The Impact of Local labor Market Conditions on the Federal Disability Insurance Program: Evidence from the Bakken Oil Boom

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November 5, 2014

Abstract

While much of the United States was suffering from the Great Recession, parts of Montana, North Dakota, and South Dakota were experiencing unprecedented economic growth and labor market activity as a result of an oil boom. This paper seeks to examine the extent to which an economic boom resulting in increased earnings and labor force participation contributes to the decrease in Disability Insurance (DI) payments and participation. I use the value of county oil reserves as an instrument for earnings to estimate a causal relationship between local economic boom and a decrease in DI payments and program participation in Montana, North Dakota, and South Dakota. Because current DI applicants and beneficiaries are likely to be more responsive to local economic conditions, this new evidence can shed light on the impact of local labor market conditions on the growth of DI payments and participation. My estimates suggest a strong relationship between local economic conditions and DI program participation. I find an elasticity of DI payments with respect to local earnings of -1.04.

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I. Introduction

The Social Security Disability Insurance (DI) program is the largest income replacement program in the United States for non-elderly adults. In 2009, there were approximately 7.7 million individuals in the United States receiving $110 billion in DI benefits. This represents an increase from nearly 5 million beneficiaries receiving about $50 billion in benefits in 2000.[1] Coinciding with this growth in program participation and real increases in spending on DI and other social insurance programs was a decline in wages and employment among low-skilled workers. In addition, two recent changes leave questions about the current relationship between DI and labor force participation. First, there is a negative relationship between local labor market conditions and DI payments and participation. Second, the liberalization of disability acceptance and an increase in benefit generosity mean that new DI applicants and entrants are younger and suffer from lower mortality impairments (Autor and Duggan, 2003). While these changes are well-documented in the literature, the new estimates in this paper provide evidence of the relationship between DI and labor force participation, which are most pertinent to the DI program as it currently stands.

In this paper, I examine the impact of local labor market conditions on DI payments and participation. The objective of this paper is to provide new estimates of this relationship that now reflect the changes to the makeup of the labor force and DI applicant and beneficiary pools over the past two decades. Estimating a causal relationship between local labor market conditions and DI payments and participation is intrinsically difficult. A fundamental challenge is that at the level of the local labor market, earnings, employment, and DI participation are jointly determined. That is, an increase in county-level earnings will increase both employment and the

[1] *Statistical Abstract of the United States*, Table 567 provide benefit amounts for DI benefit amounts (US Census Bureau, 2012).

value of an individual's potential DI payments. The value of individual DI payments is expected to increase due to the increase in earnings, which increases the level of income replacement from DI.

To surmount these challenges, I develop an instrumental variable that exploits variation in local earnings induced by the value of oil reserves, which is exogenous. Following closely the approach of Black et al. (2002), I use changes in in local earnings growth within states to see how changes in local labor market conditions affect participation in the DI program. An oil boom in certain areas of Montana, North Dakota, and South Dakota (henceforth referred to as "the three-state region") was spurred by technological advances in drilling techniques and rising oil process, which have made drilling for oil profitable (see Figure 1 for a map of the region). For the oil-rich portions of these states, there is an exogenous shock to the value of labor force participation. Much of the oil activity and, by extension, economic activity takes place around the Bakken formation, where there are large amounts of proven reserves. Oil-rich portions of these states experienced rising employment and earnings, while other parts of the region and the country suffered from the impacts of the Great Recession. I use oil reserves data from the Energy Information Administration (EIA), county-level administrative earnings data from the Internal Revenue Service (IRS), and DI payment and beneficiary data from the Social Security Administration (SSA). I use an instrumental variables (IV) strategy, with the value of county oil reserves as an instrument for earnings, to estimate a causal relationship between the local economic boom and a decrease in DI payments and program participation.

My work contributes to an influential literature that explores the relationship between disability and labor force participation in the U.S.[2] Black et al. (2002) and Autor and Duggan (2003) provide evidence, at both the local labor market and national levels, that economic

[2] Bound and Burkhauser (1999) present a review of the literature.

conditions impact DI participation. Both studies rely on economic changes of the 1970s, 1980s, and early 1990s to identify these effects. This paper will provide more recent evidence on the impact of local labor market conditions on DI program participation and labor market outcomes. Providing more recent evidence is important because the impact of local labor market conditions on DI may be greater today than in the past. Research suggests that current DI applicants and beneficiaries may be more responsive to changes in local labor market conditions due to recent systematic and programmatic changes to DI (Autor and Duggan, 2003).[3]

Understanding the impact of local labor markets on DI is a first-order issue in the design of DI program benefits. The public provision of DI is the outcome of a market failure in which it is not feasible for private markets to insure high-risk individuals against the event of work-inhibiting disability. The resulting moral hazard problem is that individuals may select into risky occupations or opt out of the labor force when DI is provided, reducing program efficiency. The DI program continues to play an important role in the social safety net, particularly for low-skilled workers. Thus, new estimates will contribute to our broader understanding of the labor force attachment of low-skilled workers.

