Two Americas and One Central Bank: Did QE Work?

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December 2020

Abstract

We estimate a causal effect of QE1 on quarterly wage income in every county in the U.S including Puerto Rico. For each of the 3,195 counties, we run difference-in-differences regressions with controls for county-level American Recovery and Reinvestment Act transfers, the local tax rate, manufacturing employment shares, population, and time fixed-effects. We then use these estimates to (a) construct a national index of the geography of ZLB-constrained monetary policy effectiveness in the United States, (b) construct regressions with county-characteristics related to industry, education, inequality, and political preference, and (c) check the robustness of our findings by building VAR models for every county, state, and region in the United States to estimate whether monetary policy has become more or less effective over time. There is substantial variation in counties' causal effects and we find our coefficients for geographic differences in wage income response to be significant at the 95% level for 2,013 of the 3,195 counties we test. We characterize the types of counties where QE1 was more effective: Counties with higher student-teacher ratios, lower local tax rates per capita, lower government expenditures per capita, less population loss, less racial segregation, more colleges per capita, more Democrat votes, more divorced parents, and more urban areas were more likely to have stronger wage-income responses to QE1. Of particular note, counties with an economic reliance on mining and farming had significantly less wage-income effects to QE1 and counties which changed their Presidential Election vote from Republicans to Democrats from 2008 to 2016 were overwhelmingly counties with stronger wage-income responses to QE1. Ultimately, this paper suggests that monetary policy constrained by the zero-lower bound is significantly less effective at stimulating wage income for some regions in the United States than others, and these distributional impacts can and already have exacerbated the growing divide within our country.

1 Introduction

After the 2008 financial crisis, interest rates in the United States remained low for the better half of the past decade: it was not until July 2017 that the effective federal funds rate rose above 1% for the first time since 2008, and rates quickly plunged at the beginning of 2020 after a high of 2.42% in 2019. This phenomenon is replicated across most of the developed world, with key interest rates in Europe turning negative. The rise of expansionary monetary policy, with low interest rates and multi-trillion dollar balance sheet expansion by central banks should indicate inflation, yet inflation across developed economies has generally remained around 1%. Over this time, the Federal Reserve's balance sheet increased four-fold as interest rates were constrained at the ZLB. During the Great Recession, as GDP growth contracted at the fastest rate in 50 years and countless jobs were lost, the Fed ran out of traditional monetary stimulus at the ZLB for the first time since modern central banking was established the Treasury-Federal Reserve Accord of 1951. To immediately save our economy, the Federal Reserve implemented quantitative easing, increasing the Fed's balance sheet from $891 billion in December 2007 to $4,498 billion December 2014. Much of the increase in the Fed's balance sheet occurred after the Great Recession, and the composition of assets changed. In December 2007, 32.1 percent of the Fed's securities were short-tern Treasury bills. By December 2013, the Fed did not hold any Treasury bills, and 41 percent of their holdings were long-maturity MBS. This unprecedented step to ensure monetary stimulus helped the economy recovered faster. Engen et al. (2015) estimate that QE reduced the unemployment rate by more than 1 percentage point, and Sims and Wu (2019) use a structural model to estimate that QE1-QE3 accounted for two-thirds of the observed declines in the Shadow Fed Funds rate. QE undoubtedly prevented what could have been a more significant crisis.

Today, in the midst of the coronavirus pandemic, the Federal Reserve has implemented "QE infinity." By December 9, 2020, the Federal Reserves assets reached $7.2 trillion – an eight-fold increase from 2004. As interest rates have become constrained at the ZLB, QE has become one of the primary forms of expansionary monetary policy. However, there are troubling signs. First, QE has diminishing returns, requiring more and more asset purchases every time in order to achieve the same amount of stimulus. Krishnamurthy and Vissing-Jorgensen (2012) find that QE1 reduced 10-year treasury yields by 6 bps per $100bn of security purchases, while QE2 only reduced yields by 3 bps per $100bn. Second, since QE primarily operates through lowering long-term yields, the portfolio rebalancing channel, the credit channel, and the signaling channel, there are distributional questions of its impact on real economy conditions. For example, households which own Treasuries during Fed purchases will have greater increases in asset holdings than those which do not, implying rising inequality as an unintended consequence of QE.

As the Fed drives more money into the economy through unconventional monetary policy, it is necessary to consider these distributional consequences. The core concern of this paper is the story of Figure 5, which shows a countrywide trend - that our economic polices operate over two divided Americas. In one, unconventional monetary policy induces wage growths in the midst of pandemics or recessions. In the other, QE has little effect.

The academic literature has yet to address the potential effects of monetary policy stimulus at the ZLB on the political economy. As we watched the television on the afternoon of January 6th, we noticed one of the young men push past the news reporter to chant obscenities against the Federal Reserve into the camera. Why were some incensed about the Federal Reserve? What did that concept mean in the American imagination? We would argue that most Americans have never heard of Quantitative Easing (perhaps except in viral videos), much less understood the mechanisms, and that the obscurity of its name "QE Infinity" and the large asset numbers incites the imagination in undue ways. But that is not the core concern of this paper.

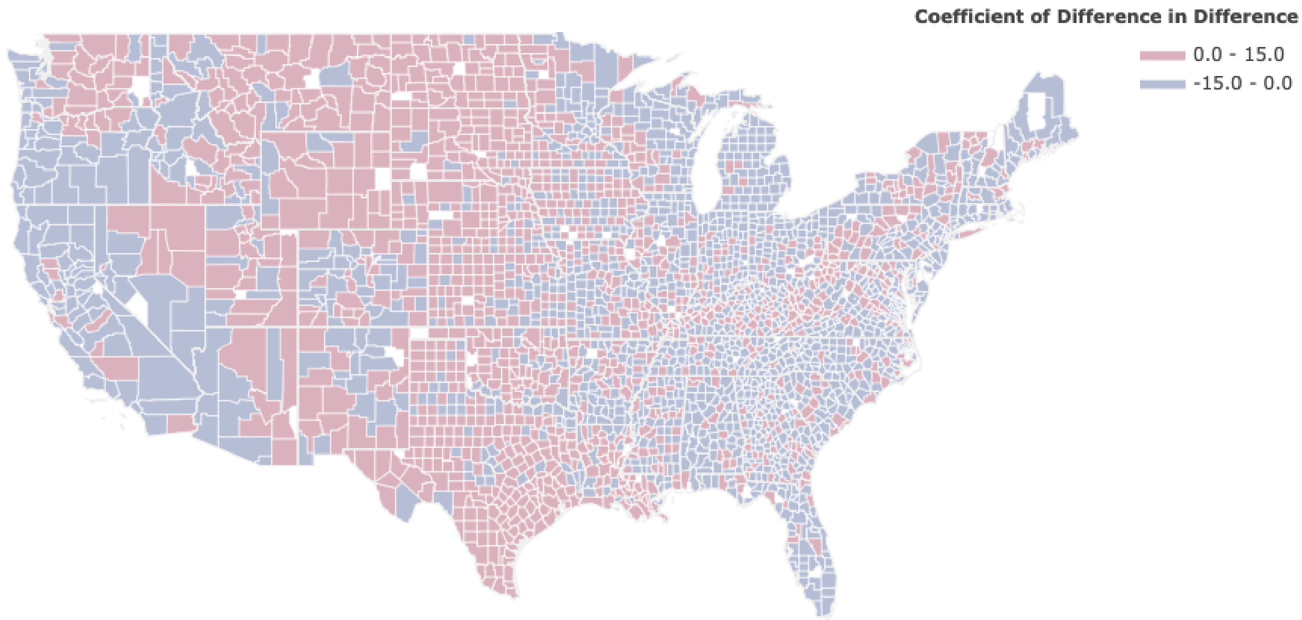

Figure 1: Effectiveness of MP at the ZLB by County in the USA.

The goal of this paper is thus simple. We describe and estimate a model of monetary policy transmission channels, desiring identification on geographic heterogeneity in American counties. We review classical and neo-classical monetary policy transmission mechanisms to describe the hypothesized effects of heterogeneity in Section 2. In Section 3, we describe the data and various empirical strategies used, and construct a resulting index of 'effectiveness' of monetary policy, showing that our results are robust to different fixed effects and various specifications within monetary policy transmission channels. Section 4 provides a discussion of results, robustness checks, and extensions, and Section 5 concludes.

