations, with similar magnitudes. In the antebellum period, cotton revenue was not related to the current cotton crop. For Table 14, the log of the October crop price was regressed on the same variables on the right-hand side of the regressions in Table 13. Coefficients on cotton crop deviations are more negative – larger in absolute value - in the antebellum periods. Apparently, in the antebellum period, the short-run elasticity of demand for American cotton was small enough to eliminate any positive relation between harvest shocks and crop revenue. In the postbellum period the short-run demand elasticity was greater, so a large crop was associated with greater crop revenue. Coefficients on crop deviations for wheat are a bit smaller than postbellum cotton coefficients, implying greater demand elasticities for wheat than cotton.

For Table 15, the right-hand side variable was the log of export revenue in the classes containing cotton, wheat and flour exports. This was regressed on crop deviations along with logs of the current and previous years' WPI's (excluding farm products and foods) and quadratic time trend terms. In the antebellum period, the cotton crop deviation was not positively related to export revenue. In the postbellum period, the cotton crop *was* positively related to export revenue. But wheat crop deviations are also positively related to export revenue, with coefficients that are about the same magnitude as those on cotton.

For Table 16, the left-hand side variable was the dollar value of net merchandise exports. Again, in the antebellum periods, coefficients on the cotton crop are not significantly different from zero. In the postbellum periods, both the cotton and wheat crop deviations appear to be positively related to the trade balance.

V. Conclusion

We conclude that over 1879-1913, variations in the annual cotton harvest reflecting largely exogenous factors, such as weather and crop diseases, were an important cause of business-cycle fluctuations in industrial output. Variations in the wheat harvest did not cause business cycles in this way, and variations in the cotton harvest did not cause business cycles over 1829-1860.

What accounts for the apparent effect of cotton harvests on industrial production in the postbellum period, and the absence of the effect in the antebellum period or for the wheat harvest? In some ways, data from the period appear consistent with a monetary explanation. Within the postbellum period, the cotton harvest was associated with gold inflows and a decrease in New York interest rates, or New York rates relative to London rates. The wheat harvest did not have these effects, and the cotton harvest did not affect gold flows in the antebellum period. The difference between the antebellum and postbellum effects of cotton harvests can in turn be accounted for by a change in the short-run elasticity of demand for cotton. Within the antebellum period, the cotton price was more sensitive to the harvest – the short-run elasticity of demand for cotton was smaller – so good harvests did not bring greater import revenues. In the postbellum period, cotton prices were less sensitive to harvest size. So far, however, we cannot explain the apparent *absence* of an effect of the wheat harvest on gold flows and U.S. interest rates. Wheat harvest variations were about as big as cotton harvest variations, while the wheat price was no more sensitive to harvest size: thus, the wheat harvest appears to affect export revenues in the same manner as the cotton harvest.

What about explanations based on real channels? We tentatively judge our results to be inconsistent with a real channel through the effect of harvests on industrial producers' terms of trade. In all periods, good harvests tended to depress the crop's relative price, most strongly for antebellum cotton; yet only the postbellum cotton harvest appears to cause business cycles. But this issue certainly requires more investigation. So does the possibility of real channels through the relation between harvests and farmers' real incomes.

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Figure 1: Labor Force Shares, 1800-1920

