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Three Essays on Growth, Housing Market and Inequality

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THREE ESSAYS ON GROWTH, HOUSING MARKET AND INEQUALITY

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ECONOMICS

by

Shahrzad Ghourchian

2018

To: Dean John F. Stack, Jr.
Green School of International and Public Affairs

This dissertation, written by Shahrzad Ghourchian, and entitled Three Essays on Growth, Housing Market and Inequality, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Date of Defense: June 22, 2018

The dissertation of Shahrzad Ghourchian is approved.

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Florida International University, 2018

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DEDICATION

To my family for their love, support, and patience.

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ABSTRACT OF THE DISSERTATION
THREE ESSAYS ON GROWTH, HOUSING MARKET AND INEQUALITY

by

Shahrzad Ghourchian

Florida International University, 2018

Miami, Florida

Professor Hakan Yilmazkuday, Major Professor

This dissertation includes three essays on growth, the housing market, and inequality. In the first essay, I analyze the effects of government consumption and government debt on long-run economic growth by considering the economic characteristics of the countries investigated. Linear regressions reveal that government consumption has a much bigger negative impact on long-run growth compared with the negative (and sometimes insignificant) effects of government debt. Nonlinear analyses further show that such effects are highly impacted by the economic characteristics of the countries investigated.

In the second essay, I study time-series fluctuations in the United States housing market from 2010 to 2016 using the Gordon growth model. Using variance decomposition analysis, I find that the housing premium is the main driver of housing market fluctuations. Motivated by previous studies and using impulse response functions, I show how different components of the housing market respond over time to a shock in the interest rate in regions with different levels of income or demographics. My findings suggest that the impact of monetary policy is smaller (and less persistent) in the U.S. housing market when households have more females, more African Americans, or fewer well-educated members; a combination of these demographics and a lower income in

households results in a smaller impact of monetary policy in the housing market, due to the necessity of housing for these families.

In the third essay, I use Internal Revenue Service (IRS) annual data and Zillow median housing price data, to analyze the impact of income inequality on housing price to rent ratio from 2005 to 2015 for more than 12,700 zip codes. Employing various specifications, I find a consistent positive and significant relationship between the Gini coefficient and housing affordability index. My results are robust to different methods of estimating the Gini index. Moreover, the empirical results of this study suggest a larger impact of inequality in zip codes with higher levels of income.

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CHAPTER 1

INTRODUCTION

The effect of government debt on growth continues to be a subject of debate after decades of research. The Great Recession of 2007-2009 proliferated this debate after many governments increase their debt by financing bailouts of their financial institutions, which has put them at high risk for fiscal sustainability. While the short-run effects on national income can be positive due to sticky prices and wages, the effects can be negative in the long-run due to reductions in national saving. Government debt can also affect long-run growth through several other channels, including its effects on private savings, public investment, total factor productivity, sovereign long-term nominal and real interest rates, higher inflation, higher taxation, greater uncertainty, and vulnerability to crisis. Without referring to any of these channels, empirical studies based on cross-country investigations have shown that the negative relationship between government debt and growth becomes effective after passing a certain threshold. However, such an ad hoc approach cannot provide any policy suggestions due to the lack of details based on the economic characteristics of the analyzed countries.

In the second chapter, I bridge this gap by analyzing the effects of government debt on long-run growth by considering the economic characteristics of the countries investigated. In particular, I would like to know how the typical long-run economic conditions, such as physical capital, human capital, financial development, trade openness, inflation, and investment interact with the level of government debt across countries. I consider the sample period covering the years between 1966 and 2010 which is suitable for analyzing the effects of government debt on long-run growth during The Great Recession. The data also covers 57 countries, including both developed and developing markets.

The interaction between the economic conditions and the effects of government debt (on long-run growth) requires a non-linear investigation. Following the literature, I achieve a threshold analysis based on a rolling-window analysis of 5-year averages, where each window represents a specific set of country characteristics. I also consider the problem of endogeneity by using two-stage least squares (2SLS) where I consider the initial conditions of the countries as instruments.

The implication is that, due to its negative effects, government consumption/expenditure is the key variable in forming fiscal policy based on a growth strategy, while government debt, as corroborated by many studies in the literature, is not as effective. Regarding the interaction of government consumption with other economic country characteristics, its negative effects on growth are more evident when trade openness is below approximately 55% of GDP, inflation is above around 10%, private credit is above 50%, or government consumption itself is above about 10% of GDP. Therefore, the economic growth of countries with such characteristics have been hurt more by government consumption, while such characteristics have not played any significant role on effects of government debt on growth.

Overall, chapter two contributes to the literature by (i) comparing the effects of government expenditure versus government debt on growth, (ii) using a rich data set with more countries and time coverage compared with the existing studies, (iii) considering nonlinearities in the relationship between growth and government expenditure/debt that are essential in the determination of country-specific policies.

Following the financial crises, given the importance of housing price volatility on macroeconomic stability, the Federal Reserve urged researchers and policy makers to enhance their understanding of the housing market. Most economists believe the most likely triggering factor for the crisis to be the bursting of the housing bubble. By lending to individuals with poor credit scores, the so-called sub-prime market, financial

institutions and investors in mortgage-backed securities were effectively speculating on ever-increasing housing prices (Gorton, 2009). For a deeper understanding, I research the sources behind fluctuations in the housing market, as well as the various impacts of monetary policy.

I study time-series fluctuations in housing prices and the returns to housing using tools that have proved successful in characterizing the nature of return in the stock and bond markets. Using variances and covariances, I determine the effect of different factors on changes in housing prices. I apply the dynamic Gordon growth model to the housing market in the United States from 2010 to 2016, using monthly zip code level data published by Zillow. The model allows us to split the rent-price ratio at each date into the expected present discounted value of rent growth, real interest rate, and the housing premium over real rates. To put this model into practice, I must measure expectations at each point in time. My strategy, which is common in the financial literature, is to use a vector autoregressive model (VAR) with fixed coefficients. Subsequently, I use variance decomposition to detail how each of the three components contribute to the volatility of the rent-price ratio over this period of time.

Motivated by previous studies that stress the importance of local and regional factors, I use zip code level data on demographics in order to further analyze the housing market in the United States. and to examine the differential effect of monetary policy on housing in different regions. My main contribution to the literature, therefore, is to document the effect of income and demographics on housing demand, that lead to differential impacts of monetary policy across socioeconomic groups. Using Impulse Response Functions (IRF), I show how different housing factors respond over time to an interest rate shock in areas with different levels of income or demographics. My analysis shows that, although the interest rate is not the main driver of housing

market fluctuations, any shocks to the interest rate affects rent growth and housing premia indirectly. My IRF analysis results show that, monetary policy affects the housing market indirectly through rents and housing premia. This effect is smaller for low-income families, comprising more females, more African Americans, and/or less educated members. I believe these groups face tighter financial constraints, making consumption rather than investment, the primary concern when making housing decisions. Therefore, a change in the interest rate will not affect their demand for housing assets as much as it will for households with less binding financial constraints.

The persistent increase in housing and the experience of previous recessions, raised concerns regarding the consequences of volatility in this market. Besides the impact of housing price fluctuations on macroeconomics, an increase in housing prices will make housing unaffordable for many middle- and low-income households. On the other hand, income inequality has been continuously rising in the United States, inspiring some researchers to investigate whether there is a relationship between inequality and housing affordability. Theoretically, it is easy to argue that income inequality has an effect on housing prices. In a competitive market with a limited housing supply, prices will increase if the income of wealthy households increases, since they will bid up on houses. The housing will then be less affordable for households whose incomes have not changed or have decreased.

In the final chapter, I study the impact of income inequality on housing affordability in the United States. Using Internal Revenue Service (IRS) annual data, I calculate the Gini coefficient for each zip code for the years 2005 to 2015. Employing the Zillow and IRS zip code level data set, I compute the price to income ratio, the most widely-used measure of housing affordability (Hulchanski, 1995). The price to income ratio, calculated using median house prices over median income, is an index of access to housing; the ratio increases as housing becomes less affordable.

I study the impact of income inequality on housing affordability among zip codes in the United States using ordinary least squares (OLS), fixed effect (FE) estimations and then system generalized method of moments (GMM), to address potential endogeneity. My results suggest the Gini coefficient positively and significantly relates to the housing price to income ratio. The consistency of the results across various specifications indicates this to be a robust relationship, and given the rapid rise in housing prices and inequality in many countries, a crucial policy-related subject. Income redistribution policies, therefore, clearly have an impact on housing affordability.

CHAPTER 2

GOVERNMENT CONSUMPTION, GOVERNMENT DEBT AND ECONOMIC GROWTH

2.1 Introduction

The Great Recession of 2007-2009 resulted in many governments bailing out their financial institutions and even providing finance for the real sector using government resources. Combined with the necessity of an expansionary fiscal policy due to the restricted monetary policy at the zero lower bound, many governments around the world experienced problems regarding their budgets, and eventually employed austerity measures, potentially at the cost of their economic growth. Influential studies such as Rogoff and Reinhart (2010) have ignited the debate based on such budget problems and their impact on growth from a policy perspective by showing a negative correlation between government debt and growth for countries with debt above 90% (of GDP) for the post–World War II era.

Within this context, however, the effects of government consumption/expenditure on growth lack investigation and sufficient comparison with those of government debt. While the latter may be effective on growth through the reductions in public saving (e.g., as in Elmendorf and Mankiw [1999]), the former may affect growth through factor accumulation or influences on technical progress such as public research and development (as discussed in Gemmell et al. (2001)), the reductions in company profits and private investment (as in Alesina, Ardagna, Perotti, and Schiantarelli [2002]), or organized interest groups attempting to gain benefits for themselves in the form of legislation or transfers (as in Olson [2008]). Such a comparison between government consumption and government debt is also important from the policy

perspective; e.g., as stated in 2001 by former Director of the Fiscal Affairs Department of the International Monetary Fund, :¹

“Government debt remains very high in many advanced economies, and fiscal adjustment to bring debt down over the medium term is essential. Nearly all advanced economies plan to reduce their deficits this year. But if growth slows more than expected, some may feel inclined to preserve their short-term plans through additional tightening, even if hurts growth more. My bottom line for them: unless you have to, you shouldn’t.”

Director Cottarelli also emphasized the importance of country-specific fiscal policies due to the economic characteristics of the countries. Accordingly, the debate is not only about the government debt itself but also about the short- and medium-term adjustments of fiscal policies, which can be measured by government consumption/expenditure and/or tax revenues.

Based on the discussion so far, in this paper, I compare the effects of government consumption versus government debt on growth by considering three alternative data sets, where samples cover as much as 84 countries over the period between the years 1960 and 2014, including both developed and developing markets. In order to connect my results to the existing studies, I first consider linear regressions supported by state-of-the-art statistical tests regarding the potential issue of endogeneity. Such a linear investigation results in government consumption having a much bigger reducing impact on growth compared with the negative (and sometimes insignificant) effects of government debt, independent of the data set considered. Even when I only consider the cases in which the effects of government debt are statistically significant, the (negative) elasticity of growth with respect to government consumption is about ten times that of government debt. This result contradicts with the argument in studies

¹See <http://voxeu.org/article/fiscal-adjustment-too-much-good-thing>

such as Elmendorf and Mankiw (1999) who show that government consumption may boost aggregate demand due to the Keynesian view, but government debt may lead into a reduction in output and income by reducing investment and capital stock.

I further investigate this contradiction by considering nonlinear/threshold effects of government fiscal policies on growth as advocated in studies such as Kumar and Woo (2010), Rogo and Reinhart (2010), Cecchetti, Mohanty, and Zampolli (2011), Checherita- Westphal and Rother (2012), Panizza and Presbitero (2014), Baum, Checherita-Westphal, and Rother (2013), Pescatori, Sandri, and Simon (2014). Such nonlinear analyses show that (mostly negative) effects of government consumption on growth are highly affected by the economic characteristics of the countries investigated; nevertheless, the effects of government debt on growth are either weak or nonexistent, independent of the nonlinear/threshold effects considered or the data sets employed.

The implication is that, due to its negative effects, government consumption/ expenditure is the key variable in forming fiscal policy based on a growth strategy, while government debt, as advocated by many studies in the literature, is not as effective as government consumption. Regarding the interaction of government consumption with other economic country characteristics, the negative effects of government consumption on growth are more evident when trade openness is below approximately 55% (of GDP), inflation is above about 10%, private credit is above 50% (of GDP), or government consumption itself is above around 10% (of GDP). Therefore, the economic growth of countries with such characteristics have been hurt more by government consumption, while such characteristics have not played any significant role on (either weak or nonexistent) effects of government debt on growth.

Overall, this paper contributes to the literature by (i) comparing the effects of government expenditure versus government debt, (ii) using a rich data set with more

countries and time coverage compared with the existing studies, (iii) considering nonlinearities in the relationship between growth and government expenditure/debt that are essential in the determination of country-specific policies. The rest of the paper is organized as follows. The next section covers the theoretical background of my investigation and shows the contribution of this paper with respect to the existing empirical evidence. Section 3 introduces three alternative data sets and the empirical methodology. Section 4 depicts the results based on a linear investigation, while Section 5 shows the results when considering nonlinearities/thresholds in the economic characteristics of the countries investigated. Section 6 concludes.

2.2 Literature Review

The theory of economic growth has determined three channels through which government policies can affect economic growth. First, according to neoclassical models, government policies only have short-run rather than long-run effects, since they only affect savings or labor force participation in the short-run. Second, according to endogenous-growth models, government policies can have long-run effects depending on the type of government expenditure; e.g., the positive effects of education expenditure on human capital and thus economic growth. Third, government policies may facilitate growth through the quality of institutions that are measurable by items such as transparent rules, rule of law and well-defined property rights.²

Within this theoretical picture, there is no clear-cut implication on the effects of government consumption/expenditure on economic growth.³ Nevertheless, stud-

²See Barro and Sala-i Martin (2004); Bergh and Henrekson (2011).

³Certainly, in the short-run, according to the standard textbook approach, fiscal expansion may boost aggregate demand and lead to an economic expansion due to the Keynesian view, but this does not imply anything for the long-run, except for the indirect implications through accumulated government debt leading to a reduction in output and income by reducing investment and the capital stock (as I discuss, below); e.g., see Elmendorf and

ies such as by Alesina, Ardagna, Perotti, and Schiantarelli (2002) have shown that increases in government spending can impact company profits and thus lead to a reduction in private investment and economic growth. From an alternative perspective, political economy studies such as Olson (2008) have shown that organized interest groups may attempt to gain benefits for themselves in the form of legislation or transfers that in turn may retard the growth of the private sector. Since the scope for such interest group action is potentially larger in countries with bigger governments, and since higher-income countries have bigger governments, one may expect to observe a negative relationship between government size and growth in higher-income countries, while the relationship between such variables is ambiguous. Therefore, one may expect to have either a negative relationship or no relationship between government consumption/expenditure and growth according to this political-economy perspective, depending on economic characteristics of countries. The implication is that one should take into account such heterogeneity across countries while investigating the effects of government consumption/expenditure on growth, as I do in details in this paper.

The empirical literature on the effects of government consumption/expenditure on growth is also mixed. In particular, earlier studies such as Kormendi and Meguire (1985), Ram (1986), Lin (1994), and Zagler and Drnecker (2003) have all found a positive relationship between government consumption and growth. Nevertheless, recent studies such as Flster and Henrekson (2001), Dar and AmirKhalkhali (2002), Romero-Avila and Strauch (2008), Afonso and Furceri (2010), and Bergh and Karlsson (2010) have all found negative and significant effects of government size (defined as either total taxes or total expenditure) on growth (defined as the growth of real GDP per capita as in this paper) by using data on higher-income (e.g., European Union [EU] Mankiw (1999)).

or Organisation for Economic Co-operation and Development [OECD]) countries.⁴ Therefore, the results highly depend on the countries and periods included in the empirical investigation. Accordingly, compared with these mentioned studies, this paper considers a large data set based on both low-income and high-income countries for the longest possible sample period available, so that I can observe how the relationship between government size and growth is affected by the heterogeneity across countries regarding their economic characteristics.

On the other hand, the conventional view of public debt (e.g., as in Elmendorf and Mankiw [1999]) implies a positive effect of government consumption/expenditure on the demand-determined short-run output and a negative effect of government debt on the economic growth due to lower public savings (brought about higher budget deficits) which in turn would reduce total investment and thus growth.⁵ According to Cochrane (2011a, 2011b), such negative effects of government debt on growth could be much higher due to uncertainty and expectations of future confiscation through inflation or financial repression. Moreover, recent theoretical models have also shown that there may be a tipping point above which public debt becomes unsustainable.⁶ High-levels of government debt may also restrict a country's ability to conduct counter-cyclical policies and thus reduce growth (e.g., see Ramey and Ramey [1995]), although such restrictions may depend on the composition of public debt rather than the level of public debt as advocated by Hausmann and Panizza (2011) and De Grauwe (2011). Therefore, the effects of government debt on growth

⁴The study by Colombier (2009) is an exception finding a small but positive effect of government size and growth, although this result has been rebutted by a study by Bergh and Öhrn (2011).

⁵See Afonso and Jalles (2014) for the mixed empirical evidence on the relationship between government expenditure and growth (that depends on fiscal decomposition) and Afonso and Jalles (2013) for evidence on the negative relationship between government debt and growth.

⁶For example, see Ghosh, Kim, Mendoza, Ostry, and Qureshi (2013).

may change with respect to the economic characteristics of the countries investigated as well, which imply nonlinearities in this relationship.