2 Conceptual Framework

Much academic discussion exists regarding the disparate distributional impacts of quantitative easing, with regards to geographical heterogeneity and income inequality. Selezneva et al. (2015) show that monetary policy may have widened disparities between the regions in the US during the Great Recession, identifying that mortgage refinancing increased the most during QE1 in the places with the fewest underwater homeowners, due to the difficulty of low-equity borrowers to refinance. The implication of the model with specific ties to housing was simply that when there was strong correlation between income and home prices, as in 2008, monetary policy was likely to exacerbate existing regional inequalities along housing lines. Moreover, this is likely to be an effect that persists specifically due to the ZLB: the authors observe that in 2008, when borrowers faced negative shocks due to financial panics, they were not underwater and so could more easily benefit from easy monetary policy by refinancing. With this backdrop in mind, we describe the various classical and neo-classical channels of monetary policy, and denote the specific areas where geographical inequality is likely to play some role. This section serves both as a survey of monetary policy transmission literature, and also justifies our approach - while we do not estimate a single channel, we believe there are many ways that geographic inequalities are likely to persist through MP, especially unconventional monetary policy, transmission. We discuss the classical channels, the credit channels, and finally, quantitative easing.

2.1 Traditional Keynesian Interest Rate Channel

$$M \uparrow \implies i_r \downarrow \implies \rightarrow I \uparrow \implies Y \uparrow \tag{1}$$

Expansionary monetary policy causes real interest rates to fall, decreasing the cost of capital and increasing investment spending. When central banks decrease short-term nominal interest rates, investors arbitrage the difference in risk-adjusted expected returns leading to a decrease in long-term nominal interest rates. Since nominal prices take time to adjust, this initial movement of nominal interest rates translates into changes in the real interest rate and firms find that the cost of borrowing may have decreased which may incentives increased investment. While Keynes emphasized firm spending, later economists applied the same argument to household expenditure on housing and durable goods.

2.2 Exchange Rate Channel

When domestic real interest rates fall, domestic dollar deposits become less attractive relative to deposits denominated in foreign currencies, leading to dollar depreciation. The lower value of the dollar makes domestic goods cheaper than foreign goods, driving net exports and aggregate output up. This channel also directly affects inflation, as if the domestic currency appreciates, imported goods and services become more affordable, keeping a limit on inflation. We can thus describe monetary transmission through the exchange rate channel as such:

$$M \uparrow \implies i_r \downarrow \implies \rightarrow E \downarrow \implies NX \uparrow \implies Y \uparrow \tag{2}$$

The exchange rate channel is one of the most well-studied channels of monetary policy transmission, due to the availability of data. The vast majority of literature incorporates similar mechanisms to our study, and attempts to track the effect of monetary policy shocks or surprises on exchange rates. Hausman and Wongswan (2011) studies the impact of US monetary policy announcement surprises on foreign equity indices and exchange rates in 49 countries between 1995 and 2004, using the methodology behind Gürkaynak et al. (2005) to construct monetary policy surprises. Unsurprisingly, in accordance with economic intuition, they find that different asset classes across countries respond differently to the monetary policy surprises, and that variation in the equity market response is related to the percentage of each country's equity market capitalization owned by US investors, suggesting that exposure to US markets plays a role in transmitting monetary policy surprises across countries.

Zettelmeyer (2004) conducts similar analysis, measuring monetary policy shocks by the reaction of three month market interest rates to policy announcements in Australia, Canada, and New Zealand during the 1990s. This paper supports the conventional view about the direction of the impact of interest rates on exchange rates during both normal times and volatility in the exchange rate markets. The authors also show, rather interestingly, that when central bankers attempt to lean against exchange rate pressure, offsetting depreciation requires far higher interest rate moves during turbulent times.

There is likely to be a rather large effect of geographic inequality through the exchange rate channel, due to the advancements in globalization, trade, and manufacturing in the last 20 years. Intuitively, it is likely to be obvious that areas that suffered from outsourcing and the removal of manufacturing hubs are likely to be poorly affected by long-term changes in exports and imports. Meanwhile, areas that are likely to be service-sector hubs might experience less of the harms from changing amounts of exports, but would benefit from cheaper imports. This intuition is backed up by Silva and Leichenko (2004), which investigates the effects of trade on income inequality, and finds that the primary mechanism for transmission of income inequality is import and export prices. Across census regions, states in regions home to low-wage sectors (the Southeast) were likely to be made worse by lower import prices and import-competing goods; meanwhile states more competitive hubs (the Northeast), were likely to be affected more positively. So, not only is there a concern regarding the magnitude of monetary policy, but its specific effect can be flipped due to regional inequalities.

2.3 Cost of Capital

The cost of capital channel is closely associated with the wealth effects channel. These two channels are often grouped together as the equity price channels. This channel relies on Tobin's q Theory, where Tobin's q is termed as the market value of firms divided by the replacement cost of capital. If Tobin's q is high, the cost of replacing equipment capital is cheap relative to the market value of firms; companies can issue equity and get a high price for it relative to the cost of the capital investments they make. So, when Tobin's q is high, we expect investment spending to rise because investments can be made cheaply with small equity issues. Monetary policy affects Tobin's q by affecting equity prices in two ways. First, when the money supply rises, the public spends their money in the stock market, increasing equity prices. Second, when interest rates fall, bonds are less attractive than equities, so equity prices rise. Either story results in equity prices driving up Tobin's q, increasing investment spending and thus net aggregate output. We can describe this mechanism as follows:

$$M \uparrow \Longrightarrow i_r \downarrow \Longrightarrow P_e \uparrow \Longrightarrow q \uparrow \Longrightarrow I \uparrow \Longrightarrow Y \uparrow$$

Ehrmann and Fratzscher (2004) studies the effect of US monetary policy on stock markets, finding that monetary policy tightening reduces returns, as expected. More specifically, the paper finds industry-specific effects using propensity score matching (as per Rosenbaum and Rubin (1983)), noting that industries with high Tobin's q, high P/E ratios, and low cash flows are more affected by monetary policy effects, validating this channel. This paper also finds that market returns move more strongly in response to unexpected monetary policy and rate changes during times of uncertainty.

Bernanke and Kuttner (2005) studies both the wealth effect and the cost of capital channel, and mainly attempts to estimate the response of equity prices to monetary policy actions. This paper uses federal funds futures data to construct a measure of 'surprise' rate changes and estimates revisions in expectations by using vector autoregressions. The results, as expected, show that the market reacts fairly strongly to surprise funds rate changes and very little to the components of funds rate changes that are anticipated by future market participants.

This is likely to be mildly affected by income inequality and regional heterogeneity: we discuss in 2.5.4 the effect of bank concentration and geographic inequality that compromises the credit channel. This implies that similar mechanisms, such as the cost of capital channel can be affected by these problems. More specifically, it is well known that the cost of servicing and replacing capital is affected by the loans and interest rates banks are willing to offer: in that, it is likely that geographic inequalities with banks also affect the cost of capital channel.

2.4 Wealth Effects

Monetary policy also has an effect through equity prices on wealth effects, as theorized by Franco Modigliani's life-cycle hypothesis. The idea is fairly simple, that increases in equity prices drive increase financial wealth, and thus increase the amount of capital available to consumers and consequently consumption and output. This channel can be succinctly summarized as follows:

$$M \uparrow \implies i_r \downarrow \implies P_e \uparrow \implies C \uparrow \implies Y \uparrow$$

This channel is often difficult to establish empirically because stock prices are forward-looking, so an anticipated decline in future economic fundamentals that drives monetary policy changes could also lead to both a negative stock return and decline in household spending and employment. As mentioned earlier, Bernanke and Kuttner (2005) discusses the wealth effects channel in their paper. Chodorow-Reich et al. (2020) provides recent evidence on this paper, studying wealth effects and the real economy through local labor markets. More specifically, this paper exploits regional heterogeneity in stock market wealth with aggregate movements in stock prices to estimate the wealth effect channel. Without measuring the actual effect of monetary policy on this channel, the authors simply measure the response of consumers and laborers to higher stock market valuations, estimating the pass through effect of stock market changes onto consumers. This paper also clearly implies the existence of geographic inequality with regards to MP transmission: it is well known that there is both regional heterogeneity in stock market wealth and local labor market power;

the fact that the wealth effects channel intuitively depends on the former and depends on the later as constructed in Chodorow-Reich et al. (2020) implies that geographic inequality is likely to affect the transmission of MP through this channel.