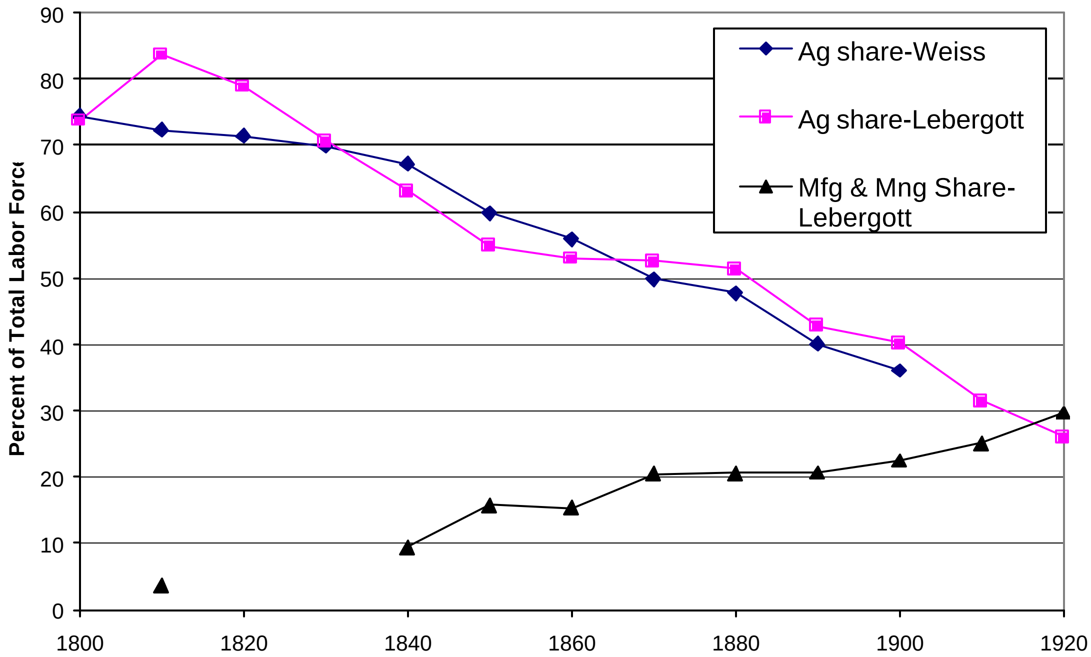


Figure 2: Agricultural Shares of Export Values, 1802-1915

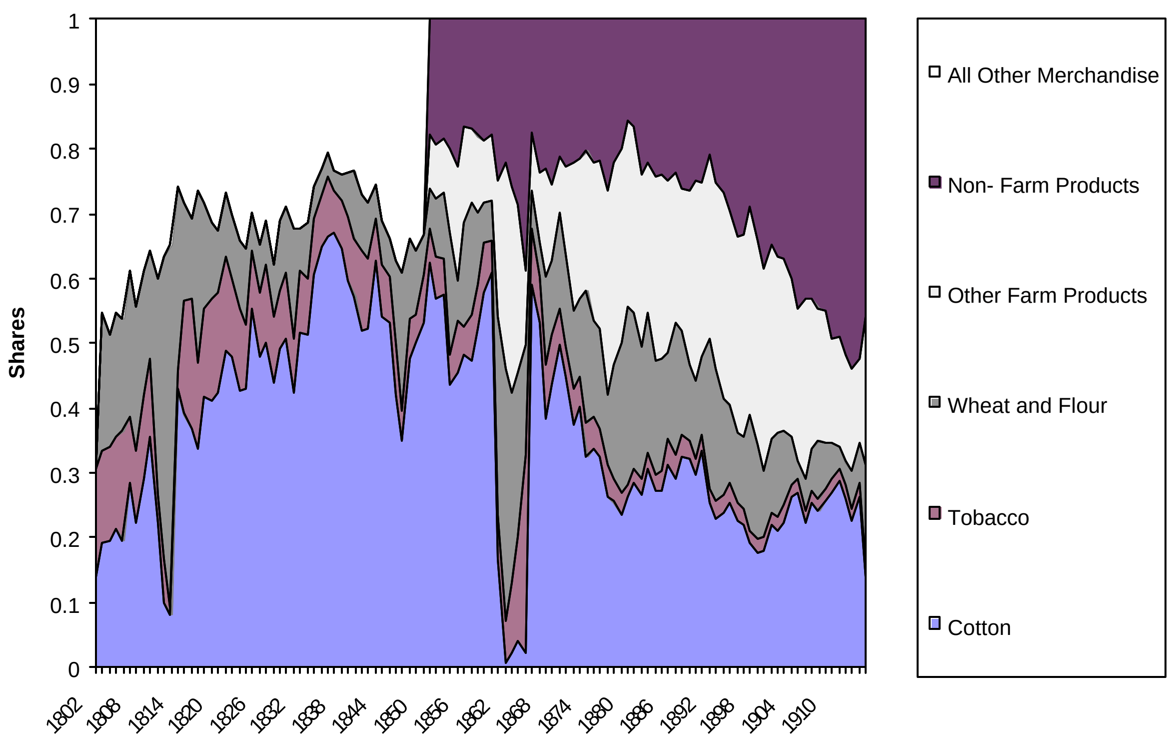
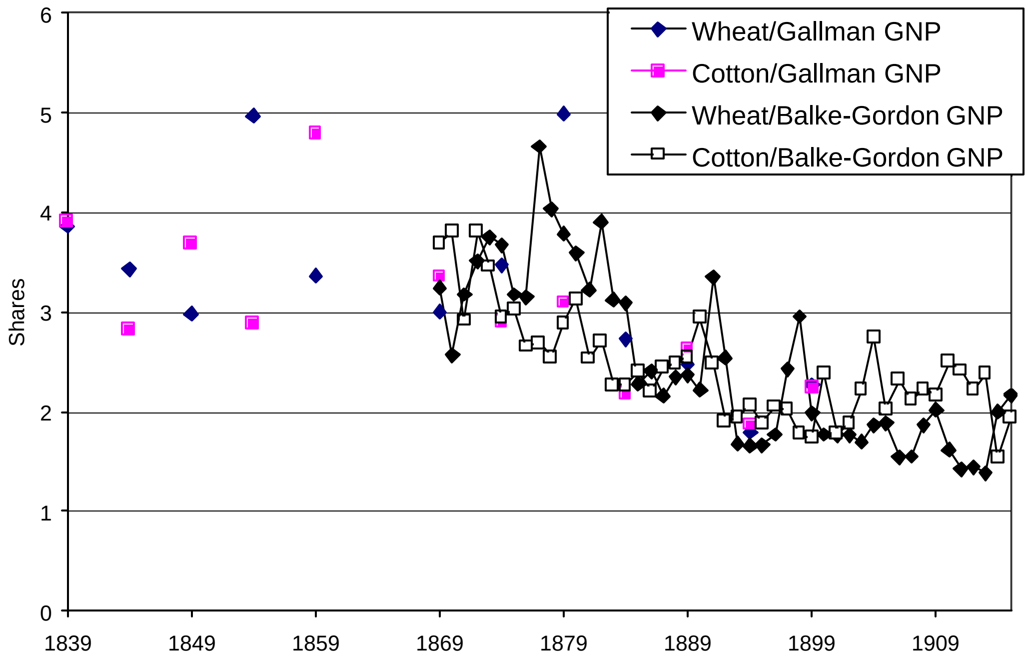