The empirical literature also supports the view of nonlinearities; one influential paper is Rogoff and Reinhart (2010) who have shown a negative correlation between government debt and growth for countries with debt above 90% (of GDP). Similarly, Minea and Parent (2012) find that public debt is negatively correlated with growth when government debt is above 90% and 115% (of GDP), although the correlation turns out to be positive for countries with government debt above 115% (of GDP). According to Checherita-Westphal and Rother (2012), the range of government debt for which the effects on growth rate are negative is between 90% and 105% (of GDP). Using much smaller data, Baum, Checherita-Westphal, and Rother (2013) find a positive correlation between debt and growth when government debt is below 67%, no significant correlation when it is between 67% and 95%, and a negative correlation when it is above 95% (of GDP). Nevertheless, Égert (2015) has found that the negative nonlinear correlation between government debt and growth kicks in at much lower levels of public debt (between 20% and 60% of GDP). There are also other empirical studies such as Kourtellis, Stengos, and Tan (2013) who suggest that the relationship between government debt and growth is statistically insignificant for advanced economies; accordingly, they advocate for other threshold variables besides government debt itself, such as trade openness, inflation, and other country-fixed effects such as language, institutions, and geographical variables, as I also conclude in this paper.

2.3 Data and Empirical Methodology

I am interested in the effects of government final consumption expenditure and government debt on economic growth. In terms of methodology, the growth regressions

used in this paper closely follow studies such as Barro (1991) and Levine and Renelt (1992) by considering a set of explanatory variables, where data are averaged over 5-year (non-overlapping) periods in order to smooth out any cyclical effect. Specifically, while the dependent variable is real per capita income growth (annual rate), government consumption (% of GDP) or government debt (% of GDP) is the explanatory variable, with variables such as log of initial GDP per capita, initial secondary school enrollment rate, private credit, inflation rate and trade openness are considered as other control variables (as they are standard in the literature). In the regressions, I also include country fixed effects in order to control for any country-specific factor that is constant over time and time fixed effects in order to control for any time-specific factor that affects the global economy during my sample period.

In particular, the log of initial per capita GDP has an expected negative effect on growth, since I expect lower income countries to grow faster in order to catch up. I capture the effects of human capital by log initial school enrollment; it has an expected positive effect on growth. I use domestic credit to private sector (private credit) as a proxy for financial depth; although financial depth has an expected positive effect on growth, the expected effects of private credit require a detailed discussion, as I achieve below. I consider inflation rate (defined as the annual growth rate of the consumer price index, [CPI]) to examine the expected negative effect of prices on growth. I use trade openness (defined as the sum of import and export divided by GDP) to capture the effect of international openness; which has an expected positive effect on growth.

2.3.1 Data

In order to make my results comparable with the existing literature and also due to data availability, I employ three alternative data sets. To investigate the effects of government consumption on economic growth, the first data set is from the World

Bank's World Development Indicators (WDI) for which the corresponding descriptive statistics appear in Table 1. This annual data set covers 84 countries for the period between the years 1966 and 2010. The data, which are averaged over 5-year periods, include information on per capita income growth, government consumption, log initial GDP, trade openness, inflation and private credit; I combine this data set with initial secondary school enrollment rate obtained from the Barro-Lee data set (<http://www.barrolee.com/>). As shown in Table 1, the per capita income growth rates range between -5.20% to 10.70% , with mean of 1.91% and an SD (standard deviation) of 2.46. Government consumption (% of GDP) ranges between 3.91 and 37.03, with a mean of 14.97 and an SD of 5.55. Minimum and maximum values for school enrollment are 0.5 and 86.56 with an SD of 18.22. The values across countries range between 8.88 and 218.1 with an SD of 37.59 for trade openness (sum of export and import divided by GDP), between -6.73 and 145.27 with an SD of 17.91 for inflation rate, and between 1.77 and 202.43 with an SD of 38.68 for private credit (% of GDP). Therefore, there are significant differences across country characteristics that may affect the way government consumption affects economic growth. Correlation between these variables are also indicated in Table 1, where government consumption has a negative correlation coefficient with per capita income growth.

I borrow the second data set is borrowed from Rogoff and Reinhart (2010) for the investigation of the effects of government debt on economic growth; the corresponding descriptive statistics appear in Table 2. This annual data set covers 57 countries for the period between the years 1966 and 2010. The data, which are also averaged over 5-year periods, include information on government debt only; I combine this data set with WDI data (introduced above) and the initial secondary school enrollment rate obtained from the Barro-Lee data set (again, introduced above). The descriptive statistics in Table 2 reveal that per capita income growth has a mean value of 2.33%

with an SD of 2.26 and minimum and maximum values of -5.49% and 10.98% , which is relatively close to what I have for 84 countries in Table 1. Regarding government debt (% of GDP), the mean value is 51.25 with and SD of 40.02, minimum of 3.86 and maximum of 236.85. Therefore, compared with government consumption data in Table 1, the accumulated value of government debt is much higher in Table 2; in relative terms, the heterogeneity across countries is also worth noticing. The correlation between government debt and growth shown in Table 2 is also negative with a higher coefficient (in absolute terms) compared to the correlation between government consumption and growth in Table 1. Data for other control variables are comparable with the values in Table 1.

The third data set is the updated version of the data used in Abbas, Belhocine, El-Ganainy, and Horton (2011) for the investigation of the effects of both government consumption and government debt on economic growth for which the corresponding descriptive statistics appear in Table 3.⁷ This annual data set covers 83 countries for the period between 1960 and 2014. The data, which are also averaged over 5-year periods, include information on government debt only; I combine this data set with WDI data (introduced above) and the initial secondary school enrollment rate obtained from the Barro-Lee data set (again, introduced above). As is evident, the descriptive statistics in Table 3 are very similar to what I have in Table 1 and Table 2, although Table 3 includes information on more countries compared with Table 2 and more years compared with both Table 1 and Table 2. The implication is that all three data sets are comparable to each other in terms of the magnitude of the series and the heterogeneity across countries, although I employ all of them in order to have a robust investigation.

⁷I thank S. M. Ali Abbas for sharing the updated version of the data with us.

2.3.2 Empirical Methodology

I consider economic growth regressions based on both linear and nonlinear frameworks for robustness. Regarding the linear investigation, as has been well documented, growth regressions may be subject to the important drawback of potential endogeneity, especially when using 5-year averages for an investigation. Moreover, in the context of government-growth nexus, according to Wagner’s law: “as the economy develops over time, the activities and functions of the government increase”, not only government consumption and government debt have impacts on economic growth, but growth may also cause government to expand, leading the regression analysis facing another endogeneity problem. To address these issues, I use two-stage least squares (2SLS) methodology in my regressions, where the 5-year averages of the explanatory variables are instrumented by their initial levels; e.g., for the 5-year average taken between 2010 and 2014, the instrument used is the initial value of 2010 and so on.

I further support the linear 2SLS regressions with state-of-the-art statistical tests regarding issues of under-identification, weak identification, and weak-instrument-robust inference, which are standard and essential tests for the robustness of a typical 2SLS regression and are mostly missing in the existing literature on economic growth regressions. In particular, following Baum, Schaffer, Stillman, et al. (2007), I use the Kleibergen-Paap rk LM test and the Kleibergen-Paap rk Wald test regarding under-identification, the Kleibergen-Paap F -test regarding weak-identification, and the Anderson-Rubin Wald test and the Stock-Wright LM S statistic regarding weak-instrument-robust inference.⁸

⁸Stata package called “ivreg2” is used to obtain such statistics. Hansen tests cannot be used, since I have the same number of instruments as endogenous variables (i.e., exact identification), although I still consider tests for under-identification for which exact identification is a necessary but not a sufficient condition.

Finally, although linear 2SLS regressions would provide evidence on the effects of government consumption and government debt on economic growth, they would be silent regarding how such effects would change based on country characteristics such as initial income, initial human capital, financial development, trade openness or inflation. The corresponding literature has also advocated for nonlinear effects of government consumption/debt on growth; e.g., see studies such as Kumar and Woo (2010), Rogo and Reinhart (2010), Cecchetti, Mohanty, and Zampolli (2011), Checherita-Westphal and Rother (2012), Panizza Kumar and Woo (2010), Rogoff and Reinhart (2010), Cecchetti, Mohanty, and Zampolli (2011), and Checherita-Westphal and Rother (2012). Accordingly, in order to capture such nonlinear effects of government consumption and government debt on economic growth, following earlier studies such as Rousseau and Wachtel (2002) or Yilmazkuday (2011), I also consider a continuous threshold analysis based on rolling-window, two-stage least squares regressions with a constant window size of 100, after ordering the data according to the threshold variable.⁹ For instance, if the financial development thresholds are of interest, all the observations (i.e., the pooled sample of 5-year average data from all the countries) are sorted in the order of the lowest to the highest private credit; the first regression was run with the first 100 observations of the sorted data set, the second regression by moving the 100 window toward higher inflation rates by one observation, and so on. The selection of a constant window size is important for comparison of coefficient estimates across the windows, while the selection of a window size of 100 is important to ensure a fair distribution across the power of the regressions and the degree of nonlinearity.

⁹Compared with other threshold methodologies such as sample-splitting, which imply a linear relationship between the marginal effects of regressors and the threshold variable, the main advantage of using rolling-window regressions is that the data are allowed to speak in a more flexible way that is essential to capture any nonlinearities.

2.4 Linear Empirical Results

This section reveals the empirical results based on linear 2SLS regressions, where I distinguish between the effects of government consumption and government debt on economic growth.

2.4.1 Effects of Government Consumption

I show the results regarding the effects of government consumption on growth based on linear 2SLS regressions using WDI data (with 84 countries) in Table 4, where all regressions include country and time fixed effects (for each 5-year period). As is evident, independent of the control variables considered, there are negative and significant effects of government consumption on economic growth. When considering the full set of control variables in the last column of Table 4, 1% of an increase in government consumption leads to a -0.13% drop in economic growth, on average across countries.

When using the updated version of the data set by Abbas, Belhocine, El-Ganainy, and Horton (2011) as an alternative, the results appear in Table 5, where, again, all regressions include country and time fixed effects. Once again, the effects of government consumption are negative and significant, independent of the control variables considered. The last column in Table 4 (with the full set of control variables) reveals that a 1% increase in government consumption would reduce economic growth by about -0.11% , which is similar to result in Table 4.

Compared with the existing literature, these results are consistent with relatively recent empirical studies such as Landau (1983), Grier and Tullock (1989), Engen and Skinner (1992), Dar and AmirKhalkhali (2002), and Afonso and Furceri (2010) who find a negative relationship between government consumption and growth. How-

ever, these results go against the relatively older empirical results in studies such as Kormendi and Meguire (1985), Ram (1986), and Lin (1994), who find a positive relationship between government consumption and growth.

Regarding the magnitude of the coefficient estimates, my results are in line with the recent survey of empirical studies by Bergh and Henrekson (2011) who have shown that an increase in government size by 10% is associated with a 0.5% to 1% lower annual growth rate. Despite the consistency of my results with such average estimates, there are differences in coefficient estimates of alternative studies. For instance, Dar and AmirKhalkhali (2002) have estimated a coefficient of -0.905 for OECD countries, while Afonso and Furceri (2010) have estimated a coefficient of -0.227 for OECD countries and -0.313 for EU countries. Compared with these estimates, my coefficients are much lower; this result raises the concern of whether such coefficient estimates depend on the countries investigated. Accordingly, I achieve two further analyses: (i) I restrict my data with the observations for which I have a common set of countries and years during the comparison of the effects of government consumption and government debt, below; such data mostly cover developed (including OECD and EU) countries; (ii) I investigate the relationship between economic country characteristics and the effects of government consumption on growth during my nonlinear investigation, below.

Regarding the control variables, their estimated coefficients are significant and have their expected signs, except for initial secondary school enrollment in Table 4, inflation in Table 5, and private credit in both Tables 4 and 5. The latter is of particular interest, since earlier studies such as Checherita-Westphal and Rother (2012) and Presbitero (2012) have also found negative coefficients in front of private credit in growth regressions. The definition of private credit might help us understand the reason for this negative sign. In particular, domestic credit to the private sector

refers to financial resources provided by financial corporations. One might interpret that as expanding government size (more consumption or higher debt) meaning fewer sources assigned to the private sector for saving and investment purposes. Also, it is argued that the fast expansion of private credit does not necessarily represent an improvement in the financial sector, if this expansion leads to an increase in risk at the microeconomic and macroeconomic levels (e.g., see Honohan [2004] and Arcand, Berkes, and Panizza [2015]). Hence, one can expect a negative sign for private credit in growth regressions, showing a negative effect on growth (through private savings, capital formation, and total factor productivity). High adjusted R-squared values further support the 2SLS regression results.

2.4.2 Effects of Government Debt

The results regarding the effects of government debt on growth based on linear 2SLS regressions using the Rogoff and Reinhart (2010) data set (with 57 countries) appear in Table 6, where, again, all regressions include country and time fixed effects. As is evident, the effects of government debt are negative independent of the control variables considered; however, their significance depends on the control variables. In particular, when columns (1), (2), (4), and (6) are considered where inflation is excluded, the effects of government debt are negative and significant, but they become insignificant when statistically-significant inflation is included in columns (3), (5), (7), and (8). Therefore, the effects of inflation may catch the effects of government debt on growth when both variables are included at the same time. This is consistent with the argument by Elmendorf and Mankiw (1999, p. 1630) regarding the difference between the effects of government on economic growth in the short-run versus the long-run, “a country with a large public debt is likely to face high interest rates” and inflation as a result if the fiscal authority can force the monetary authority to finance

ongoing deficits with seigniorage (even if the people only think that this would be the case) as argued by Sargent and Wallace (1987) or Cochrane (2011a). This result is also consistent with the empirical observation of Rogoff and Reinhart (2010) that high debt levels correlate with higher inflation in emerging markets. The empirical results are similar when the updated version of the data set by Abbas, Belhocine, El-Ganainy, and Horton (2011) is used in Table 7; i.e., the effects of government debt on growth are negative and significant except for the regressions where inflation is included.

Compared with the existing literature, the negative effects of government debt on growth (when inflation is excluded from the regressions) are consistent with recent empirical studies such as Schlarek et al. (2004) and Afonso and Jalles (2012); nevertheless, the insignificant effects of government debt on growth (when inflation is included in the regressions) are also consistent with other empirical studies such as Herndon, Ash, and Pollin (2014), and Eberhardt and Presbitero (2015). Therefore, the evidence is mixed, and it may depend on the countries included in the investigation (i.e., country characteristics). Based on this mixed evidence, many other studies have considered thresholds in the relationship between government debt and growth; these include studies such as Kumar and Woo (2010), Rogoff and Reinhart (2010), Cecchetti, Mohanty, and Zampolli (2011), Checherita-Westphal and Rother (2012), Panizza and Presbitero (2014), Baum, Checherita-Westphal, and Rother (2013), Pescatori, Sandri, and Simon (2014) who have mostly found that there is a threshold ranging between 67% and 90% of government debt (% of GDP) above which there is a negative relationship between government debt and growth. I further investigate such nonlinear effects, below.

Regarding the magnitude of the effects of government debt on growth, the statistically significant coefficients are about -0.01 (while the insignificant ones are not

statistically distinguishable from zero, by definition), which imply that 1% of an increase in government debt would result in about 0.01% of a reduction in growth. Such estimated values are consistent with the existing literature, where Presbitero (2012), ´gert (2015), and Woo and Kumar (2015) all have a similar coefficient of around -0.01 , although the coefficient by the latter has been insignificant. Finally, regarding the control variables, their estimated coefficients are significant and have their expected signs, again, except for initial secondary school enrollment and private credit in both Tables 6 and 7, and inflation in Table 7. High adjusted R-squared values further support the 2SLS regression results.

2.4.3 Government Consumption versus Government Debt

Regarding the magnitude of the effects of government debt on growth, the estimated coefficients are about -0.01 in Tables 6 and 7, which are significantly lower than the estimates regarding the effects of government consumption on growth that are about -0.1 (in Tables 4 and 5). Therefore, government consumption has a much bigger reducing effect on economic growth compared with government debt. Nevertheless, such a comparison may not be healthy, since the countries for which I have data on government consumption may be different from the countries for which I have data on government debt.

Accordingly, for robustness, I also consider a combination of WDI and Reinhart-Rogoff data sets, where the countries considered (28 of them) have data for both government consumption and government debt. The corresponding results regarding the effects of government consumption are given in Table 8 (Table 9), where 1% of an increase in government consumption (government debt) results in about -0.16% (-0.01%) of a statistically significant reduction in per capita income growth when using all control variables. Hence, even when a common set of countries are consid-

ered for which I have data on both government consumption and government debt, the negative effects of government consumption are much higher (in absolute terms) compared with the negative effects of government debt.

Tables 10-11 show the results when I replicate the very same analysis for the common set of countries for which I have data on both government consumption and government debt in the Abbas, Belhocine, El-Ganainy, and Horton (2011) data set. Once again, the negative effects of government consumption are statistically significant and much higher (in absolute terms) compared with the negative and significant effects of government debt on economic growth.

