Recovery from the Great Depression: The Farm Channel in Spring 1933

ONLINE APPENDIX

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July 16, 2018

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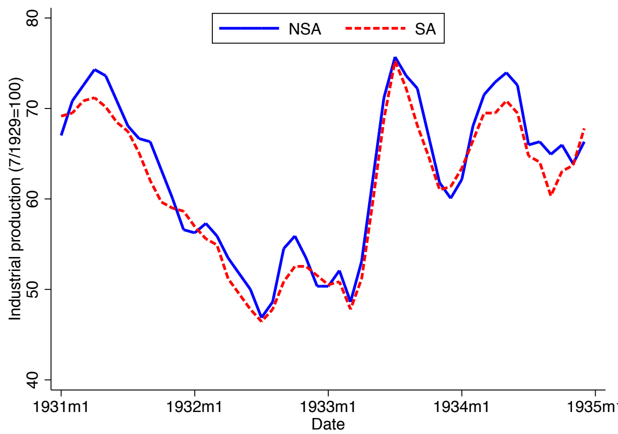
A Checking data consistency in spring 1933

Rapid growth rates over a short period naturally lead to questions of data quality: should one believe that seasonally adjusted industrial production rose 57 percent in spring 1933 or might this reported increase be a result of data construction problems? We argue the former. Since our conclusion is in line with Taylor and Neumann (2016), our analysis in this appendix is brief.

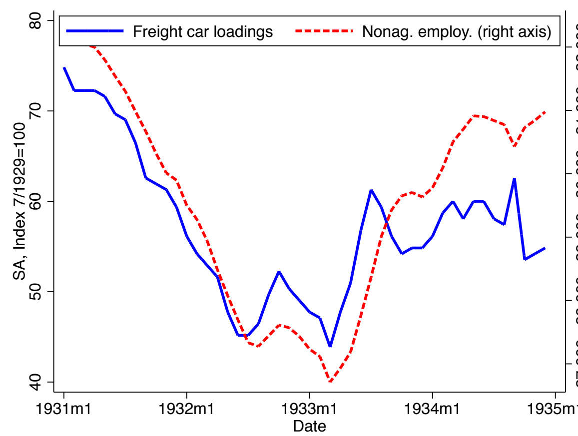
The first check is to consider the behavior of non-seasonally adjusted production. This is shown in figure A.1a. The rapid increase in industrial production is also present in the raw, non-seasonally adjusted data and is not a regular seasonal phenomena. Only in 1933 does one see such a dramatic increase in spring. A second check on data quality is to see whether the rapid production increase is driven by outliers. It appears not. Of the 19 individual industry production series comprising durable manufacturing published in Federal Reserve (1940), eight saw seasonally adjusted production rise more than 100 percent between March and July 1933; all but one (railroad car production) of the 19 saw production rise more than 20 percent.

A.1 Other production indicators A further check on the industrial production data is to consider alternative indicators of economic activity. Figure A.1b shows two such indicators: the Federal Reserve index of freight car loadings and nonagricultural employment (Federal Reserve, 1941). Freight car loadings measure the real quantity of shipments by rail, with underlying data from the railroads themselves. The broad picture is similar to that for industrial production. After reaching a trough in March 1933, seasonally adjusted freight car loadings grew rapidly through July. In these four months, the seasonally adjusted series rose 40 percent.

It is also natural to examine the evolution of employment. Caution is necessary since the employment data are not entirely independent of the industrial production data. For some industries, the industrial production figures rely heavily on the Bureau of Labor Statistics establishment survey, which is the employment data's source (Federal Reserve, 1940, p. 761). Nonetheless, it is reassuring that, like industrial production, employment rose rapidly in spring 1933. Total, seasonally adjusted, nonagricultural employment grew from 26.7 million

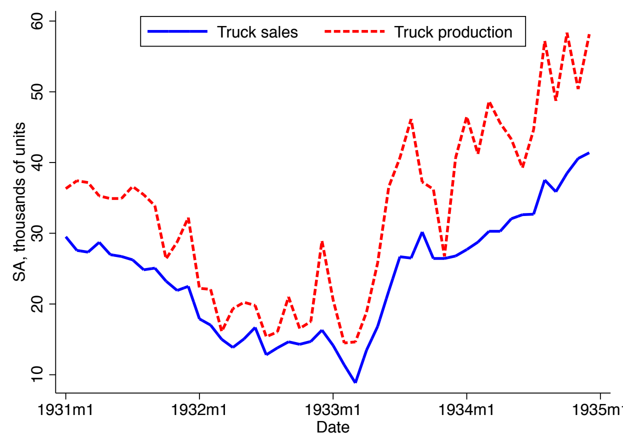


(a) Non-seasonally adjusted and seasonally adjusted industrial production



(b) Freight car loadings and employment

(c) Car sales and production



(d) Truck sales and production

Figure A.1 – Notes: See text for details on the seasonal adjustment of car and truck sales / production. Sources: Industrial production: Federal Reserve Board, G.17 data release. Freight car loadings and employment: Federal Reserve (1941). Cars: Sales data are from NBER macrohistory series m01109; production data are from NBER series m01107a. Trucks: Sales data are from NBER macrohistory series m01146a; production data are from NBER series m01144a.

in March 1933 to 28.4 million in July.[1] Seventy-three percent of this employment increase was accounted for by an astonishing 20 percent increase in manufacturing employment.[2]

A.2 Sales Together, the data on industrial production, employment, and freight car loadings leave little doubt that output rose rapidly in spring 1933. But was the recovery of production due to contemporaneous consumer demand or to expectations of future demand? If the former, the historians' task is to explain the increase in consumption. If the latter, to explain why firms expected higher future sales. Therefore we examine the behavior of sales in spring 1933. Figure A.1c shows seasonally adjusted passenger car sales and production from 1931 through 1934.[3] Seasonally adjusted sales behave similarly to production in spring 1933, roughly doubling from March to July. Figure A.1d presents the analogous data for trucks. Interestingly, the recovery of truck sales is even more rapid than that of car sales in spring 1933: they rise 202 percent from March to July.[4]

As with cars, the difference between truck production and sales is not obviously anomalous in spring 1933. Figures A.1c and A.1d suggest a roughly parallel movement in production and sales of cars and trucks. This mirrors the finding of Taylor and Neumann (2016) that manufacturing inventories behaved normally in spring 1933.

B Appendix Tables

[1]Note that these employment data exclude relief workers. Data are from Federal Reserve (1941) p. 534.

[2]Manufacturing employment rose from 6.12 million in March to 7.36 million in July (Federal Reserve, 1941, p. 534).