A central question of this literature has been the degree to which disability participation and labor force participation are substitutes. This substitutability is determined by the relationship between local economic conditions and DI program participation; Black et al. (2002) find an elasticity of DI payments with respect to local earnings of -0.3 to -0.4. In comparison, I expect that my estimates will be negative but larger in magnitude. A larger effect may serve to bolster Autor and Duggan's (2003) argument that systematic and programmatic changes have altered the labor force attachment of current workers. It may also indicate that this most recent

[3] Due to a 1984 eligibility policy change, DI beneficiaries are now younger and suffer from more musculoskeletal conditions and mental impairments (Bound and Waidmann, 2002; Autor and Duggan, 2006; Duggan and Imberman, 2009; von Wachter et al., 2011).

recession and oil boom have had a more profound impact on labor force attachment than previous economic downturns. Overall, my estimates suggest that there is a substantial, statistically significant relationship between local economic conditions and DI payments. I find an elasticity of payments and participation with respect to local earnings of -1.04 and -0.67, respectively. These estimates suggest that the oil boom led to decreases of 2.5 percent and 1.6 percent for DI payments and participation, respectively.[4]

The rest of this paper proceeds as follows. Section II presents a description of the DI program. Section III describes the previous literature. Section IV provides an overview of the oil boom. Section V describes the data and econometric specifications. Section VI outlines the results, and Section VII concludes.

II. DI Program Description

All participants in the Social Security system are covered by the DI program. To qualify for DI benefits, an individual must be deemed disabled by the Social Security Administration (SSA). While the criteria for eligibility for the federal DI program are uniform across states, applicants file their claims to state-appointed boards. According to SSA rules, an individual is deemed disabled if he or she is unable "to engage in substantial gainful activity by reason of a physical or mental impairment." In 2013, “substantial” employment was determined by an individual’s ability to earn more than $1,040 per month. In addition, impairment must last for at least 12 months or be expected to result in death.

SSA maintains a list of impairments that, if diagnosed by a physician, qualify individuals for benefits. If individuals have conditions not on this list, however, they may still qualify for benefits if physicians determine that the conditions result in sufficient impairment. In making the

[4] For the DI program, Black et al. (2002) find that the elasticity of payments with respect to local earnings is between -0.3 and -0.4. This estimate corresponds to a decrease in DI payments of 1.26 percent for Appalachian coal counties.

determination of impairment, the applicant's age, education, and work experience are also considered when deciding whether an applicant is able to work. Such work does not need to exist in the area in which the applicant resides, nor does there need to exist a job vacancy for the individual.

There are no income or asset tests or further requirements for participation in the DI program. DI payments are based on past earnings. High-income individuals receive more benefits from DI than low-income individuals. Caps on the amount that individuals can receive from (or pay into) the DI system as well as income replacement rates make the system progressive—the income replacement rate is higher for low-income individuals than for high-income individuals. Therefore, the relative reduction in income resulting from labor market withdrawal is smaller for disabled, low-wage workers than for disabled, high-wage workers.

III. Previous Literature

A substantial body of previous literature explores the causes and consequences of growth in DI payments and participation. The majority of these studies focus on the relationship between DI and labor force participation of men. Early works disagree about the extent to which the post-WWII decrease in male labor force participation was caused by increases in DI benefit generosity. Parsons (1980 and 1984) argue that increases in DI generosity account for nearly all of the decrease in male labor force participation. Haveman and Wolfe (1984) and Bound (1989) find a much more modest relationship. Subsequent studies support the hypothesis that increased benefit generosity and liberalized eligibility criteria reduce labor force participation, with the magnitude of the relationship varying across studies (Bound, 1991; Bound and Waidmann, 1992 and 2002; Parsons, 1991a and 1991b; Gruber, 2000; Gruber and Kubik, 1997; Stapleton et al., 1998).

More recent studies have focused on the changing composition of DI applicants and beneficiaries due to increases in generosity and the liberalization of eligibility criteria.[5] In 1984, in response to the negative public opinion regarding a series of successful efforts to reduce the number of beneficiaries, Congress passed legislation which greatly liberalized the DI system. Generally, the 1984 reforms broadened the definition of disability and provided applicants and doctors greater opportunity to influence the decision process.[6] Studies on these compositional changes, resulting from liberalization, find that DI applicants and beneficiaries are now younger and suffer from more musculoskeletal conditions and mental impairments (Autor and Duggan, 2006; Bound and Waidmann, 2002; Duggan and Imberman, 2009; von Wachter et al., 2011).

Autor and Duggan (2003) emphasize the role these changes, as well as rising replacement rates, play in the financial incentive to apply for DI benefits. The authors argue that the interaction between the progressive formula used in determining replacement rates (the fraction of one's income that can be replaced with DI benefits) and rising income inequality resulted in the relative increase of replacement rates for low-skilled workers.[7] This discrepancy effectively increased the value of participation in the DI program, and decreased the value of labor force participation, for low-skilled workers.[8] The authors use state-level data and an instrumental

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[5] See Autor and Duggan (2003), Goodman and Waidmann (2003), and Burkhauser and Daly (2011) for more detailed discussions of these policy changes.

[6] Three main aspects of the 1984 legislation contributed to the expansion of the DI program. First, mental illness screening guidelines were relaxed, placing more weight on the individual's ability to function in a workplace. Second, additional weight was placed on general pain in the disability determination process. Finally, criteria were relaxed such that an individual would qualify for DI if he or she had numerous impairments, which alone would not qualify him or her for benefits, but together these impairments could prevent the individual from participating in gainful activity. At the same time, Continuing Disability Reviews became much less common. As a result, fewer beneficiaries were terminated for failing to meet eligibility requirements.

[7] According to Autor and Duggan (2003), real weekly earnings of full-time workers with less than a high school degree fell by 19.1 percentage points between 1975 and 1999. During the same period, the SSA's mean wage series increased by 21.6 percentage points in real terms.