In sum, government consumption has a much bigger reducing impact on economic growth compared with government debt, independent of the data set considered. This is against the argument by Elmendorf and Mankiw (1999) who show that government consumption may boost aggregate demand due to the Keynesian view, but government debt may lead to a reduction in output and income by reducing investment and capital stock. Nevertheless, this contradiction may be due to nonlinear/threshold effects of government debt on growth as advocated by studies such as Kumar and Woo (2010), Rogo and Reinhart (2010), Cecchetti, Mohanty, and Zampolli (2011), Checherita-Westphal and Rother (2012), Panizza and Presbitero (2014), Baum, Checherita-Westphal, and Rother (2013), and Pescatori, Sandri, and Simon (2014); as promised, I further investigate such nonlinear effects, below.

2.4.4 Results of Statistical Tests based on the Validity of Instruments

I test the validity of the instruments used in my 2SLS using various statistical tests. I run these tests for the case in which all control variables are included in my regressions (i.e., column (8) in Tables 4-11).

Regarding under-identification, I use the Kleibergen-Paap rk LM test and the Kleibergen-Paap rk Wald test; both have the null hypothesis that the estimated equation is under-identified, while the alternative hypothesis is that the estimated equation is identified. I give the corresponding results in Table 12. As is evident, the null hypothesis of under-identification is rejected for all the 2SLS regressions that I have run at the 10% significance level, independent of the statistic considered.

Regarding weak-identification, I use the Kleibergen-Paap F -test, which has the null hypothesis that the estimated equation is weakly identified. The corresponding test statistic is based on the rejection rate r (10%, 20%, etc.) that I would like to tolerate if the true rejection rate should be the standard 5%; in this context, weak instruments are defined as instruments that will lead to a rejection rate of r when the true rejection rate is 5%. I give the results are given in Table 12, which I compare with the critical value table in Stock and Yogo (2005). The implication is that my estimated equations do not suffer from weak identification problem based on the rejection rate r of 20% (with a critical value of 6.66) for all the 2SLS regressions that I have run at the 5% significance level.

Regarding weak-instrument-robust inference, I employ the Anderson-Rubin Wald test and the Stock-Wright LM S statistic that test whether the estimated coefficients of the endogenous variables are compatible with the data used, independent of the strength of instruments used. The corresponding null hypothesis is that the estimated coefficients of the endogenous variables are jointly equal to zero. The results I give

in Table 12 reject the null hypothesis for all the 2SLS regressions that I have run at the 5% significance level, independent of the statistic considered. Therefore, my estimated coefficients are compatible with the data used, independent of the strength of instruments used.

In sum, the empirical results in Tables 4-11 are robust to the consideration of any endogeneity problem, since all the employed statistical tests imply evidence for the validity of the instruments used in 2SLS regressions.

2.5 Nonlinear Empirical Results

As discussed in detail above, the effects of government consumption and government debt on economic growth may highly depend on the country characteristics such as initial income, initial human capital, financial development, trade openness or inflation. Accordingly, this section depicts the results of 2SLS rolling-regressions where each regression corresponds to a particular country characteristic.

I depict the results of 2SLS rolling-regressions by focusing on the coefficient of government consumption or government debt after ordering the data with respect to a threshold variable (that represents the country characteristics), where the dependent variable is the per capita income growth as in Tables 4-11. Using a window length of 100 observations in order to have enough power in 2SLS regressions, I create figures that have the median value (across 100 observations) of the threshold variable in the horizontal axis, while I have the corresponding coefficient of government consumption or government debt in the vertical axis.

2.5.1 Effects of Government Consumption

I start with investigating the effects of government consumption on growth by using the WDI data set. For this investigation, I consider the same variables (and observations) as in column (8) of Table 4, although I only focus on the coefficient of government consumption. I give the corresponding results in Figure 1, where threshold variables of trade openness, inflation, private credit, initial school enrollment, initial GDP per capita, and government consumption are considered.

As is evident, there is evidence for negative and significant effects of government consumption on growth when trade openness is below approximately 55% (of GDP), inflation is above around 10%, private credit is above about 50% (of GDP), and government consumption is above about 14% (of GDP), while the negative (and mostly significant) effects are present for nearly all values of initial school enrollment or initial GDP per capita. It is implied that the effect of government consumption on growth in fact depend on certain country characteristics.

Based on the threshold value of 55% (of GDP) for trade openness, there is evidence that closer markets suffer more from higher government consumption. This result can be connected to the observation by Rodrik (1998) that more open economies have bigger governments (as we also observe in Tables 1 and 3 up to a certain point), because government expenditures are used to provide social insurance against external risk. Therefore, government consumption not used to provide social insurance against external risk may be problematic for closer economies.

The threshold value of 10% for inflation (above which government consumption starts having negative effects on growth) can be connected to "inflation tax" through the requirement of the private sector for having higher surplus of income over expenditure in order to compensate for higher prices; studies such as Anand and Van Wijnbergen (1988) support this idea theoretically as well.

In the existing literature, the thresholds of private credit (above which the effects of government consumption become negative) are connected to studies such as Berthelemy and Varoudakis (1996), who show that government consumption has negative coefficient for countries with high levels of financial depth; however, my results differ from theirs because I do not find any positive coefficient of government consumption for countries with low levels of financial depth (as they have).

The results given in Figure 2 show what happens when I continue investigating the effects of government consumption on growth by using the updated version of the Abbas, Belhocine, El-Ganainy, and Horton (2011) data set. As is evident, the qualitative results are very similar to the results in Figure 1, except for the thresholds of trade openness and inflation for which the median values are different across two data sets. One potential explanation is the difference in the coverage of the data sets in terms of both countries and years. As evidence, while the minimum (median) trade openness measures are in the lower 30's (as % of GDP) in Figure 1, the measures are in the upper 30s in Figure 2; similarly, (median) inflation rates are as high as 20% in Figure 1, while they are at most about 15%. Nevertheless, the results are nearly the same for other thresholds of private credit, initial school enrollment, initial GDP per capita, and government consumption. I talk more about the comparison of alternative data sets, below, during the comparison of government consumption and government debt effects on growth.

2.5.2 Effects of Government Debt

Figure 3 shows the effects of government debt on growth when the data set of Rogoff and Reinhart (2010) is used, while Figure 4 shows the effects when the updated version of Abbas, Belhocine, El-Ganainy, and Horton (2011) data set is used. Once again, due to the coverage of alternative countries and years, the country characteristics

(measured by the horizontal axes) are not exactly the same across two data sets; nevertheless, one can still make inferences on the combination of the results in Figures 3 and 4.

As is evident in Figure 4, for extremely open countries with trade openness of more than about 90% (of GDP), the effects of government debt on growth are negative and significant; although the evidence is mixed in Figures 3 and 4 when alternative measures of inflation or private credit are considered. When thresholds in initial school enrollment, initial per capita GDP or government debt are considered, the effects of government debt are insignificant for almost all country characteristics.

These results are in line with empirical studies such as Kourtellos, Stengos, and Tan (2013), who also find insignificant effects of government debt on growth when threshold variables such as trade openness, inflation, or other country fixed effects are considered. Therefore, consistent with my linear regression results, the effects of government debt on growth are extremely low, independent of the country characteristics considered.

2.5.3 Government Consumption versus Government Debt

As is evident in Figures 1-4, consistent with my linear regression results, the magnitude of the effects of government consumption on growth are much higher when compared with the effects of government debt which are mostly statistically insignificant. Nevertheless, since alternative data sets may be covering alternative countries and years for government consumption versus government debt, I replicate Figures 1 and 3 with a common set of countries/years in Figure 5, and I replicate Figures 2 and 4 with a common set of countries/years in Figure 6.

Figures 5 and 6 both depict that the estimated coefficients of government consumption are much higher (in absolute terms) compared with those of government

debt, for statistically both significant and insignificant estimates. In qualitative terms, consistent with Figure 1, government consumption has negative and significant effects for lower values of trade openness (in Figures 5-6), higher values of inflation (in Figure 5), and higher values of private credit (in Figures 5-6). Nevertheless, I cannot determine any common pattern across the coefficients of government debt in any of the figures; i.e., such evidence is mixed.

In sum, independent of the data set and the methodology used, there is a good amount of evidence for the negative and significant effects of government consumption on growth (of which magnitude depends on country characteristics), while the evidence for the effects of government debt on growth is either weak or nonexistent.

2.6 Concluding Remarks and Policy Implications

Budgetary problems during the Great Recession, when governments had to take several steps to rescue their financial institutions and/or private sectors around the globe, has ignited the debate on governmental fiscal policy. Since such policies are associated with economic growth through public and private saving/investment decisions, many studies have started to focus on the relationship between fiscal health and growth. Much of this debate has been achieved through the effects of government debt on growth, although several empirical studies have found that such effects are either weak or nonexistent.

In this paper, I not only confirm such weak or nonexistent effects of government debt on growth but also show that government consumption has much higher (and significant) negative effects on economic growth. Even when I only consider the cases in which the effects of government debt are statistically significant, the (negative) elasticity of growth with respect to government consumption is about ten times that of government debt. The implication is that, government consumption/expenditure

is the key variable in forming fiscal policy based on a growth strategy due to its negative effects on growth, while government debt, as advocated by many studies in the literature, is not as effective as government consumption. These results are shown to be robust to the consideration of any endogeneity problem by using state-of-the-art statistical tests.

In terms of policy suggestions, restrictions on government expenditure, rather than government debt, seem necessary for faster growth according to the results of my paper. These restrictions are more important for countries with lower values of trade openness, higher values of inflation, and higher values of financial depth. In particular, the negative effects of government consumption on growth are more evident when trade openness is approximately about 55% (of GDP), inflation is above about 10%, private credit is above 50% (of GDP), or government consumption itself is above about 10% (of GDP). Therefore, countries with such characteristics should pay more attention to their government expenditure rather than their government debt, which has been shown to have a weak (or nonexistent) effect on economic growth.

Table 2.1: Descriptive Statistics, 84 Countries, 1966-2010 (using WDI dataset, including government consumption)

Variables	Per capita income growth	Government consumption	Log of initial GDP	School enrolment	Trade	Inflation	Private Credit
Mean	1.911	14.974	7.949	29.125	65.044	12.663	42.783
Standard deviation	2.466	5.554	1.618	18.220	37.593	17.914	38.689
Minimum	-5.286	3.915	5.154	0.500	8.881	-6.731	1.774
Maximum	10.698	37.030	11.029	86.560	218.105	145.272	202.434
Income growth	1						
Government consumption	-0.062	1					
Log of initial GDP	0.124	0.426	1				
School enrolment	-0.022	0.274	0.309	1			
Trade	0.101	0.373	0.172	0.216	1		
Inflation	-0.148	-0.152	-0.104	-0.082	-0.212	1	
Private Credit	0.050	0.346	0.700	0.327	0.236	-0.230	1

Note: The list of 84 countries is as follows: Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Gambia, The, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.2: Descriptive Statistics, 57 Countries, 1966-2010 (using Reinhart and Rogoff dataset, including government Debt)

Variables	Per capita income growth	Government debt	Log of initial GDP	School enrollment	Trade	Inflation	Private Credit
Mean	2.332	51.251	8.483	32.263	57.224	11.806	52.273
Standard deviation	2.264	40.027	1.497	16.270	28.908	16.897	40.262
Minimum	-5.493	3.860	4.847	3.000	5.992	-0.446	2.102
Maximum	10.982	236.850	11.125	65.500	166.111	147.142	202.434
Income growth	1						
Government Debt	-0.197	1					
Log of initial GDP	-0.089	-0.092	1				
School enrollment	-0.027	0.036	0.630	1			
Trade	0.055	0.078	0.160	0.267	1		
Inflation	-0.232	0.096	-0.211	-0.255	-0.274	1	
Private Credit	-0.062	-0.007	0.621	0.551	0.150	-0.305	1

Note: The list of 57 countries is as follows: Algeria, Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Canada, Chile, China, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Finland, France, Germany, The, Ghana, Greece, Guatemala, Honduras, Iceland, India, Indonesia, Ireland, Italy, Japan, Kenya, Korea, Rep., Malaysia, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Panama, Paraguay, Peru, Philippines, Portugal, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.3: Updated version of Abbas et al. (2011) dataset, including government consumption and debt for 83 countries, 1960-2014.

Variables	Per capita income growth	Government consumption	Government debt	Log of initial GDP	School enrollment	Trade	Inflation	Private Credit
Mean	2.018	14.743	49.400	7.957	63.817	64.152	10.324	42.083
Standard deviation	2.491	5.395	34.122	1.611	33.013	37.010	14.758	37.791
Minimum	-6.784	4.080	0.000	4.928	1.294	8.423	-3.016	0.938
Maximum	13.248	36.314	227.392	11.029	154.050	207.741	147.142	195.081
Income growth	1							
Government consumption	-0.1122	1						
Government debt	-0.2058	0.2556	1					
Log of initial GDP	0.0209	0.4151	0.0214	1				
School enrolment	0.067	0.3846	0.1218	0.8489	1			
Trade	0.0984	0.3326	0.1129	0.1472	0.1974	1		
Inflation	-0.1397	-0.0978	-0.0236	-0.1552	-0.2081	-0.2148	1	
Private Credit	-0.0415	0.3038	0.1289	0.7047	0.6629	0.1968	-0.3163	1

Note: The list of 83 countries is as follows: Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Core d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Gambia, The, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.4: 2SLS regressions results using WDI dataset, including government consumption for 84 countries, 1966-2010.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government consumption	-0.108*** (-3.71)	-0.111*** (-3.86)	-0.0940** (-3.04)	-0.134*** (-4.34)	-0.104*** (-3.45)	-0.130*** (-4.31)	-0.127*** (-3.84)	-0.131*** (-4.11)
Log of initial GDP	-2.143*** (-6.10)	-2.787*** (-7.74)	-2.300*** (-6.50)	-1.384*** (-3.47)	-2.949*** (-8.22)	-1.838*** (-4.61)	-1.494*** (-3.76)	-1.961*** (-4.98)
School enrollment	-0.00245 (-0.20)	-0.00284 (-0.24)	-0.00511 (-0.42)	-0.00341 (-0.28)	-0.00570 (-0.49)	-0.00580 (-0.49)	-0.00560 (-0.47)	-0.00794 (-0.69)
Trade		0.0380*** (5.52)			0.0380*** (5.66)	0.0375*** (5.23)		0.0372*** (5.35)
Inflation			-0.00883 (-0.91)		-0.0202* (-2.21)		-0.0143 (-1.35)	-0.0274** (-2.76)
Private credit				-0.0220*** (-4.71)		-0.0253*** (-5.50)	-0.0218*** (-4.74)	-0.0250*** (-5.57)
Constant	19.57*** (7.51)	22.67*** (8.73)	20.60*** (7.87)	14.70*** (5.01)	23.92*** (9.24)	16.38*** (5.68)	15.47*** (5.29)	17.46*** (6.13)
N	705	700	695	686	690	683	677	674
R^2	0.412	0.447	0.422	0.448	0.465	0.476	0.460	0.497
adj. R^2	0.322	0.361	0.331	0.360	0.379	0.392	0.372	0.413

t statistics in parentheses

***, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 84 countries is as follows: Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Gabon, Gambia, The, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.5: 2SLS regressions results using updated version of Abbas et al. (2011) dataset, including government consumption for 83 countries, 1960-2014.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government consumption	-0.146*** (-4.52)	-0.160*** (-4.99)	-0.120*** (-3.30)	-0.136*** (-4.13)	-0.134*** (-3.70)	-0.152*** (-4.64)	-0.0917* (-2.51)	-0.108** (-2.97)
Log of initial GDP	-2.520*** (-6.44)	-3.106*** (-7.86)	-2.489*** (-5.76)	-1.517*** (-3.35)	-3.006*** (-6.80)	-1.879*** (-4.18)	-1.443** (-2.97)	-1.835*** (-3.79)
School enrollment	0.0231* (2.24)	0.0255* (2.54)	0.0141 (1.35)	0.0163 (1.57)	0.0155 (1.52)	0.0169 (1.67)	0.00654 (0.62)	0.00796 (0.77)
Trade		0.0338*** (4.91)			0.0300*** (4.10)	0.0332*** (4.68)		0.0321*** (4.32)
Inflation			-0.0150 (-1.03)		-0.0207 (-1.46)		-0.0136 (-0.94)	-0.0198 (-1.42)
Private credit				-0.0251*** (-4.72)		-0.0288*** (-5.48)	-0.0300*** (-5.38)	-0.0338*** (-6.12)
Constant	24.38*** (7.14)	28.35*** (8.34)	22.09*** (5.44)	16.90*** (4.38)	25.33*** (6.26)	19.20*** (5.05)	13.96** (3.15)	16.14*** (3.72)
N	649	647	583	623	582	622	563	562
R^2	0.384	0.416	0.406	0.416	0.429	0.442	0.431	0.457
adj. R^2	0.284	0.319	0.298	0.314	0.323	0.344	0.321	0.350