Figure 3: Gross Income from Wheat and Cotton Relative to Nominal GNP



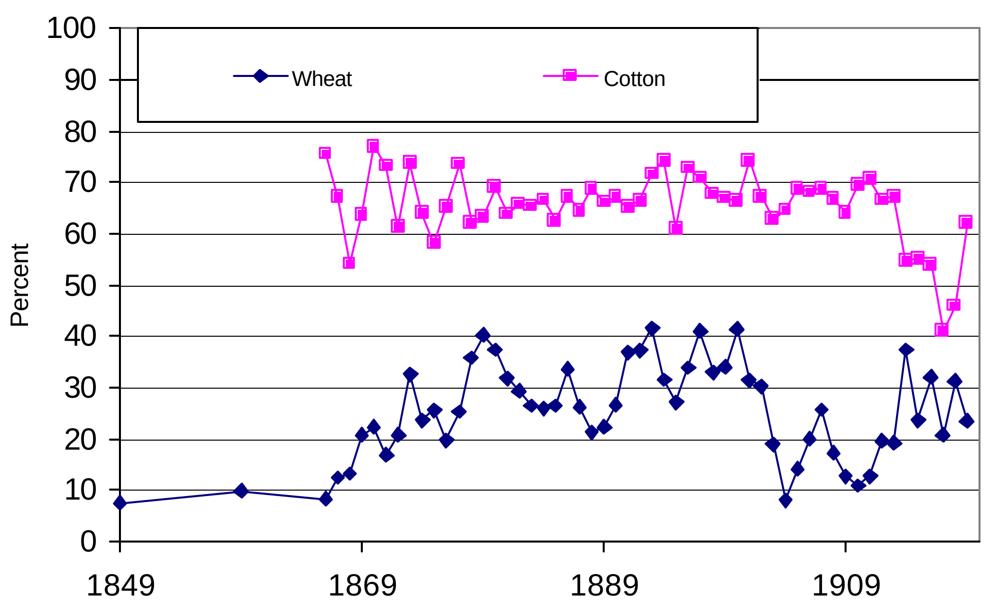
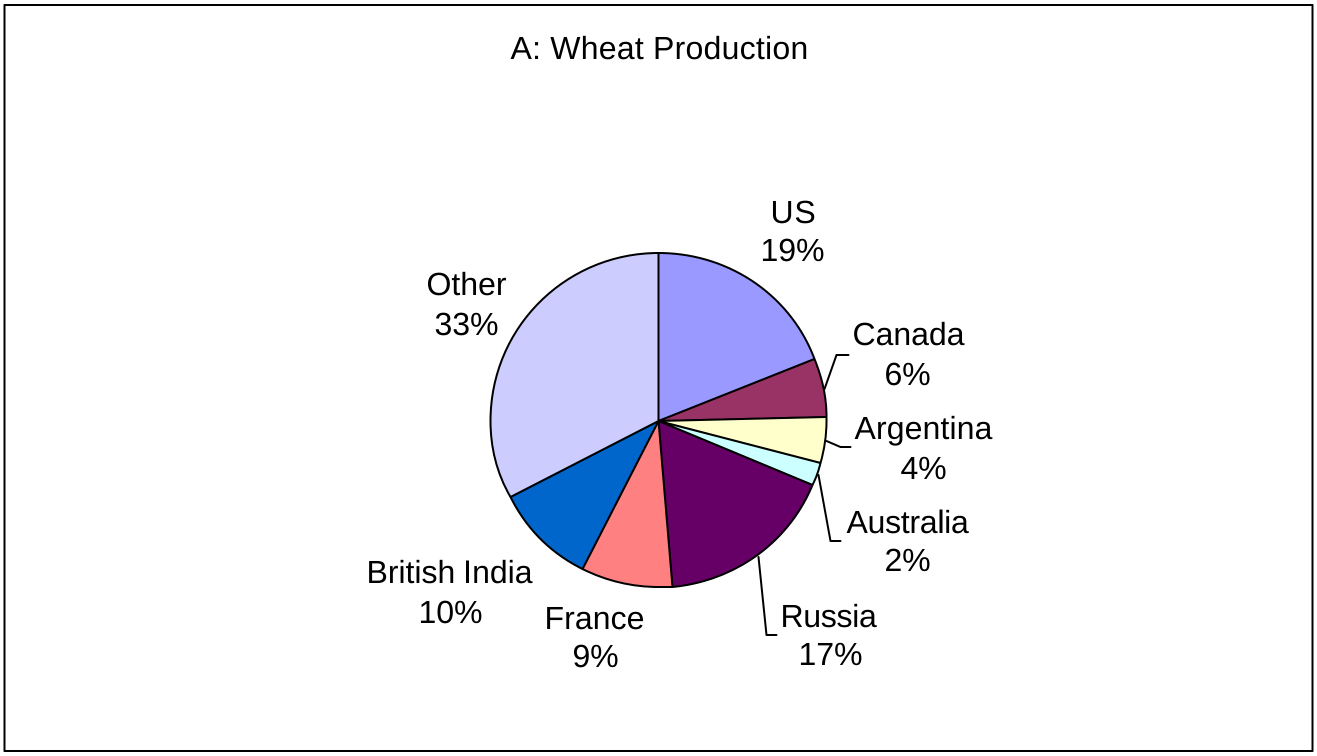
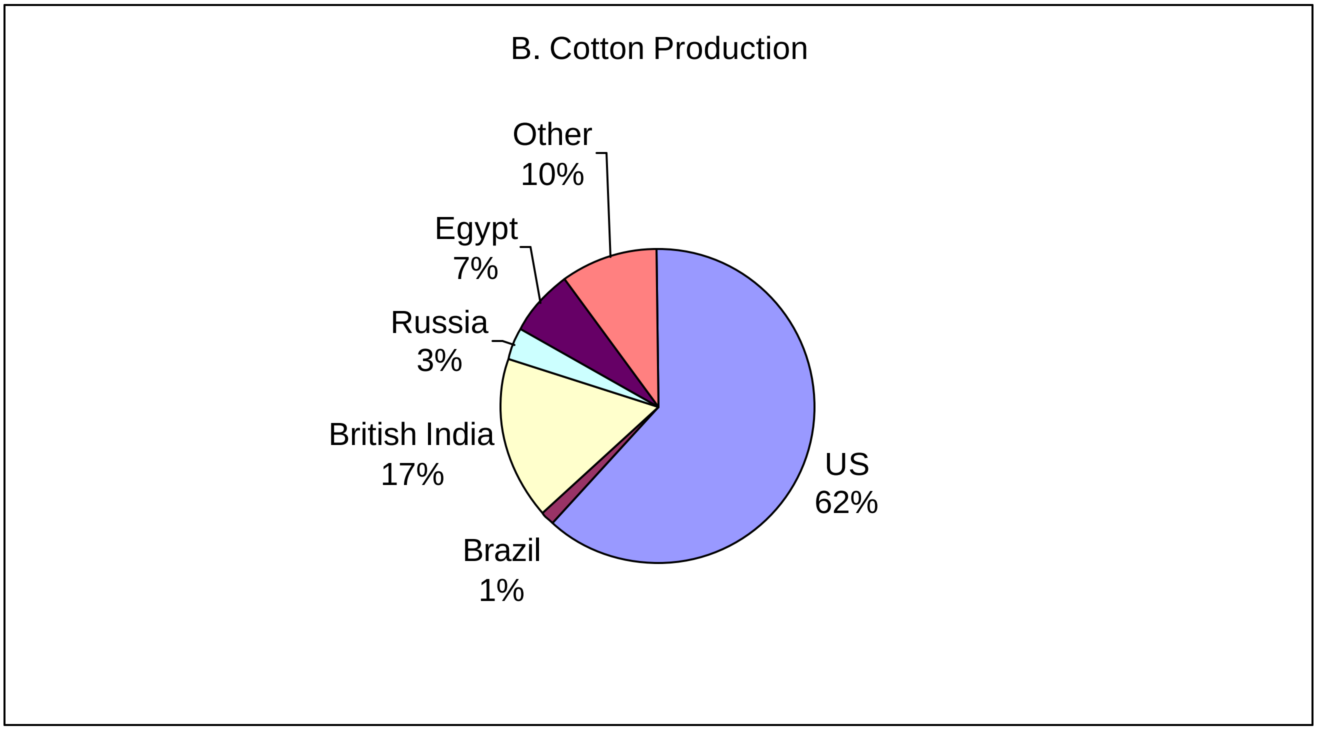