[8] Benefits are indexed to the mean wage in the economy. When income inequality is increasing, as it has over the past few decades, the income replacement rate of DI benefits for workers at the bottom of the income distribution grows faster than the replacement rate for workers at the top of the distribution. Therefore, workers with relatively

variable strategy to identify exogenous variation in the supply and demand of DI benefits. They find that increases in the supply of DI benefits are likely to result in the differential labor force exit of low-skilled workers. Ultimately, these programmatic changes increasing the supply of DI benefits double the labor force exit propensity of low-skilled workers and increase the sensitivity of DI participation to changes in economic conditions.

Other studies have further examined the extent to which economic conditions impact growth in DI participation. Stapleton and Rupp (1995) summarize earlier work exploring the relationship between unemployment rates and DI participation. These works generally find that a 1 percentage point increase in the unemployment rate increases DI awards by between 2 and 6 percentage points, with some studies finding a negligible effect (Hambor, 1975 and 1992; Lando, 1979; Levy and Krute, 1983; Muller, 1982).

In an influential study, Black et al. (2002) estimate the causal impact of local economic conditions on DI program participation using evidence from the coal boom and bust of the 1970s and 1980s in Appalachia. They find that, during the coal bust, workers in coal counties saw their earnings fall 13.5 percent relative to those in counties without coal. For the DI program, they find that the elasticity of payments with respect to local earnings is between -0.3 and -0.4. This study built on previous work examining the relationship between the increases in DI and SSI programs and the decreases in wages and labor force participation of low-skilled workers.

Past studies provide a substantial foundation for our understanding of the relationship between local economic conditions and DI payments and participation. These studies, however, largely focus on the 1970s, 1980s, and 1990s. Given DI liberalization and its impact on the

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high income replacement rates experience a relative decrease in the value of labor force participation, compared to DI participation (Autor and Duggan, 2003).

composition of beneficiaries, these studies may fail to capture the extent to which DI and labor force participation are substitutes among current beneficiaries.

IV. Oil Boom Background

The source of oil is organic matter that is preserved and buried in some sedimentary rocks. For an oil deposit to be considered for commercial production, three important geological criteria must be met (Hyne, 2012). First, there must be a subsurface source rock that generated the oil (see Figure 1). The most common source rock is black shale. Black shale originated as organic matter-rich mud on ancient seafloors.[9] As the black shale source rock was covered with more and more sediments and buried further below the Earth's surface, the heat from geological pressure turned the organic matter into oil. Second, there must be a separate subsurface reservoir rock that holds the oil. Reservoir rocks are sedimentary rock layers that contain billions of tiny spaces, or pores. Sandstone (composed of compressed grains of sand) and limestone (composed of broken down seashells and corals) are common reservoir rocks. Oil is able to flow through sandstone, limestone, and other reservoir rocks through the pore spaces between the sediments. Third, there must be a geological trap and cap rock to concentrate the oil into commercially extractable quantities. The trap is a geological high point in the formation which prevents the oil from flowing upward, and the cap rock is a seal that prevents oil from flowing through it, concentrating the oil in the reservoir rock.

In "conventional" oil extraction, a well is drilled into the reservoir rock. Such methods characterize oil production in the United States, including North Dakota, for much of the previous century.[10] In contrast, the recent shale oil boom involves drilling into and extracting

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[9] The shale oil extracted from the Bakken was formed approximately 350 million years ago during the late Devonian and early Mississippian geologic periods (Hyne, 2012).

[10] While the focus of this paper is on the Bakken formation, the explanations of the geology of fossil fuels and extraction technologies can generally be applied to other regions with shale oil and gas reserves and extraction (i.e.

resources from the shale source rock. Shale is less porous and permeable than typical reservoir rocks (i.e. sandstone and limestone, among others) (Maugeri, 2012). Shale oil and gas are often referred to as "unconventional" resources because of their geology as well as the techniques used in extraction. Shale oil is extracted using the combined application of horizontal drilling and fracking techniques. Horizontal drilling is particularly effective in shale formations because more well surface area is exposed to the oil-rich rock as compared to traditional vertical drilling. Hydraulic fracturing is the process of injecting large volumes of fluids into a well to fracture the rock (shale, in this case). The fluid used is generally combined with sand before it is injected. The sand particles, known as propping agents, hold open the fractures in the shale and allow oil to flow into the well (Hyne, 2012).

Figure 2 presents price and production data for North Dakota, since production began in 1952. Geologists and petroleum experts have been aware of the formation since the middle of the previous century when Amerada Petroleum Corporation drilled the area's first commercial oil well at the Clarence Iversen farm in Tioga, North Dakota in 1951. However, later that year Amerada made another important discovery at the Henry O. Bakken farm, also in Tioga. The Bakken well is important because it was the first in the area drilled into the older (deeper) geologic formation that became known as the Bakken formation. From 1951 through the 1970s, oil production averaged a modest 20 million to 25 million barrels per year. Beginning in 1973 with the OPEC embargo and continuing through the oil crisis of 1979, rising oil prices led to a boom in production in North Dakota in the 1980s. Even with record-high oil prices, annual production peaked at approximately 50 million barrels in 1984, compared to nearly 900 million barrels produced in Texas (EIA, 2014).

Marcellus and Utica in the Appalachian region, Eagle Ford and Barnett in Texas, and Woodford in Oklahoma, among others).