[3]Sales data are from NBER macrohistory series m01109; production data are from NBER series m01107a. Neither series was seasonally adjusted by the source. We seasonally adjust the series by regressing the natural logarithm of each series on monthly dummies for the period January 1929-December 1934, excluding 1933. We use this narrow sample to align with the seasonal adjustment procedure used for the monthly state auto sales. The series graphed in figure A.1c is $e^{\hat{\varepsilon_t}} \times \frac{\bar{y}}{\bar{x}}$, where $\hat{\varepsilon_t}$ are the residuals from the regression of the natural log of sales or production on the monthly dummies, $\bar{y}$ is the mean of non-seasonally adjusted sales over the period, and $\bar{x}$ is the mean of $e^{\hat{\varepsilon_t}}$.

[4]Sales data are from NBER macrohistory series m01146a; production data are from NBER series m01144a. The seasonal adjustment procedure is identical to that for passenger cars. See footnote above.

Table B.1 – New auto sales growth in spring 1933 (%, SA), population weighted

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Right hand side variables:								
% pop. on farms	1.49***	1.51***						
	(0.36)	(0.55)						
Crops sold p.c. 1929 ($)			0.75***	0.65***				
			(0.21)	(0.23)				
Change farm value p.c. ($)					0.73***	0.48	1.01	1.74**
					(0.23)	(0.29)	(0.67)	(0.72)
Farm product value p.c. ($)							−0.17	−0.83
							(0.44)	(0.52)
Population (millions)		−0.039		−1.03		−0.79		−1.03
		(1.43)		(1.52)		(1.53)		(1.59)
Car registrations p.c. 1929 (1000s)		0.20		0.0017		0.13		0.21
		(0.17)		(0.20)		(0.21)		(0.21)
% pop. black		1.27		1.14		1.99**		2.01**
		(0.82)		(0.88)		(0.78)		(0.76)
Region Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.32	0.48	0.25	0.48	0.19	0.45	0.19	0.47
Observations	49	49	49	49	48	48	48	48

Notes: The dependent variable is the percent change in seasonally adjusted auto sales from the October 1932-March 1933 average to the July-September 1933 average. "p.c." means per capita. Robust standard errors in parenthesis. $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$
Sources: see text.

Table B.2 – New auto sales growth Q4 1932 to Q4 1933 (%, NSA)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Right hand side variables:								
% pop. on farms	1.71^{***}	1.81^{***}						
	(0.38)	(0.63)						
Crops sold p.c. 1929 ($)			0.91^{***}	0.91^{***}				
			(0.16)	(0.22)				
Change farm value p.c. ($)					0.95^{***}	1.34^{***}	2.69^{***}	3.03^{***}
					(0.31)	(0.43)	(0.62)	(0.73)
Farm product value p.c. ($)							-0.89^{***}	-0.96^{**}
							(0.32)	(0.36)
Population (millions)		1.31		0.89		1.96		0.78
		(2.02)		(1.81)		(2.17)		(1.89)
Car registrations p.c. 1929 (1000s)		−0.067		-0.30^{*}		−0.29		−0.11
		(0.20)		(0.16)		(0.20)		(0.22)
% pop. black		0.69		0.55		1.60^{*}		1.70^{**}
		(0.83)		(0.83)		(0.83)		(0.78)
Region Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.29	0.38	0.44	0.53	0.25	0.45	0.31	0.49
Observations	49	49	49	49	48	48	48	48

Notes: The dependent variable is the percent change in non-seasonally adjusted auto sales from the fourth quarter of 1932 to the fourth quarter of 1933. "p.c." means per capita. Robust standard errors in parenthesis.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Sources: see text.

C Notes and sources for farm product data

C.1 Table 1

- The exchange rate: The source is *Survey of Current Business*, 12/32 p. 32, 12/33 p. 31, 12/34 p. 32, 12/35 p. 33.

- Wheat: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 15, p. 19. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from July 1926 through December 1935, excluding 1933. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 1, p. 6. Trade quantities are for the trade year beginning July.

- Corn: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 45, p. 39. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from October 1926 through December 1935, excluding 1933. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 37, p. 33. Trade quantities are for the trade year beginning July.

- Oats: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 60, p. 50. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from July 1926 through December 1935, excluding 1933. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 53, p. 44. Trade quantities are for the trade year beginning July.

- Cotton: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 106, p. 82. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from August 1926 through December 1935, excluding 1933. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 98, p. 76. Trade quantities are for the trade year beginning August.

- Tobacco: Annual calendar year U.S. producer prices are from Strauss and Bean (1940), p. 69, table 27. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 143, p. 104. Trade quantities are for the trade year beginning July.

- Hay: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 274, p. 190. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from July 1926 through December 1935, excluding 1933. Production and trade data are from United States Department of Agriculture (1936), table 270, p. 187. Trade quantities are for the trade year beginning July. Production of hay is the sum of tame hay and wild hay production. Farm product value is tame hay production multiplied by the December 1 price (given in United States Department of Agriculture (1936), table 270, p. 187) plus wild hay production multiplied by the December 1 price (also given in United States Department of Agriculture (1936), table 270, p. 187).

- Potatoes: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 229, p. 162. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from July 1926 through December 1935, excluding 1933. Production, farm product value, and trade data are from United States Department of Agriculture (1936), table 222, p. 157. Trade quantities are for the trade year beginning July.

- Cattle: Monthly U.S. producer prices are from United States Department of Agriculture (1936) table 307, p. 213. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Production data are from United States Department of Agriculture (1934), table 324, pp. 590-591, and United States Department of Agriculture (1935), table 327, pp. 562-563. We calculate farm product value as production multiplied by the weighted-average calendar year producer price (United States Department of Agriculture (1936) table 307, p. 213). Trade data are from United States Department of Agriculture (1936) table 312, p. 217. Trade quantities are for the calendar year. The trade data are for beef and beef products.

- Hogs: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 321, p. 224. Production data are from United States Department of Agriculture (1934), table 340, p. 601, and United States Department of Agriculture (1935), table 342, p. 572. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Farm product value is from United States Department of Agriculture (1934), table 340, p. 601. Trade data are from United States Department of Agriculture (1936) table 331, p. 229. Trade quantities are for the calendar year. The trade data are for hog products; thus they are an upper bound on trade in pork itself.

- Milk: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 376, p. 267. Production data are from United States Department of Agriculture (1934), table 383, p. 628, and United States Department of Agriculture (1936), table 368, p. 259. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Farm product value is production multiplied by the weighted-average calendar year producer price (United States Department of Agriculture (1936), table 376, p. 267). These USDA publications provide no trade data, presumably because little milk was traded. (There was trade in some milk by-products, such as condensed and evaporated milk.)