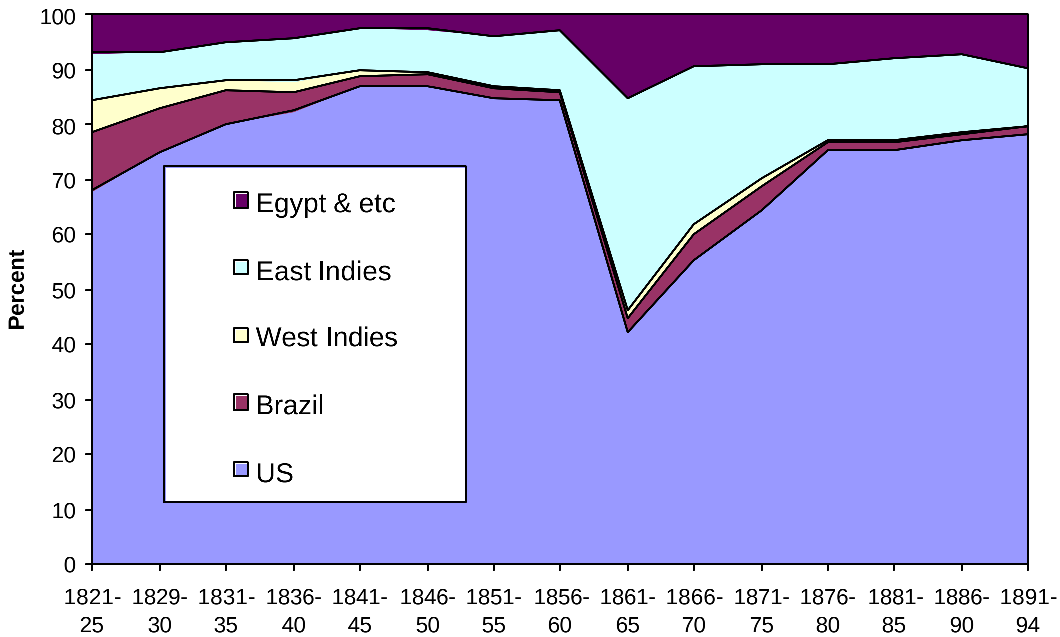
Figure 5: U.S. Shares of World Wheat and Cotton Production, 1909-13





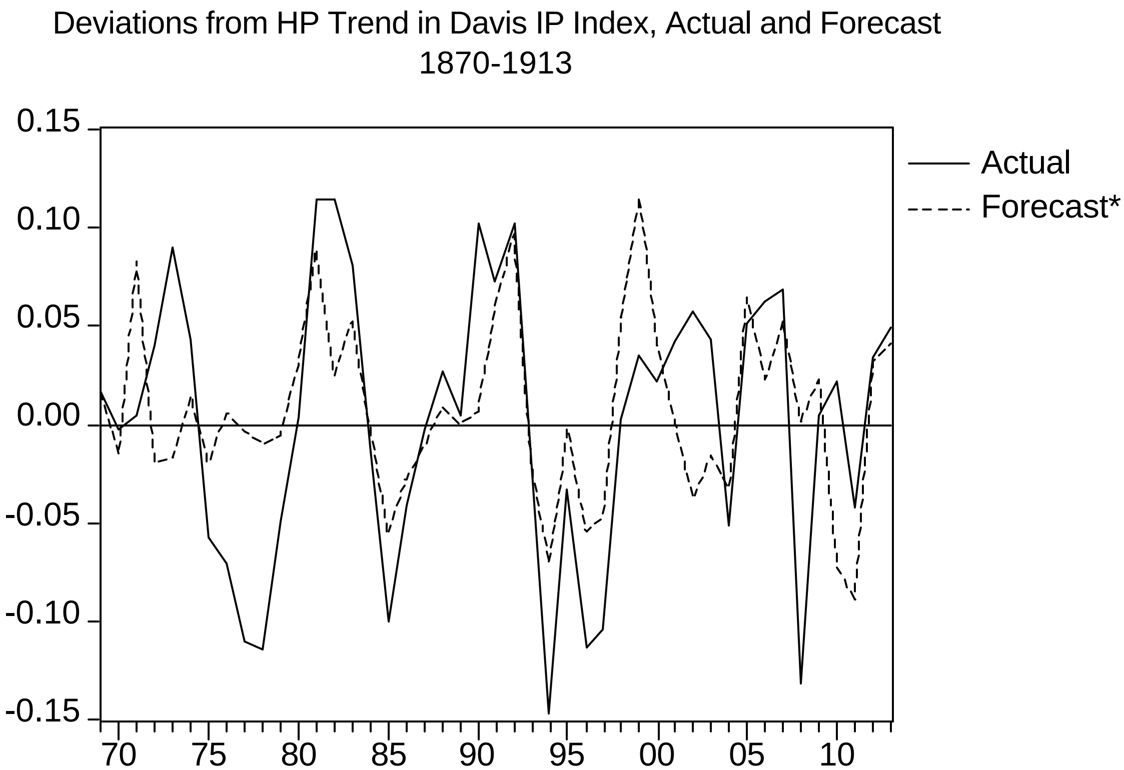
Source: USDA *Yearbook of Agriculture 1920*, pp. 547-48.