While oil companies have had access to these new technologies for some time, their combined application was not successful until 2000 when Mitchell Energy extracted natural gas from the Barnett shale in Texas (Maugeri, 2012). In North Dakota's Bakken, Continental Resources is credited with the first commercially successful combined horizontal drilling and hydraulic fracturing oil well in 2004 (Continental Resources, 2011). North Dakota oil production hit nearly 250 million barrels in 2012 and continues to increase. Production resulting from this most recent boom dwarfs that of the 1980s.

V. Methodology and Data

The goal of this paper is to provide evidence of a causal relationship between local labor market conditions and DI program participation. I begin this empirical analysis by examining the relationship between county-level earnings and DI payments and program participation.

Treating the county as the local labor market, I present the relationship between local earnings and DI payments as:

(1) $$ln(y)_{ist} = \beta_0 + \beta_1 ln(earnings_{ist}) + \beta_2 x_{ist} + \gamma_{st} + \varepsilon_{ist},$$

where $ln(y_{ist})$ represents the natural logarithm of the value of DI payments for county i in state s in year t, and ε_{ist} is the error term. The main explanatory variable is $ln(earnings_{ist})$, the natural logarithm of real earnings. Following Black et al. (2002), the term x_{ist} is a vector of control variables including county Metropolitan Statistical Area (MSA) status and the logarithm and log difference of county population as well as the share of workers in manufacturing in 1999.[11] The focal parameter is β_1, which represents the elasticity of the value of DI payments

[11] I control for whether or not the county is in a Metropolitan Statistical Area for the 2000 Census due to the concern that persons with disabilities may move to a metropolitan area for better access to health care. Controls for population serve as a proxy for access to medical care and the provision of public services, amenities which may attract individuals with disabilities.

with respect to local earnings. State-year dummy variables, γ_{st}, control for interstate systemic changes in the level of DI benefits over time.

The model presented in equation (1), however, does not take into consideration certain time-invariant, county-level characteristics which are correlated with DI payments. For example, counties with low education levels and poor health typically experience declining wages and increasing DI replacement rates. Thus, the error term in equation (1) can be written as:

(2) $\varepsilon_{ist} = \eta_i + \mu_{ist}$,

where η_i represents the fixed effect for county *i*. Using the differenced form of equation (1) will purge any fixed effects. Accordingly, I estimate regressions of the form:

(3) $\Delta ln(y)_{ist} = \beta_0 + \beta_1 \Delta ln(earnings_{ist}) + \beta_2 x_{ist} + \gamma_{st} + \varepsilon_{ist}$,

where Δ indicates a first difference. Changes in county DI benefit elasticity are identified by within state, over time, across county differences in earnings.

As earnings, employment, and DI participation are jointly determined at the level of the local labor market, OLS estimates will be biased. That is, an increase in county-level earnings will increase both employment and the value of an individual's potential DI payments. The value of individual DI payments is expected to increase due to the increase in earnings. Thus, I expect OLS estimates of the focal parameter, β_1, to be biased upward to zero.

Since this relationship will result in an upward bias of OLS estimates, I rely on an instrumental variables (IV) strategy to identify a causal relationship between local labor market conditions and the value of DI payments. Using the value of oil reserves as an instrument will capture the impact of the oil price-generated increase in local labor market earnings on the value of DI payments. I will apply a two-stage model to capture this econometrically.

The first-stage of the IV estimation is:

(4) $$\Delta ln(earnings_{ist}) = \alpha_0 + \alpha_1 \Delta ln(value\ of\ reserves_{ist}) + \alpha_2 x_{ist} + \gamma_{st} + u_{ist},$$

where the instrument is $ln(value\ of\ reserves_{ist})$. The instrument represents the logarithm of the value of county oil reserves for each year in 2009 dollars. This varies over time with oil prices, generating county-by-time variation in the value of oil reserves that is plausibly exogenous. The value of oil reserves changes earnings through the increased demand for labor.

Figures 3 through 5 present a visual depiction of my identification strategy. Estimates are based on data from 2000-2009, representing the early and later years of the oil boom, which continues today.[12] This oil reserve data come from the 2004 United States EIA assessment of the Bakken formation of the Williston Basin and the 2001 assessments of Montana Thrust Belt and Powder River Basin.

Using EIA shape files and MapInfo software, I aggregate oil reserves at the county level from estimates of oil field reserves. I use midpoint estimates for each oil field then aggregate at the county level as the reserves are listed in ranges. Oil reserves are in millions barrels of oil equivalent (MMBOE). I calculate the reserve value used in the specifications by multiplying a county's oil reserves by the real price per barrel of West Texas Intermediate (WTI) crude oil, also obtained from the EIA. Figure 5 shows fluctuations in the real price of oil between 1999 and 2012.

Figure 3 shows the oil reserves for the Bakken formation of the Williston Basin (eastern Montana, western North Dakota, and northwest South Dakota), Montana Thrust Belt (northwestern Montana), and Powder River Basin (southeast Montana and southwest South Dakota). The areas with the darkest shading have the highest levels of oil reserves; those areas

[12] During the late part of the oil boom from 2004 through 2009, oil production in the Bakken increased from 1 million to 5 million barrels per month. In 2009, oil production in the Bakken was approximately 3 percent of the US total monthly oil production. From 2009 to 2012, oil production in the Bakken increased from 5 million to 22 million barrels per month. In 2012, oil production in the Bakken represented approximately 10 percent of the US total monthly oil production (Federal Reserve Bank of Minneapolis, 2012).

that are white have no oil reserves. The darkest shaded counties have between 50 and 217 MMBOE. The counties shaded in gray have between 5 and 50 MMBOE. The counties shaded in the lightest gray have less than less than 5 MMBOE (but more than zero). The most oil-rich part of the region is the Bakken formation of the Williston Basin.