- Chickens: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 410, p. 286. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Production and farm product value data refer to the number of chickens raised; data are from United States Department of Agriculture (1936), table 403, p. 281. United States Department of Agriculture (1936) provides no trade data, presumably because little chicken was traded.

- Eggs: Monthly U.S. producer prices are from United States Department of Agriculture (1936), table 419, p. 291. We seasonally adjust these prices using the same procedure as for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Production and farm product value data are from United States Department of Agriculture (1936), table 403, p. 281. Trade data are from United States Department of Agriculture (1936), table 423, p. 293. They are for the period July 1932 to June 1933 and are reported in dollar terms; therefore, we calculate the trade output share as imports plus exports (in dollars) divided by total farm value (in dollars).

C.2 Farm product value for U.S. states Except as noted below, we compute the price for 1932 production using a weighted average of monthly, non-seasonally adjusted prices. We compute the percent change in prices from the October 1932 - March 1933 average to the July-September 1933 average using seasonally adjusted, unweighted monthly prices.

- Wheat: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. To compute annual 1932 and 1933 prices, we weight the monthly prices using monthly wheat receipts, United States Department of Agriculture (1936), table 11, p. 15. Production data for 1932 by state are from United States Department of Agriculture (1934), table 4, p. 389. For the states Colorado, Illinois, Indiana, Kansas, Maryland, Missouri, Montana, North Dakota, Ohio, Oklahoma, South Dakota, Virginia, and Wyoming we use 1932 production data from the National Agricultural Statistics Service (NASS).[5] For Illinois, we take data on winter wheat only from NASS and add to it the data on spring wheat production reported in Illinois Cooperative Crop Reporting Service (1951).

- Corn: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. To compute annual 1932 and 1933 prices, we weight the monthly prices using

[5] This and all other NASS data were downloaded on June 10, 2007. See https://www.nass.usda.gov/Quick_Stats/.

monthly marketings by farmers, United States Department of Agriculture (1935), table 48, p. 385. Production data for 1932 by state are from United States Department of Agriculture (1934), table 41, p. 415. For the states Delaware, Illinois, Indiana, Iowa, Kentucky, Maryland, Missouri, Nebraska, North Carolina, Ohio, and Wisconsin we use 1932 production data from NASS.

- Oats: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. To compute annual 1932 and 1933 prices, we weight the monthly prices using monthly marketings by farmers, United States Department of Agriculture (1935), table 64, p. 396. Production data for 1932 by state are from United States Department of Agriculture (1934), table 59, p. 427. For the states Illinois, Minnesota, Montana, North Dakota, Ohio, South Dakota, and Wisconsin we use 1932 production data from NASS.

- Cotton: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. To compute annual 1932 and 1933 prices, we weight the monthly prices using monthly marketings by farmers, United States Department of Agriculture (1935), table 117, p. 429. Production data for 1932 by state are from United States Department of Agriculture (1934), table 112, p. 460. For the states California, Georgia, Mississippi, and North Carolina we use 1932 production data from NASS.

- Tobacco: No monthly prices are available over a long enough time horizon to make seasonal adjustment possible; thus we use the calendar year, annual price reported in Strauss and Bean (1940), p. 69, table 27. Production data for 1932 by state are from United States Department of Agriculture (1934), table 155, p. 486.

- Hay: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. No monthly weights are available, so the annual price is a simple average of the monthly prices. Production data for 1932 by state are from United States Department of Agriculture (1934), table 287, p. 564, for tame hay and from United States Department of Agriculture (1934), table 288, p. 565, for wild hay. For the states Illinois, Minnesota, Missouri, North Dakota, and South Dakota we use 1932 production data from NASS.

- Potatoes: Raw and seasonally adjusted monthly price data are the same as listed in section C.1. To compute annual 1932 and 1933 prices, we weight the monthly prices using monthly potato shipments, United States Department of Agriculture (1936), table 227, p. 161. Production data for 1932 by state are from United States Department of Agriculture (1934), table 237, p. 534-535.

- Cattle: Monthly and weighted-average calendar year producer prices are taken from United States Department of Agriculture (1936) table 307, p. 213. Seasonal adjustment is as described in section C.1. Production data for 1932 by state are from United States Department of Agriculture (1934), table 324, pp. 590-591.

- Hogs: Monthly and weighted-average calendar year producer prices are taken from United States Department of Agriculture (1936), table 321, p. 224. Seasonal adjustment is as described in section C.1. Production data for 1932 by state are from United States Department of Agriculture (1934), table 340, p. 601.

- Milk: Monthly and weighted-average calendar year producer prices are taken from United States Department of Agriculture (1936), table 376, p. 267. Seasonal adjustment is as described in section C.1. Production data for 1932 by state are from United States Department of Agriculture (1934), table 383, p. 628.

- Chickens: Monthly and weighted-average calendar year producer prices are taken from United States Department of Agriculture (1936), table 410, p. 286. Seasonal adjustment is as described in section C.1. Production data for 1932 by state are from Pirtle and Slocum (1937), table 18, p. 16, for chickens sold and table 19, p. 17, for chickens consumed on farms. To match production data on number of chickens to price data on the value of a pound of chicken, we assume that each chicken weighs 3.7 pounds. We obtain this number by taking the ratio of the figures on price per chicken and price per pound of chicken reported in United States Department of Agriculture (1935).

- Eggs: Monthly and weighted-average calendar year producer prices are taken from United States Department of Agriculture (1936), table 419, p. 291. Seasonal adjustment is as described in section C.1. Production data for 1932 by state are from United

States Department of Agriculture (1934), table 432, p. 655.

- Apples: Monthly producer prices are from United States Department of Agriculture (1936), table 155, p. 116. Seasonal adjustment follows the procedure used for auto sales (footnote 14). The seasonal adjustment is done on data from June 1926 through December 1935, excluding 1933. Weights for annual prices are based on monthly car lot shipments, United States Department of Agriculture (1936), table 158, p. 118. Production data for 1932 by state are from United States Department of Agriculture (1934), table 168, p. 499.

- Oranges: Annual producer price data and production data for 1932 by state are from United States Department of Agriculture (1936), table 180, p. 131. No monthly producer prices are available, so we use the annual price for each month of the corresponding year. We follow the convention in Olmstead and Rhode (2006) of making the price in calendar year t equal to the price for the crop year beginning in year $t-1$.

- Grapefruit: Annual producer price data and production data for 1932 by state are from United States Department of Agriculture (1936), table 180, p. 131. No monthly producer prices are available, so we use the annual price for each month of the corresponding year. We follow the convention in Olmstead and Rhode (2006) of making the price in calendar year t equal to the price for the crop year beginning in year $t-1$.