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 83 countries is as follows: Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Core d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Gaubia, The, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.6: 2SLS regressions results using Reinhart and Rogoff (2010) dataset, including government debt for 57 countries, 1966-2010.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government debt	-0.00921* (-2.42)	-0.00771* (-1.99)	-0.00596 (-1.54)	-0.0108** (-2.87)	-0.00399 (-1.01)	-0.00918* (-2.43)	-0.00651 (-1.71)	-0.00461 (-1.20)
Log of initial GDP	-2.830*** (-6.78)	-3.132*** (-7.39)	-3.014*** (-6.31)	-1.964*** (-3.96)	-3.277*** (-6.75)	-2.109*** (-4.23)	-1.901*** (-3.47)	-2.051*** (-3.73)
School enrollment	0.0117 (0.83)	0.0139 (0.98)	0.0186 (1.23)	-0.00454 (-0.30)	0.0207 (1.38)	-0.00822 (-0.55)	-0.00549 (-0.35)	-0.00779 (-0.50)
Trade		0.0376*** (4.17)			0.0378*** (4.27)	0.0371*** (4.13)		0.0367*** (4.22)
Inflation			-0.0207** (-2.58)		-0.0191* (-2.42)	-0.0264** (-2.96)		-0.0242** (-2.77)
Private credit				-0.0226*** (-4.60)		-0.0246*** (-5.01)	-0.0248*** (-4.74)	-0.0273*** (-5.22)
Constant	24.35*** (7.71)	24.77*** (7.82)	25.54*** (7.15)	18.32*** (4.98)	25.70*** (7.19)	17.71*** (4.83)	17.75*** (4.40)	17.19*** (4.28)
<i>N</i>	459	444	402	449	389	436	396	383
<i>R</i> ²	0.527	0.552	0.549	0.540	0.572	0.563	0.559	0.586
adj. <i>R</i> ²	0.447	0.472	0.465	0.459	0.487	0.482	0.473	0.501

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government debt, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 57 countries is as follows: Algeria, Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Canada, Chile, China, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Finland, France, Germany, Tlc, Ghana, Greece, Guatemala, Honduras, Iceland, India, Indonesia, Ireland, Italy, Japan, Kenya, Korea, Rep., Malaysia, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Panama, Paraguay, Peru, Philippines, Portugal, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Thailand, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.7: 2SLS regressions results using updated version of Abbas et al. (2011) dataset, including government debt for 83 countries, 1960-2014.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government debt	-0.0122** (-3.03)	-0.0123** (-3.12)	-0.00920* (-2.01)	-0.0112** (-2.80)	-0.00860 (-1.92)	-0.0111** (-2.87)	-0.00687 (-1.49)	-0.00699 (-1.56)
Log of initial GDP	-2.968*** (-7.42)	-3.428*** (-8.40)	-2.903*** (-6.52)	-1.857*** (-4.01)	-3.284*** (-7.13)	-2.082*** (-4.53)	-1.792*** (-3.60)	-2.044*** (-4.14)
School enrollment	0.0152 (1.43)	0.0186 (1.78)	0.00818 (0.75)	0.00804 (0.75)	0.0116 (1.09)	0.0103 (0.98)	0.00309 (0.28)	0.00662 (0.62)
Trade		0.0290*** (4.11)			0.0256*** (3.50)	0.0306*** (4.28)		0.0286*** (3.87)
Inflation			-0.0153 (-1.20)		-0.0204 (-1.64)		-0.0120 (-0.96)	-0.0165 (-1.36)
Private credit				-0.0252*** (-4.79)		-0.0296*** (-5.68)	-0.0291*** (-5.19)	-0.0331*** (-5.97)
Constant	26.73*** (7.41)	29.49*** (8.17)	25.21*** (5.93)	18.49*** (4.59)	27.10*** (6.37)	19.37*** (4.88)	16.43*** (3.57)	17.16*** (3.81)
N	577	565	523	557	512	546	506	495
R^2	0.411	0.440	0.419	0.440	0.444	0.470	0.447	0.479
adj. R^2	0.300	0.331	0.298	0.329	0.323	0.361	0.325	0.360

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government debt, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 83 countries is as follows: Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Israel, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Table 2.8: 2SLS regression results for 28 countries (as the combination of WDI and Reinhart and Rogoff, 2010, datasets), 1966 to 2010 (including government consumption)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government consumption	-0.238*** (-4.44)	-0.196*** (-3.49)	-0.203*** (-3.55)	-0.235*** (-4.33)	-0.168** (-2.80)	-0.194*** (-3.41)	-0.196*** (-3.30)	-0.162** (-2.60)
Log of initial GDP	-4.319*** (-5.00)	-4.796*** (-5.51)	-3.492*** (-3.61)	-3.286*** (-3.53)	-3.987*** (-4.04)	-3.771*** (-4.03)	-1.951 (-1.94)	-2.431* (-2.38)
School enrollment	0.0395* (2.21)	0.0351* (1.97)	0.0241 (1.41)	0.0152 (0.77)	0.0215 (1.27)	0.0115 (0.58)	-0.00658 (-0.36)	-0.00915 (-0.50)
Trade		0.0455** (3.01)			0.0322* (2.20)	0.0439** (2.90)		0.0312* (2.19)
Inflation			-0.0255* (-2.44)		-0.0257* (-2.49)		-0.0452** (-3.23)	-0.0453** (-3.27)
Private credit				-0.0160** (-2.83)		-0.0156** (-2.80)	-0.0229*** (-4.05)	-0.0229*** (-4.10)
Constant	37.72*** (6.00)	38.60*** (6.21)	31.35*** (4.51)	30.34*** (4.49)	33.10*** (4.78)	31.36*** (4.69)	20.42** (2.81)	22.11** (3.07)
N	249	249	218	246	218	246	215	215
R^2	0.430	0.441	0.502	0.431	0.512	0.442	0.527	0.537
adj. R^2	0.323	0.334	0.396	0.319	0.405	0.330	0.422	0.431

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 28 countries is as follows: Algeria, Argentina, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Dominican Republic, Ecuador, Finland, France, Greece, Iceland, India, Ireland, Italy, Japan, Morocco, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.

Table 2.9: 2SLS regression results for 28 countries (as the combination of WDI and Reinhart and Rogoff, 2010, datasets), 1966 to 2010 (including government debt)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government debt	-0.0181*** (-3.47)	-0.0160** (-3.06)	-0.0162** (-3.27)	-0.0195*** (-3.76)	-0.0136** (-2.71)	-0.0174*** (-3.36)	-0.0155** (-3.20)	-0.0130** (-2.64)
Log of initial GDP	-4.922*** (-5.59)	-5.431*** (-6.23)	-4.060*** (-4.25)	-3.874*** (-4.11)	-4.562*** (-4.77)	-4.396*** (-4.71)	-2.465* (-2.45)	-2.953** (-2.94)
School enrollment	0.0333 (1.88)	0.0311 (1.80)	0.0202 (1.21)	0.00912 (0.47)	0.0184 (1.11)	0.00796 (0.42)	-0.0107 (-0.60)	-0.0124 (-0.70)
Trade		0.0574*** (3.91)			0.0395** (2.83)	0.0544*** (3.75)		0.0376** (2.76)
Inflation			-0.0106 (-1.10)		-0.0138 (-1.44)		-0.0228 (-1.82)	-0.0273* (-2.20)
Private credit				-0.0169** (-2.99)		-0.0163** (-2.94)	-0.0235*** (-4.23)	-0.0233*** (-4.26)
Constant	39.96*** (6.21)	40.98*** (6.50)	33.76*** (4.89)	32.59*** (4.74)	35.54*** (5.20)	33.84*** (5.02)	22.45** (3.09)	24.23*** (3.38)
N	251	251	218	248	218	248	215	215
R^2	0.449	0.469	0.516	0.458	0.529	0.478	0.537	0.551
adj. R^2	0.347	0.368	0.413	0.353	0.426	0.374	0.434	0.447

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 28 countries is as follows: Algeria, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Dominican Republic, Ecuador, Finland, France, Greece, Iceland, India, Ireland, Italy, Japan, Morocco, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.

Table 2.10: 2SLS regression results for 29 countries using Abbas et al. (2011) dataset (including government consumption for which government debt is also available), 1960-2014.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government consumption	-0.303*** (-3.90)	-0.280*** (-3.50)	-0.358*** (-4.76)	-0.310*** (-3.96)	-0.349*** (-4.38)	-0.287*** (-3.61)	-0.359*** (-4.83)	-0.348*** (-4.45)
Log of initial GDP	-2.233*** (-3.74)	-2.367*** (-3.94)	-2.075*** (-3.47)	-0.854 (-1.35)	-2.095*** (-3.49)	-0.936 (-1.48)	-0.880 (-1.44)	-0.879 (-1.44)
School enrollment	0.0265* (2.15)	0.0266* (2.18)	0.0179 (1.54)	0.0225 (1.82)	0.0178 (1.54)	0.0227 (1.86)	0.0140 (1.22)	0.0139 (1.22)
Trade		0.0134 (1.44)			0.00381 (0.42)	0.0148 (1.62)		0.00553 (0.62)
Inflation			-0.113** (-3.20)		-0.113** (-3.21)		-0.128*** (-3.79)	-0.129*** (-3.83)
Private credit				-0.0319*** (-5.65)		-0.0332*** (-5.89)		-0.0340*** (-6.01)
Constant	26.57*** (4.14)	26.80*** (4.21)	27.39*** (4.26)	16.14* (2.47)	27.27*** (4.24)	15.94* (2.46)	18.95** (2.98)	18.55** (2.90)
N	251	251	239	239	239	239	227	227
R^2	0.456	0.462	0.528	0.509	0.529	0.517	0.587	0.588
adj. R^2	0.356	0.359	0.433	0.410	0.431	0.416	0.495	0.494

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 29 countries is as follows: Australia, Austria, Belgium, Canada, Costa Rica, Denmark, Finland, France, The, Ghana, Greece, Honduras, India, Ireland, Italy, Japan, Korea, Rep., Malaysia, Morocco, Netherlands, Norway, Pakistan, Philippines, Portugal, Spain, Sri Lanka, Sweden, United Kingdom, United States, Venezuela, RB.

Table 2.11: 2SLS regression results for 29 countries using Abbad et al. (2011) dataset (including government debt for which government consumption is also available), 1960-2014.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government debt	-0.00935 (-1.69)	-0.00874 (-1.57)	-0.0119* (-2.20)	-0.0134* (-2.47)	-0.0111* (-2.03)	-0.0132* (-2.46)	-0.0149** (-2.88)	-0.0145** (-2.78)
Log of initial GDP	-2.478*** (-3.70)	-2.688*** (-4.00)	-2.138** (-3.16)	-1.060 (-1.51)	-2.226** (-3.28)	-1.172 (-1.68)	-0.875 (-1.28)	-0.871 (-1.28)
School enrollment	0.0104 (0.86)	0.0121 (1.00)	0.000953 (0.08)	0.00557 (0.46)	0.00214 (0.18)	0.00702 (0.58)	-0.00349 (-0.30)	-0.00248 (-0.21)
Trade		0.0202* (2.21)			0.0151 (1.68)	0.0198* (2.23)		0.0151 (1.74)
Inflation			-0.0725 (-1.93)		-0.0776* (-2.12)		-0.0915** (-2.58)	-0.0970** (-2.81)
Private credit				-0.0310*** (-5.51)		-0.0328*** (-5.84)	-0.0321*** (-5.65)	-0.0342*** (-5.97)
Constant	26.07*** (3.61)	27.02*** (3.76)	24.09*** (3.33)	15.27* (2.09)	24.07*** (3.33)	15.45* (2.13)	14.98* (2.10)	14.25* (2.01)
N	243	243	233	231	233	231	221	221
R^2	0.446	0.451	0.490	0.511	0.492	0.520	0.564	0.570
adj. R^2	0.339	0.342	0.383	0.409	0.383	0.416	0.465	0.468

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year average. All equations include country and time fixed effects. The list of 29 countries is as follows: Australia, Austria, Belgium, Canada, Costa Rica, Denmark, Finland, France, The, Ghana, Greece, Honduras, India, Ireland, Italy, Japan, Korea, Rep., Malaysia, Morocco, Netherlands, Norway, Pakistan, Philippines, Portugal, Spain, Sri Lanka, Sweden, United Kingdom, United States, Venezuela, RB.

Table 2.12: Validity of Instruments in 2SLS regressions

	Table 4	Table 5	Table 6	Table 7	Table 8	Table 9	Table 10	Table 11
	Column (8)	Column (8)	Column (8)	Column (8)	Column (8)	Column (8)	Column (8)	Column (8)
Under-identification tests								
Kleibergen-Paap rk LM statistic	Chi-sq(1)=17.75 [0.0000]	Chi-sq(1)=11.17 [0.0008]	Chi-sq(1)=3.21 [0.0730]	Chi-sq(1)=3.28 [0.0699]	Chi-sq(1)=9.63 [0.0019]	Chi-sq(1)=7.61 [0.0058]	Chi-sq(1)=13.13 [0.0003]	Chi-sq(1)=12.67 [0.0004]
Kleibergen-Paap rk Wald statistic	Chi-sq(1)=56.35 [0.0000]	Chi-sq(1)=119.76 [0.0000]	Chi-sq(1)=36.45 [0.0000]	Chi-sq(1)=36.53 [0.0000]	Chi-sq(1)=179.43 [0.0000]	Chi-sq(1)=95.82 [0.0000]	Chi-sq(1)=34.16 [0.0000]	Chi-sq(1)=34.23 [0.0000]
Weak identification test								
Kleibergen-Paap Wald rk F statistic	13.79	28.90	8.51	8.53	43.82	23.36	8.04	8.05
Weak-instrument-robust inference								
Anderson-Rubin Wald test	F(4,82)=8.35 [0.0000]	F(4,51)=4.08 [0.0061]	F(4,25)=13.41 [0.0000]	F(4,25)=12.96 [0.0000]	F(4,78)= 7.04 [0.0001]	F(4,78)=4.18 [0.0040]	F(4,29)=12.01 [0.0000]	F(4,29)=8.13 [0.0002]
Anderson-Rubin Wald test	Chi-sq(4)=34.11 [0.0000]	Chi-sq(4)=16.90 [0.0020]	Chi-sq(4)=57.41 [0.0000]	Chi-sq(4)=55.47 [0.0000]	Chi-sq(4)=28.84 [0.0000]	Chi-sq(4)=17.16 [0.0018]	Chi-sq(4)=51.00 [0.0000]	Chi-sq(4)=34.56 [0.0000]
Stock-Wright LM S statistic	Chi-sq(4)=23.46 [0.0001]	Chi-sq(4)=14.80 [0.0051]	Chi-sq(4)=15.79 [0.0033]	Chi-sq(4)=14.97 [0.0048]	Chi-sq(4)=21.28 [0.0003]	Chi-sq(4)=18.45 [0.0010]	Chi-sq(4)=11.35 [0.0229]	Chi-sq(4)=12.30 [0.0153]

p values in brackets

Under-identification tests, Ho: matrix of reduced form coefficients has rank=K1-1 (under-identified); Ha: matrix has rank=K1 (identified) Weak identification test, Ho: equation is weakly identified Weak-instrument-robust inference, Tests of joint significance of endogenous regressors B1 in main equation, Ho: B1=0 and over-identifying restrictions are valid.

Figure 2.1: Thresholds (Government consumption) using WDI dataset

Note: The results for rolling regression using column (8) in Table 4. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R^2 values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

Figure 2.2: Thresholds (Government consumption) using updated version of Abbas et al. (2011) dataset

Note: The results for rolling regression using column (8) in Table 5. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R-bar squared values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

Figure 2.3: Thresholds (Government debt) using Reinhart and Rogoff (2010) dataset

Note: The results for rolling regression using column (8) in Table 6. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R^2 values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

Figure 2.4: Thresholds (Government debt) using updated version of Abbas et al. (2011) dataset

Note: The results for rolling regression using column (8) in Table 7. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R-squared values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

Figure 2.5: Thresholds (comparison) using the combination of WDI and Reinhart and Rogoff (2010) datasets

Note: The results for rolling regression using column (8) in Tables 8 and 9. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R^2 values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

Figure 2.6: Thresholds (comparison) using Abbas et al. (2011) dataset

Note: The results for rolling regression using column (8) in Tables 10 and 11. Solid (blue) lines in the left panel show the estimated coefficient of government consumption, while dashed (red) lines show the corresponding 90% confidence intervals. The figure in the right panel show the corresponding R^2 values. The initial values of government consumption, trade, inflation and private credit in each 5-year period are used as instruments for the corresponding 5-year averages. All rolling regressions include fixed effects.

CHAPTER 3

**HOUSING PRICE DYNAMICS WITHIN THE UNITED STATES:
EVIDENCE FROM ZIP CODES WITH DIFFERENT
DEMOGRAPHICS**

3.1 Introduction

The housing market in the United States experienced a tremendous boom from 2000 to 2007. There is disagreement in the literature about the primary factors. Himmelberg et al. (2005) argue that the increase in housing prices occurred due to a sharp decline in mortgage rates as a result of historically low federal funds rates (Taylor, 2007), or, as Kivedal (2013) argues, because risky borrowers were able to obtain larger loans, prices increased due to higher bids on houses¹. By the end of 2006, a burst in the housing market bubble resulted in a sharp decline in housing prices (about 30%), leading to the greatest recession in the United States since 1947.

Following the financial crisis in 2007, the Federal Reserve urged researchers and policy makers to enhance their understanding of the housing market, given the importance of housing price volatility on macroeconomic stability.² In this paper, I study the source behind fluctuations in the housing market. There are two reasons behind any change in housing prices: changes of expectation toward future returns (a

¹This caused a wealth effect and then a further increase in housing prices, known as the financial accelerator effect (Bernanke et al. 1999).

²The housing wealth and housing collateral effects on consumption are the most important or most explored channels of the transmission of house-price fluctuations to the real economy (Goodhart and Hofmann, 2008).

bubble³), a change in fundamentals (rent growth⁴), or a combination of these two.⁵ I explore whether fundamentals are the main factors behind the volatility in housing prices. I then study how monetary policy (such as changes in the interest rate) would affect this market in different regions.