Figure 4 represents quartiles of average annual earnings growth rates. The areas with the darkest shading have the greatest increases in average annual earnings growth over the timeframe. The first through fourth quartiles represent income growth below 0.6 percent, between 0.6 percent and 1.4 percent, between 1.4 percent and 2.2 percent, and above 2.3 percent, respectively. The lowest growth county experienced a 1.7 percent decrease in average annual earnings; the highest growth county experienced a 7.5 percent increase. The earnings data are county-level data from the IRS. The IRS data contain information regarding wage and salary income, number of exemptions, and number of returns all at the county level.

Figure 5 depicts quartiles of average annual DI payment growth rates at the county level. Areas with the darkest shading have the highest growth in DI payments. The first through fourth quartiles represent DI payment growth below 3 percent, between 3.1 percent and 4.4 percent, between 4.9 percent and 5.5 percent, and above 5.5 percent, respectively. The county with the lowest DI payment growth experienced a 4.7 percent decrease in payments; the county with the highest payment growth experienced a 12.7 percent increase in payments. DI recipient data is available from the SSA OASDI data and contains recipient count and benefit information.

Figures 3 and 4 represent the first stage [equation (4)] relationship between oil reserves and earnings growth. Those counties with high earnings growth have the highest levels of oil reserves, as evidenced by the dark shading on both maps. The reverse is also true; areas with low earnings growth have little to no oil reserves. I find a strong positive relationship between earnings growth and value of oil reserves; the F-statistic from the test on excluded instruments is 11.37, suggesting that the value of oil reserves is a strong instrument. Without an instrument for earnings, it is not possible to establish a causal relationship between local labor market conditions and DI.

Figures 3 and 5 represent the reduced form relationship between oil reserves and DI payments. There is a negative relationship between oil reserves and growth in DI payments. Those areas with high levels of oil reserves have low levels of DI payment growth. This is evidenced by the fact that high oil reserve counties are more darkly shaded while low DI payment growth counties are lightly shaded.

VI. Results

In this section, I present estimates of the impact of earnings growth on DI program expenditures for counties in the three-state region of interest. Table 1 presents summary statistics of the sample and evidence of the negative relationship between earnings growth and DI program participation. From 2000 through 2009, oil prices were increasing at an average rate of approximately 5.4 percent per year; the average annual increase is nearly the same for the early boom (2000 through 2004) and the late boom (2005 through 2009). During the early part of the oil boom, both oil counties and counties without oil experienced average annual earnings growth between 1 and 2 percent per year. During the late part of the boom, however, average annual earnings growth in oil counties was 3.7 percent, compared to 1.3 percent in counties without oil. In the early part of the boom, growth in DI payments averaged approximately 4 percent per year in oil counties and 4.6 percent in counties without oil. During the late part of the part of the oil boom, growth averaged 2.5 percent per year in oil counties. Counties with no oil, however, experienced 4.8 percent average annual growth in DI payments. Counties with oil also seem to differ from the counties without oil in other ways. While the entire three-state region is very rural, none of the oil counties contain an MSA, compared to 7% for counties without oil (or approximately 10 of 143). Additionally, the average population of counties with oil is nearly half that of counties without oil.

I estimate four different models of DI payments. First, I estimate the OLS model from equation (3) using state-year dummies, the log difference in earnings, and other covariates, excluding control variables. Because this is a double-log model, the parameter estimate for the change in earnings can be interpreted as an elasticity of the change in DI payments with respect to a change in the level of the county's real earnings. The OLS estimates indicate a fairly weak link between earnings growth and DI payment growth. Column (1) of Table 2 shows the estimate for the model without the control variables. I repeat the analysis with control variables. These results are presented in column (2) of Table 2. Based on these OLS estimates, a 10 percent increase in county earnings would result in an approximately 1.5 percent decrease in the value of DI payments in the county. OLS estimates show a small, statistically insignificant negative relationship between DI payments and county earnings growth. These OLS estimates, however, do not focus on the oil price-induced changes in county earnings. These estimates are likely to be biased upward, compared to IV estimates, as discussed in the previous section.

In the next specifications, I use an IV strategy to estimate equation (4), with the log difference of oil reserve value and two of its lags as instruments. I interpret the log difference in oil reserve values as the percentage change in the real value of oil reserves. Table 3 presents the IV estimates. These estimates suggest a strong, statistically significant impact of earnings growth on DI expenditures. The point estimate of -1.04 in column 2 represents the elasticity of DI payments with respect to earnings growth. This estimate implies that a 10 percent increase in a county's earnings would result in a decrease in DI payments within the county of nearly 10.4 percent.[13] Clearly, increases in county earnings substantially decrease DI payments.

In Tables 4 and 5, I repeat the analysis for DI beneficiaries rather than payments. Again, OLS estimates in columns (1) and (2) of Table 4 indicate a small, negative relationship between earnings growth and growth in the number of DI beneficiaries. Based on these OLS estimates, a 10 percent increase in county earnings would result in an approximately 1.6 percent decrease in the number of DI beneficiaries in the county. These OLS estimates, however, do not focus on the oil price-induced changes in county earnings and may suffer from bias as previously discussed.