- Wool: Monthly and weighted-average producer prices are from United States Department of Agriculture (1936), table 347, p. 244. Seasonal adjustment follows the procedure used for auto sales (footnote 14). The seasonal adjustment is done on data from January 1926 through December 1935, excluding 1933. Production data for 1932 by state are from United States Department of Agriculture (1934), table 362, p. 616.

C.3 Farm product value for U.S. counties Since we use national prices, all prices are identical to those described above for the state data. County-level production data are constructed as follows:

- Wheat: we calculate the county's share in 1929 state wheat production from the 1930 agricultural census (Haines, Fishback, and Rhode, 2015). We then multiply 1932 state production by that share to impute 1932 county production. For the states Colorado, Illinois, Indiana, Kansas, Maryland, Missouri, Montana, North Dakota, Ohio, Oklahoma, South Dakota, Virginia, and Wyoming we use county-level 1932 production data from NASS. For Illinois, we take data on winter wheat only from NASS and add to it the data on spring wheat production reported in Illinois Cooperative Crop Reporting Service (1951).

- Corn: we calculate the county's share in 1929 state corn production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production. For the states Delaware, Illinois, Indiana, Iowa, Kentucky, Maryland, Missouri, Nebraska, North Carolina, Ohio, and Wisconsin we use county-level 1932 production data from NASS.

- Oats: we calculate the county's share in 1929 state oats production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production. For the states Illinois, Minnesota, Montana, North Dakota, Ohio, South Dakota, and Wisconsin we use county-level 1932 production data from NASS.

- Cotton: we calculate the county's share in 1929 state cotton production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production. For the states California, Georgia, Mississippi, and North Carolina we use county-level 1932 production data from NASS.

- Tobacco: we calculate the county's share in 1929 state tobacco production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Hay: we calculate the county's share in 1929 state hay production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production. For the states Illinois, Minnesota, Missouri, North Dakota, and South Dakota we use county-level 1932 production data from NASS.

- Potatoes: we calculate the county's share in 1929 state potato production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Cattle: we calculate the county's share in 1929 state cattle numbers from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Hogs: we calculate the county's share in 1929 state hog numbers from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Milk: we calculate the county's share in 1929 state milk production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Chickens: we calculate the county's share in 1929 state chicken numbers from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Eggs: we calculate the county's share in 1929 state egg production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Apples: we calculate the county's share in 1929 state apple production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Oranges: we calculate the county's share in 1929 state oranges production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Grapefruit: we calculate the county's share in 1929 state grapefruit production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

- Wool: we calculate the county's share in 1929 state wool production from the 1930 agricultural census (Haines et al., 2015). We then multiply 1932 state production by that share to impute 1932 county production.

D Monthly state auto sales data

Our monthly state auto sales data come from the *Automotive Daily News Review and Reference Book* 1935, pp. 22-23. The source is given as "R. L. Polk & Co., New Jersey Motor List Co. and Sherlock & Arnold."

To check the accuracy of these data, we computed annual totals by state for 1932 and 1933 and compared these to the numbers reported in *Automotive Industries*, 2/25/33, p. 224 (for 1932) and 2/24/34, p. 220 (for 1933).

In 52 of 98 cases, these sources exactly agree, and in all but two cases, the two sources are within 0.2 percent of each other. The two larger discrepancies are in Indiana in 1932, where *Automotive Industries* records 29,202 cars sold while *Automotive Daily News Review and Reference Book* records 28,505 cars sold, and in Iowa in 1932 where *Automotive Industries* records 18,971 cars sold and *Automotive Daily News Review and Reference Book* records 19,525 cars sold.

When these sources differ, it may be due to misreporting / typos in the monthly data. In a few cases, these typos were obvious, and we fixed them by using reported totals to compute a residual. *Automotive Daily News Review and Reference Book* always reported the total by month and state for the years 1929-1934, e.g. they reported the sum of sales in Alabama for January 1929 + January 1930 . . . + January 1934. This allows us to fill in months in which there is an obvious typo. Specifically:

- January 1932, Indiana: *Automotive Daily News Review and Reference Book* reports car sales equal to 5180. As reported, this means car sales for the six Januarys from 1929 to 1934 total to 25,260, much more than the reported total of 22,563. Furthermore, the 5180 figure for January 1932 is suspect because it is larger than Indiana sales in January 1930, 1931, 1933, or 1934, and it is larger than Illinois sales in January 1932. Thus we replace it with the difference between the reported six-January total (22,563) and the sum of the reported figures for all Januarys except January 1932. The resulting number is 2,483 cars sold.

- July 1932, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, and Missouri: In these states, the reported figure for July 1932 sales is identical to that for July 1933 sales. Since on average summer 1932 sales were below summer 1933 sales, we replace the July 1932 figure with the reported six-July sum and sales in all Julys except July 1932. In all cases, this results–as expected–in a number that is less than the July 1933 number.

- February 1929, Nebraska: *Automotive Daily News Review and Reference Book* reports 470 cars sold in Nebraska in February 1929. This is implausibly low (e.g. 3986 cars were sold in Nebraska in the more depressed conditions of February 1930). So we replace it with the difference between the 6-February sum and the sum of all February sales except February 1929. The resulting number is a more plausible 4705 cars sold.

E Banking data: Net demand deposits by reserve district

We seasonally adjust the series using the procedure defined in footnote 14, excluding the year 1933. Data begin in April 1923 and end in July 1935, when there is a discontinuity in the series (Federal Reserve, 1935, p. 644).

Sources:

- 1923-27: Federal Reserve Board (1928), table 87, pp. 210-213.
- 1928: Federal Reserve Board (1929), table 93, p. 187.
- 1929: Federal Reserve Board (1930), table 89, p. 175.
- 1930: Federal Reserve Board (1931), table 95, p. 183.
- 1931: Federal Reserve Board (1932), table 93, p. 187.
- 1932: Federal Reserve Board (1933), table 70, p. 125.
- 1933: Federal Reserve Board (1934), table 74, p. 167.

- 1934: Federal Reserve Board (1935), table 68, p. 153.
- 1935: Federal Reserve Board (1936), table 55, p. 151.

F Model appendix

Time is discrete and indexed by t.

F.1 Technology and Incomes

The final consumption good C_t is a CES aggregate of a farm good F_t and labor L_t,

$$C_t = \left[\psi^{\frac{1}{\varepsilon}} F_t^{\frac{\varepsilon-1}{\varepsilon}} + (1-\psi)^{\frac{1}{\varepsilon}} L_t^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε is the elasticity of substitution across goods. We will consider the case where labor and farm goods are complements in production, $\varepsilon < 1$.

