The Impact Of Farm Subsidies On The United States Macroeconomy

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ABSTRACT

Since the 2018 trade war with China, farmers and farm subsidies have been pushed into the spotlight, as stabilization of crop markets became a critical issue for Donald Trump in order to maintain his political support. Since 2018, billions of dollars have been given out to farmers in direct cash subsidies each year, without so much as a vote in congress. Until now, the effects of these subsidies have gone relatively unstudied, with very little in economic literature showing their effect on the economy as a whole. We have attempted to change that, constructing an instrument to examine both the effects of subsidy announcements as well as the farm bills on immediate stock values of farm manufacturers, before looking at the effect that that instrument has on the GDP, CPI, and Federal Funds rate. Our instrument ultimately seems to lack significance, with an F-Statistic of only 0.7822, thus calling its usage into question, but if we push past this we do see significant positive impacts on both the real GDP as well as the CPI, indicating that over a two year period a shock to subsidies will cause real GDP to increase by about 0.4% while inflation will increase by about 8%. We also found within the forecast error variance decompositions that farm subsidy spending accounts for 2.4% of variance in real GDP, 9.2% of variance in the federal funds rate, and 7.6% of the variance in the CPI, meaning that farm subsidy packages have a significant impact on the economy as a whole. While the true significance of these results may be hard to guarantee, they do fit with economic theory, and would indicate that more thought and regulation should be put into the subsidy packages that, at present, get sent out without any vote or congressional oversight.

INTRODUCTION

Ever since the start of the 2018 US trade war with China, subsidies for farmers have been a topic of debate. Since President Donald Trump announced subsidies worth around 12 billion dollars in late August 2018 (per the USDA), there has been a sudden appearance of non-insurance related subsidization of the farming sector. Under both parties, multibillion dollar programs have been announced that give large amounts of money directly to farmers, but what is the actual cost of this? For years, many experts have claimed that subsidies in the agricultural sector are having a negative impact on the everyday person, and even on farmers themselves, but that due to the lobbying of those profiting off of farmers, subsidies remain in place. These theories pushed us to investigate a link between farm subsidies and the economy as a whole, with the expectation that where we see an increase in subsidies, we will see this translated into a shock to inflation.

LITERATURE REVIEW

In his 2015 paper on the US agricultural complex, Lima makes the claim that subsidies have been maintained despite widespread criticism due to heavy support from the various industries that stand to profit from these injections to farms. He argues that while there may be merit to the subsidies, they must be considered with a broader perspective than simply that of farmers lobbying in congress[1]. Lima's paper therefore works as a sort of starting position for us, giving reason to examine the connection between the large farm supplying companies and farm

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[1] Lima, "Agricultural Subsidies for Non-Farm Interests: An Analysis of the US Agro-Industrial Complex."

subsidies, and to then take that instrument and use it to examine the macroeconomic effects of these policies.

While Lima doesn't go so far as to directly attack the idea of the subsidies, Edwards does in a 2023 paper. By breaking the subsidies apart into their various categories of implementation, he lays out numerous problems with each method and the effects therein. From crop insurance subsidies encouraging farmers to employ irresponsible, moral hazard behavior, to disparate impact effects stemming from the subsidies disproportionately benefiting the wealthy, he argues that there needs to be a new bill introduced with a complete overhaul of the subsidy system[2].

Along with Edwards, Graddy-Lovelace and Diamond are strongly opposed to farm subsidies. In their 2017 article, they argue that the current system of farm dependence on subsidies is inefficient, and that it would be better to support farms with supply side management, helping stabilize prices and reducing the need for cash injections[3]. This condemnation helps shed light on the areas for investigation, as if there's bloat, there should be an observable effect on some other area of the economy.

While Graddy-Lovelace and Diamond argue for supply side management, Springmann and Freund argue in a 2022 paper that subsidies should not be eliminated, but rather reallocated. They make the case that subsidies are inefficient on multiple levels: economic welfare, health, and climate. In their paper, they analyze how redistributing the subsidies to various types of farming or various products could increase health or climate outcomes without any negative impact on economic welfare[4]. This allows us to at the very least consider a couple possible policy solutions: supply-side management or subsidy reallocation.