Using a dynamic version of the Gordon growth model, which successfully explain fluctuates in the stock and bond market analysis, I study time-series fluctuations in house prices and the returns to housing. I model houses as assets purchased by homeowners (investors), with rent acting as the return to the asset. The model, also known as dividend-ratio model (introduced by Campbell and Shiller, 1988), allows the rent-price ratio at each date to be split into the expected present discounted value of rent growth, the real interest rate,⁶ and the housing premium over real rates. By taking macroeconomic variables into consideration (following Campbell et al. [2009] and Shi [2016]), I provide a more useful framework to understand changes in housing market fundamentals.

I apply this model to the U.S. housing market from 2010 to 2016, using monthly zip code level data published by Zillow. To the best of my knowledge, I am the first to

³Stiglitz (1990): “if the reason that the price is high today is only because investors believe that the selling price is high tomorrow when fundamental factors do not seem to justify such a price then a bubble exists. At least in the short run, the high price of the asset is merited, because it yields a return (capital gain plus dividend) equal to that on alternative assets.”

⁴As Kivedal (2013) explains, the fundamental value of an asset will be the present value of all the future cash flows of the asset, which is equivalent to rent growth in housing market.

⁵In previous literature regarding the recent financial crisis in the U.S., Himmelberg et al. (2005) answer that housing prices increased because of fundamental factors. Campbell et al. (2009) argue low interest rates are one of the explanations for the housing price increase. They argue that housing premium and interest rate together are the main reasons behind fluctuations in the housing market. Shiller (2007) and Kivedal (2013) argue for the presence of a bubble in the U.S. housing market prior to 2007.

⁶Kivedal (2013) argues that the interest rate needs to be taken into account since it is an important factor in determining demand for housing mortgages and Leamer (2002) explains that a high ratio between prices and earnings of an asset may be justified if other assets are also highly priced. Inclusive of the interest in my analysis improved my prediction power.

attempt using this model with monthly zip code level data and therefore utilization of this dataset is one of the main contributions of my paper. To put this model into practice, I need to measure expectations at each point in time. My strategy, which is common in the financial literature, is to use a vector autoregressive model (VAR) with fixed coefficients. I realize that my model might not catch all the variations in housing prices, therefore I compare my results to the actual rent-price ratio for each zip code at each point in time (each month) to see how different my prediction is (known as “forecast error”).

My approach has several advantages over more conventional analysis. As I explain in more detail later, frequent data and local factors are important for understanding the housing market. For instance, Gelain and Lansing (2014) have applied rent-price ratio methodology to the U.S. data for the period 1960 to 2013 and estimated that their model can approximately match the volatility of the price-rent ratio if agents continually update their estimates of recent fundamental data. Their analysis shows the significance of monthly data as a substitute for annual or quarterly data, which is common in the literature. In addition, Del Negro and Otrok (2007) find that, historically, local factors, rather than variations in national factors, mainly drive movements in housing prices. Fratantoni and Schuh (2003) also argue that housing is determined in local markets and heavily depends on regional factors. However, in previous studies, researchers mostly used either state or metropolitan level data, while I use zip code level data. The availability of this high frequency and detailed data set provided us the opportunity to improve my prediction power.

Using the Gordon growth model, I am able to explain the broad movements in the rent-price ratio, both on average among all zip codes and on the national level. I use variance decomposition analysis to determine which components account for changes in housing prices over this period of time. We see that future premium is

estimated to be the largest source of variability of the rent-price ratio. These results are consistent with some studies such as Fairchild et al. (2014) and Campbell et al. (2009);⁷ they show that the main factor behind fluctuations in the housing market is expectation regarding future returns, rather than fundamentals, which is consistent with my findings. My prediction power, however, is higher relative to previous studies, confirming the importance of detailed data sets.⁸ The results can be valuable both for borrowers (households investing in the housing market) and lenders (at the time they are lending to house buyers).

Given the importance of housing market fluctuations for the aggregate economy, I am not the first to analyze them. Numerous studies have attempted to test the predictive power of the rent-price ratio.⁹ While acknowledging that local housing markets may react differently to monetary policy, few explore this implication carefully. Housing is the single most important component in financial portfolios (Fairchild et al.,

⁷Campbell et al. (2009, p. 90) note that “explanations of house-price dynamics that focus only on interest rate movements and ignore these covariances can be misleading”. However, I show later with IRF results that the interest rate affects the housing market through rents and premium, rather than affecting it directly.

⁸On average, the adjusted R^2 of my results is higher, which I believe is because of my more detailed data set.

⁹Some examples among the most recent studies include Gallin (2005), Himmelberg et al. (2005), Del Negro and Otrok (2007), Davis et al (2008), Campbell et al. (2009), Cochrane (2011), Kivedal (2013), Fairchild et al (2014), Gelain and Lansing (2014), Engsted and Pedersen (2015), Engsted et al. (2015), Kishor and Morley 2015, and Shi (2016). Among these studies, some argue that a burst in the housing market bubble caused the financial crisis (e.g. Shiller 2005, Kivedal 2013). Fairchild et al. (2014) find evidence that the housing market bubble leading to the financial crisis was accompanied by money illusion. They also point out that risk premium is the most important source of housing market volatility and interest rates play a smaller role in driving the movements of housing markets. Kishor and Morley (2015) argue that most of the variation in the present-value level of the price-rent ratio is due to the variation in the expected housing return. However, others, such as Himmelberg et al. (2005), show that it is due to a change in fundamentals. Shi (2016) also finds no bubble, even when considering changes in the macroeconomic conditions. These findings are consistent with the stock and bond market studies; for instance, Campbell and Ammer (1993) use U.S. monthly data and find that real interest rates have little impact on stock returns.

2014). Most households face different borrowing constraints due to their differing financial situation and when there is a change in interest rates, they have different reactions regarding their investments. Since both supply and demand affect the housing market, household income and demographics shape the demand for housing, and thus affect market prices. I explore zip code level data on demographics and income to study the differential effect of monetary policy on housing assets.

We frequently see in previous literature the importance of local and regional factors. Fratantoni and Schuh (2003), Hwang and Quigley (2006) and Arestis and Gonzalez-Martines (2017) confirm that there is a link between house prices and demographics. Himmelberg et al. (2005) argue that changes in underlying fundamentals can affect cities differently. Del Negro and Otrok (2007) find that, historically, movements in housing prices are mainly driven by local factors, rather than variations in national factors. Motivated by these studies, I use zip code level data on demographics¹⁰ in order to further analyze the housing market in the United States and to examine the differential effect of monetary policy on housing in different regions. My main contribution to the literature is, therefore, to document the effect of income and demographics on housing demand, that leads to differential impacts of monetary policy across socioeconomic groups.

Using Impulse Response Functions (IRF), I show how different housing factors respond over time to an interest rate shock in areas with different levels of income or demographics. My IRF results show that housing premia respond negatively to a shock in the interest rate, regardless of the level of income, gender of family members, their education or race. The rent growth responds positively, but with a lag rather than immediately. The magnitude of the response of the housing premium and rent

¹⁰This data was gathered from the Census, 2010.

growth is initially bigger in low income zip codes compared with high income areas.¹¹ For zip codes with a higher percentage of males in the population, I find a smaller response of housing premia and rent growth.¹² Looking at the results from zip codes with a higher percentage of African Americans, the magnitude of the response in both housing premia and rent growth is higher than zip codes with a lower percentage of African Americans. Finally, the response is smaller in areas with a lower percentage of family members holding a bachelor's degree compared with zip codes with a higher percentage.¹³

My analyses in this paper show that although the interest rate is not the main driver of housing market fluctuations, any shocks to the interest rate affects rent growth and housing premia indirectly. My IRF analysis results show that, monetary policy affects housing market indirectly through rents and housing premia. This effect is smaller for families with low income, more females, African Americans, and members with low education levels. I believe these groups face tighter financial constraints, making consumption rather than investment the primary concern when making housing decision. Therefore, a change in the interest rate will not change their demand for housing assets as much as it will for households with less binding financial constraints.

The organization of this paper is as follows. In section 2, I discuss the economic environment of this paper. Then I explain my empirical strategy and my data in sections 3 and 4. I will present my results in section 5 and my conclusion in section 6.

¹¹Although the difference is insignificant, showing that the income level alone is not as important as its combination with other factors (demographics).

¹²These results can be explained by discrimination of females.

¹³However, the response turns positive after a couple of periods for zip codes with more females, African Americans and lower educated family members.

3.2 The Economic Environment

Campbell and Shiller (1988) developed a dynamic Gordon growth model in order to analyze the determinants of stock market volatility. Using the definition of one period gross returns, this model shows the ratio of an asset's flow of fundamental value to its price, known as "dividend-price ratio". The dividend-price ratio is more an accounting identity than an economic theory, measuring the deviation between an asset price and its fundamental value.

Campbell et al. (2009) applied the same model to the housing market, arguing that housing is like an asset purchased by homeowners (investors) and, therefore, the flow from this asset will be the rent received by the owner. They introduce the log of the rent-price ratio as an analog of the dividend-price ratio, claiming that housing prices are equivalent to the discounted sum of housing rents and returns, which varies over time; thus, changes in expected rent growth and returns will change the prices. Using this model, I am able to study the factors responsible for time-series fluctuations in housing market.

The one period gross real return to an investment can be written as $R_{t+1} = (P_{t+1} + V_{t+1})/P_t$. Campbell et al. (2009) extended this model to the housing market and argued that rent in the housing market is equivalent to V_{t+1} , the flow of the fundamental value in the stock market and therefore the gross return to housing investment is:

$$\frac{P_{t+1} + R_{t+1}}{P_t} \tag{3.1}$$

where P_t is the price at time t and R_{t+1} is the rent at time $t + 1$. Using the method of Campbell and Shiller (1988a,b) and a log-linear approximation, I can write $\log(R_t/P_t) \equiv r_t - p_t$ where the log of the rent-price ratio at time t is equal to the expected net present value of future real rates of return to housing and real

growth in rents,

$$r_t - p_t = k + E_t \left[\sum_{j=0}^{\infty} \rho^j \varphi_{t+1+j} - \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \right] \quad (3.2)$$

where,

$$\rho = (1 + e^{\overline{r-p}})^{-1},$$

$$k = (1 - \rho)^{-1} [\ln(\rho) + (1 - \rho) \ln(1/\rho - 1)]^{14},$$

φ is the log of return to housing¹⁵ and Δr is rent growth.¹⁶ By defining $\pi = \varphi - i$, which sets the return to housing, φ , as the sum of a real risk-free interest rate, i , and the per-period premium over the rate (computed from the real yield on the 10-year Treasury bond at time t), then:

$$r_t - p_t = k + E_t \sum_{j=0}^{\infty} \rho^j i_{t+1+j} + E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+1+j} - E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \quad (3.3)$$

This equation implies that the ratio of rents to housing prices (the rent-price ratio) is equal to the sum of expected future risk-free interest rates and the housing premium (return to housing) minus the present discounted value of expected future housing flows (rent growth), or

$$r_t - p_t = k + \Gamma_t + \Pi_t - \Phi_t \quad (3.4)$$

which is a dynamic version of the classic Gordon growth model¹⁷, and

$$\Gamma_t = E_t \sum_{j=0}^{\infty} \rho^j i_{t+1+j} \quad (3.5)$$

$$\Pi_t = E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+1+j} \quad (3.6)$$

¹⁴ ρ is a discount factor and k is a constant of linearization. I follow Davis et al. (2008) to obtain values for ρ and k ; As I explain in more detail in footnote 23, I use a fitted value method for each zip codes using a set of dummy variables.

¹⁵The real return to housing is calculated as $\varphi_t = \frac{R_t + P_t - P_{t-1}}{P_{t-1}}$; R_t is the real(inflation-adjusted) rent index and P_t is the real price index of housing at time t .

¹⁶Lower case denotes the log of each variable.

¹⁷The classic Gordon growth model defines rent-price ratio as $R_t/P_t = i + \pi - \Delta r$

$$\Phi_t = E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \quad (3.7)$$

Equations (5), (6) and (7) represent the present value of households' time t expectations of the interest rate, housing premium and rent growth, respectively.

3.3 Empirical Strategy

3.3.1 The Vector Autoregressive Model

To put the Gordon growth model in practice, I obtain a time-series estimation for Equations (5), (6), and (7) using data on housing rents, prices, interest rates, and various macroeconomic variables¹⁸ and the VAR model:

$$Z_t = (i_t, \pi_t, \Delta r_t, x_t')' \quad (3.8)$$

Following the literature, I assume that Z_t follows a first-order VAR, i.e.,

$$Z_t = AZ_{t-1} + \varepsilon_t \quad (3.9)$$

Using a VAR model, I estimate Equations (5), (6), and (7) for each zip code. Let $\widehat{\Gamma}_t$, $\widehat{\Pi}_t$, and $\widehat{\Phi}_t$ represent the results of my VAR model estimation. Therefore, the predicted rent-price ratio will be equal to:

$$\widehat{r_t - p_t} = k + \widehat{\Gamma}_t + \widehat{\Pi}_t - \widehat{\Phi}_t \quad (3.10)$$

However, I know that households might not exactly follow a first order VAR model (Equation (9)) to shape their expectation. In that case, my prediction will differ

¹⁸Real per-capita income growth (ΔY_t), employment growth (ΔL_t) and population growth (ΔN_t) are the macroeconomic variables frequently used in the literature. I include these variables in the vector x_t in order to help my forecasting.

from the actual rent-price ratio at each point in time, which is known as the “forecast error”, e_t :

$$\widehat{r_t - p_t} = r_t - p_t + e_t \quad (3.11)$$

Following the literature, I treat the present value of future rent growth as a residual:

$$\widehat{\Phi}_t + e_t = \varepsilon_t \quad (3.12)$$

therefore,

$$r_t - p_t = k + \widehat{\Gamma}_t + \widehat{\Pi}_t - \varepsilon_t \quad (3.13)$$

I estimate a first-order VAR as a Seemingly Unrelated Regression system (SUR) for each zip code (the US superscript refers to the national level of the variable):

$$i_t = \delta_0 + \delta_{\Delta r} \Delta r_{t-1}^{US} + \delta_{\pi} \pi_{t-1}^{US} + \delta_i i_{t-1} + \delta_{\Delta Y} \Delta Y_{t-1}^{US} + \delta_{\Delta L} \Delta L_{t-1}^{US} + \delta_{\Delta N} \Delta N_{t-1}^{US} + \varepsilon_t^i \quad (3.14)$$

$$\pi_t = \beta_0 + \beta_{\Delta r} \Delta r_{t-1} + \beta_{\pi} \pi_{t-1} + \beta_i i_{t-1} + \beta_{\Delta Y} \Delta Y_{t-1}^{US} + \beta_{\Delta L} \Delta L_{t-1}^{US} + \gamma_{\Delta N} \Delta N_{t-1}^{US} + \varepsilon_t^{\pi} \quad (3.15)$$

$$\Delta r_t = \gamma_0 + \gamma_{\Delta r} \Delta r_{t-1} + \gamma_{\pi} \pi_{t-1} + \gamma_i i_{t-1} + \gamma_{\Delta Y} \Delta Y_{t-1}^{US} + \gamma_{\Delta L} \Delta L_{t-1}^{US} + \gamma_{\Delta N} \Delta N_{t-1}^{US} + \varepsilon_t^{\Delta r} \quad (3.16)$$

Equations (14), (15), and (16) are the estimation for Equations (5), (6), and (7), shown in Equation (10) as $\widehat{\Gamma}_t$, $\widehat{\Pi}_t$, and $\widehat{\Phi}_t$, respectively. Note that in these equations, the interest rate only depends on national level variables. However, as I discussed earlier, the housing market is affected by monetary policy as well as local factors; therefore, my rent growth and housing premium equations depend on local variables (zip code level data) as well as national variables (with US superscript). I use the first lag in these equations for two reasons; first, it is commonly used in the literature to use a single lag, and, secondly, Gelain and Lansing (2014) argue the volatility of the price-rent ratio in the data will match the real world if near-rational agents continually update their estimates of fundamentals using recent data, in this case, monthly.

3.3.2 Variances Shares, Covariances Shares, and IRF

I use variance decomposition analysis to determine the relative importance of different factors in changes in housing prices at each zip code. By taking the variance of Equation (13) I have:

$$var(r_t - p_t) = var(\hat{\Gamma}_t) + var(\hat{\Pi}_t) + var(\varepsilon_t) + 2cov(\hat{\Gamma}_t, \hat{\Pi}_t) - 2cov(\hat{\Gamma}_t, \varepsilon_t) - 2cov(\hat{\Pi}_t, \varepsilon_t) \quad (3.17)$$

Since I treat the present value of future rent growth as a residual, along with the forecast error, all elements in Equation (13) that include ε_t are related to rent growth contribution (following Campbell et al. 2009).

Motivated by recent studies, I use IRF to determine how different elements in the rent-price ratio equation respond over time to a shock in the interest rate in areas with different household characteristics. For this matter, I categorize my data into different groups: zip codes with higher percentages of income and zip codes with lower percentages of income (compared with the average among all zip codes); zip codes with higher percentages of females in households and zip codes with higher percentages of males in households; zip codes with higher percentages of African Americans and zip codes with lower percentages of African Americans; and zip codes with higher percentages of family members with a bachelor's degree and zip codes with lower percentages of family members with a bachelor's degree. Next, I use a panel VAR on each group and then, using IRF, I analyze the effect of a change in the interest rate on housing premia and rent growth.

3.4 Data

I gathered monthly housing price and rent indices from Zillow¹⁹ by zip code from November 2010 to June 2016. My data set covers 991 zip codes.²⁰ Since I cannot show the results for all 991 zip codes, I show the average and standard deviation among all zip codes, or the national level. I use Zillow’s median home value as median housing prices and Zillow’s median rent series as the rent index for each zip code. My data set covers single-family residences, condominiums and co-op homes.