In columns (1) and (2) of Table 5, I provide the IV estimates of equation (4) with the logarithmic difference in the number of county DI beneficiaries as the dependent variable. Again, these estimates are presented with and without the control variables, and the addition of controls does not seem to impact the results. The point estimate of -0.67 in column 2 represents the elasticity of DI payments with respect to earnings growth. This estimate implies that a 10 percent increase in a county's earnings would result in a decrease in DI participation within the county by 6.7 percent. This represents a substantial and statistically significant inverse relationship between county earnings growth and growth in the number of DI beneficiaries in the county. Additionally, the instruments perform well in identification tests. The results of these tests are displayed in Table 5.

During the oil boom, however, oil counties experienced earnings growth that was 2.4 percent greater than counties without oil. This growth differential combined with the point estimates from tables 3 and 5 suggest the oil boom led to a 2.5 percent decrease in DI payments and a 1.6 percent decrease in participation in oil counties relative to counties without oil.

[13] The instruments perform well in identification tests. The results of these tests are displayed in Table 3.

My results show that, for this three-state region, the earnings growth in local labor markets generated by the oil boom significantly decreased DI payments as well as the number of DI beneficiaries. It is important to understand how to compare my estimates to those in the literature as well as generalize these results beyond this three-state region. These results are in line with the broader literature which finds a negative relationship between economic conditions and DI program participation. These results are larger than those found by Black et al. (2002).[14] There are a few explanations worth exploring. First, programmatic changes to DI have altered the make-up of both the pool of applicants and beneficiaries. Black et al. (2002) present estimates from 1970 through 1993. The 1984 reforms to the DI program expanded eligibility. Goodman and Waidmann (2003) explain that these reforms may have had a delayed impact, which did not occur until the 1990s. They surmise that it took time for people to understand the reforms and that those who lost their jobs during the economic downturn of the early 1990s applied for DI.

Autor and Duggan (2003) provide evidence that DI applicants have become increasingly sensitive to employment shocks and local labor market conditions. They find that for a given decline in the demand for labor, the increase in DI applications per capita from 1993 to 1998 was seven times larger than the increase from 1979 to 1984. If the estimates from Black et al. (2002) did not fully capture the impacts of the expansion, it could explain why it appears as though there was a smaller response to the economic conditions of the Appalachian coal boom and bust than to the more recent Bakken oil boom.

Second, while this paper and the paper by Black et al. (2002) both focus on rural areas, it is possible that there are more nuanced differences between the two regions. It is possible that

[14] Black et al. (2002) find that the elasticity of payments with respect to local earnings is between -.3 and -.4 for the DI program.

the three-state region of interest is more rural, and thus more susceptible to changes in local labor market conditions, than Kentucky, Ohio, Pennsylvania, and West Virginia. Nearly 27 percent of the Appalachian counties contained an MSA during the 1990 census, compared to just 5.7 percent of the counties in the three-state region of interest. More rural regions with smaller populations are likely to have fewer physicians. While SSA rules forbid physicians from considering local economic and labor market conditions, physicians may be more likely to approve a patient for DI if they if they are aware of the troubled local economy. Additionally, in such areas, physicians may have a more personal relationship with their patients which could increase the DI acceptance rates in such areas.

Finally, Table 6 presents IV estimates of the impact of earnings growth on the value of county DI payments, using different income measures. These additional specifications rely on wage and salary income data from the IRS as well as OASDI and Medicare earnings data from the SSA. The samples in the specifications in Table 4 are restricted to the 135 counties (out of 175 total counties in the three-state area) for which SSA data are available. The SSA data is censored to avoid disclosure due to the small populations of the counties within the region. Furthermore, SSA earnings data is available through 2010. Overall, these results are consistent with the estimates using IRS data.

VII. Conclusion

In this paper, I use variation in local labor market conditions to estimate the impact of economic growth on DI program participation. The oil boom created an exogenous shock to local economies. I use data from three oil-producing states and use the oil boom as a natural experiment to identify the causal impact of earnings growth on DI program participation. The oil boom substantially increased earnings in oil-rich areas within the region. The economic benefits, however, were not spread evenly across the region. In the three-state region of Montana, North Dakota, and South Dakota, where the Bakken formation is located, only 32 out of the 175 counties have any oil reserves. Among the counties with oil reserves, there is great variation in the size of the oil endowments. I use the variation in the price of oil over time combined with the variation in oil reserves across space (together, these make up the value of the county's oil reserves) to investigate the impact of economic growth on DI. I find that for the DI program, the elasticity of program payments with respect to earnings growth is approximately -1; the elasticity of program participation with respect to earnings growth is approximately -0.7.

These results are consistent with previous literature. They are substantially larger than the estimates from Black et al. (2002) and indicate a higher degree of substitutability between labor force participation and DI participation. My estimates, however, are consistent with Autor and Duggan (2003), who suggest that current workers will be more responsive to changes in economic conditions due to various programmatic and systematic changes, which have essentially increased the generosity of the DI program. The three-state region I examine in this paper is also more rural and less populous than the Appalachian region examined by Black et al. (2002). These differences could imply a higher level of DI generosity and a higher degree of substitutability between labor force participation and DO participation, especially among low-skilled workers. Additionally, it is possible that the concurrent oil boom and Great Recession have contributed to a unique set of local labor market conditions than has been previously studied during other more mild economic downturns.