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[2] Chrise Edwards, "Cutting Federal Farm Subsidies"

[3] Garrett Graddy-Lovelace and Adam Diamond, "From Supply Management to Agricultural Subsidies—and Back Again? The U.S. Farm Bill & Agrarian (in)Viability."

[4] M Springmann and F Freund, "Options for Reforming Agricultural Subsidies from Health, Climate, and Economic Perspectives."

Packard takes a bit of a different approach in his 2017 paper. He looks at the impact of subsidies on poverty, specifically poverty within the context of agricultural workers. He argues that the subsidies are negatively impacting agricultural workers' economic well-being, but the solution he offers is a bit different: Increasing agricultural exports. He makes the case that instead of subsidizing farms (at least at the level we currently do), we should be opening up more opportunities for trade. Part of opening up more opportunities could be the elimination of the subsidies themselves- he makes the point that the subsidies are a major part of the hindrance of free trade[5]. This isn't as directly related to our research insofar as we won't be looking at potential solutions, we will just be analyzing the impact of subsidies on the economy, but his paper is still relevant in its consideration of subsidies as an inefficient economic tactic.

While there has been little research into the link between farm subsidies and inflation, Tong, Pham, and Ulubaşoğlu have investigated the link between farm subsidies and farm exports. Utilizing a gravity model, they find that a 1% decrease in subsidies correlates to a 0.4% decrease in farm exports. Of even greater significance from their findings is that changes in counter-cyclical payments and marketing loans gains have a much larger effect on farm exports than similarly sized changes in direct payments[6]. This means that while eliminating farm subsidies entirely would reduce farm exports by about 15.3 Billion dollars per year (as of 2018), the elimination of the direct payments that have been heavily employed since 2018 would have a much smaller proportional effect.

With this foundation laid out, we are now able to contribute to this conversation by adding in a quantitative component that thus far has taken little part in the discussion. Utilizing instrumental analysis in order to establish a structural VAR, we will be able to examine the

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[5] Clark Packard, "Rural Poverty, Farm Subsidies and the Way Forward"
[6] Lan Anh Tong, Cong S Pham, and Mehmet A Ulubaşoğlu, "The Effects of Farm Subsidies on Farm Exports in the United States."

impacts of these subsidies on the greater economy, and through that lend credence to the claims already being made by economists on the matter.

DATA REVIEW

In examining farm subsidies it became clear that in order for us to get a clean picture of the data with a higher frequency than yearly, we would need to create some sort of instrument. In order to do this, we aimed to mirror Känzig's 2021 paper, where he looked at announcements from OPEC and their effects[7], and so we looked to find announcements of farm subsidies and farm bills, and from there get a picture of their effect on the stock market for farm manufacturing firms. To this end, we selected five firms: Deere & Company, CNH Industrial N.V, AGCO Corporation, Alamo Group Incorporated, and Kubota Corporation. All are major producers of farm machinery, and so they were all natural choices, although CNH Industrial N.V. has only been publicly traded since 2013, meaning that their data was unavailable for our earliest 3 observations. In order to make sure our instrument captured only a change in the farming sector, we also considered the NASDAQ 100 and the Dow Jones Industrial Average to get an idea of how the market was moving independently of farm announcements.

In selecting our other variables we were mostly interested in the impacts of farm subsidies on inflation, but in order to control for other factors we also included measures of gdp and the interest rate. Our shock date data came from a mixture of announcements from the USDA as well as farm bill announcements, with the subsidy dates being sourced from the USDA's website, and the farm bill dates coming from the bills themselves as accessed through

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[7] Diego Känzig, "The Macroeconomic Effects of Oil Supply Shocks: New Evidence from OPEC Announcements"

the Library of Congress. The actual stock change data was sourced from Yahoo Finance. The data on subsidy size was sourced from the BEA, and all the other data was pulled from the FRED website. We chose to use real GDP in percentage change form to eliminate concerns of homogeneity. For similar reasons, we examined the Federal Funds effective rate in terms of percentage point change, and CPI in terms of percent change. Additionally, we used sticky price CPI without food and energy, in order to examine a more realistic picture of what farmers would spend excess funds on, as it's relatively unlikely that these subsidies would be used for food consumption or energy.