Himmelberg et al. (2005) claim a major drawback of many data sets is that they are “subject to biases due to changes in the quality of existing houses”. One of the advantages of the Zillow data set is the Zestimates index.²¹ Instead of the actual sale prices on every home, the index is created from estimated sale prices on every home. Another advantage of this data set is that the data is zip code level, allowing us to take both local variables as well as national factors into account. Himmelberg et al. also argue that house price dynamics are a local phenomenon, and national-level data obscure important economic differences among cities. One limitation of this data set is that Zillow only publishes data on rent from 2010, leaving us with less than 6 years (69 months to be exact) of data.

I convert nominal housing rent and price indices to their real value for each zip code by deflating each index using the national CPI excluding shelter.²² Following

¹⁹See <https://www.zillow.com/research/data/>. For an in-depth comparison of the Zillow Home Value Index to the Case Shiller Home Price Index, please see: <https://wp.zillowstatic.com/3/ZHVI-InfoSheet-04ed2b.pdf>

²⁰This zip codes are mostly urban areas.

²¹The innovation that Zillow developed in 2005 was a way of approximating this ideal home price index by leveraging the valuations Zillow creates on all homes. See for more details: <https://www.zillow.com/research/zhvi-methodology-6032/>

²²The monthly data for CPI excluding shelter was gathered from the Federal Reserve Bank of St. Louis (FRED). See: <https://fred.stlouisfed.org/series/CUUR0000SA0L2>

Davis et al. (2008), I use a fitted value model to benchmark the level of the rent-price ratio.²³ This benchmarking is to obtain the values for ρ and k for each zip code. For real interest rate, i , I use real expected yield on a 10-year US Treasury bond, which is common in the literature. Following Campbell et al. (2009), I use the nominal 10-year Treasury yield (monthly data) minus the median of 10-year inflation expectation to calculate the real expected yield.²⁴

There are three macroeconomic variables used frequently in the literature in order to enhance the prediction: real per-capita income growth (ΔY_t), employment growth (ΔL_t) and population growth (ΔN_t). I obtain these variables from the Federal Reserve Bank of St. Louis (FRED).²⁵ The data on real per-capita income, employment, and population are available monthly and at the national level (as I show in the VAR model with the US superscript).

The demographics data and income level for each zip code was obtained from the Missouri Census Data Center.²⁶ Data on average household income, average percentage of males in the family (versus percentage of females), average percentage of African Americans, average percentage of members in the family with bachelor degrees (or higher) are the variables I obtained from the Missouri data set, which originally were gathered from the 2010 Census. Note that here I am controlling for both national and regional variables in order to examine the predictability of my model, something that has been absent in the literature.

²³For each zip code, rent index should be regressed on a set of housing characteristics, which here I have the number of bedrooms. I also included zip code fixed effect in this regression. Then I used the regression coefficient to predict rental value for each zip code. Then, I set the rent-price ratio equal to the average annual calculated rent over the price in each zip code; $\rho = (1 + e^{\overline{r-p}})^{-1}$, $k = (1 - \rho)^{-1}[\ln(\rho) + (1 - \rho) \ln(1/\rho - 1)]$.

²⁴These data were gathered from the Livingston survey (See: <https://www.philadelphiafed.org/research-and-data/real-time-center/livingston-survey>).

²⁵See <https://fred.stlouisfed.org/>.

²⁶See <http://mcdc.missouri.edu/>.

Table 1 shows the summary data for all of my variables. The first column shows the average, the second column shows the standard deviation (SD), the third and fourth columns show minimum and maximum value for the variable, the fifth and sixth columns show the 25th percentile and 75th percentile. Figure 1 shows the graph of rent and price at the national level from November 2010 to June 2016, the period my data set covers. The first row shows the data description for rent-price ratio for all the zip codes that I include in my research. The average of rent-price ratio is 9.22 for my 991 zip codes and the standard deviation is 3.29. The minimum value for the ratio is 2.99, which is for a zip code in Los Angeles, California and the maximum value is 34.17, which belongs to a zip code in Philadelphia, Pennsylvania.

The next three rows are the data summary for rent growth, Δr_t , real return to housing, Φ_t , and housing premium, Π_t . On average, we have 0.4% rent growth (monthly) among all of the zip codes included; the average of housing return and premia is 1 and 0.98, respectively. The standard deviation for rent growth is around 0.01; however, this number is greater for housing return and premia (more than 10 times as large, approximately 0.13), showing that housing return and premia tend to be volatile in similar ways, but much more than rent growth. As seen in column 3, some zip codes show negative rent growth in my data (minimum value, -0.08, and 25th percentile are both negative), but for housing return and premium they are always positive (ranging from around 0.58 to 1.77 and 0.56 to 1.74, respectively).

The last three rows show the data summary on macroeconomic variables used in this study. As the table shows, real per-capita income growth, ΔY , is negative on average during the period included in this paper, -0.54. The SD for this variable is 1.72. For employment growth, ΔL , we have an average of 0.08 and a standard deviation of 0.56. Population growth also has a negative average of -0.06 and 0.24 SD. According to this data description, during this period of time real, per-capita

income was most variable compared with employment and population growth, which are considerably less volatile. Note that these trends relate to national level monthly data for November 2010 to June 2016.

3.5 Results

3.5.1 The Vector Autoregressive Model Results

I estimate Equations (14), (15), and (16) using a VAR model as a SUR system for each of my 991 zip codes and at the national level. I summarize the results of VAR model estimation in Table 2. These results show what component of the rent-price ratio is predictable. Since I am not able to report the results for each zip code, I use the average (mean), the SD, the 25th percentile, and the 75th percentile among all zip codes. The top panel in Table 2 shows the estimation related to Equation (14), my prediction for the real interest rate, the middle panel is related to Equation (15) (housing premium), and the bottom panel shows the results for rent growth, Equation (16). The columns show the coefficient estimates on each variable related to each equation. The last two columns report the adjusted R^2 and p -value associated with each equation.

Looking at the top panel, real interest rates are highly predictable. My results show a p -value of 0 on average for all zip codes (column 8) and a high value for adjusted R^2 , 0.94 (on average), which both show the predictability power of Equation (14). These results are consistent with many studies in the literature; I typically observe high predictability of real interest rates using VAR models. The results in the middle panel show that housing premia are quite predictable as well. The adjusted R^2 is 0.71 on average for all zip codes alongside p -value of 0. This R^2 is higher when compared with previous literature, which might be a result of my more detailed data

set, as recent studies point out the importance of analyzing local factors rather than national or state level factors. Since I am the first to use zip code level data, my equations have better predictive power. In the bottom panel, I report the results of the rent growth equation (Equation (16)). Consistent with the literature, I have lower predictability for rent growth compared with the other two equations. However, with an adjusted R^2 of 0.49 and p -value of (almost) 0, I still have useful predictive power. The interquartile range of the adjusted R^2 for all the zip codes ranges between 41% and 56%. These results are also higher compared to previous literature, likely a result of my disaggregated data.

The magnitude of the coefficient on column 3 for the top panel shows how, on average, 97% of variation in interest rates can be explained by the housing premium. According to the middle panel, the interest rate accounts for 67% of variance of housing premium,²⁷ another motivation for us to study the impact of a shock in interest rates on housing premia. The coefficient for rent growth in the bottom panel, 0.58, demonstrates how rent growth is persistent compared with interest rates and housing premia.

3.5.2 Variances and Covariances

The variance decomposition analysis helps us determine the relative importance of each element in the variation of rent-price ratio over time. I use this method to study whether fundamentals are the main reason behind changes in the housing market and if not, what component can account for those changes. In table 3, we see the results of the variance decomposition analysis: share of each component in Equation (17)²⁸.

²⁷However, these results could be due to the correlation between housing premium and interest rate.

²⁸ $var(r_t - p_t) = var(\hat{\Gamma}_t) + var(\hat{\Pi}_t) + var(\varepsilon_t) + 2cov(\hat{\Gamma}_t, \hat{\Pi}_t) - 2cov(\hat{\Gamma}_t, \varepsilon_t) - 2cov(\hat{\Pi}_t, \varepsilon_t)$. Columns shows the variance of actual rent-price ratio, $var(r_t - p_t)$, the variance of pre-

Column 1 of table 3 demonstrates the variation in actual rent-price ratio. Column 2 exhibits the variance of predicted rent-price ratio. Columns 3 to 5 display the variance shares of interest rate, housing premium, and rent growth, respectively. The last three columns are dedicated to the covariance shares of these three components. The first row shows the average of the variation among all zip codes. The second row shows the SD of the variance, 0.99. The last two rows include the number associated with the 25th percentile and 75th percentile of my data set. These numbers reveal the differences between different zip codes in the United States, confirming again the importance of a more detailed analysis using a comprehensive data set such as mine, rather than metropolitan, state or national level data, which has been used frequently in previous literature.

The variance of the $\widehat{r - p}$ (predicted rent-price ratio, shown in column 2) compared with the number in column 1 tells us that the variance of my prediction, on average, is as large as 70% of the variation in the actual rent-price ratio. This number means that, on average, I am able to predict 70% of the fluctuations in the housing market in the United States. This result implies that using the VAR model, I am able to track the general movement in the rent-price ratio. My result is quite consistent with previous literature. Campbell et al.'s (2009) estimation shows that, using the same model, the variation for the median of the metropolitan areas is also 70% of the variation in the actual ratio. However, my results have higher prediction power compared with previous studies generating a more reliable analysis, probably due to my more detailed data set.

Looking at columns 3 to 5, we notice that almost all the variation in the rent-price ratio is due to the variation in housing premium. According to my results in column

dicted rent-price ratio, $var(\widehat{r_t - p_t})$, $var\widehat{\Gamma_t}$, $var\widehat{\Pi_t}$, $var\varepsilon_t$, $+2cov(\widehat{\Gamma_t}, \widehat{\Pi_t})$, $-2cov(\widehat{\Gamma_t}, \varepsilon_t)$ and $-2cov(\widehat{\Pi_t}, \varepsilon_t)$, respectively. Since I am showing the variance and covariance shares, these numbers add up to 1.

3, on average housing premium accounts for most of the variation in the rent-price ratio. My VAR model results can help account for the empirical findings of Campbell et al. (2009), who use the rent-price ratio for the U.S. housing market and find that the housing premium accounts for a significant fraction of rent-price ratio volatility at the national and local levels. Fairchild et al. (2014) also point out that the premium is the most important source of housing market volatility and interest rates play a smaller role in driving the movements of the housing markets. Furthermore, Kishor and Morley (2015) argue that most of the variation in the present-value level of the price-rent ratio is due to the variation in the expected housing return. These findings are consistent with stock and bond market studies; for instance, Campbell and Ammer (1993) use U.S. monthly data and find that real interest rates have little impact on stock returns.

Other components account for only a small fraction of variation in the rent-price ratio. The share of rent growth is less than 30% and interest rate accounts for only 0.8% of the variation in the ratio. These results show that, in the U.S. housing market, changes in expectations towards future returns are the main reason behind volatility in housing prices; a rise in prices reflects optimistic expectations toward the future rather than a change in fundamentals (rent growth). These results are valuable both for lenders and borrowers in a housing market. If fundamental factors cannot explain prices, as noted by Kivedal (2013), lenders should take this into account when submitting loans to households. Since the price will decrease eventually to its fundamental value, higher house prices that are the results of psychological factors should not be considered as future higher returns.²⁹

²⁹My results for the covariance shares are also consistent with most of the previous findings in the housing market and stock market literature. The covariances among three components are shown in the last three columns. My results show that, on average among all zip codes, the negative covariances dampen the fluctuation in the rent-price ratio, as we see in previous studies (Campbell et al., 2009); however, my results show smaller covariances. Column 6 shows the covariance between interest rate and housing premium is

3.5.3 The Impulse Response Function Results

The results from the variance decomposition analysis show that the housing premium accounts for most of the variation in the rent-price ratio and that the interest rate plays a less important role. However, previous studies have shown that monetary policy, especially changes in interest rate, can affect housing prices indirectly; an increase in interest rates will make other assets more attractive to investors, causing a capital switch. This will decrease the demand for housing, and subsequently cause a decrease in housing prices. Since housing market volatility will compromise economy stability, it is important for policy makers to prevent excess volatility in housing prices.³⁰

Researchers show that, although a housing market is affected by aggregate variables³¹, historically, movements in housing prices are driven mainly by local factors; different regions respond differently to monetary policy actions according to previous literature, such as Fratanoni and Schuh, 2003, Hwang and Quigley, 2006, and Del Negro and Ortok, 2007. These studies explain that a centralized market does not exist for housing assets (Fairchild et al. 2014); housing is determined by local markets because supply and demand strongly depend on regional and local factors. Also, housing is a basic need for the middle and lower classes of a society (Arestis and Gonzalez-Martinez, 2017). As I mentioned previously, for an average family, housing is the single most important component in its financial portfolio. Therefore, the financial situations of families in a region will directly shape their demand for hous-

negative. This negative correlation shows that the movements in one component are offset by the other one. According to the last two columns, the correlation between interest rate and rent growth and the housing premium and rent growth are positive. Vuolteenaho (2002) finds that expected future premium and fundamentals are also positively correlated in the stock market.

³⁰Zhang et al., 2016.

³¹Fairchild et al., 2014

ing. For instance, higher income will result in a higher demand for housing due to the “affordability index”; McCarthy and Peach (2004) explain that when the income level is higher, households bid up house prices simply because they can afford it. But the income level itself is not the only determinant of financial status; demographics such as race, employment opportunities, education, credit and population are other important elements.

Motivated by these studies, in this paper I use the IRF to show how a change in the interest rate has different effects on different regions (zip codes here), considering their demographic characteristics. The demographic data for this analysis comes from the Missouri Census Data (2010).³² Figures 4 to 11 shows the results of my IRF analysis. Here I used a panel VAR on my data set after separating the zip codes into two different groups: zip codes with higher levels of income and lower levels of income (figures 4 and 5), zip codes with higher percentages of females and higher percentages of males (figures 6 and 7), zip codes with higher percentages of African Americans and lower percentages of African Americans (figures 8 and 9), and zip codes with higher percentages of family members with a bachelor’s degree and lower percentages (figures 10 and 11), respectively.³³ The graphs on the left show the impact of a monetary policy shock on the housing premium and those on the right show this effect on rent growth.

Regardless of the demographics, the response of the housing premium to a change in the interest rate is initially negative (figures on the left), which is consistent with the literature and what we expected; an increase in interest rates will cause a decrease

³²I assume that demographic characteristics of these zip codes have not changed in the time period of this analysis.

³³All these comparisons are to the average level of the variable of interest. For instance, I calculated the average of income level among all these zip codes, then compared each zip code’s income level to this average in order to group them as low level of income or high level.

in housing prices. When there is a rise in interest rates, other assets will look more attractive to investors, since they have a higher future return compared with the housing market. Then households will buy less housing assets (and more of the other assets), which will cause a decrease in demand for housing and therefore a decrease in prices. The response of the housing premium to a shock in the interest rate turns positive by the 3rd month (a quarter). The reason behind this increase in the housing premium can be explained by the response in rent growth to a shock in the interest rate. Note that (almost all of) these results are statistically significant.

For rent growth (figures on the right), my results show that, in all cases, a change in the interest rate will not affect rent growth immediately. The effect starts showing up after a couple of months in all figures (around 3 months, or a quarter, around the time that the response in the housing premium turns positive); and we observe that the rent growth starts increasing. The effect goes away after approximately 12 months (a year) and it dies out completely after 15 to 20 months. The reason behind these changes is that, as an investment good, the return to a housing asset comes from the capital gains brought by the rise of prices and also rental income (Zhang et al. 2016). Therefore, a shock in the interest rate will also affect rents. When there is an increase in the interest rate, new buyers are less motivated to buy a house. Therefore, the demand for renting will rise and rents will increase. Hwang and Quigley (2006) and Zhang et al. (2016) argue that since rents exhibit a positive serial correlation over time, a change in current rents will cause a change in future rents, an increase in rental income and therefore a rise in prices and premium. This is probably why we see that after a short period of time (a quarter), the effect of the interest rate on housing premium becomes positive (with a delay rather than occurring instantly).³⁴

³⁴The negative effect of a shock in the interest rate on the housing premium (at first) and a positive effect after a couple of periods is consistent with the literature.

Looking at the results related to zip codes with different levels of income, figures 4 and 5, we observe an initial negative response of the housing premium to a shock in the interest rate for both groups. The magnitude, however, is smaller for high levels of income compared with lower incomes at the beginning (after 20 months, the change in housing premium is the same in both categories), but the difference is not noticeable. Figures 6 and 7 show the different responses in zip codes with a higher percentage of females compared with a higher percentage of males. In zip codes with a higher percentage of females, the results are quite close to what I had for zip codes with lower income levels. For zip codes with a higher percentage of male, the results are similar to zip codes with higher levels of income. Here the difference between the two groups is smaller at the beginning, but by the end of one year, the impact of interest rate shock on the housing premium is greater for zip codes with higher percentages of males.