The demand functions for farm goods and labor are,

$$F_t = \psi \left(\frac{P_t^f}{MC_t}\right)^{-\varepsilon} C_t$$
$$L_t = (1-\psi) \left(\frac{W_t}{MC_t}\right)^{-\varepsilon} C_t$$

where P_t^f is the price of the farm good, and W_t is the nominal wage. The marginal cost to produce the final good, MC_t, is a CES composite of the nominal farm price and the nominal wage,

$$MC_t = \left[\psi (P_t^f)^{1-\varepsilon} + (1-\psi) W_t^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}.$$

Capitalists sell the final good at a mark-up $m_t \geq 1$ over marginal costs, so the final retail price is

$$P_t = m_t MC_t.$$

Farm goods F_t and labor L_t are in perfectly elastic supply at zero marginal cost up to a full-employment limit $\bar{F}$ and $\bar{L}$. We will consider the case where $F_t < \bar{F}$ and $L_t < \bar{L}$ to capture underutilization of the factors of production during the Great Depression.

The income share of farmers is then,

$$s_t^f = \frac{p_t^f F_t}{Y_t} = \psi m_t^{-\varepsilon} (p_t^f)^{1-\varepsilon}$$

where we use the fact that $C_t = Y_t$ in equilibrium, and p_t^f is the real farm product price, $\frac{P_t^f}{P_t}$. Since farm goods and labor are complements, the farm income share is increasing in the real farm price. Thus, a higher real farm price redistributes income towards farmers.

The income share of capitalists comes from charging a mark-up over marginal cost,

$$s_t^{cap} = \frac{(P_t - MC_t)C_t}{P_t Y_t} = 1 - \frac{1}{m_t}$$

and the income share of workers is the complement,

$$s_t^w = 1 - s_t^f - s_t^{cap} = \frac{1}{m_t} - s_t^f$$

Thus, when the farm share increases, the losses are split between workers and capitalists depending on the response of the mark-up. When the mark-up remains constant (i.e., firms raise their price sufficiently), then all losses are borne by workers. By contrast, when real wages are unchanged (e.g., final goods prices and wages are sticky), then the mark-up falls and all losses are borne by capitalists.

F.2 Aggregate demand

Any farmer, worker, or capitalist may be either unconstrained (u) or constrained (c) in their consumption choices. We directly parameterize consumption functions for these types,

$$C_t^u = [\beta(1 + r_t)]^{-\sigma} \bar{C}^u$$
$$C_t^c = Y_t^c.$$

C_t^x is consumption and Y_t^x is income of type x, β is the discount factor, r_t is the real interest rate, and σ is the intertemporal elasticity of substitution. Unconstrained consumers follow the permanent income hypothesis, where the quantity $\bar{C}^u$ is their permanent income. They may consume more than their permanent income when the real interest rate is low and vice-versa. In writing the Euler equation in this way, we assume perfect foresight as in Werning

(2011) and Wieland (2017) and let the horizon over which the real interest rate applies be relatively long.[6]

By contrast, constrained consumers are at their borrowing constraint and consume all their income. We think of farmers as being primarily in the constrained group, although we allow for some of them to be unconstrained as well.

Specifically, we assume that a fraction θ^f of farmers and fraction θ^w of workers are constrained. In line with our evidence that debt problems were less severe for firms than for workers or households, we assume that no capitalist is constrained. Then the constrained income share is

$$\begin{aligned} s_t^c &= \theta^w s_t^w + \theta^f s_t^f \\ &= \theta^w \frac{1}{m_t} + \left(\theta^f - \theta^w\right) s_t^f, \end{aligned}$$

and the unconstrained income share is

$$s_t^u = 1 - \theta^w \frac{1}{m_t} - \left(\theta^f - \theta^w\right) s_t^f.$$

Market clearing implies that output equals expenditure, $Y_t = C_t = C_t^u + C_t^c$. Substituting our consumption functions yields a solution for output akin to a Keynesian cross,

$$Y_t = [\beta(1+r_t)]^{-\sigma} \bar{C}^u + s_t^c Y_t$$

where $[\beta(1+r_t)]^{-\sigma} \bar{C}^u$ is autonomous consumption and s_t^c is the MPC. The aggregate MPC out of income is the share of constrained consumers, since they have an MPC of 1, whereas unconstrained consumers have an MPC of zero. Thus $mpc_t = s_t^c \times 1 + s_t^u \times 0 = s_t^c$.

Define the aggregate multiplier as $\mu_t = \frac{1}{1-mpc_t}$. Then the solution for aggregate output is

$$Y_t = \mu_t [\beta(1+r_t)]^{-\sigma} \bar{C}^u.$$

Thus, any change in aggregate output must come from a change in the multiplier μ_t or in

[6] More precisely, we can write the perfect-foresight Euler equation as $C_t = [\tilde{\beta}^s \prod_{k=1}^{s}(1+r_{t+k})]^{-\sigma} C_{t+s}$. We then let s be sufficiently large such that $C_{t+s} \approx \bar{C}^u$, assuming (as in most monetary models) that the economy converges to a single deterministic steady-state. Then define $r_t = \prod_{k=1}^{s}(1+r_{t+k})]^{-1}$ as the real interest rate from t to $t+s$ and $\beta = \tilde{\beta}^s$ as the corresponding discount factor.

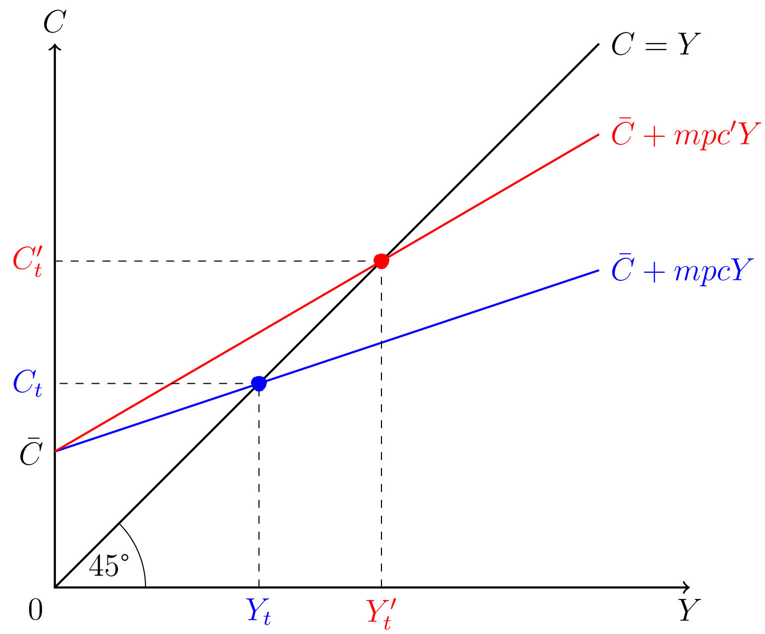


Figure F.1 – Keynesian cross diagram. Redistribution towards constrained consumers increases the average MPC in the economy from mpc to mpc', and increases output from Y_t to Y_t'.

the real interest rate. Redistribution of income directly affects aggregate output through the aggregate multiplier. For example, increasing the share of income going to constrained consumers will raise s_t^c and thus the multiplier μ_t, which in turn raises output. Graphically, the expenditure curve in the Keynesian cross rotates up as shown in figure F.1. Our analysis of the farm channel will focus on this mechanism.