Figure 6: Shares of Cotton Consumption, 1821-94



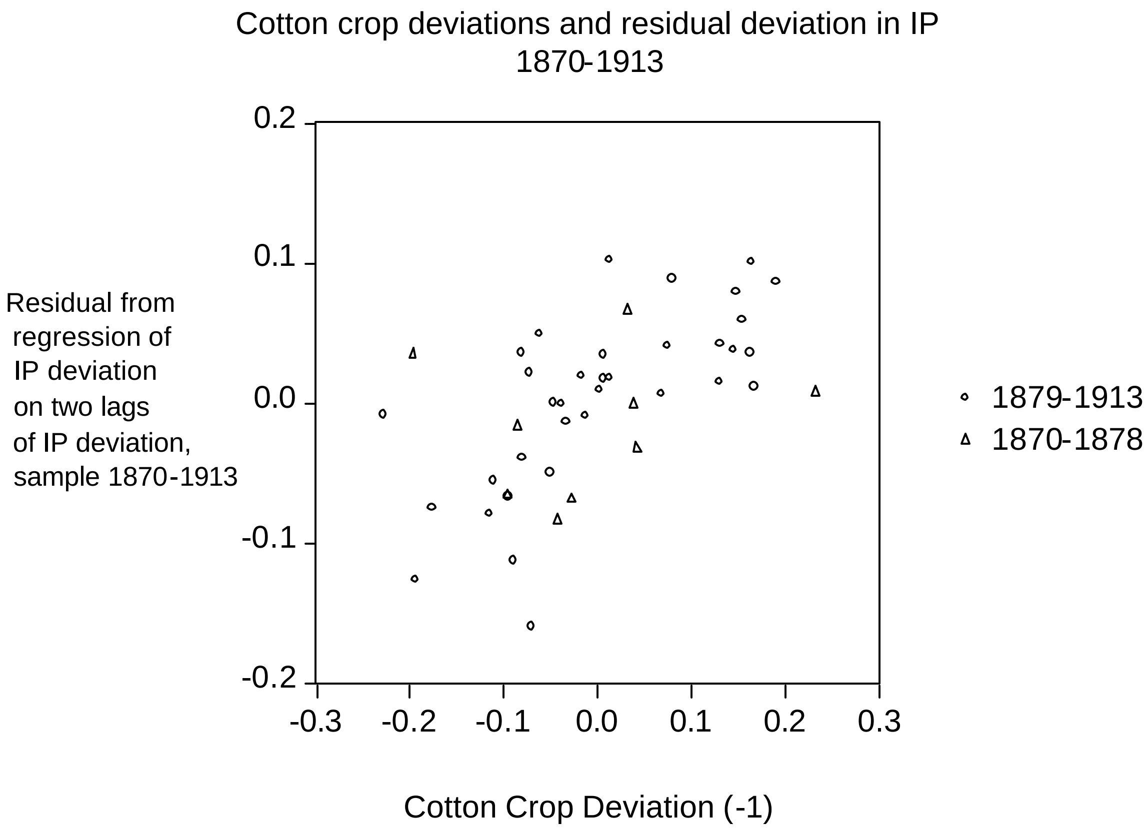
Sources: Ellison (1968) p. 99; U.S. Treasury (1895) p. 304.

Figure 7:



*Using coefficients from regression on 1879-1913 sample, starting with 1869 IP deviation and rolling forward forecast IP for subsequent years

Figure 8:



Cotton crop deviations and residual deviation in IP
1870-1913
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
Residual from regression of IP deviation on two lags of IP deviation, sample 1870-1913
Cotton Crop Deviation (-1)
1879-1913
1870-1878

Table 1: Sectoral Distribution of GNP, 1840-1900

Percent of U.S. GNP

Year	Agriculture	Manufacturing/ Mining
1840	41%	17%
1850	35	22
1860	35	22
1870	33	24
1880	28	25
1890	19	30
1900	18	31

Source: Gallman (2000) p. 50. Manufacturing and Mining includes "Hand trades." Agriculture includes "land clearing, breaking, and fences as well as home manufacturing." The remainder of activity was in transportation and public utilities, commerce, government, and shelter.

Table 2: Summary of Estimates of the Price-Elasticity of Demand for U.S. Wheat and Cotton Relevant to the Long Nineteenth Century **Preliminary and Incomplete**

Commodity/Market	Price-Elasticity	Time Period	Source
Wheat			
US crop	-0.36	1896-1913	Working 1937, pp. 185-6.
US crop	-0.24 ±0.09	1921-1935	Working 1937, pp. 185-6
US crop	-0.21±0.04	1921-1934	Schultz 1938, p. 399.
Per Capita Flour	-0.07	1922-1941	Fox 1953, p. 69.
Domestic Food	-0.04	1921-38	Meinken, 1995, p. 43.
World Crop/ World Price	-0.70	1921-38	Meinken, 1995, p. 43 (calculation based on price flexibility)
Cotton			
US crop	-0.51	1875-1895	Schultz 1938, p. 321.
	-0.25	1896-1913	Schultz 1938, p. 321.
	-0.12	1914-1929	Schultz 1938, p. 321.
British Demand for US crop.	-0.31 to -0.65	1830-1860	Wright 1971, p. 119.
World Crop	-0.6	1830-1860	Surdam 1998, p. 11.
US Crop	-0.88	1830-1860	Surdam 1998, p. 11
For US Crop	~ -1.0	1830-1860	Wright 1971, p. 119
	~ -1.5	1860-1895	Wright 1979, p. 119
	~ -1.0	1880-191	Wright 1979, p. 1193
Foreign Demand For US crop	-1.49	1820-1859	Irwin 2001, p. 23.

Notes: Lehfeldt (1914) computed one of the first estimates of the elasticities of demand for wheat. Using the price of wheat imported to England and the previous year's world crop, he calculated elasticity of –0.61 for the 1888-1991 period. His approach was subject to considerable criticism (Christ 1985).

Table 3: Characteristics of IP and Crop Deviations from Trend, 1828-1860 1869-1913

		HP			Quadratic		
Series	Period	Std. Dev.	Max.	Min.	Std. Dev.	Max.	Min.
IP including textiles, flour	1828-1860	0.066	0.116	-0.151			
	1869-1913	0.069	0.115	-0.147			
IP excluding textiles, flour	1828-1860	0.077	0.140	-0.151			
	1869-1913	0.077	0.138	-0.160			
Cotton crop	1828-1860	0.111	0.208	-0.222	0.115	0.234	-0.221
	1869-1913	0.112	0.233	-0.229	0.116	0.207	-0.241
Wheat crop	1869-1913	0.111	0.239	-0.192	0.121	0.236	-0.191