2.5 Credit Channels

In this section, we describe the various credit-based channels of monetary policy transmission, including the bank lending, balance sheet, and deposit channels. We end the section by describing their shared weaknesses with regards to geographic inequality.

2.5.1 Bank Lending Channel

Expansionary monetary policy increases reserves and decreases banks' cost of funds, increasing the supply and the real spending of borrowers. Specifically, the bank lending channel works because banks are able to reach borrowers that are otherwise inaccessible, and the channel is satisfied when borrowers' real spending changes with the availability of bank loans and when changes in reserves induced by the central bank influences bank reserves and deposits.

$$M \uparrow \implies deposits \uparrow \implies loans \uparrow \implies I \uparrow \implies Y \uparrow$$

2.5.2 Balance Sheet Channel

The balance sheet channel is effectively an analogue to the bank lending channel, for non-bank financial institutions and corporations, and relies on the net-worth of borrowers. Specifically, it is well known that lenders assume less risk when lending to high net-worth agents that are able to offer more collateral. The Fed, by affecting monetary policy, can affect the strength of borrowers' balance sheets and thus lender sensitivity to balance sheets - for example, increasing interest interests hurts riskier companies either by increasing the interest payments they directly pay and decreasing the value of firm collateral through discounting or by reducing the demand for a firm's products, erasing a risky firm's net worth. This channel also has household, in addition to corporate effects; households with higher liquidity ratios are more able to cope with shocks to their income while consumers with high debt ratios are less able to. Consequently, the Fed affecting the valuation of assets on consumer and corporate balance sheets can result in lower household spending. Bernanke and Gertler (1995) also observes that this has opposite international and domestic effects, with banks substituting away from domestic lending to foreign lending when domestic MP contracts.

$$M \uparrow \implies risk \downarrow \implies \implies loans \uparrow \implies I \uparrow, C \uparrow \implies Y \uparrow$$

2.5.3 Deposit Channel

Drechsler et al. (2017) presents this as a new channel of monetary policy. The authors demonstrate that contractionary monetary policy widens the spreads banks charge on deposits, causing deposits to flow out of the system. This is consistent with general market power mechanisms in deposit markets, Moreover, as deposits are the main source of liquid assets for households, this channel explains a sizable relationship between the Fed funds rate adn the liquidity premium in addition to impacting the bank lending channel.

$$M \uparrow \implies rates \implies \downarrow deposits \uparrow \implies loans \uparrow \implies I \uparrow \implies Y \uparrow$$

2.5.4 Geographic Inequality and Credit-Based Channels

There are clear reasons to assume that the suite of credit channels are affected by geographic inequality. Poorer states, such as North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma, have a greater concentration in the number of small banks per capita and small banks share of total state loans. This is in part because rural areas have less developed financial sectors in comparison to wealthier coastal peers. The market concentration of the banking industry over the past thirty years affected coastal states more than rural states, which in turn affects the lending channel. Smaller banks are more sensitive to contractionary monetary policy than stimulatory monetary policy for two reasons for this. First, smaller banks have a harder time finding external sources of finance in the case of a liquidity crunch. Smaller banks have less liquid balance sheets and face greater challenges to finding alternative sources of funding for deposits and loans, as seen in Kashyap and Stein (1994) and Kashyap and Stein (2000). Shocks to internal liquidity are more sensitive to smaller banks, suggesting that poorer states will also be more sensitive to contractionary monetary policy than their peers. Second, smaller banks are more likely to close during recessions than larger banks. Nguyen (2019) studies the relationship between local bank branch closings and local credit supply. He finds that, even in markets where the branch network is dense and new banks enter the market, bank branch closings decrease the number of new small business loans by 13following years. These declines are local and particularly concentrated in low-income and high- minority neighborhoods. An unexpected contractionary shock could cause small banks to close, exacerbating credit conditions. Rural states have a greater concentration of smaller banks which, in turn, make the area more sensitive to contractionary monetary policy than expansionary monetary policy in a comparison with peers. Similarly, Black et al. (2010) describe the tight relationship between the bank lending channel and its effect on mortgage lending, implying that the same effects that were observed in Selezneva et al. (2015) with regards to geographic inequality in mortgage lending were likely to affect the ability of banks, in general, to distribute loans. As such, geographic inequality in credit conditions causes poorer states to likely experience less MP transmission through this channel. The focus of Drechsler et al. (2017) on the market power effects in the deposit channel also highlight that geographic inequality is likely to play a role here: banks that raise deposits in concentrated markets are more likely and able to contract lending than other banks, implying that the effects of easing and tightening are more likely to be felt in more concentrated markets. This implies again that smaller banks and rural areas that experience higher bank concentration rates are more sensitive to the spreads changes and contractionary effects of MP.

2.6 Quantitative Easing

Quantitative easing works as central banks purchase large scale asset purchases to stimulate the market without targeting interest rates. It has significant effects on many of the classical and neoclassical channels. First, it provides liquidity to banks and makes it easier for banks to extend loans to companies and households, affecting the credit channels. Second, it pushes investors to turn to other financial securities by buying large amounts of 'safe' or even riskier assets. Third, it increases the money supply and lowers yields, depreciating exchange rates and stimulating export demands. Fourth, it increases government borrowing by lowering yields, enabling fiscal stimulus. Fifth, it increases asset prices when funds that governments purchase bonds from have more liquidity to invest in asset prices. Sixth, it has signaling effects. In this, it is similar to forward guidance - with quantitative easing, the central banks signals its willingness to engage in extreme monetary policy to support the economy, suggesting that market psychology will respond. Similarly, under forward guidance, the Fed makes promises about its long-term monetary policy to keep investors expecting that monetary policy and drive investor behavior.

Structural trends in geographic inequality, such as a lower number of assets, demographic changes, and declining human capital, likely depress the overall sensitivity of poorer regions to monetary policy. These long-term trends will be exacerbated by use of unconventional monetary policy. As the Federal Reserve increasingly faces constraints from the ZLB, quantitative easing will become a more critical tool for macroeconomic regulation. Poorer states have less assets and household wealth than richer states. Since quantitative easing more directly benefits those with investment more than those without assets, the pre-existing trend of geographic inequality may become further exacerbated by monetary policy. Poorer states are less sensitive to unconventional expansionary monetary policy than richer states, causing a self-reinforcing cycle where existing geographic inequalities limit the effectiveness of monetary policy transmission. There are several other factors – such as interest rates effects on trade, different behavioral saving preferences, and different behavioral loan preferences – that may further explain why geographic inequality causes heterogeneity in monetary policy responses with respect to quantitative easing. In each of the three sections discussed above (classical channels, neoclassical credit-based channels, and QE), an existing inequality limits the effectiveness of monetary policy, which in turn further exacerbates monetary policy and limits its aggregate effectiveness.

3 Empirical Framework and Results

First, we discuss the data used in our empirical tests and provide an explanation of our identification strategy. Next, we construct 3,195 difference-in-differences regressions for each county in the United States to create a national index and map of where unconventional monetary policy in the Great Recession was most effective. Third, we walk through a comparison of the difference-in-differences results of two counties on the opposite spectrum of monetary policy effectiveness. We analyze and discuss how the different channels presented in our conceptual framework might supplement these empirical findings. Fourth, we examine correlations and regressions for where unconventional monetary policy was most effective with county characteristics related to industry, government policy, education, and more. We discuss trends we find, potential ways to improve our empirical analysis in future versions of this paper, and implications for the future of monetary policy.

After these initial empirical results, we build and support our earlier findings with Vector Auto-Regression models. We build these for each of the 3,195 counties we test, as well as all 50 states, and the 8 regions of the United States. In these models, we change the time frame. For some VAR models, we examine data from 1994 to 2019. For others, we examine data from 1962 to 2019. We also alternate between personal income and wage income to test whether our results can be supported in another real economy measure.