With our variables sourced, we then needed to construct an instrument. In order to do so we took opening stock prices from two days ahead of the shock through the day of the shock, then took the opening prices for the following three days. We then averaged those two groups out and found the percentage change day to day. We then took our two measures of market success from the same time period and did a similar process to get averages for those changes. Then, we averaged out the change in the farm manufacturing sector and the change in the market as a whole, and by subtracting the market change from the farm manufacturing change, procured the effects of the shock on the farm manufacturing sector.

A few interesting things popped up within the data, specifically within the usage of our instrument. While our instrument only had a correlation of only 0.089 with the data on subsidies, it had a correlation of 0.141 with the real GDP measure. In looking at the instrument, whether or not the values are positive or negative seemed to largely depend on the source of the dates, as when the date in question was a farm bill, the stock values often fell, but when the announcement was purely an additional subsidy, it tended to be a positive shock. Our instrument's correlation

with real GDP is logical- changes in stock prices, as isolated as we tried to make them, are going to correlate with changes in the overall economy.

Before conducting any analysis with our data, we ran a Phillips-Perron test in order to confirm that our variables are stationary. The test yielded the result that we expected; our variables were stationary, as we found that the absolute value of all of the test statistics is greater than 2.89, meaning that we can say with 95% confidence that our variables are stationary.

EMPIRICAL METHODS

In order to examine the connection between farm subsidies and the economy as a whole, we utilized a structural VAR model. By regressing subsidy data onto the percent change of the market price of farm equipment supplier stocks, we were able to build our instrument, allowing us to measure the impact of the subsidies. We did this by building the following equation:

$$\text{instrument}_t = \alpha + \lambda \text{stocks}_t$$

Utilizing this instrument, we then constructed the structural VAR element of our process. The system was constructed utilizing the inflation rate, GDP, interest rates, and our instrumental form of subsidy impacts. Ordering our variables, we placed our instrument first in order to capture all of its contemporaneous effects on other systems, then the interest rate, GDP, and inflation rate, following general economic modeling practice.

$$
\begin{bmatrix} e_{s,t} \\ e_{i,t} \\ e_{y,t} \\ e_{inf,t} \end{bmatrix}
=
\begin{bmatrix}
1 & \beta_{12} & \beta_{13} & \beta_{14} \\
\beta_{21} & 1 & \beta_{23} & \beta_{24} \\
\beta_{31} & \beta_{32} & 1 & \beta_{34} \\
\beta_{41} & \beta_{42} & \beta_{43} & 1
\end{bmatrix}
\times
\begin{bmatrix} \epsilon_{s,t} \\ \epsilon_{i,t} \\ \epsilon_{y,t} \\ \epsilon_{inf,t} \end{bmatrix}
$$

In order to create a functional VAR we followed a Cholesky decomposition, meaning that we have a burden of providing $\frac{k(k+1)}{2} = 6$ assumptions, with $k = 4$ variables. We first assume that β_{12}, β_{13} and β_{14} are all equal to zero, as we are investigating the impact of the shocks of subsidy announcements, and thus assume that the subsidies operate free of any contemporaneous effects from our other variables. Next, we assume that β_{23} and β_{24} are both equal to zero, as established economic practice dictates that the interest rate be placed early in the model, given its tendencies to impact other variables. The last assumption is that β_{34} is equal to zero, claiming that the inflation rate has no contemporaneous effect on real GDP, again based on general economic practice in building a structural VAR model.

In general, when using an instrumental variable approach, one would expect to see a proxy VAR employed, rather than a structural VAR. Our choice here was motivated by the constraints of our technology, rather than a methodology preference, but it is important to note that results have shown that in many cases there is little significant difference between the CIRFs produced by a proxy VAR and those produced by a structural VAR, provided that the instrument is ordered first. This is an assumption we didn't intend to have to make, and one we would've preferred to not have to make, but as a result of our own technological limitations it became necessary. Through this method we were able to capture the same effects of our instrument on economic systems as we would have with a proxy VAR, but using something within the capacity of the tools at our disposal.