F.3 Aggregate effect

Our experiment is an unanticipated change in the nominal farm price P_t^f. This requires some control by the policy maker over P_t^f. In an international framework we could appeal to the law of one price, so that the local farm price is the product of the foreign farm price and the exchange rate, $P_t^f = P_t^{f*}\mathcal{E}_t$. Then a devaluation would raise the local farm price holding the foreign farm price fixed. In our model the farm price is instead exogenous since any price P_t^f clears the farm product market when there is underemployment, $F_t << \bar{F}$.[7] This helps us simplify the model and more transparently focus on the effects of redistribution.

For now, it will be more convenient to work with the implied change in the farm income

[7]We assume that P_t^f never rises so high that marginal cost exceeds price for final goods producers; this guarantees that output remains demand-determined as farm product prices increase.

share $d\ln s_t^f$. We can then later express that change in terms of the percent change in farm prices $d\ln P_t^f$.

The percent change in output from a percent change in the farm income share combines the effect on the aggregate multiplier (through redistribution) and the real interest rate,

$$d\ln Y_t = \left[\underbrace{\mu_t}_{\text{Multiplier}} \times \underbrace{\frac{-ds_t^u}{d\ln s_t^f}}_{\text{Redistribution}} + \underbrace{\sigma\frac{-d\ln(1+r_t)}{d\ln s_t^f}}_{\text{Intertemporal Substitution}} \right] \times \underbrace{d\ln s_t^f}_{\text{\% Change farm income share}}$$

In this model, a higher farm income share raises output to the extent that it redistributes income towards constrained consumers (lowering the unconstrained share s_t^u) and / or lowers the real interest rate.

The extent to which a higher farm income share redistributes towards high-MPC consumers depends on (1) the importance of constrained farmers and (2) the response of the mark-up m_t to higher farm product prices, since higher prices hurt constrained workers,

$$ds_t^u = \underbrace{-\theta^f s_t^f d\ln s_t^f}_{\text{Redistribution towards high-MPC farmers}} + \underbrace{\theta^w \left[\frac{1}{m_t} d\ln m_t + s_t^f d\ln s_t^f\right]}_{\text{Redistribution from high-MPC workers}}$$

For what follows we parameterize the change in mark-ups by,

$$d\ln m_t = -(1-\xi) m_t s_t^f d\ln s_t^f$$

where $\xi = 0$ implies that the mark-up fully absorbs the increase in the farm share, whereas $\xi = 1$ implies that the mark-up is unchanged.

Then the aggregate effect is

$$d\ln Y_t = \left[\underbrace{\mu_t}_{\text{Multiplier}} \times \underbrace{(\theta^f - \theta^w \xi)}_{\text{Redistribution to high-MPC consumers}} + \underbrace{\sigma\frac{-d\ln(1+r_t)}{s_t^f d\ln s_t^f}}_{\text{Intertemporal Substitution}} \right] \times \underbrace{s_t^f d\ln s_t^f}_{\text{Farm channel}} \quad (1)$$

where the redistribution term consists of the gains to constrained farmers (θ^f) net of the losses to constrained workers ($-\theta^w \xi$). For redistribution to be expansionary for the economy as a whole, the former must exceed the latter, $\theta^f > \theta^w \xi$.

F.4 Cross-section

We are interested in recovering information about the aggregate output effect from our cross-sectional estimates. To construct a mapping between the aggregate and the cross section we split the economy into two areas, agriculture a and manufacturing m. Local income $Y_{a,t}$ accruing to the agricultural area is,

$$Y_{a,t} \equiv s_{a,t} Y_t$$

where $s_{a,t}$ is the share of national income accruing to the local area.

We assume that the agricultural area is populated by the farmers, a fraction ζ of capitalists, and a fraction η of workers. The share of income accruing to the agricultural area is then,

$$\begin{aligned} s_{a,t} &= s_t^f + \zeta s_t^{cap} + \eta s_t^w \\ &= s_t^f + \zeta \left(1 - \frac{1}{m_t}\right) + \eta \left(\frac{1}{m_t} - s_t^f\right) \\ &= \frac{\zeta(m_t - 1) + \eta}{m_t} + (1 - \eta)\, s_t^f \end{aligned}$$

and the share of income accruing to the manufacturing area is

$$s_{m,t} = 1 - \frac{\zeta(m_t - 1) + \eta}{m_t} - (1 - \eta)\, s_t^f.$$

Note that the agricultural area will in general benefit from a higher farm income share relative to the manufacturing area. This is because some part of the higher farm income share is paid for by a lower income share of individuals living in the manufacturing area (either workers or capitalists).

We next need to characterize the local unconstrained and constrained income shares. We assume that for workers the probability of being constrained is the same in both areas, $\theta^w = \theta_a^w = \theta_m^w$. Adding the restrictions that income shares have to sum to 1 yields the income shares of locally unconstrained and constrained consumers,

$$
\begin{aligned}
s^u_{a,t} &= 1 - \left(\theta^f - \eta\theta^w\right) \frac{s^f_t}{s_{a,t}} - \frac{\eta\theta^w}{m_t s_{a,t}} \\
s^c_{a,t} &= \left(\theta^f - \eta\theta^w\right) \frac{s^f_t}{s_{a,t}} + \frac{\eta\theta^w}{m_t s_{a,t}} \\
s^u_{m,t} &= 1 - (1-\eta)\frac{\theta^w}{m_t}\frac{1 - m_t s^f_t}{s_{m,t}} \\
s^c_{m,t} &= (1-\eta)\frac{\theta^w}{m_t}\frac{1 - m_t s^f_t}{s_{m,t}}
\end{aligned}
$$

Local consumption is simply the sum of consumption by local constrained consumers and local unconstrained consumers,

$$
\begin{aligned}
C_{a,t} &= C^u_{a,t} + C^c_{a,t} \\
&= [\beta(1+r_t)]^{-1}\bar{C}^u_a + mpc_{a,t} s_{a,t} Y_t
\end{aligned}
$$

Analogous to aggregate consumption, the first term is a permanent income component coming from unconstrained consumers, $[\beta(1+r_t)]^{-1}\bar{C}^u$. The second term again captures variable expenditure, which is a function of local income $s_{a,t}Y_t$ and the local MPC, $mpc_{a,t} = s^u_{a,t} \times 0 + s^c_{a,t} \times 1 = s^c_{a,t} = 1 - s^u_{a,t}$. As is the case nationally, the local MPC is solely determined by the importance of constrained consumers.