3.1 Data

Quarterly Wage Income Panel Data: We use county-level nominal wage quarterly data from the *Quarterly Census of Employment and Wages* (QCEW). The dataset includes the average weekly wages and total wages for every county in the United States by Federal Information Processing Standard code, and we omit counties with missing data between 2004 and 2014. We seasonally adjusted the data and incorporated appropriate time lags for monetary policy pass-through. To measure labor income dynamics, we use a logarithm of county-level nominal wage income. In the next iteration of the paper, we will use the logarithm of nominal wage income divided by the county-level population multiplied by the GDP deflator to better capture real income changes:

$$w_{it} = \ln\left(\frac{W_{it}}{P_{it}}\right)$$

3.1.1 Controls in our Difference-in-Difference Measures:

Fiscal Policy County-Level Data: We use cumulative ARRA transfers as a fraction of income per each county from Crucini and Vu (2020). They exclude any funds where the zip code is not available for the end recipient and use data from the now-defunct website Recovery.gov, a government depository of ARRA data. They carefully identify fiscal stimulus by local zip code of the recipient and aggregate totals to each quarter and take the log of real per capita quarterly flows of ARRA transfers. In addition to ARRA data, we use data on the county-level local tax rates from Chetty and Hendren (2016). They collect tax rate data from federal income tax records from 1996 to 2013.

Population Change Data: We collect U.S. Census Bureau's estimated population data for each county from 2004 to 2014. In future variations of the paper, we will use population data as a control to ensure that our estimates are not driven by demographic changes.

Manufacturing Employment Share Data: We include controls for the share of workers employed in manufacturing per county because of secular trends in the industry during the financial crisis. We find the percentage share of employment in the manufacturing industry for each county from Opportunity Insights.

3.1.2 County Descriptors:

USDA County Descriptors: The US Department of Agriculture Economic Research Service classifies all U.S. counties according to six mutually exclusive categories based on economic dependence: farming, mining, manufacturing, Federal/State government, recreation, and non-specialized counties. These dummy variables were assigned in 2015. We also include the USDA county descriptors for low education, low employment, persistent poverty, persistent child poverty, population loss, and retirement destination.

County Descriptors and Demographics: We use county-level descriptor data from Opportunity Insights that is included in Chetty et al. (2014) as covariates. The county-level data measures demographics, labor force, racial composition, inequality, and more.

County-level Political Voting: We use presidential election results for 2008, 2012, and 2016 from The Guardian, Townhall.com, Fox News, Politico, and the New York Times. We use 2016 county-level election results from Townhall.com, 2012 county-level election results from the Guardian, and 2008 election results from Bill Morris. All data was originally web-scraped by Tony McGovern.

3.1.3 Extensions, VAR Models, and Robustness Checks:

Monetary Policy Shocks Data: We use the monetary policy shock series from Bu et al. (2020) that updates the Romer and Romer (2004) series to additionally track unconventional monetary policymaking. The data covers every quarter from 1994 to 2019.

3.2 Identification Strategy

To construct our national index of monetary policy's effectiveness at the zero lower bound, we run difference-in-differences regressions for each county in the United States. For each regression, we compare the county's wage income change against the country's wage income change. The treatment group is the county and our control group is the nation. We repeat this regression 3195 times for each county in the United States. We control for fiscal policy by including county-level ARRA transfers and local tax rates. We include time fixed-effects for each year.

Our difference-in-differences estimator is obtained by the following regression

$$\begin{aligned} WageIncome = \beta_0 + \beta_1 County + \beta_2 AfterQE + \beta_3 County * QE \\ + \beta 4 CountyARRATransfer + \beta 5 LocalTaxRate + \beta 6 Population \\ + \beta 7 IndustryControls + YearFixedEffects + u_i \end{aligned} \tag{3}$$

Where β_3 measures the difference between the average wage income change in each county and the average wage income change in the nation:

$$\begin{aligned} DD = [E(WageInc_1(1)|County = 1) - E(WageInc_0(0)|County = 1)] \\ -[E(WageInc_1(1)|County = 0) - E(WageInc_0(0)|County = 0)] \end{aligned} \tag{4}$$

Next, we discuss several decisions we made in the process of creating this identification strategy. We also discuss potential doubts, and suggest additional modifications for future variations of this paper.

Choice of Time parameters: We selected to cover 2004 - 2014 in order to best capture the growth of the balance sheet after the Great Recession. Much of the growth in the Fed's balance sheet occurred after the Great Recession ended in June 2009. During the Great Recession, most of the increase in the Fed's assets came from purchases of troubled assets and commercial paper. After the recession, Treasury securities and MBS purchases composed the largest increases in assets. In future versions of this paper, we will run the same results to cover different time periods in order to ensure robustness.

Monetary Policy Lag: Romer and Romer (2004) demonstrates that monetary policy transmits to the real economy with long and variable lags. They estimate that a 1% increase in the policy rate takes an average of 22 months to fully affect inflation in the U.S. However, recent monetary policy papers suggest that contractionary and expansionary monetary policy may take a different amount of time to transmit to real variables. In order to account for lags in the real economy, we extended our analysis to 2014 and ran one version of the regressions with a one year lag – we found no significant difference in our coefficient measures.

Wage Income: We select change in quarterly wage income as our measure for several reasons. First, we wanted to try and track quarterly data (seasonally adjusted) in order to get a better sense of the overall business cycle throughout each of the years and provide more data points for more robust findings. On a county-level, real economy data is only available for wage income. In future variations of this paper, we would use a similar approach to Chetty et al (2014) to find personal income from tax documents, trace them to the ZIP locations for each county, and build even better real economy variables. We hypothesize that tracking personal income will result in even larger estimated differences in unconventional monetary policy effectiveness in different geographic regions. Second, we select wage income as our variable of choice because it likely affects poorest communities most. Wage income reflects the dynamics of the labor market and allows us to have a broader view of the real economy.

However, tracking wage income does pose limit the interpretation of our results. For example, it is possible that our trends actually reflect the decline in worker power in some regions of the United States more than others. To address this, we include industry controls and in future versions of this paper, we hope to include more robust measures of county-level estimates of unionization. Additionally, it is also possible to argue that wage inflation may simply track secular changes in inflation. Since we use a difference-in-differences to compare the county to the national, these potential concerns around lower inflation should not likely affect our results.

Selecting wage inflation as our variable also does open the scope of interpretation of our empirical results. It is possible that we are simply estimating that it takes longer in some counties than others for UMP to pass through to wage income. This finding, however, would still support our hypothesis – the longer it takes for UMP to pass through to real economy variables in some places than others, the less effective it is in some locations.

Last, it is possible that we may be potentially tracking how wage inflation took longer to recover for lower-income populations. We would be open to this interpretation of our results - our findings on location effects are not about the physical geography and land, but about the spatial distribution of economic power and resources in America.

3.3 County Difference-in-Difference Example

3.3.1 Comparing the Two Counties

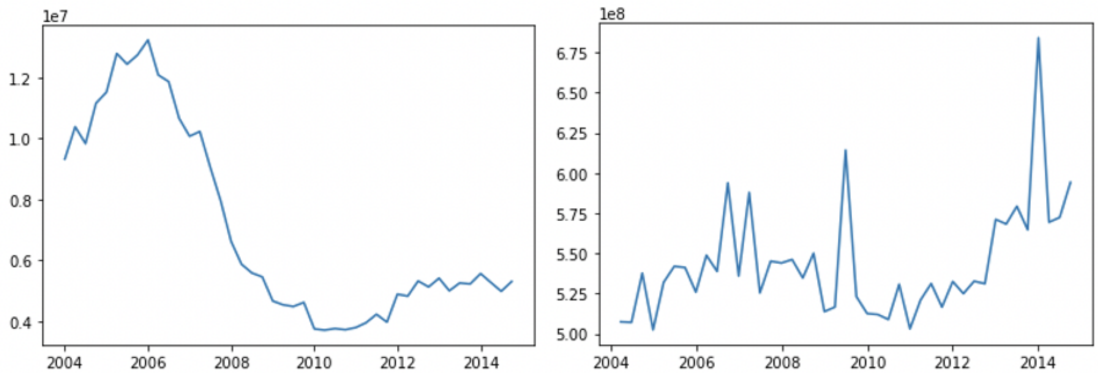

Figure 2: Average Weekly Wages from 2004 to 2014 for Jenkins County, Georgia (Left) and Hunterdon County, New Jersey (Right).

Jenkins County, Georgia, miles away from New Jersey, covers a population of 8,340. The median income for a household in the county in 2010 was $27,686 and the median rent in 2012 to 2016 was $501. The college graduation rate is 11% and only 4.1% of the county is in the top 20% based on household income. When I went to check their website, the Jenkins local high school just announced a shut-down in wake of the overwhelming deluge of coronavirus cases. The employment rate is 73% and the density of jobs in 2013 was 8.4 for every square mile. 40.5% of the county is African-American and the county is most noted in history for a riot during the Red Summer of 1919.