RESULTS

Before we could establish our proper VAR and get our results, we first had to construct the instrument itself. We regressed our subsidy data on the instrument data we had, and got the following equation:
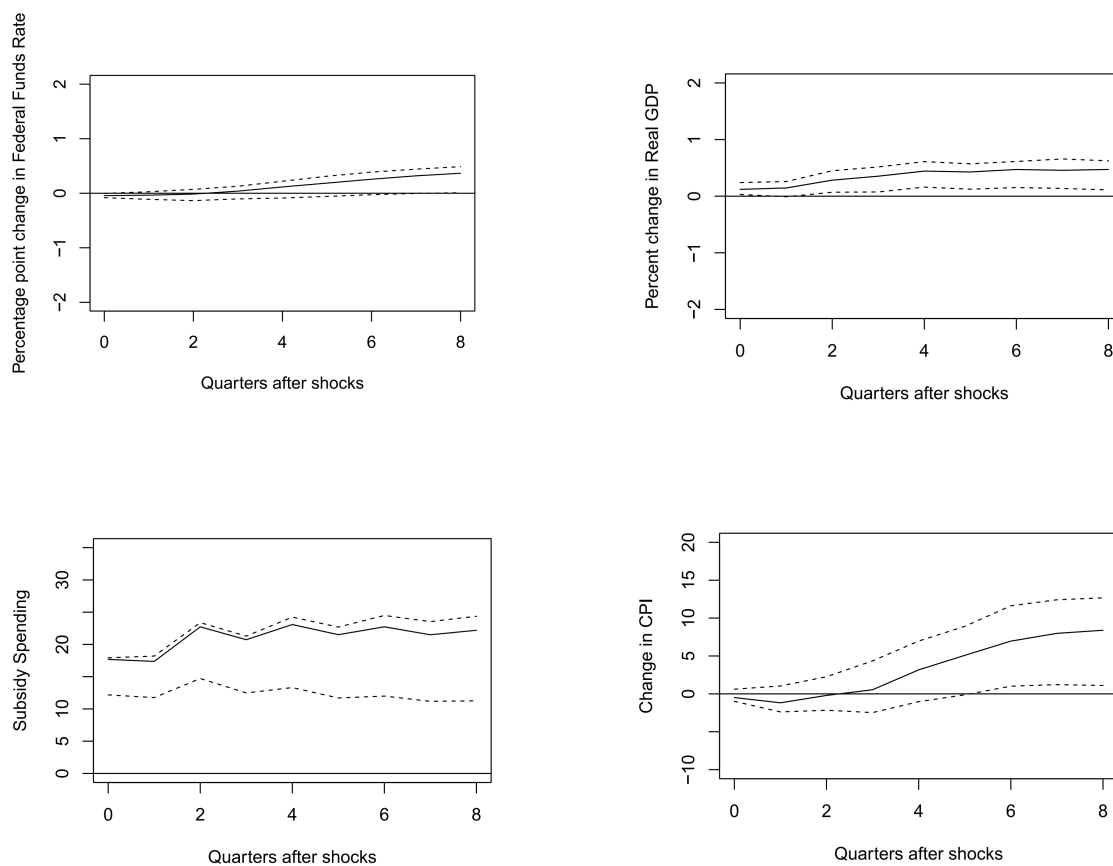
$$\text{instrument}_t = 108.84 + 28.28\text{stocks}_t$$

Ultimately, the results of our model were relatively unsurprising. Examining our cumulative impulse response functions at the 68% confidence level, we see an immediate increase in subsidy spending, but that the net effect does not continue to rise. This makes sense with our model, as due to the isolated nature of our instrument, having one observation means that another will likely not appear for a while, meaning that the net effect is felt but doesn't indicate more growth going forward. What is more interesting is the effect on real GDP, as two quarters after a shock to subsidies we see a statistically significant increase in real output. This increase ends up being only about a net 0.4% change, but does show a positive relationship between subsidy spending and the economy.