Table 4: Determinants of harvest variations, 1829-60 and 1870-1913

LHS variable: log crop, deviation from trend

Coefficient
[Standard error]
p-value

	A) Cotton				B) Wheat	
Trend:	HP		Quadratic		HP	Quadratic
Period:	1829-1860	1870-1914	1829-1860	1870-1913	1870-1913	
Crop(-1)	-0.239	-0.298	-0.191	-0.256	-0.179	-0.024
	[0.181]	[0.189]	[0.183]	[0.193]	[0.152]	[0.151]
	0.20	0.12	0.31	0.19	0.25	0.87
Other crop		0.180		0.260	0.160	0.255
		[0.170]		[0.158]	[0.150]	[0.155]
		0.30		0.11	0.30	0.11
Other crop(-1)		-0.065		0.004	0.293	0.398
		[0.164]		[0.152]	[0.178]	[0.184]
		0.70		0.98	0.11	0.04
IP	-0.000	-0.085	-0.079	-0.159	0.303	0.197
	[0.361]	[0.400]	[0.373]	[0.346]	[0.317]	[0.342]
	0.99	0.80	0.83	0.64	0.35	0.57
IP(-1)	-0.379	0.107	-0.421	-0.159	0.027	-0.023
	[0.362]	[0.309]	[0.374]	[0.346]	[0.292]	[0.317]
	0.30	0.73	0.27	0.65	0.93	0.94
F-statistic	0.99	0.975	0.96	0.920	1.721	2.016
p-value	0.41	0.45	0.43	0.48	0.15	0.10
R bar sqr	-0.00	-0.00	-0.00	-0.01	0.08	0.11
IP & IP(-1)						
F-stat		0.062		0.107	0.729	0.210
p-value		0.94		0.90	0.49	0.81

Table 5: Determinants of yields and acreage, 1870-1913

LHS variable at head of column

Coefficient
[Standard error]
p-value

	Cotton		Wheat	
	Acreage	Yield	Acreage	Yield
Acreage or Yield(-1)	-0.126	-0.284	0.397	-0.294
	[0.177]	[0.174]	[0.147]	[0.148]
	0.48	0.11	0.01	0.05
IP	0.016	-0.096	0.166	0.316
	[0.129]	[0.234]	[0.125]	[0.209]
	0.90	0.68	0.19	0.14
IP(-1)	0.034	0.055	-0.052	-0.150
	[0.118]	[0.222]	[0.126]	[0.211]
	0.77	0.80	0.68	0.48
F-statistic	0.248	1.583	3.86	1.962
p-value	0.86	0.21	0.02	0.14
R bar sqr	-0.06	0.04	0.17	0.06

Table 6: Industrial Production and Crops, Deviations from HP Trends, 1829-60 and 1870-1913
LHS variable: IP series

Coefficient
[Standard error]
p-value

IP series:	Davis including textiles, flour			
Period:	1829-1860	1834-1860	1870-1913	1879-1913
Cotton	-0.011	0.050	-0.057	-0.121
	[0.098]	[0.093]	[0.076]	[0.080]
	0.91	0.60	0.46	0.14
Cotton(-1)	-0.053	0.004	0.300	0.360
	[0.098]	[0.093]	[0.080]	[0.085]
	0.59	0.96	0.00	0.00
Wheat			0.040	0.042
			[0.080]	[0.082]
			0.62	0.61
Wheat(-1)			0.032	0.004
			[0.076]	[0.080]
			0.67	0.96
IP(-1)	0.679	0.597	0.650	0.617
	[0.187]	[0.207]	[0.141]	[0.144]
	0.00	0.01	0.00	0.00
IP(-2)	-0.262	-0.063	-0.286	-0.312
	[0.187]	[0.210]	[0.138]	[0.135]
	0.17	0.77	0.05	0.03
R sqr	0.35	0.33	0.53	0.61
R bar sqr	0.25	0.21	0.46	0.52
Wheat & wheat(-1)				
F-statistic			0.176	0.133
p-value			0.84	0.88

Table 6 (cont.)

IP series:	Davis excluding textiles, flour				Frickey	
Period:	1829-1860	1834-1860	1870-1913	1879-1913	1870-1913	1879-1913
Cotton	0.011	0.092	-0.037	-0.131	-0.053	-0.101
	[0.109]	[0.102]	[0.089]	[0.093]	[0.095]	[0.092]
	0.92	0.38	0.68	0.17	0.58	0.28
Cotton(-1)	-0.154	-0.100	0.285	0.356	0.226	0.331
	[0.108]	[0.104]	[0.091]	[0.096]	[0.102]	[0.101]
	0.17	0.35	0.00	0.00	0.03	0.00
Wheat			0.046	0.053	0.136	0.125
			[0.091]	[0.092]	[0.100]	[0.096]
			0.62	0.57	0.18	0.20
Wheat(-1)			0.042	0.001	0.044	0.010
			[0.087]	[0.090]	[0.098]	[0.097]
			0.63	0.99	0.65	0.92
IP(-1)	0.700	0.661	0.660	0.651	0.389	0.331
	[0.185]	[0.200]	[0.146]	[0.150]	[0.153]	[0.152]
	0.00	0.00	0.00	0.00	0.02	0.04
IP(-2)	-0.155	-0.025	-0.275	-0.337	-0.217	-0.263
	[0.196]	[0.214]	[0.145]	[0.143]	[0.147]	[0.138]
	0.44	0.91	0.07	0.03	0.15	0.07
R sqr	0.42	0.47	0.50	0.58	0.34	0.49
R bar sqr	0.34	0.38	0.42	0.49	0.23	0.38
Wheat & wheat(-1)						
F-statistic			0.209	0.173	0.95	0.87
p-value			0.81	0.84	0.40	0.43

Table 7:Industrial Production and Crops, Log Levels, 1829-60 and 1870-1913

LHS variable: Davis IP series

Period:	1829-1860	1834-1860	1870-1913	1879-1913
Cotton	0.062	0.115	-0.022	-0.097
	[0.118]	[0.112]	[0.099]	[0.112]
	0.60	0.32	0.83	0.40
Cotton(-1)	0.009	0.035	0.330	0.410
	[0.118]	[0.114]	[0.103]	[0.117]
	0.95	0.76	0.00	0.00
Wheat			0.062	0.016
			[0.105]	[0.115]
			0.56	0.89
Wheat(-1)			-0.008	-0.063
			[0.099]	[0.113]
			0.94	0.58
IP(-1)	1.081	1.015	0.999	1.006
	[0.189	[0.212]	[0.157]	[0.169]
	0.00	0.00	0.00	0.00
IP(-2)	-0.103	-0.025	-0.008	-0.040
	[0.187]	[0.211]	[0.157]	[0.168]
	0.59	0.91	0.96	0.81
R bar sqr	0.987	0.98	0.99	0.98
Wheat & wheat(-1)				
F-statistic			0.198	0.201
p-value			0.82	0.82