As of 2011, Hunterdon has the highest taxes in the nation, with a median of $8,216 and a per capita personal income of $80,759. The Hunterdon Central Regional High School has a student ratio of 11.9:1 students, 23 classrooms, a gymnasium and complete renovation of all 47 classrooms. The teachers in the classroom are required to build Moodle, Wikispaces, and Google Sites for every course they teach. The county is 0.13% black or African American and has a population density of 300 per square miles. Hunterdon County is solidly Republican, and as of 2020, they have 40,557 registered Republican voters and 33,156 registered Democratic voters.

Figure 3: Photographs of Jenkins County, Georgia (Left) and the local high school in Hunterdon County, New Jersey (Right).

Throughout the Great Recession, the Hunterdon County local newspaper published several articles explaining quantitative easing. In one series of articles, a local resident argues that "QE1 and QE2 were ineffective, so why should we expect a third attempt to succeed?" In a series of letters to the editors in 2012, a staff-writer proposes some reasons not to vote for Romney: "Mr. Romney and his fellow Republicans have voiced their discontent with the present chairman of the Federal Reserve, Ben Bernanke. They are upset with the Fed's three quantitative easing initiatives which have helped rescue the economy."

In 2007 through 2009, the Jenkin County local newspaper kept track of its government transfers and funding, but no articles in the history of the newspaper have been published which mention the Federal Reserve. In 2009, an article described the allocation from the Recovery act funding: "Congressman John Barrow recently announced . . . the county will be the first local recipients of the 2009 Recovery Act funding." In 2010, Jenkins County news editor Deborah Bennett writes: "Everyone could use a little more 'jingle' in their pockets, the county being no exception."

3.3.2 Our Estimates of The Two County Responses to UMP

We find statistically significant results that monetary policy was more effective at stimulating wage income in Hunterdon County than in Jenkins County. We do this by estimating two difference-in-differences models. First, we look at just Hunterdon County. The table below offers the co-efficient estimates for the following regression:

$$\begin{aligned} WageIncome_{Hunterdon} &= \beta_0 + \beta_1 County(1 = Hunterdon, 0 = Nation) \\ &+\beta_2 QE(1 = AfterQE1, 0 = BeforeQE1) \\ &+\beta_3 County * QE(DDEstimator) \\ &+\beta 4 CountyARRATransfer(Transfer\%Incomepercounty) \\ &+\beta 5 LocalTaxRate + \beta 6 Population + \beta 7 IndustryControls \\ &+YearFixedEffects + u_i \end{aligned} \tag{5}$$

We present our results as follows. First, there is a notable positive treatment effect for living in Hunterdon County. Since this is a difference-in-differences regression and we are examining the log of wage income, the magnitude of our coefficient matters less to us than the sign. We note two interesting and important results from our regression. When ARRA transfers and local tax rates are not accounted for, the co-efficient for our difference-in-differences estimator is negative. However, when we include fiscal policy differences as part of the control and we include industry-level controls, the coefficient turns positive and is significant at the 99% level. In contrast to our findings for Hunterdon County, we found Jenkins County to have a negative difference-in-difference coefficient, suggesting the opposite effect – monetary policy at the ZLB supported wage income less.

These results suggest that fiscal policy was effective in addressing geographic inequality in wage income response. This is supported by recent literature. Crucini and Vu (2019) found that ARRA transfers effectively supported counties most hard-hit by the pandemic with 7% of the macroeconomic component of private wages shocks mitigated by the grants in aid. For public wages, they find that 13.5% of the county-specific shocks are offset while there is no offset of the macroeconomic component of public wages. Second, these results also suggest that controlling for the share of employment in specific industries can be important. More research should be conducted into the response of wages across different industries following the Great Recession and how these trends could be applicable for the recovery from the coronavirus pandemic. Last, these results suggest possible reasons why other papers within the literature might have mistakenly deduced QE to have reduced inequality. Bivens (2015) from the Economic Policy Institute found that QE reduced inequality by pushing the economy closer to full employment – however, his paper does not address differences in wage income and does not address how industry-level changes and temporary employment affects his findings.

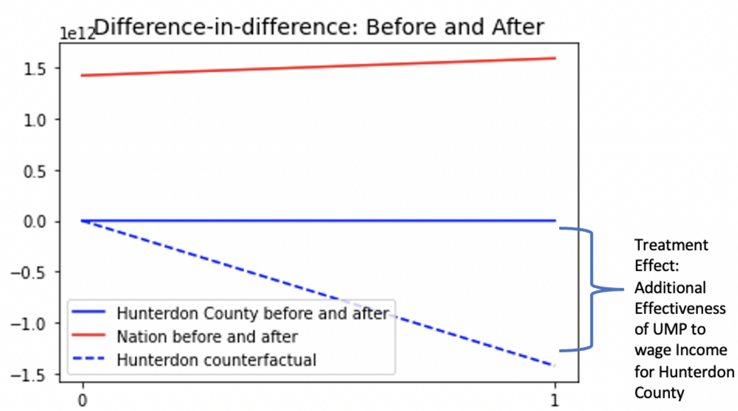

Figure 4: Means DD Estimator Visually Graphed for Hunterdon County – the counterfactual is how wage income would have responded without the additional effectiveness of QE. The visual above graphs an estimation of the treatment effect, where 0 and 1 map out the mean value for wage income change from before and after QE.

Table 1: Hunterdon County: The Effectiveness of QE

	(1)	(2)	(3)	(4)
County Dummy	-3.421^{***}	-2.7908^{***}	$6.161e{-}12^{***}$	$5.77e{-}7^{***}$
	(0.006)	(0.036)	$(4.85e{-}13)$	$(1.89e{-}7)$
QE Dummy	-0.0259	-0.0220^{*}	-0.0402^{***}	-0.0485^{***}
	(0.019)	(0.009)	(0.010)	(0.012)
County*QE	-0.0407^{*}	-0.0432^{***}	$1.015e{-}13^{***}$	$1.291e{-}11^{***}$
	(0.016)	(0.008)	$(7.99e{-}15)$	$(4.23e{-}12)$
ARRA	0.0001	.	0.518^{***}	$-9.501e{-}05$
	(0.001)		(0.000)	(0.00)
Local Tax		-1.1086^{***}	0.3813^{***}	0.6122^{***}
		(0.063)	(0.03)	(0.201)
Population				$-2.437e{-}9$
				$(2.09e{-}9)$
Coefficient	-14.34^{***}	-14.4781^{***}	-11.546^{***}	-18.5381^{***}
	(2.608)	(2.533)	(0.909)	(6.071)
R^2	1.000	1.000	0.947	0.949
Year Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Industry Controls	*No*	*No*	*Yes*	*Yes*

Notes: In this regression table, we examine four different difference-in-difference models where we test the effectiveness of QE on wage income. The County*QE variable is our Difference in Difference estimator here – a positive coefficient suggests that living in Hunterdon County increases the effectiveness of UMP on wage income. The 'treatment' is living in Hunterdon County and the control is the national wage income trend. We find that the distributional effects of QE to be significant. In the first two models, we omit fiscal policy and industry controls –in these scenarios, it seems as if QE would be less significant in Hunterdon County than the national trend. However, the sign switches once we include industry controls and fiscal policy – suggesting that there was a significant difference in wage income responsiveness through industries and fiscal stimulus. We make special note that model (1) and model (2) in Table 1 has an R^2 value of 100%, suggesting a high degree of over-fitting.

3.4 Construction of National Index

We repeat the above model from our difference-in-differences regression for Hunterdon County and replicate it for all 3,195 counties in the United States and Puerto Rico. Using the same methodology, we construct a national index of difference-in-difference coefficients for every county in the United States. Of the 3,195 counties, 2,013 difference-in-differences regression coefficients were significant at the 95% level.

The difference-in-differences coefficients serve as a measure of the county-level distributional effectiveness of monetary policy at the ZLB during the Great Recession. We found that counties at the extremes of coefficient values were more likely to have significant p-values. We present a map of the measure of UMP effectiveness by county below and a table including a sample of counties with stronger and weaker effects.