The effect of a shock on interest rates on the housing premium and rent growth is similar to levels of income in the IRF results regarding African Americans and education. But looking at figures 8 and 9, we realize that for zip codes with higher percentages of African Americans, the response in the housing premium disappear after 10 to 12 periods (around a year); however, in zip codes with lower percentages of African Americans, after one year we observe a response of 0.5% in housing premium. For the different levels of education (shown in figures 10 and 11), we can see that the response after one year for zip codes with less educated families is smaller compared with zip codes with higher educated families. The reason behind these results is explained by the fact that lower education translates into lower income, less employment opportunity, and less credit. All these factors together will result in a zip code containing more middle or lower income families. As I argued earlier, for these families, housing is more a necessity than an investment. Therefore, when there

is a change in the interest rate, these households will not change their demand for housing as much as high levels income families do. Therefore, the rents and prices will change less in these zip codes compare to zip codes with higher education and less African Americans. These results are again consistent with what we expected.

As for the rent growth response to a monetary shock, for all demographic groups we observe a delayed and temporary increase. The magnitude, however, is greater for zip codes with higher percentages of males, lower percentages of African Americans, and higher percentages of family members with higher education, close to my results regarding the housing premium that show the greater impact of interest rate shock on these group³⁵.

Notice that I am not only talking about income level. My results show that the combination of different characteristics of households will shape their financial status, therefore, different demands for housing. Arestis and Gonzalez-Martinez (2017) confirm the linkage between house prices and demographics and argue that the combination of two factors in their study (for instance an aging population and unemployment) could lead to a change in housing prices, since the bridge between monetary policy and financial premium is represented by the financial position of borrowers (Agnello and Schuknecht, 2011). In regions with better employment opportunities or zip codes with higher education, the possibility of higher income is greater (Hwang and Quigley, 2006) as is the possibility of better credit. My results confirm that the combination of the levels of income and demographics, which can lead to better employment, job opportunities and better credit, will result in a greater impact of a monetary shock in the housing market in the United States.

³⁵The results regarding the response of rent growth on different levels of income is similar for both groups.

3.6 Conclusion

The housing market in the United States experienced a boom and bust from year 2000 to year 2006, causing the greatest recession in the country since 1947. Given the significance of the role that housing market volatility plays in economic stability, researchers have been trying to enhance their understanding of this market and the reasons behind its variability. Regardless of the differences in findings of recent studies, they all agree on the importance of accounting for local factors in housing market, rather than state or national level variables. In this paper, I studied time-series fluctuation in the U.S. housing market using the Gordon growth model. The model allows the rent-price ratio at each date to be split into the expected present discounted value of rent growth, real interest rate, and the housing premium over real rates. To put this model in practice, I have applied VAR model with fixed coefficient. My zip code level data set enables us to study the effect of both national and local factors on the housing market. This data set, published by Zillow, covers 991 zip codes across the United States and comprises monthly data from 2010 to 2016. To the best of my knowledge, I am the first to attempt to use this model with monthly zip code level data.

Using the Gordon growth model and zip code level monthly data set, I have shown that I am able to track the broad movement in housing volatility. I examined the relative importance of different elements in the volatility of the housing market, using the variance decomposition analysis. My empirical analysis on housing dynamics has shown that the main reason behind housing market fluctuation is returns in this market, rather than fundamentals (i.e., rent growth). I also found that interest rate plays a less important role.

However, as we see in previous studies (e.g. Fairchild et al. 2014), interest rate has indirect impact on housing market as well. Moreover, recent studies have proven

the importance of local and regional factors on housing markets, as well as national variables. Motivated by these studies, I have used IRF analysis and zip code level data on demographics to explain the effect of monetary policy on housing returns and rent growth, in different regions with different characteristics, such as income level or demographics. According to my IRF results, monetary policy shock initially has a negative effect on housing premium. This effect turns to be positive after 3 periods (a quarter). The impact of this shock on rent growth is felt after a delay; after a quarter, rent growth starts to increase, while this response dies out after a year. The reason behind these changes is that a higher interest rate causes other assets to be more attractive to investors, hence there will be a decrease the demand for housing assets. However, this will also increase the demand for renting, and therefore an increase in rent growth will cause prices to go up after a period of time (which is a quarter according to my analysis).

My findings also suggest that the impact of a shock in interest rate is less in zip codes with families compromising more female, more African American, or less educated members. In particular, these results suggest that the combination of income and demographics, for example, gender race, or education, that can lead to better job opportunities and employment or higher credit will result in a greater effect of monetary policy shock in housing markets of the United States. I have argued that these results are due to the necessity of housing for low income and middle-class families. My findings suggest that demographics play an important role in changes in the housing market in the United States and therefore policy makers should know that an expansionary monetary policy for instance will have different results in different regions due to the various characteristics of households. Including more demographics, such as, gender and race of the head of household, credit scores and other limitations in future studies regarding monetary policy effects will garner interesting results.

Table 3.1: Summary data on all variables

	Average	SD	Minimum	Maximum	p25	p75
	(1)	(2)	(3)	(4)	(5)	(6)
Rent-price ratio	9.218023	3.289121	2.986685	34.17313	6.962034	10.7801
Δr_t	0.0040131	0.007527	-0.089657	0.0866911	-0.0004586	0.0081225
Φ_t	1.003466	0.1273081	0.5799236	1.770732	0.929288	1.074425
Π_t	0.9891115	0.1287331	0.5651945	1.743242	0.912769	1.061985
ΔY_t	-0.5411023	1.722623	-6	3	-1	0
ΔL_t	0.0769231	0.5639321	-1	1	-0.3333333	0
ΔN_t	-0.0634921	0.2438478	-1	0	0	0

Table 3.2: The VAR model results: coefficient estimates, adjusted R^2 and P value

	interest rate	rent growth	housing premium	dY	dL	dN	$\bar{R}^2$	P value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interest rate equation								
mean	0.28041	0.16149	0.97105	-0.00044	-0.00014	0.00638	0.94474	0.00000
SD	0.54139	0.46283	0.06683	0.00102	0.00249	0.00807	0.05855	0.00000
p25	-0.01218	-0.14231	0.93603	-0.00102	-0.00168	0.00169	0.92635	0.00000
p75	0.62761	0.49025	1.01895	0.00014	0.00137	0.01129	0.98352	0.00000
Housing premium equation								
mean	0.67372	-0.25917	-0.01890	-0.00035	0.00064	-0.00249	0.71241	0.00000
SD	0.03432	0.04627	0.00438	0.00003	0.00003	0.00022	0.00201	0.00000
p25	0.65280	-0.28630	-0.02137	-0.00038	0.00062	-0.00263	0.71177	0.00000
p75	0.69594	-0.23095	-0.01607	-0.00033	0.00066	-0.00235	0.71379	0.00000
Rent growth equation								
mean	0.10440	0.58811	-0.01445	-0.00037	-0.00018	-0.00025	0.49107	0.00024
SD	0.16082	0.11047	0.02947	0.00039	0.00105	0.00316	0.10672	0.00206
p25	0.01131	0.51642	-0.02307	-0.00058	-0.00074	-0.00189	0.41768	0.00000
p75	0.20188	0.66646	0.00295	-0.00017	0.00034	0.00150	0.56415	0.00000

Table 3.3: Variance decomposition of rent-price ratio

	Variance		Variance shares			Covariance shares		
	$r - p$	$\widehat{r - p}$	$\widehat{\Gamma}_t$	$\widehat{\Pi}_t$	ε_t	$(\widehat{\Gamma}_t, \widehat{\Pi}_t)$	$(\widehat{\Gamma}_t, \varepsilon_t)$	$(\widehat{\Pi}_t, \varepsilon_t)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mean	0.81084	0.5845	0.83	108.23	29.45	-6.74	-1.45	-28.26
SD	0.99626	0.65252	1.23	5.06	25.69	7.35	2.80	44.39
p25	0.17606	0.14339	0.19	106.15	10.00	-10.04	-2.28	-64.14
p75	1.01758	0.73872	0.95	110.76	39.70	-3.91	-0.09	6.93

Figure 3.1: National level rent and price movement over 2010 to 2016

Figure 3.2: Predicted rent-price ratio and actual rent-price ratio

Figure 3.3: Forecast Error

Figure 3.4: IRF results - zip codes with high level of income

Figure 3.5: IRF results - zip codes with low level of income

Figure 3.6: IRF results - zip codes with high percentage of female in the family

Figure 3.7: IRF results - zip codes with high percentage of male in the family

Figure 3.8: IRF results - zip codes with high percentage of African Americans

Figure 3.9: IRF results - zip codes with low percentage of African Americans

Figure 3.10: IRF results - zip codes with higher percentage of family members with a bachelor's degree

Figure 3.11: IRF results - zip codes with lower percentage of family members with a bachelor's degree

CHAPTER 4

INCOME INEQUALITY AND HOUSING AFFORDABILITY: EVIDENCE FROM ZIP CODES IN THE UNITED STATES

4.1 Introduction

The housing market in the United States experienced a dramatic boom and bust cycle that led to a financial and economic crisis. This great recession, which started in the 2000s and ended in 2009, was the most severe economic contraction since 1947, as measured by the peak-to-trough decline in real GDP (Glick et al., 2015). Since 2011, the constant increase in the median sale price of houses in the United States and the experience derived from previous recessions raised concerns regarding the reasons behind, and the consequences of, volatility in the market. Apart from the macroeconomic impact of housing price fluctuations, an increase in housing prices will make housing unaffordable for a large number of middle and low-income households. Some poor families struggle to maintain a basic level of subsistence even if they spend a relatively low proportion of their income on housing (Chen et al., 2010).

On the other hand, income inequality has been rising continuously in the United States as well, inspiring some researchers to investigate whether there is a relationship between inequality and housing affordability. Theoretically, it is easy to argue that income inequality has an effect on housing prices. In a competitive market with a limited housing supply, housing prices will increase if the income of wealthy households increases, since they will increase the amount they are willing to pay on houses simply because they can afford it. The housing then will be less affordable for those households whose income has not changed or has decreased. Figure (1) shows the parallel trend of the housing affordability index (housing price-to-income ratio) and inequality (Gini coefficient) in the United States between 2005 to 2015. Although

the positive relationship between housing affordability and income inequality over time only demonstrates correlative, and not causal, relationship between these two, it certainly motivates us to investigate this subject.

In this paper, I study the impact of income inequality on housing affordability in the United States. Using Internal Revenue Service (IRS) annual data, I calculate the Gini coefficient for each zip code from 2005 to 2015. Employing Zillow and IRS zip code level data sets, I compute the price-to-income ratio, the most widely used measure of housing affordability (Hulchanski, 1995). The price-to-income ratio, calculated using median house prices over median income, is an index of access to housing; the ratio increases as housing becomes less affordable.

Affordable housing for all citizens has been one of the main concerns of governments around the world. In the United States this subject was raised regularly, for example, by the Clinton Administration and Millennial Housing Commission in 2002. The public concerns about housing affordability arise from the fact that housing is an investment asset, and for an average family housing is the single most important component of their financial portfolio (Fairchild et al., 2014). The average household devotes roughly one-quarter of its income to housing expenditures, while poor and near-poor households commonly devote half of their incomes to housing (Quigley and Raphael, 2004), resulting in small changes in housing prices having a major impact on some households' well-being.

The recent debate over government tax cut policy focused on argument that increasing the income of wealthy individuals has an indirect “trickle-down” effect on those further down the income distribution, as explained by Matlack and Vigdor (2008); however, income increase at the high end of distribution can raise the prices of goods consumed by the poor. In reality, because of the down-payment requirements and limited affordable housing supply available to low-income households, the

demand for low quality or smaller housing will increase as well, leading to an increase in all types of housing in a region. Therefore, wealthy households will gain the most advantages, not only due to income increases but also because of the capital gains associated with owning their own house, causing the inequality (wealth inequality if not income inequality) to increase even more.

This paper is not the first that investigates the impact of income inequality on housing affordability. Rodda (1994) shows a positive relationship between the income inequality and housing prices. Lamont and Stein (1999) show that in cities where homeowners are more leveraged, house prices react more sensitively to city-specific shocks, such as changes in income. The results of Quigley et al.'s (2001) estimation suggests that rather modest improvements in the affordability of rental housing or its availability can substantially reduce the incidence of homelessness in the United States. Vigdor (2002) investigates the hypothesis that an increase in the income of the wealthy causes housing affordability problems for the poor. Ortalo-Magne and Rady (2002) argue that homeownership adds to the volatility of the housing market, amplifies the dispersion of household income within a location, and raises distributional issues. They also confirm that the families who acquire the most housing gain the most from the ability to own their home. Quigley and Raphael (2004) argue that modest changes in institutional arrangements could greatly affect the affordability of homeownership, especially for young households whose incomes will increase over the life cycle of ownership. Matlack and Vigdor (2008) show that in a simple partial equilibrium model, an increase in income at the high end of the distribution can raise prices paid by those at the low end of the income distribution. Using census micro-data and data on housing markets in American metropolitan areas between 1970 and 2000, they show that in markets with low-vacancy rates, increases in income at the high end of the distribution are associated with significantly higher rent per room.

Gyourko et al. (2013) document large long-term differences in average housing price appreciation across metropolitan areas over the past 50 years. They show that these differences can be explained by an inelastic supply of land in some unique locations combined with an increasing number of high income households nationally. Ray et al. (2015) show that there is an affordability crisis in Los Angeles that is accentuated by income inequality. Chen et al. (2010), Zhang (2015) and Zhang et al. (2016) show that income inequality is one important factor in housing affordability in China.

I am, however, one of the first papers to study the relationship between income inequality and housing affordability in the United States. In previous studies I continuously see the importance of local economic variables. Using zip code level data sets, I am the first to capture local and regional factors affecting the housing market, as well as demographics. For instance, Abraham and Hendershott (1996) document a significant difference in time-series properties between coastal and inland cities, Capozza et al. (2004) argue that the dynamic properties of housing markets are specific to the given time and location being considered, and Hwang and Quigley (2006) argue that housing demand is a function of prices, incomes and demographic variables as well. Their studies confirm the importance of changes in regional economic conditions, income and employment on the local housing market.

In this paper, I study the impact of income inequality on housing affordability among zip codes in the United states using OLS, Fixed Effect (FE) estimations and then system GMM method, to address potential endogeneity. My results confirm that an increase in income inequality leads to an increase in the housing affordability index, meaning less affordable housing for families in the United States. Using three different estimation methods and two ways of calculating the Gini index, I show that my results are robust.

The rest of the paper is organized as follows: in Section 2, I provide a simple model that emphasizes the relationship between income inequality and housing price to income ratio; in Section 3 I discuss the data and methodology used in this research; sections 4 and 5 contain the empirical results of my analysis and robustness check; and, finally, I present my concluding remarks and policy implications in Section 6.

4.2 Economic Model

Following Zhang et al. (2016) and using a simple partial equilibrium model, I can show how an increase in income inequality will lead to a higher housing price-to-income ratio, i.e. less affordable housing, especially for low-income households. Without loss of generality, here are the assumptions I make:

- We have two types of households in each zip code: high income households (H) and low income households (L).
- The total number of households is standardized as a unit, with the proportion of H-type household denoted by θ .
- $0 < \theta < 1/2$, i.e., high income households are the minorities in each zip code.
- The total income of all households is denoted by Y , with the total income proportion of H-type households as γ . By definition, we have $1/2 < \gamma < 1$.
- The utility functions for H-type and L-type households take the same form, i.e. $U(x, y) = x^\alpha y^{1-\alpha}$, where x denotes the size of houses and y denotes all other consumption.
- The unit price of houses is denoted by p , while the unit price of other goods is normalized to a unit.
- The supply function of housing is linear in price, i.e., $S(p) = bp$, where $b > 0$.

After simple calculations, I have the Gini coefficient, G , equals $\gamma - \theta$. Then, solving the utility-maximization problem of the household gives us the housing demands of H-type households and L-type households as:

$$x_H = \frac{\alpha\gamma Y}{p\theta} \quad (4.1)$$

and

$$x_L = \frac{\alpha(1-\gamma)Y}{p(1-\theta)} \quad (4.2)$$

and therefore the demand for housing in each zip code is:

$$D(p) = \theta x_H + (1-\theta)x_L = \frac{\alpha Y}{p} \quad (4.3)$$

In equilibrium, I have the housing price p as:

$$p = \sqrt{\frac{\alpha}{bY}} \quad (4.4)$$

and aggregate demand for housing as:

$$X = \sqrt{abY} \quad (4.5)$$

The housing price to income ratio, R , is then:

$$R = \sqrt{\frac{\alpha}{bY}} \left(1 + \frac{G}{1-\gamma}\right) \quad (4.6)$$

which is median housing price over median household income. Looking at equation (6) we see that an increase in income inequality (Gini coefficient, G) will cause the housing affordability index (R) to increase (Zhang et al 2016). Intuitively, when inequality increases, so does median income, since I assume that some households become wealthier while the income of others stays the same¹, which as argued previously, leads to an increase in prices for all types of housing, causing an increase in

¹or even decreases.

the median housing price. However, since the majority of the population consist of middle or low-income households, changes in the median housing price will be much bigger than changes in median income, causing the housing price-to-income ratio to rise.

4.3 Data and Methodology

In this paper, I use Internal Revenue Service (IRS) data to calculate the frequently used inequality index, the Gini coefficient, from 2005 to 2015. This zip code level annual data is drawn from the number of returns and adjusted gross income (before taxes), based on administrative records (individual income tax returns) from the Internal Revenue Service’s Individual Master File (IMF) system². Since these data is based on individual income tax returns filed with the IRS, I believe self-reported measurement error is minimized.