In our regressions we compare the growth rate of consumption across areas conditional on a change in farm product prices. Thus, we need to characterize how local consumption in each area responds to a change in farm prices. In the model any change in consumption can be decomposed into the following terms,

$$
\begin{aligned}
d\ln C_{a,t} = & \underbrace{\frac{mpc_{a,t} s_{a,t} Y_t}{C_{a,t}}}_{\text{Constrained consumption share}} \times \Bigg[\underbrace{d\ln mpc_{a,t}}_{\text{Redistribution within area}} + \underbrace{d\ln s_{a,t}}_{\text{Redistribution across areas}} + \underbrace{d\ln Y_t}_{\text{Aggregate}} \Bigg] + \\
& + \underbrace{\left(1 - \frac{mpc_{a,t} s_{a,t} Y_t}{C_{a,t}}\right)}_{\text{Unconstrained consumption share}} \times \underbrace{d\ln(1+r_t)}_{\text{Intertemporal Substitution}}
\end{aligned}
$$

where the first line is the consumption response by constrained consumers, and the second line is the consumption response by unconstrained consumers. Thus, these effects are weighted by their respective consumption share.

Starting with the constrained consumers, the first term in brackets captures the within-area redistribution effect on local consumption. When income is redistributed towards high-MPC consumers, then the MPC increases, and local consumption will be higher for any level of income. The second term in brackets captures redistribution of income across areas. Since spending either accrues in region a or m, we have $s_{a,t} + s_{m,t} = 1$. Thus, an increase in the income share of the agricultural area must come at the expense of the manufacturing area. The third term in brackets captures the aggregate increase in income, which is common to both the agricultural and the manufacturing area. All these terms are multiplied by the share of consumption by constrained consumers in local consumption. When few consumers are constrained then this term is small, so that any of these three terms will only have small effects on local consumption. By contrast, the second part of this equation, the intertemporal substitution effect, will be more important when fewer consumers are constrained.

We assume that *initially* the importance of high-MPC consumers is the same in the agricultural and the manufacturing area. That is, $s^u_{a,t} = s^u_{m,t} = s^u_t$, which implies $mpc_{a,t} = mpc_{m,t} = mpc_t$. In addition, we assume that the share of consumption by unconstrained consumers is the same in both areas, $\frac{\bar{C}^u_a}{C_{a,t}} = \frac{\bar{C}^u_m}{C_{u,t}}$. This implies,

$$\frac{s_{a,t} Y_t}{C_{a,t}} = \frac{s_{m,t} Y_t}{C_{m,t}} = 1$$

These assumptions imply that, initially, both areas are equally exposed to aggregate fluctuations. Thus, any aggregate effects are differenced out in the cross-section. Importantly, we only make these assumptions on initial conditions. After redistributing towards high-MPC farmers, the MPCs and income shares may (and will) differ across regions.

We can now compute the difference in consumption growth across regions, which is one important component of our cross-sectional regression,

$$d \ln C_{a,t} - d \ln C_{a,t} = mpc_t \left[\underbrace{d \ln mpc_{a,t} - d \ln mpc_{m,t}}_{\text{Relative redistribution within areas}} + \underbrace{d \ln s_{a,t} - d \ln s_{m,t}}_{\text{Redistribution across areas}} \right]$$

The aggregate effects on output and the real interest rate are differenced out, so the relative consumption growth across regions does not directly tell us about what we are ultimately interested in. Differences in consumption growth across areas are instead due to the relative effectiveness in redistributing income towards high-MPC consumers (the first term in brackets) and redistribution across areas (the second term).

The term capturing redistribution across areas is easiest to characterize. The agricultural areas' income share change is,

$$d\ln s_{a,t} = \underbrace{[1-\zeta(1-\xi)-\eta\xi]}_{\text{Redistribution from } m \text{ to } a} \times \underbrace{\frac{s_t^f}{s_{a,t}} d\ln s_t^f}_{\text{Local exposure to farm channel}}$$

The term in square brackets subtracts the local losses from the gains to the farmers. These are losses by the fraction ζ of local entrepreneurs, $\zeta(1-\xi)$, when mark-ups fall $\xi < 1$, and losses by the fraction η of local workers, $\eta\xi$, when real wages fall $\xi > 0$. The second term captures the local exposure to the farm channel, whereby the aggregate change in the farm income share is scaled by the local income share.

We obtain an analogous expression for the manufacturing area. The key differences are that local exposure is negative (since income is redistributed away) and calculated based on the manufacturing area's income share,

$$d\ln s_{m,t} = \underbrace{-[1-\zeta(1-\xi)-\eta\xi]}_{\text{Redistribution from } a \text{ to } m} \times \underbrace{\frac{s_t^f}{s_{m,t}} d\ln s_t^f}_{\text{Local exposure to farm channel}}$$

Next we determine how effectively income is redistributed towards high-MPC consumers in the agricultural area,

$$\begin{aligned} d\ln mpc_{a,t} &= -\frac{s_{a,t}^u}{mpc_{a,t}} d\ln s_{a,t}^u \\ &= \underbrace{\frac{1}{mpc_{a,t}}}_{\text{Sensitivity of mpc}} \times \underbrace{\left[(\theta^f - \theta^w\eta\xi) - (1-s_{a,t}^u)(1-\zeta(1-\xi)-\eta\xi)\right]}_{\text{Local redistribution to constrained consumers}} \times \underbrace{\frac{s_t^f}{s_{a,t}} d\ln s_t^f}_{\text{Local exposure to farm channel}} \end{aligned}$$

The first term determines how sensitive the local MPC is to changes in the income share of constrained consumers. The second term captures how the income share of unconstrained consumers varies with the farm income share. This consists of how much income we move towards the constrained farmers and away from constrained workers, $\theta^f - \theta^w\eta\xi$, modulated by the increase in local income to constrained agents $(1-s^u_{a,t})(1-\zeta(1-\xi)-\eta\xi)$.[8] The third term is the local exposure to the change in the farm income share.