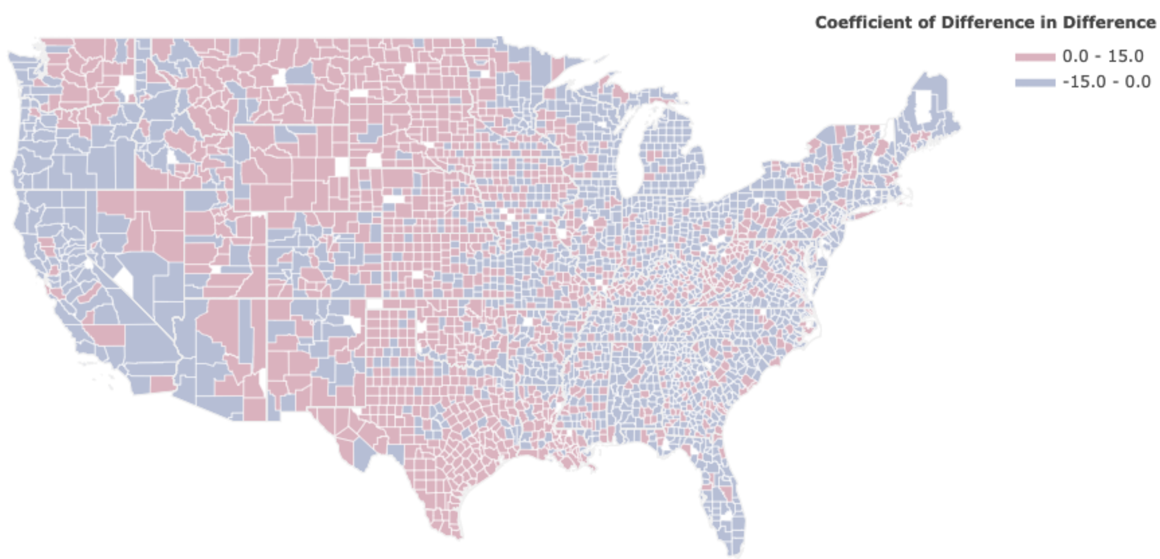

Figure 5: Effectiveness of MP at the ZLB by County in the USA.

County	Coefficient	P-Value
Niagara County, New York	0.0469	0
Prince George's County, Maryland	0.0468	0
Branch County, Michigan	0.0468	0
Calhoun County, Alabama	0.0467	0
Montrose County, Colorado	0.0466	0.008
Scott County, Kentucky	0.0464	0.026
Union County, Florida	0.0463	0.001
Brevard County, Florida	0.04	0.001
Livingston County, Illinois	0.04	0
Howard County, Iowa	0.04	0.002
Hamilton County, New York	0.0399	0.001
Stark County, Ohio	0.0398	0
Jackson County, Oregon	0.0398	0
Charlotte County, Florida	0.0397	0.001
Montgomery County, Arkansas	0.0298	0.005
Sacramento County, California	0.0298	0
Charlton County, Georgia	0.0298	0.002
Washington County, Maryland	0.0298	0.001
Bergen County, New Jersey	0.0298	0.004
Mason County, West Virginia	0.0298	0.255
Maricopa County, Arizona	0.0297	0.003
Clinton County, New York	0.0297	0.007
Tyler County, Texas	0.0292	0.002
Monmouth County, New Jersey	0.0291	0.003
Hillsborough County, Florida	0.029	0.001
Charlevoix County, Michigan	0.029	0.026
Stone County, Mississippi	0.029	0.072
Cumberland County, New Jersey	0.029	0.001
Contra Costa County, California	0.0289	0.001
Modoc County, California	0.0032	0.723
St. Louis County, Minnesota	0.0032	0.572
Grayson County, Texas	0.0032	0.644
Cowlitz County, Washington	0.0032	0.634
Bond County, Illinois	0.003	0.653
Carroll County, Indiana	0.003	0.572

Figure 6: Sample of Counties with Higher Difference-in-Difference Coefficients

County	Coefficient	P-Value
Kaufman County, Texas	-0.023	0.052
Lubbock County, Texas	-0.023	0
Warren County, Iowa	-0.0231	0
Codington County, South Dakota	-0.0231	0.08
Liberty County, Texas	-0.0231	0.205
Morgan County, Utah	-0.0231	0.185
Rosebud County, Montana	-0.0233	0.041
Navarro County, Texas	-0.0233	0
Salt Lake County, Utah	-0.0234	0.017
Towner County, North Dakota	-0.037	0.003
Jackson County, Colorado	-0.0371	0.034
Allen Parish, Louisiana	-0.0371	0.337
Wilkin County, Minnesota	-0.0371	0.003
Hardin County, Texas	-0.0371	0.026
Warren County, Indiana	-0.0372	0
Traverse County, Minnesota	-0.0372	0.001
Washington County, Iowa	-0.0373	0.001
Ward County, Texas	-0.1542	0.003
Washington County, North Carolina	-0.1549	0
Hettinger County, North Dakota	-0.1551	0
Sioux County, Nebraska	-0.1554	0.018
Los Alamos County, New Mexico	-0.1554	0.221
Corson County, South Dakota	-0.1577	0
McCulloch County, Texas	-0.1582	0
Upton County, Texas	-0.1594	0.001
Red River Parish, Louisiana	-0.1606	0
Campbell County, South Dakota	-0.1627	0
McMullen County, Texas	-0.3979	0.011
La Salle County, Texas	-0.4198	0
Dimmit County, Texas	-0.4575	0
Williams County, North Dakota	-0.5536	0
Mountrail County, North Dakota	-0.5632	0
Dunn County, North Dakota	-0.6719	0
McKenzie County, North Dakota	-0.6968	0

Figure 7: Sample of Counties with Lower Difference-in-Difference Coefficients

In future versions of the paper, we will work on building out and incorporating more covariates. We also hope to make the coefficient more interpretable. At the moment, we mix data-sources that include percentages, logs of ratios, and stock variables. With revision and with suggested edits from others, we hope to refine this index and the units used.

For the full results for every county, please see the attached files. We also include code to build a JSON map which allows you to zoom in on counties and see their coefficient and p-values when you hover over the indicated area.

3.5 Where is QE Most Effective?

With our national index of county-level difference-in-differences coefficients, we run OLS regressions with a variety of county characteristics and search for correlations. We construct OLS regressions for 75 different series on county characteristics, mixing US Department of Agriculture indexes, Opportunity Insights measures, and political voting trends. We constructed simple OLS regressions where the independent variable was the county characteristic and the dependent variable was the coefficient of monetary policy effectiveness.

For voting trends, we flipped the dependent and independent variable to better match our interpretation. While characteristics related to social factors or unemployment likely shed more light on our coefficient difference-in-differences in result, we expect the opposite to be true for political patterns. These regressions offer several key insights:

1. First, unconventional monetary policy was significantly less effective in counties that relied on mining or farming. The 'industry' classifiers from the USDA reported the largest R-squared scores, suggesting evidence for the importance of industry responses.

2. Second, the unemployment rate of a county surprisingly seemed uncorrelated with whether or not unconventional monetary policy was more effective at stimulating wage income after 2008. This result suggests why previous papers on QE which focus solely on employment might have mistakenly assumed that unconventional tools do not increase inequality.

3. Third, places with lower taxes, less government expenditure per capita, and less tax progressivity had stronger responses to unconventional monetary policy in 2008.

4. Fourth, places which had weaker responses to monetary policy in 2008 were places with worth education and social capital factors.

5. Fifth, racial segregation within a county better predicted the strength of monetary policy stimulus than the racial composition of the county.

6. Sixth, we found that counties which originally voted for Democrats in 2008 and switched to Republicans in 2016 were significantly less impacted by monetary policy. The opposite also held true – counties which originally voted for Republicans in 2008 were much more likely to switch to Democrats in 2016 if they experience stronger monetary stimulus during the Great Recession.

3.5.1 Industry Type

Table 2: Independent Variable: Mining

	(1)
Mining Dummy	-0.0586^{***}
	(.006)
N	2138
R^2	0.04

Table 3: Independent Variable: Metro

	(1)
Metro Dummy	0.0084^{**}
	(.003)
N	2138
R^2	0.004

Table 4: Independent Variable: Farming

	(1)
Farming Dummy	-0.0367^{***}
	(.004)
N	2138
R^2	0.033

We ran OLS regressions with our coefficient and each of the USDA county characteristics dummy variables as measured in 2015:

$$UMPCountyLevelResponse = \beta_0 + \beta_1 USDACode(1 = true, 0 = false)$$

The above sample three of our most important results. We found that counties which relied on mining and farming were associated with a decrease in the effectiveness of unconventional monetary policy. The $R\hat{2}$ for mining and for farming are notably high, and suggest the importance. Places which were classified as having a metro were associated with stronger UMP effectiveness.