The published IRS data, i.e., Individual Income Tax Statistics (SOI), is in group form. I rely upon the studies of Cowell and Mehta (1982), Cowell (1995) and Frank (2009), to construct a compromise Gini coefficient. Accordingly, the lower limit of the Gini coefficient can be derived based on the assumption that all individuals in a group receive exactly the mean income of the group:

$$G_L = \frac{1}{2} \sum_{i=1}^k \sum_{j=1}^k \frac{n_i n_j}{n \mu} |\mu_i - \mu_j| \quad (4.7)$$

where n is the number of individuals, μ is mean income, and subscripts i and j denote within-group values. The upper limit of the Gini can be derived based on the assumption that individuals within the group receive income equal to either the lower or the upper bound of the group interval:

²SOI Tax Stats - Individual Income Tax Statistics ZIP code documentation guide

$$G_U = G_L + \sum_{i=1}^k \frac{n_i^2(a_{i+1} - \mu_i)(\mu_i - a_i)}{n^2\mu(a_{i+1} - a_i)} \quad (4.8)$$

The compromise Gini coefficient proposed by Cowell and Mehta (1982) is then simply $2/3G_U + 1/3G_L$ (Frank 2009).

The data used for median housing prices was gathered from the Zillow data set. Zillow Home Value Index (ZHVI) is a seasonally adjusted measure of the median estimated home value across a given region (here different zip codes) and housing types³. I use ZHVI and median income (calculated using same IRS zip code-level data) to estimate my dependent variable, housing price to income ratio. This ratio has been used widely in the literature as a measure of housing market situation; a high housing price-to-income ratio is an indication of the housing market status, sometimes even a measure of a housing bubble (Green and Malpezzi, 2003; Jensen, 1998; Girouard et al., 2006). A threshold for this measure is often employed to judge whether housing bubbles exist or not, although the choice of threshold is under debate and varies across different contexts⁴ (Zhang et al, 2016).

To estimate the impact of inequality on housing affordability, I use OLS and FE methods. FE estimation was chosen to eliminate omitted variable bias. However, I am also facing endogeneity. To address this issue, I add the system GMM developed by Arellano and Bover (1995) and Blundell and Bond (1998) to my analysis.

The model, as elaborated in previous literature, is as simple as:

$$R_{it} = \alpha + \beta G_{it} + X_{it} + u_{it} \quad (4.9)$$

³<https://www.zillow.com/research/data/>

⁴Renaud (1991) claimed that the housing price to income ratio in a healthy housing market should have a value between 2 and 6, whereas a higher value may reflect housing bubbles.

where R_{it} is housing price to income ratio of the zip code i at time t , G_{it} is the constructed compromise Gini coefficient and X_{it} is a set of control variables that I believe may impact housing affordability, including share of minorities (African American households), proportion of members of the male gender and population (all at zip code level), and GDP per capita (at the state level). u_{it} is the error term including the city fixed effect. Zip code level demographic data was gathered from the 2010 U.S. Census and the state level GDP per capita was gathered from the Bureau of Economic Analysis (BEA). β is my coefficient of interest.

Table (1) shows a summary of the statistical data I use in this study. My data set covers more than 12,700 zip codes of the United States from 2005 to 2015. The upper part of the table shows the average of the variables across all zip codes and their corresponding standard deviation. As indicated in this table, housing price-to-income ratio and Gini coefficient are 8.84 and 0.46 on average across all zip codes with a standard deviation of 5.4 and 0.07, respectively. The average of the share of minorities (African Americans) and proportion of members of the male gender in households is 20 and 49 respectively, with standard deviations of 21 and 2 respectively, showing the vast differences especially in the share of different races between regions of this country. Percentages of family members with a bachelor's degree has an average of 29 with standard deviation of 14. These data set covers zip codes with average population of 20821 per square mile. The last column shows the state level GDP is 48904 dollars per capita on average with a standard deviation of 9226.

This table clearly indicates the significant differences across zip codes, confirming again that housing is a local market, hence a comprehensive zip code analysis has more advantages over country or state level studies, as are commonly used in other investigations. A detailed data set, such as mine, will capture the importance of regional factors affecting the fluctuations in this market. Examples of previous studies

that verify the significance of local factor are Del Negro and Otrok (2007) who argue that historically, movements in housing prices are mainly driven by local factors, rather than variations in national factors, or Fratantoni and Schuh (2003) who explain that housing is determined in local markets and heavily dependent upon regional factors. The bottom part of table (1), which shows the correlation between these variables, confirms a positive correlation between the Gini coefficient and housing price to income ratio.

4.4 Empirical Results

In this section, I present the regression results using Equation (9). Table (2) shows the results of regression specifications examining the impact of income inequality on housing affordability, which is measured using the logarithm of the Gini Coefficient so that these regressions examine the effect of variation in income inequality operating both through variation in their own and others' income (Matlack and Vigdor, 2008). I use 3 methods of estimation: OLS, FE and system GMM. All variables have a positive sign, as expected, especially for the coefficient of interest, the Gini coefficient, showing that inequality is positively related with housing affordability, regardless of the method used. OLS results without and with control variables are shown respectively in the first two columns of table (2). The coefficient of the Gini coefficient in the second column suggests that a ten percent increase in the Gini coefficient leads to 0.53 increase in housing price to income ratio. This estimation is statistically significant at the 0.1 percent level.

In the next two columns, (3) and (4), I turn to FE estimation to control for unobserved zip code and time heterogeneity. The results using fixed effect show that a ten percentage change in inequality causes the housing price to income ratio to rise by 5, statistically significant at the 0.1 percent level, which is close to my OLS

estimation results. Controlling for the year fixed effect in column (4), the point estimate of the Gini coefficient becomes 0.08, which is slightly bigger than the OLS estimate, and still significant. The small difference between the estimates with and without control variables implies that the potential endogenous bias may not be severe (Zhang et al., 2016).

To address the reverse causality problem, I turn to system GMM estimation results, shown in the last column. The Gini coefficient here shows that an increase in inequality by ten percent, will lead to an increase in housing price to rent ratio index by 0.8, statistically significant at the 0.1 percent level, which is close to the FE estimation. The points estimate the Gini coefficient using all methods are consistent with my hypothesis that an income inequality measured by Gini coefficient is significantly and positively related to housing affordability. My results in table (2) indicates that an increase in inequality leads to an increase in housing affordability index, meaning less affordable housing in the United States.

4.5 Robustness Check

4.5.1 Income Inequality Measured with Salaries and Wages

There has been a concern regarding an endogeneity problem in previous studies, arguing that housing prices may affect income inequality as well. The reverse causality problem comes from the fact that there is a capital gain associated with housing assets, especially when housing prices are rapidly increasing⁵. Moreover, owners in this market may benefit from rental income. The endogeneity problem will cause my OLS and FE estimation to be biased. However, I included the system GMM in my specifications to address in this issue and my regression results in table 2 show that the

⁵Zhang et al. 2016.

Gini coefficient is quite similar among various methods, suggesting that the potential, omitted variable bias is not severe enough to alter my conclusions qualitatively (Zhang et al., 2016).

Nevertheless, to address the reverse causality problem as a robustness check, I analyze the impact of inequality using the Gini coefficient measured only with salaries and wages reported to the IRS. As we see in the previous studies, although salaries and wages may still not be entirely independent of the housing prices, they are less likely to be affected and less likely to have measurement errors, compared to reported total income.

Tables (3) and (4) represents the summary statistics of the data and same regression results, only this time I am using a Gini coefficient measured with salaries and wages. In table (3), the correlation between income inequality and housing price to rent ratio is a bit smaller, but still positive. Using salaries and wages, the coefficient of interest in my analysis shown in table (4) has still a positive sign and is statistically significant at the 0.1 percent level. However, the coefficient reported in columns (4) and (5) of table (4) are bigger than corresponding columns in table (2), suggesting that after including city and time fixed effect and addressing endogeneity problem, the impact of inequality on housing affordability is larger when Gini index is measured using salaries and wages. My main results, however, stays the same; with an increase in income inequality, housing affordability index rises, meaning less affordable housing for households.

4.5.2 Impact of Income Inequality on Zip Codes with Different Levels of Income

Now I turn to the impact of inequality on housing affordability in different zip codes. As I mentioned before, Lamont and Stein (1999) argue that in cities where homeowners are more leveraged housing prices react more sensitively to city-specific shocks, such as changes in income. One might expect zip codes with higher levels of income to experience higher levels of housing prices as income inequality increases; wealthier households bid higher on houses in their zip code because they can afford paying higher prices, whereas low income households may struggle even for low quality and cheap types of housing.

Table (5) shows the regression results of my analysis on the relationship between income Gini coefficient (using total income) and the housing price-to-income ratio at different percentiles. Following the literature, considering the endogeneity problem and the robustness of my results among different methods used in the previous sections, I used the fixed effect method here. The coefficients in the Gini index in this table shows that a ten percent increase in income inequality has a larger negative effect on housing affordability for zip codes with households with higher levels of income, compared to low and middle-income households, which is as we expected and which confirms Lamont and Stein's argument. Table (6) shows the results of same regression analysis, this time using salaries and wages to measure Gini coefficient. The results are the same, suggesting that in wealthier zip codes, the housing price-to-income ratio is more affected by the inequality. My results also confirm the research of Abraham and Hendershott (1996) that documents a significant difference between coastal and inland cities.

4.6 Conclusion and Policy Implications

Housing prices and income inequality have been rising rapidly since 2011 in the United States. Some scholars and policy makers are now concerned that prices are too high relative to median household income, causing affordability problems for many families especially the poor. This paper estimates the impact of income inequality on housing affordability. The relationship between these two variables can be explained theoretically. Wealthier households bid higher on houses when their income increases, while middle and low-income households struggle for low quality housing, leading prices to rise for all types of housing.

Employing zip code level data from 2005 to 2015, this paper empirically studies the impact of inequality on housing affordability in the United States. My indicator of income inequality is the Gini coefficient, and for housing affordability I use the housing price-to-income ratio. The analysis in this study yields three main findings. First, using IRS data on income and Zillow data on median housing prices, this paper argues that an increase in income inequality (Gini coefficient) is associated with an increase in the housing affordability index. Using OLS, FE and system GMM methods, I provide results that suggest that the Gini coefficient is positively and significantly related to the housing price to income ratio. The consistency of the results across various specifications indicates a robust relationship.

Second, to address the endogeneity problem, I use data on salaries and wages (published by the IRS) to calculate the Gini coefficient. The results present consistent patterns; a higher Gini coefficient is associated with a higher housing price-to-income ratio. According to the literature, in highly-leveraged cities, the reaction of housing prices to a change in income is greater⁶. These findings were confirmed in my paper; in zip codes with higher levels of income, we observe more substantial impact of

⁶Lamont and Stein, 1999.

inequality on housing affordability compared to zip codes with middle and low-income households. Furthermore, the empirical results in my paper serve as evidences against “trickle-down” theory. My findings confirm previous studies and reveal that a rise in wealthy households’ income leads to an increase in product prices faced by low-income families and thus makes the objective well-being of the poor worse (Zhang, 2015).

In sum, my analysis proves a positive relationship between inequality and housing affordability. Given the rapid rise in housing prices and inequality in many countries, this is a crucial policy related subject. The importance of income redistribution policies is, therefore, clearly the crux of my argument. Higher prices lead to higher rents, thus forcing the poor families to spend large fractions of their income on shelter (Quigley and Raphael, 2004). Once they have covered their housing costs, there will be less income available for saving or other consumption (Matlack and Vigdor, 2008). To maintain a healthy developed economy, governments needs to adopt redistribution policies to alleviate income inequality, as it was also suggested by Zhang et al. (2016) for China.

	HPIR	Gini Index	Minorities (%)	Male (%)	Bachelors Degree (%)	Population	GDP
Mean	8.843613	.4682712	19.99664	49.1919	29.35671	20821.54	48904.52
SD	5.401261	.0709575	21.07048	2.029753	14.41628	15821.32	9226.227
HPIR	1.0000						
Gini Index	0.3257	1.0000					
Minorities	0.0723	-0.2282	1.0000				
Male	0.0167	-0.0225	-0.0721	1.0000			
Bachelors Degree	0.4819	0.5127	-0.2114	-0.1415	1.0000		
Population	0.1467	-0.0812	0.4595	-0.1489	0.0380	1.0000	
GDP	0.3882	0.0893	0.0452	-0.0135	0.2672	0.0204	1.0000

Table 4.1: Summary Statistics of data, 2005–2015. All variables are zip code level data (except for GDP that is State level). Gini Index in this table is calculated using Adjusted Gross Income (AGI). The upper part of this table shows mean and standard deviation and the bottom part shows correlation between these variables.

Dependent variable: Housing Price-to-Income Ratio					
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	FE	FE	GMM
Gini Index	0.114*** (109.28)	0.0531*** (51.04)	0.0500*** (41.63)	0.0886*** (60.86)	0.0874*** (57.98)
Minorities (%)		0.0364*** (49.96)	-	-	0.0367*** (33.35)
Male (%)		0.265*** (40.43)	-	-	0.117*** (6.44)
Bachelors degree (%)		0.140*** (125.08)	-	-	0.133*** (82.50)
Population		0.306*** (32.45)	-	-	0.148*** (6.23)
GDP		1.559*** (105.80)	-	-	1.931*** (49.41)
Lag of the ratio					0.00860** (3.07)
Constant	17.62*** (215.45)	-13.65*** (-39.04)	-13.58*** (-27.76)	-13.87*** (-29.57)	9.502 (0.06)
Year fixed effect	No	No	No	Yes	Yes
N	111026	111026	111026	111026	100496
R^2	0.097	0.359	0.350	0.427	-
adj. R^2	0.097	0.359	0.350	0.427	-

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 4.2: Regression results of panel data analyses of the impact of inequality (calculated using Adjusted Gross Income, AGI) on housing price-to income ratio. Robust standard errors clustered at the city level are in parentheses. For the system GMM estimation in the last column, P-value of the Arellano-Bond test suggests that instruments are valid.

	HPIR	Gini Index	Minorities (%)	Male (%)	Bachelors Degree (%)	Population	GDP
Mean	8.226779	.4206804	20.26871	49.18923	29.56019	21283.32	48920.66
SD	4.89593	.0562135	21.01639	2.085061	14.05455	15773.48	9101.493
HPIR	1.0000						
Gini Index	0.2705	1.0000					
Minorities	0.0874	-0.3088	1.0000				
Male	0.0320	-0.0386	-0.0732	1.0000			
Bachelors Degree	0.4450	0.5728	-0.2084	-0.1164	1.0000		
Population	0.1467	-0.1052	0.4619	-0.1498	0.0115	1.0000	
GDP	0.1373	0.1333	0.0412	-0.0101	0.2632	0.0127	1.0000

Table 4.3: Summary Statistics of data, 2005–2015. All variables are zip code level data (except for GDP that is State level). Gini Index in this tables is calculated using salaries and wages.

Dependent variable: Housing Price-to-Income Ratio					
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	FE	FE	GMM
Gini Index	0.0956*** (82.48)	0.0272*** (21.79)	0.0210*** (13.92)	0.0929*** (52.55)	0.120*** (44.07)
Minorities (%)		0.0343*** (46.03)	-	-	0.0423*** (39.37)
Male (%)		0.243*** (38.18)	-	-	0.0996*** (4.54)
Bachelors degree (%)		0.130*** (111.05)	-	-	0.0995*** (65.95)
Population		0.265*** (28.01)	-	-	0.105*** (3.66)
GDP		1.398*** (93.62)	-	-	1.734*** (36.14))
Lag of the ratio					0.0112** (3.08)
Constant	16.59*** (161.81)	-13.75*** (-39.31)	-14.18*** (-27.34)	-10.69*** (-21.69)	0 (.)
Year fixed effect	No	No	No	Yes	Yes
N	96745	96745	96745	96745	77496
R^2	0.066	0.316	0.306	0.401	-
adj. R^2	0.066	0.316	0.306	0.401	-

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 4.4: Regression results of panel data analyses of the impact of inequality (calculated using salaries and wages) on housing price-to income ratio. Robust standard errors clustered at the city level are in parentheses. For the system GMM estimation in the last column, P-value of the Arellano-Bond test suggests that instruments are valid.

Dependent variable: Housing Price-to-Income Ratio			
	(1)	(2)	(3)
	< 10 th percentile	25 th > and < 75 th percentile	> 90 th percentile
Gini Index	0.0248***	0.107***	0.213***
	(4.11)	(46.47)	(22.23)
Fixed effect	Yes	Yes	Yes
N	11103	55510	11103
R^2	0.374	0.415	0.672
adj. R^2	0.373	0.415	0.671

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 4.5: Regression results of panel data analyses of the impact of inequality (calculated using Adjusted Gross Income, AGI) on housing price-to income ratio for zip codes in different percentiles of income. The results in this table were estimated using FE model (column 4 of table 2).

Dependent variable: Housing Price-to-Income Ratio			
	(1)	(2)	(3)
	< 10 th percentile	25 th > and < 75 th percentile	> 90 th percentile
Gini Index	-0.00420	0.105***	0.209***
	(-0.64)	(38.21)	(20.50)
Fixed effect	Yes	Yes	Yes
N	11103	55510	11103
R^2	0.374	0.415	0.672
adj. R^2	0.373	0.415	0.671

t statistics in parentheses

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 4.6: Regression results of panel data analyses of the impact of inequality (calculated using salaries and wages) on housing price-to income ratio for zip codes in different percentiles of income. The results in this table were estimated using FE model (column 4 of table 2).

Figure 4.1: Dynamics of Gini coefficient and housing price to income ratio over 2005 to 2015

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