Analogously, we obtain an expression for the change in the MPC in the manufacturing area,

$$
\begin{aligned}
d\ln mpc_{m,t} &= -\frac{s^u_{m,t}}{mpc_{m,t}} d\ln s^u_{m,t} \\
&= \underbrace{\frac{1}{mpc_{m,t}}}_{\text{Sensitivity of mpc}} \times \underbrace{\left[-(1-\eta)\theta^w\xi + (1-s^u_{m,t})(1-\zeta(1-\xi)-\eta\xi)\right]}_{\text{Local redistribution to constrained consumers}} \times \underbrace{\frac{s^f_t}{s_{m,t}} d\ln s^f_t}_{\text{Local exposure to farm channel}}
\end{aligned}
$$

The manufacturing MPC decreases with the income losses to constrained workers, $-(1-\eta)\theta^w\xi$, but the fall in the local constrained income *share* is mitigated to the extent that local income (the denominator) falls.

Combining these expressions we can determine the difference in consumption growth across areas,

$$
d\ln C_{a,t} - d\ln C_{m,t} = \underbrace{\left[\theta^f - \theta^w\xi\frac{\eta - s_{a,t}}{1-s_{a,t}}\right]}_{\text{Relative redistribution towards high-MPC consumers}} \times \underbrace{\frac{s^f_t}{s_{a,t}} d\ln s^f_t}_{\text{Local exposure to farm channel}}
$$

The first term in brackets, θ^f, captures that redistribution to constrained farmers will raise consumption in the agricultural area relative to the manufacturing area. The second term captures how redistribution from unconstrained workers affects the cross-sectional consumption growth rates. Its sign is ambiguous. If $\eta = 1$, so all workers reside in the agricultural area, then this reduction in consumption accrues in the agricultural area and thus reduces the cross-sectional difference. However, when η is sufficiently small, $\eta < s_{a,t}$, then workers' losses disproportionally accrue in the manufacturing area. In that case the term becomes positive and amplifies the cross-sectional consumption differences.

Our model-based cross-sectional coefficient is this difference in consumption growth divided by the difference in farm population shares. Let the aggregate farm population share be ϕ^f and the local population shares by ϕ_a and ϕ_m. Then the difference in farm population

[8] To see the necessity of this last term suppose that only farmers live in the agricultural area, $\eta = \zeta = 1$. Then redistributing to farmers cannot change the local constrained share $s^c_{a,t} = \theta^f$. In this case the redistribution towards farmers and the local increase in (constrained) income are the same, leaving the ratio unchanged.

shares is $\phi_a^f - \phi_m^f = \phi_a^f - 0 = \frac{\phi^f}{\phi_a}$, which yields a cross-sectional coefficient,

$$\beta = \frac{d \ln C_{a,t} - d \ln C_{a,t}}{\frac{\phi^f}{\phi_a}} = \left[\theta^f - \theta^w \xi \frac{\eta - s_{a,t}}{1 - s_{a,t}}\right] \frac{\phi_a}{\phi^f} \frac{s_t^f}{s_{a,t}} d \ln s_t^f$$

$$\Rightarrow \qquad \beta \times \phi^f = \underbrace{\left[\theta^f - \theta^w \xi \frac{\eta - s_{a,t}}{1 - s_{a,t}}\right]}_{\text{Relative redistribution towards high-MPC consumers}} \times \underbrace{\frac{\phi_a}{s_{a,t}}}_{\text{Relative income p.c.}} \times \underbrace{s_t^f d \ln s_t^f}_{\%\Delta\text{National farm channel}}$$

The left-hand-side is what we call the "naive" extrapolation from the cross-section to the aggregate. We simply multiply the cross-sectional coefficient with the national farm population share. The right-hand-side tells us what this quantity measures. It shares some similarities with the the aggregate effect (1) we want to uncover, but also some important differences.

First, term $\theta^f + \theta^w \xi \frac{s_{a,t} - \eta}{1 - s_{a,t}}$ will, in general, differ from the analogous term in the aggregate effect (1), $\theta^f - \theta^w \xi$. As an instructive case, these two terms coincide when $\eta = 1$. Then both the losses and the gains to high-MPC consumers accrue only in the agricultural area. So the manufacturing area provides an appropriate counterfactual for measuring the redistribution to high-MPC consumers. However, when $\eta < 1$, then the cross-sectional term will be larger. This is because redistributing away from high-MPC consumers in the manufacturing area reduces manufacturing consumption, which amplifies the cross-sectional coefficient but also reduces the aggregate effect of redistribution.

Second, the term $\frac{\phi_a}{s_{a,t}} = \frac{\text{U.S. income p.c.}}{\text{Farm area income p.c.}}$ was not present in the aggregate effect. In our model, the importance of the farm channel for an area is a function of the farm income share, the ratio of local farm income to total local income. The higher the farm income share, the greater the fraction of local income "treated" by higher farm prices and the greater the expected consumption growth. The farm population measure (and all our other available measures) only captures this exposure imperfectly. Farm income and population share are linked through the identity Farm income share $\equiv \frac{\text{Farm income per farmer}}{\text{Income per capita}} \times$ Farm population share. Holding relative incomes fixed, if the farm population share rises one percentage point in the cross-section, the local farm income share rises by $\frac{\text{Local farm income per farmer}}{\text{Farm area income per capita}} \times$ 1%. The national farm income share increases by $\frac{\text{National farm income per farmer}}{\text{National income per capita}} \times 1\%$. To correct for the relative difference in treatment we multiply by $\frac{\text{U.S. income p.c.}}{\text{Farm area income p.c.}}$.

Third, there is no multiplier in the cross-sectional expression whereas there is an aggregate multiplier for the economy as a whole. Even though local MPCs can be quite sizable, a local multiplier requires that some fraction of spending remains in the local area. Otherwise both areas benefit equally from higher local spending, which is differenced out in our specification.

Substituting the cross-sectional coefficient into equation (1) yields the following mapping to the aggregate output effect:

$$d\ln Y = \underbrace{\beta \times \phi^f}_{\substack{\text{“naive”}\\ \text{extrapolation}}} \times \underbrace{\frac{\text{Farm area income per capita}}{\text{National income per capita}}}_{\text{Relative income p.c.}} \times \underbrace{\left(\frac{1-\xi\frac{\theta^w}{\theta^f}}{1-\xi\frac{\theta^w}{\theta^f}\frac{\eta-s_{a,t}}{1-s_{a,t}}}\right)}_{\substack{\text{Redistribution from}\\ \text{high-MPC consumers}}} \times \underbrace{\mu_t}_{\text{Multiplier}}$$
$$+ \underbrace{-\sigma d\ln(1+r_t)}_{\text{Intertemporal Substitution}} .$$

In the text we further simplify the redistribution correction to $1-\xi\frac{\theta^w}{\theta^f}$. This is exact when the share of worker income accruing to the agricultural region is commensurate to the income share of the agricultural region, $\eta = s_{a,t}$. For reasonable parameterizations of η this is a good approximation.

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