In addition to the above regressions, counties that were labeled as recreation-based, nonspecialized-based, retirement destinations, and manufacturing-based were more likely to have responded strongly to monetary stimulus at the 95% confidence level. Counties which experienced population loss from 2010 to 2015 and persistent child poverty were negatively correlated with monetary stimulus effectiveness at the 95% confidence level. The regression for whether or not a county relied on public government employment was statistically insignificant.

3.5.2 Labor Market

Table 5: Independent Variable: Low Employment County 2008

	(1)
Low Employment County	0.0086^{**}
	(0.003)
N	2138
R^2	0.003

Table 6: Independent Variable: Unemployment Rate 2012 (Standardized)

	(1)
Unemployment Rate	0.0002
	(.002)
N	2138
R^2	0.000

Table 7: Independent Variable: Labor Force Participation 2012 (Standardized)

	(1)
Labor Force Participation	0.0024
	(.001)
N	2138
R^2	0.002

We use the USDA Dummy Variable for Low Employment County where 1=true, and 0=false. We found that low employment counties were negatively correlated with monetary policy effectiveness at the 90% confidence level. However, the average unemployment rate and the labor force participation rate for each county was statistically insignificant when measuring correlation with the effectiveness of UMP on change in wage income. This suggests two key takeaways.

First, papers which only focus on the effect of quantitative easing on the unemployment rate are not fully capturing the impact of UMP on labor market and real economy trends. For example, places with higher unemployment may also include retirement destinations, which as discussed in the earlier section, are positively correlated with monetary policy effectiveness. Second, QE is likely relatively effective for both the middle and upper class. However, the difference in the results for our USDA Low Employment County index and the LFPR measure suggests that places where people cannot find work even if they want it are most negatively impacted. The unemployment rate does not capture workers who have 'given up' on searching and might not reflect the underlying conditions of a county. Counties with consistently low employment as measured by the USDA are likely to have been relatively more disadvantaged from QE measures.

3.5.3 Fiscal Policy

Table 8: Independent Variable: Local Government Expenditures per Capita (Standardized)

	(1)
Govt Expenditures per Capita	-0.0015
	(.002)
N	2138
R^2	0.003

Table 9: Independent Variable: Local Tax Rate per Capita (Standardized)

	(1)
Local Tax Rate per Capita	-0.0127^{***}
	(.002)
N	2138
R^2	0.020

The correlations above suggest that places with less government expenditure per capita in 2016, lower local tax rates in 2016, and less tax progressivity in 2016 were more sensitive to QE. However, only the local tax rate per capita is significant in predicting the coefficient – the high $R\hat{2}$ score and the 95% confidence level suggests that our findings are statistically significant. This matches a broader picture and story about the relationship between monetary policy and fiscal policy. To return to our example of Jenkins County and Hunterdon County, covered fiscal stimulus more in local newspapers, the latter covered quantitative easing more than fiscal policy measures. What supported the recovery in some places of the United States differed from what encouraged growth to return in others.

Table 10: Independent Variable: Tax Progressivity (Standardized)

	(1)
Tax Progressivity	-0.0034
	(.002)
N	2138
R^2	0.001

Table 11: Independent Variable: High School Dropout Rate (Standardized)

	(1)
HS Drop Out Rate	0.005^{**}
	(0.002)
N	2138
R^2	0.005

Table 12: Independent Variable: Student Teacher Ratio (Standardized)

	(1)
Student Teacher Ratio	0.0079^{***}
	(.001)
N	2138
R^2	0.025

3.5.4 Social Factors and Education

Counties with higher high school drop-out rates and higher student-teacher ratios were strongly correlated with having higher responsiveness to quantitative easing. In particular, the student teacher ratio variable has a high $R\hat{2}$ implying that the correlation is notable. While we do not expect variables related to education to play a role in any of the transmission channels of unconventional monetary policy, we see that the correlation demonstrated here suggests that places with lower social capital tend to be relatively less responsive to new forms of expansionary monetary policy.

3.5.5 Race

Table 13: Independent Variable: Racial Segregation (Standardized)

	(1)
Racial Segregation	-0.045^{**}
	(.002)
N	2138
R^2	0.003

Likewise, while we do not expect variables related to racial composition to play a role in any of the transmission channels of unconventional monetary policy, we note the correlations

Table 14: Independent Variable: Fraction Black (Standardized)

	(1)
Fraction Black	$5.36e-05$
	(.002)
N	2138
R^2	0.000

demonstrated here for the broader picture they provide. While there was not a significant correlation between QE effectiveness and counties with higher fractions of racial minorities, places with less racial segregation were more responsive to UMP.

3.5.6 Voting

Table 15: Dependent Variable: Change from 2008 Republican to 2016 Democrat County

	(1)
DD Coefficient	0.3988^{***}
	(0.116)
N	2138
R^2	0.006

Table 16: Dependent Variable: Change from 2008 Democrat to 2016 Republican County

	(1)
DD Coefficient	-0.1528^{**}
	(0.051)
N	2138
R^2	0.004

The above tables estimate the following OLS regressions:

$$ChangeinVotingTrends = \beta_0 + \beta_1 UMPResponsiveness \quad (6)$$

Counties that responded more to QE were more likely to change their votes from Republican in 2008 to Democrat in 2016, and the opposite is true – counties which were less responsive to QE were more likely to change their vote from Democrat in 2008 to Republican

Table 17: Dependent Variable: Percent Democrat Voting 2016 (Standardized)

	(1)
DD Coefficient	0.3904
	(.097)
N	2138
R^2	0.008

in 2016. The coefficients are significant at the 95% level.

Furthermore, we also find that places which voted for Democrats in 2016 and 2012 to have had stronger responses to unconventional monetary policy stimulus.

These results are important because of their political economy implications. We encourage further research on the role of place-based economic differences in the 2008 Great Recessions on voting trends in 2016. On the following page we provide OLS regression results for the indicators we tested.

In addition to the variables discussed above, we test county-level characteristics across 72 other measures listed below with the coefficient and P-Value. In future variations of this paper, we hope to include more variables that include house prices, stock market holdings, and government bond purchases.

Independent Variable	Coefficient	P-Value
Mining 2015-Update	-0.0586	0
Farming 2015 Update	-0.0367	0
Pop Loss 2010	-0.0202	0
Local Tax Rate Per Capita (Standardized)	-0.0127	0
Local Tax Rate (Standardized)	-0.0095	0
School Expenditure per Student (Standardized)	-0.0047	0
Fraction of Adults Married (Standardized)	-0.0047	0.012
Racial Segregation (Standardized)	-0.0045	0.009
Household Income per Capita (Standardized)	-0.0037	0.121
Low Education 2015 Update	-0.0036	0.432
Tax Progressivity (Standardized)	-0.0034	0.144
Social Capital Index (Standardized)	-0.0027	0.073
Migration Outlflow Rate (Standardized)	-0.0022	0.138
Migration Inflow Rate (Standardized)	-0.0019	0.254
Test Score Percentile (Income adjusted) (Standardized)	-0.0019	0.26
Poverty Rate (Standardized)	-0.0019	0.3
College Graduation Rate (Income Adjusted) (Standardized)	-0.0016	0.352
Local Govt Expenditures Per Capita (Standardized)	-0.0015	0.393
Income Segregation (Standardized)	-0.0002	0.877
Fraction Black (Standardized)	5.36E-05	0.979
Unemployment Rate (Standardized)	0.0002	0.887
Persistent Related Child Poverty 2013	0.0003	0.925
Segregation of Affluence (>p75) (Standardized)	0.0004	0.805
College Tuition (Standardized)	0.0005	0.81
Fraction Middle Class (between p25 and p75) (Standardized)	0.001	0.455
State EITC Exposure (Standardized)	0.0011	0.514
Location Affordability of Median Household (Standardized)	0.0011	0.549
Gini (Standardized)	0.0011	0.588
Teenage (14-16) Labor Force Participation (Standardized)	0.0013	0.298
Number of Colleges per Capita (Standardized)	0.002	0.013
Labor Force Participation (Standardized)	0.0024	0.067
Location Affordability of Very Low-Income Individual (Standardized)	0.0031	0.155
Fraction with Commute < 15 Mins (Standardized)	0.0039	0
High School Dropout Rate (Income adjusted) (Standardized)	0.005	0.005
Log Population Density (Standardized)	0.0052	0.011
Student Teacher Ratio (Standardized)	0.0079	0
Metro-nonmetro status, 2013 0=Nonmetro 1=Metro	0.0084	0.004
Low Employment Cnty 2008 2012 25 64	0.0086	0.008
Fraction of Children with Single Mothers (Standardized)	0.0092	0
% Democratic Voting	0.3904	0
Voting Change to Democrat from 2008 to 2016	0.3988	0.001

Figure 8: OLS Regression Results for County Characteristics on QE Effectiveness

4 Extensions and Robustness

4.1 Robustness and Vector Auto-Regression Checks

A growing body of literature uses vector autoregression models to estimate the impact of monetary policy on the real economy. VAR models find the dynamic causal effects of monetary policy shocks on the vector of real economy time series, while holding all exogenous changes constant.