My research provides new insights into the impact of economic boom on the labor force participation of low-skilled workers. Since the concept of DI is commonly viewed as a continuum, my results do not provide evidence that certain DI recipients are undeserving as they may enter the labor force given certain local labor market conditions. Rather, the responsiveness of certain individuals to this economic boom sheds more light on conditional DI applicants. Consistent with previous literature, these results suggest that current DI beneficiaries are more responsive to economic shocks than beneficiaries of previous generations.

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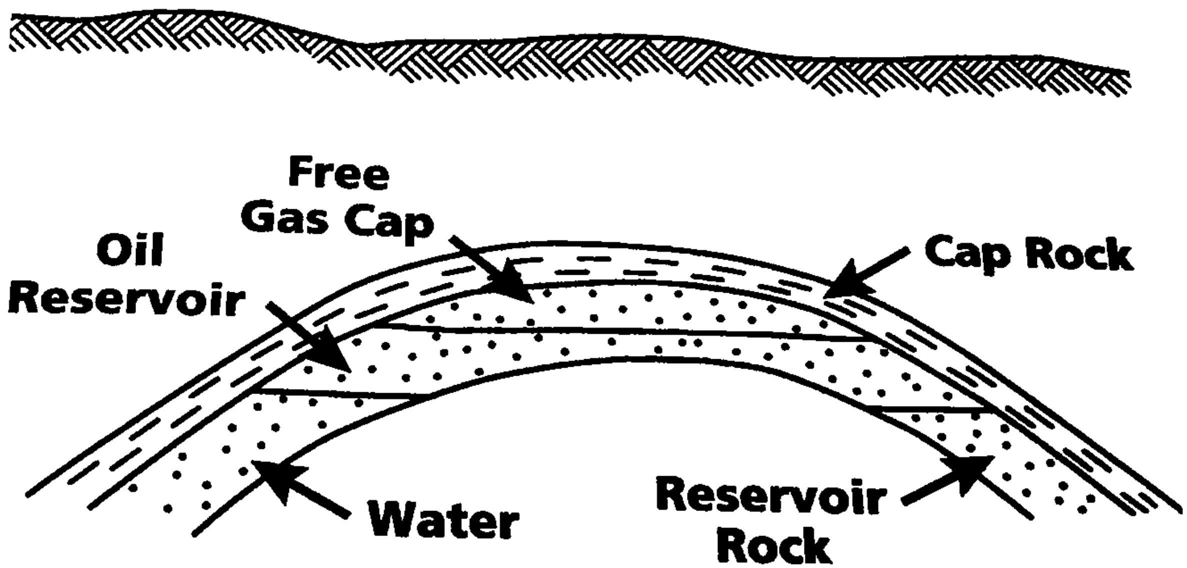
Figure 1 – Petroleum Geology