Table 8: Industrial Production and Cotton Crop, Yield, and Acreage, deviation from HP trends, 1870-1913

LHS variable: Davis IP

Period:	1870-1913					1879-1913				
Specification:	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Cotton Crop(-1)	0.332			0.284		0.393			0.297	
	[0.069]			[0.106]		[0.074]			[0.105]	
	0.00			0.01		0.00			0.00	
Cotton Yield (-1)		0.397					0.433			
		[0.98]					[0.107]			
		0.00					0.00			
Cotton Acres (-1)			0.685	0.156				0.885	0.342	
			[0.184]	[0.261]				[0.208]	[0.268]	
			0.00	0.55				0.00	0.21	
IP(-1)	0.663	0.670	0.581	0.653	0.557	0.599	0.576	0.534	0.594	0.458
	[0.125]	[0.134]	[0.134]	[0.128]	[0.153]	[0.129]	[0.144]	[0.139]	[0.127]	[0.171]
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
IP(-2)	-0.283	-0.277	-0.237	-0.280	-0.196	-0.269	-0.258	-0.213	-0.262	-0.168
	[0.125]	[0.133]	[0.135]	[0.126]	[0.154]	[0.124]	[0.138]	[0.134]	[0.123]	[0.166]
	0.03	0.04	0.09	0.03	0.21	0.04	0.07	0.12	0.04	0.32
R sqr	0.52	0.46	0.44	0.53	0.25	0.57	0.46	0.48	0.59	0.18
R bar sqr	0.48	0.42	0.40	0.48	0.21	0.53	0.41	0.43	0.54	0.13

Table 9: U.S. and British Industrial Production and Cotton Crop, Deviations from HP Trends

	1829-1860		1834-1860		1870-1913		1879-1913	
LHS IP	U.S.	British	U.S.	British	U.S.	British	U.S.	British
Crop(-1)	-0.117	0.094	-0.076	0.080	0.207	0.010	0.259	0.006
	[0.107]	[0.055]	[0.092]	[0.054]	[0.080]	[0.03]	[0.087]	[0.066]
	0.28	0.10	0.42	0.15	0.01	0.84	0.01	0.93
RHS IP								
British	0.663		0.784		0.740		0.636	
	[0.332]		[0.294]		[0.227]		[0.237]	
	0.06		0.01		0.00		0.01	
U.S.		0.182		0.292		0.278		0.289
		[0.091]		[0.109]		[0.085]		[0.108]
		0.06		0.01		0.00		0.01
R sqr	0.13	0.178	0.23	0.27	0.36	0.25	0.41	0.24
R bar sqr	0.07	0.121	0.17	0.21	0.32	0.22	0.37	0.20

Table 10: Relative interest rates and Crop Deviations from Trend 1870-1913

LHS variable: Deviation from HP trend in New York Commercial Paper rate less London three-month rate, average of June and July

Period	1870-1913		1879-1913	
Specification	(1)	(2)	(1)	(2)
Cotton(-1)	-4.195	-3.613	-5.101	-4.305
	[1.276]	[1.383]	[1.470]	[1.713]
	0.00	0.01	0.00	0.02
Wheat(-1)	0.412	0.833	0.728	1.112
	[1.266]	[1.323]	[1.406]	[1.472]
	0.75	0.53	0.61	0.46
US rate less London rate (-1)	-0.373	-0.425	-0.325	-0.392
	[0.129]	[0.137]	[0.147]	[0.165]
	0.01	0.00	0.03	0.02
IP		-2.643		-2.899
		[0.245]		[3.178]
		0.29		0.37
R sqr	0.28	0.30	0.33	0.35
R bar sqr	0.23	0.23	0.26	0.26

Table 11: Interest rate levels and crop deviations from Trend 1870-1913

LHS variable: Deviation from HP trend in New York Commercial Paper rate, average of June and July

Period	1870-1913		1879-1913	
Specification	(1)	(2)	(1)	(2)
Cotton(-1)	-3.133	-4.882	-3.655	-5.655
	[1.418]	[1.451]	[1.699]	[1.895]
	0.03	0.00	0.04	0.01
Wheat(-1)	2.110	1.024	2.372	1.479
	[1.443]	[1.388]	[1.637]	[1.622]
	0.15	0.47	0.16	0.37
US rate(-1)	-0.291	-0.211	-0.341	-0.230
	[0.134]	[0.127]	[0.159]	[0.161]
	0.04	0.11	0.04	0.16
IP		6.941		6.793
		[2.477]		[3.345]
		0.01		0.05
R sqr	0.20	0.33	0.24	0.33
R bar sqr	0.14	0.27	0.17	0.24

Table 12 Specie Flows and Crop Deviations from Trend 1829-60 and 1870-1913

Period	1830-1860*	1834-1860*	1870-1913 (1)	1870-1913 (2)	1870-1913 (3)	1879-1913 (1)	1879-1913 (2)	1879-1913 (3)
Cotton(-1)	0.082	0.061	244.582	231.970	265.81	348.739	275.172	358.221
	[0.171]	[0.163]	[188.82]	[164.335]	[185.07]	[154.957]	[128.340]	[149.151]
	0.63	0.71	0.20	0.17	0.16	0.03	0.04	0.02
Wheat(-1)				272.890	291.64		204.98	238.401
				[166.934]	[174.69]		[125.545]	[128.923]
				0.11	0.10		0.11	0.07
IP(-1)	-0.120	0.019	5.398		-128.26	-161.48		-272.776
	[0.332]	[0.349]	[305.52]		[309.29]	[254.01]		[251.654]
	0.72	0.96	0.99		0.68	0.53		0.29
R sqr	0.60	0.67	0.32	0.36	0.36	0.29		0.36
R bar sqr	0.55	0.61	0.25	0.30	0.28	0.19		0.25

*Excluding 1842

Table 13: Crop Value and Crop Deviations from Trend 1829-60 and 1870-1913

LHS variable: log (crop times October crop price)