To provide additional empirical support to our difference-in-differences index, we build 3,195 VAR models for all counties in the United States. To provide a larger swath of data, we track quarterly wages from 1994 to 2019 and we use monetary policy shocks measured by Bu et al (2020) that cover LSAPs, forward guidance, and other unconventional tools. To select the lags for our vector autoregression models, we ran lag-order selection diagnostics and used the Akaike's information critera (AIC) to select the optimal time frame. The AIC prioritizimes the minimization of inflation loss in VAR models.

In our impulse response functions, pictured below, we decompose how a one standard deviation impulse to the monetary shock measure influences average weekly wages on a quarterly basis for every county. The Y-axis is measured in quarters and demonstrates the amount of time after the initial response. The X-axis measures the responsiveness of average weekly wages. 95% confidence intervals are reported. While the confidence intervals are large, this is standard in VAR macroeconomic estimations. The critical visual to look at in the impulse response functions below is where the 'cumulative' bar is relative to 0 – the direction of the black horizontal bar maps the overall response.

We build these models for all 3,195 counties and provide them in an additional zip file attached to the paper. Below, we present three example counties for discussion.

Jenkins County, describes in our earlier county vs county comparison, shows no cumulative response of average weekly wages to a one standard deviation increase in the monetary

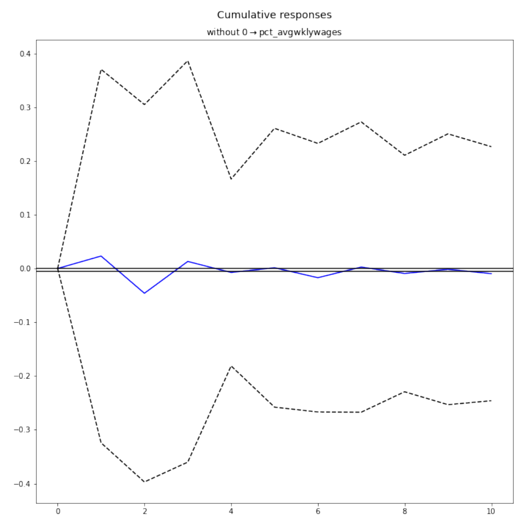

Figure 9: Jenkins County, Georgia Responsiveness to Monetary Policy

policy shock. The lack of cyclical variation in our graph below suggests that labor market conditiosn have been stagnant throughout the period of time, and moetnary shocks are ineffective – whether they are interest rate cuts or unconventional tools.

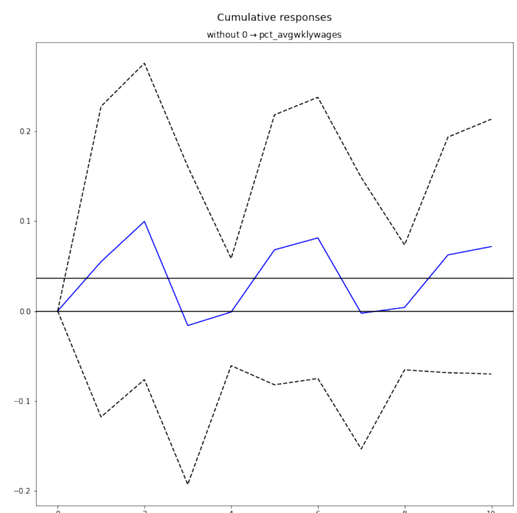

Figure 10: Maricopa County, Arizona Responsiveness to Monetary Policy

Maricopa county, Arizona was recently in the headlines because of its role in flipping Arizona. Biden successfully flipped Arizona by 10,000 votes – with Maricopa county's 45,000 votes of critical importance. The county has not voted for a Democratic presidential nominee since 1948. Here, we see that average weekly wages in Maricopa County was notably responsive to monetary policy shocks from 1994 to 2019. In particular, these shocks had a stimulatory effect – average weekly wages were more likely to rise after expansionary monetary policy.

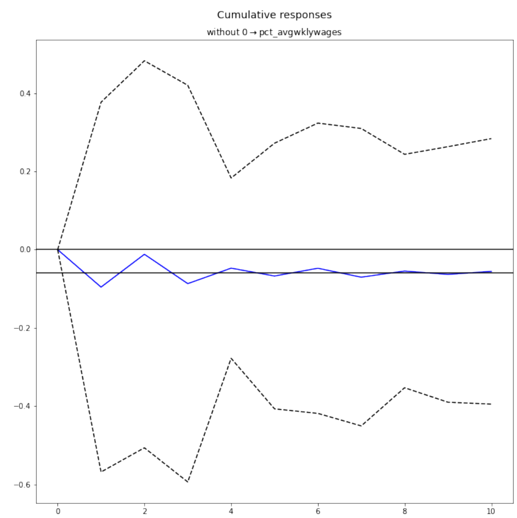

Figure 11: Hidalgo County, Texas Responsiveness to Monetary Policy

Hidalgo County, Texas border mexico and is primarily composed of working-class families. There are notably high rates of poverty and the county is primarily composed of racial minorities. However, in 2020, Hidalgo swung by 23 points towards the republican party and there was a 27% increase in voter turnout. We note that expansionary monetary policy was notably ineffective from 1994 to 2019.

5 Conclusion

A debated topic amongst economists today is whether or not we should implement place-based policies. We would argue that there is another question to ask. In truth, we are already implementing place-based economic policies – we just haven't measured whether or not our policies are helping some places more than others. The same, uniform policy – even if it is not intended to be place-based – can have disparate effects in some regions over others. This paper attempts to build on the other way of asking this question: Where are our unconventional monetary policy measures more effective than in other places?

The success of this paper is in developing that metric. We show a national index of the geography of ZLB-constrained monetary policy effectiveness in the United States, and describe the set of results that accompany that. Our index shows that unconventional monetary policy was likely to be less effective in rural areas focusing on agriculture and mining, regardless of levels of employment after 2008. As such, while geographic inequalities due to sectoral differences were likely to manifest in non-uniform responses to QE, studies that focused on income inequality or employment effects were likely to reveal no heterogeneity in treatment. This result is obviously important with regards to considering the targeting of future MP transmission, as well as future work. Economists should attempt to specifically estimate channel by channel the impacts of regional heterogeneity, which is likely to be effective in revealing which channels affect geographic inequality in transmission more. Sectoral differences as geographic predictors of QE effectiveness, for example, suggest the exchange rate channel a as likely mechanism to explain why agricultural areas are likely to be affected differently than manufacturing hubs.

We also observe political results which are of further note. Specifically, we observed that poor education, and social capital, and higher government expenditures were all predictors of weaker monetary response in 2008, and that racial segregation predicted MP strength better than racial composition. We make no conclusions about these on their own, but they are interesting in widening the scope of political economy discussions with regards to QE. That is, the effects of QE on income inequality are semi-discussed, but the mythos of the "Federal Reserve" and its pseudo-perennial target by the more libertarian sector of the conservative parties in the United States certainly leaves questions up for debate. Specifically, what are the political implications of continued QE with regards to inequality, especially in an era where conservatives from Rand Paul and liberals like Bernie Sanders jointly decry trillion dollar injections by the Fed into the US economy? While we do not cover those political questions, our results are interesting starting points to attempt to determine salient political attributes in those affected by QE, and our index is particularly useful in setting the groundwork for academic research that focuses primarily on political outcomes that are frequently geographically heterogenous.

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