In examining the effect of a shock to subsidies on the federal funds effective rate, we find that the effect is at no point significant. There is a slight and insignificant increase by the 8th quarter of about 0.3 percentage points, which is in line with the impact to GDP, and as we will see, the impact to CPI, but as it isn't significant we can't read too deeply into it. Finally, we examine the effects of the shock on CPI, where we witness a slight decrease over the first quarter, before 7 periods of growth. This eventually cumulates to be significant for quarters 6 through 8, with a net change of around 8%. This fits with both our hypothesis and with the other

movements we see, as we would expect output, the federal funds rate, and inflation to all be positively correlated.

The time between the shock and its eventual significant effect on inflation is particularly interesting. These subsidies are cash injections into the economy, so it stands to economic intuition that inflation should increase, but it takes a year and a half before that impact is seen. Our cumulative impulse response functions (CIRFs) are shown below:

As far as the strictly contemporaneous effects of our variables go, we generated the following matrix:

$$
\begin{bmatrix} e_{s,l} \\ e_{i,l} \\ e_{y,l} \\ e_{inf,l} \end{bmatrix} = \begin{bmatrix} 17.69 & 0 & 0 & 0 \\ -0.04 & 0.33 & 0 & 0 \\ 0.12 & 0.58 & 1.16 & 0 \\ -0.49 & 1.76 & 3.80 & 8.13 \end{bmatrix} \times \begin{bmatrix} \epsilon_{s,l} \\ \epsilon_{i,l} \\ \epsilon_{y,l} \\ \epsilon_{inf,l} \end{bmatrix}
$$

Within this, we can see that much is as we would expect, with subsidy shocks having little contemporaneous effect on the interest rate, a small contemporaneous effect on GDP, and that still somewhat surprising contemporaneous negative effect on the inflation rate. The most surprising element of this matrix is the shock of interest rates having a positive effect on the inflation rate, as it is very solid economic understanding that interest rates have a negative relationship with then inflation rate. which can only be explained by assuming that efforts to combat inflation take time to have an effect, meaning that they don't work contemporaneously. By the Akaike Information Criterion, we established that the most effective model would be one that uses ten lags in addition to the contemporaneous effects, and so our model utilizes exactly that.

To complete our analysis, we examined the forecast error variance decompositions of real GDP, the federal funds rate, and CPI. We see reflected here some of the weaknesses of our instrument, as the results show only a limited effect of subsidies on the other variables. We found that subsidies account for 2.4% of the variation in real GDP, 9.2% of the variation in the federal funds rate, and 7.6% of the variation in CPI. While these numbers aren't as high as we would've liked to see, they do show that subsidy spending has a significant impact on the economy on the whole.

CONCLUSION

In short, subsidies have a positive impact on both real GDP and CPI, and no significant impact on the Federal Funds rate. This is very much in line with general economic theory and our hypothesis- that subsidies lead to an increase in inflation. Although the impact is a few time periods removed, it is certainly there and significant. That being said, we didn't necessarily expect to see an increase in real GDP- the general economic consensus is that farm subsidies are overall negative for the economy and should be reformed, and this actually shows the opposite. Of course the increase in CPI must be considered, but the fact that real GDP is increasing as well is a surprising outcome. This could mean that policy change around subsidies isn't actually necessary.

However, it's also important to consider the limitations of our model when coming to a true conclusion. Because of our own computational limitations, we had to run a simpler model with more assumptions, and even though that's usually an accepted practice, it's possible it influenced our results. There's also the actual effectiveness of our instrument to consider- in looking at its creation, our regression of subsidy data onto the stocks, we had an F-Statistic of only 0.7822, indicating that our instrument may not be very effective in properly measuring what we want it to. A lack of effectiveness in our instrument could render our CIRFs generally insignificant.

If our model is truly faulty, which seems at least somewhat likely, then it's overwhelmingly probable that our results are statistically insignificant and no real conclusion can be drawn from them. That being said, under the assumption that our model does in fact work as intended, our conclusion rests upon the subsidies' impact on real GDP and inflation. When

implementing these subsidies, policy-makers should recognize that these subsidies can help keep farms afloat and stimulate growth in real GDP, but they should remain wary of potential increases in inflation.

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