	Cotton				Wheat	
Period:	1829-1860	1834-1860	1870-1913	1879-1913	1870-1913	1879-1913
Crop	0.149	0.086	0.467	0.425	0.586	0.489
	[0.363]	[0.303]	[0.150]	[0.157]	[0.248]	[0.244]
	0.68	0.78	0.00	0.01	0.02	0.06
Crop(-1)	-0.556	-0.614	-0.326	-0.417	-0.144	-0.242
	[0.365]	[0.304]	[0.150]	[0.159]	[0.250]	[0.254]
	0.14	0.06	0.04	0.01	0.57	0.35
WPI	0.684	-0.009	1.199	1.235	0.550	0.757
	[0.524]	[0.491]	[0.202]	[0.224]	[0.341]	[0.364]
	0.20	0.98	0.00	0.00	0.11	0.05
Time	-0.012	-0.317	0.046	-0.051	0.093	-0.073
	[0.076]	[0.111]	[0.053]	[0.069]	[0.091]	[0.111]
	0.87	0.01	0.388	0.046	0.31	0.52
Time Sqr	0.001	0.003	-0.000	0.000	-0.000	0.000
	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
	0.32	0.00	0.84	0.23	0.41	0.43
R sqr	0.87	0.89	0.93	0.94	0.61	0.62
R bar sqr	0.84	0.86	0.92	0.93	0.56	0.56

Table 14: Crop Price and Crop Deviations from Trend: 1829-60 and 1870-1913

LHS variable: log (October crop price)

	Cotton				Wheat	
Period:	1829-1860	1834-1860	1870-1913	1879-1913	1870-1913	1879-1913
Crop	-0.882	-0.939	-0.543	-0.580	-0.485	-0.554
	[0.363]	[0.314]	[0.141]	[0.155]	[0.223]	[0.247]
	0.02	0.01	0.00	0.00	0.04	0.03
Crop(-1)	-0.589	-0.641	-0.342	-0.427	-0.193	-0.281
	[0.364]	[0.315]	[0.141]	[0.158]	[0.231]	[0.258]
	0.12	0.05	0.02	0.01	0.41	0.283
WPI	0.605	-0.032	1.227	1.256	0.602	0.791
	[0.524]	[0.509]	[0.190]	[0.222]	[0.315]	[0.368]
	0.26	0.95	0.00	0.00	0.06	0.04
Time	-0.127	-0.409	-0.039	-0.090	-0.018	-0.130
	[0.076]	[0.115]	[0.050]	[0.069]	[0.084]	[0.112]
	0.11	0.00	0.44	0.20	0.83	0.26
Time Sqr	0.001	0.003	0.000	0.000	0.000	0.001
	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
	0.08	0.00	0.37	0.17	0.82	0.26
R sqr	0.39	0.60	0.88	0.82	0.48	0.50
R bar sqr	0.27	0.51	0.87	0.79	0.41	0.41

Table 15: Raw materials export revenue and crop deviations from trend 1829-60 and 1870-1913

LHS variable: log (revenue from exports of crude materials, foods and partially-processed foods)

Period:	1829-1860*	1834-1860*	1870-1913 (1)	1870-1913 (2)	1879-1913 (1)	1879-1913 (2)
Cotton(-1)	-0.131	-0.196	0.409	0.390	0.523	0.480
	[0.250]	[0.226]	[0.210]	[0.194]	[0.206]	[0.187]
	0.61	0.40	0.06	0.05	0.02	0.02
Wheat(-1)				0.460		0.411
				[0.175]		[0.153]
				0.01		0.01
IP	-0.046	0.313	0.228	0.207	-0.051	0.029
	[0.564]	[0.713]	[0.483]	[0.447]	[0.437]	[0.395]
	0.94	0.67	0.64	0.64	0.91	0.94
IP(-1)	0.561	0.345	0.198	-0.129	0.590	0.308
	[0.509]	[0.556]	[0.446]	[0.431]	[0.394]	[0.371]
	0.28	0.54	0.66	0.77	0.15	0.41
WPI	1.255	0.636	-0.027	-0.152	0.116	-0.161
	[0.612]	[0.648]	[0.425]	[0.397]	[0.392]	[0.368]
	0.05	0.34	0.95	0.70	0.77	0.67
WPI(-1)	-0.271	-0.147	0.264	0.527	0.036	0.341
	[0.637]	[0.639]	[0.397]	[0.382]	[0.364]	[0.347]
	0.67	0.82	0.51	0.18	0.92	0.33
R sqr	0.94	0.93	0.90	0.91	0.88	0.90
R bar sqr	0.92	0.91	0.88	0.89	0.85	0.87

*Excluding 1843

Table 16: Net exports of merchandise and crop deviations from trend 1829-60 and 1870-1913

LHS variable: net exports of merchandise

Period:	1829-1860*	1834-1860*	1870-1913 (1)	1870-1913 (2)	1879-1913 (1)	1879-1913 (2)
Cotton(-1)	20.995	18.129	562.558	553.092	693.66	644.477
	[26.034]	[29.287]	[250.575]	[238.275]	[321.384]	[311.694]
	0.43	0.54	0.03	0.03	0.04	0.05
Wheat(-1)				456.902		431.097
				[207.987]		[251.018]
				0.03		0.10
IP	-67.184	-41.849	-663.951	-772.394	-994.667	-934.736
	[62.173]	[98.224]	[552.651]	[527.750]	[667.673]	[645.744]
	0.29	0.68	0.24	0.15	0.15	0.16
IP(-1)	-33.967	-50.932	180.573	-110.226	248.837	-31.392
	[54.168]	[72.579]	[507.329]	[500.180]	[619.122]	[619.778]
	0.54	0.49	0.72	0.83	0.69	0.96
WPI	-2.527	-2.729	-0.640	-0.729	5.088	2.474
	[0.491]	[0.664]	[4.108]	[3.906]	[6.196]	[6.175]
	0.00	0.00	0.88	0.85	0.42	0.69
WPI(-1)	2.024	2.135	0.336	1.995	-0.694	2.192
	[0.515]	[0.646]	[3.952]	[3.833]	[5.815]	[5.862]
	0.00	0.00	0.93	0.61	0.91	0.71
R sqr	0.77	0.76	0.68	0.72	0.61	0.65
R bar sqr	0.70	0.67	0.62	0.65	0.51	0.55

*Excluding 1843