Source: Hyne, 2012

Figure 2 – Historical North Dakota Oil Production and Prices

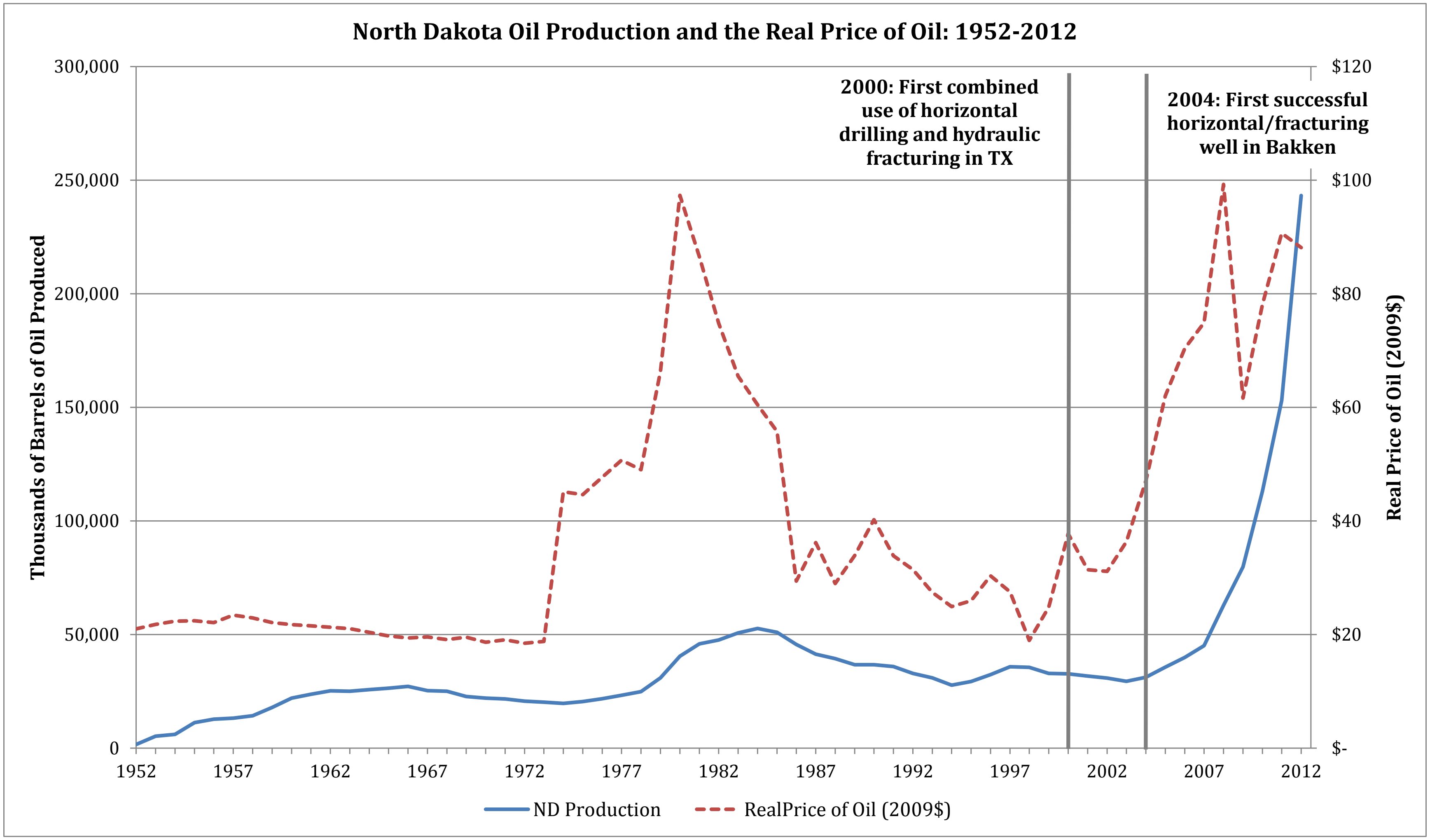


Figure 3 – Oil Reserves in Montana, North Dakota, and South Dakota

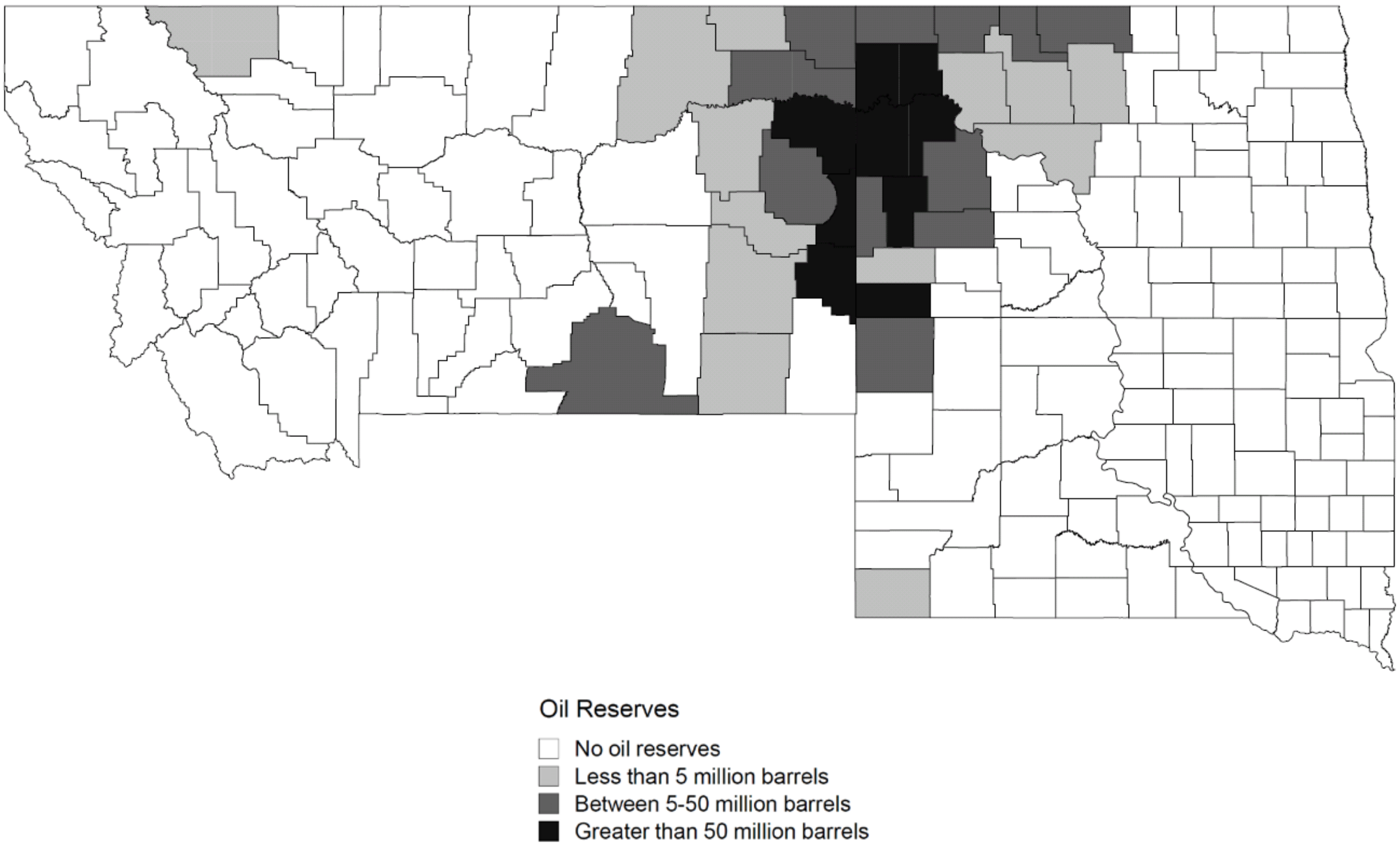


Figure 4 – Quartile of Average Annual Earnings Growth:
Montana, North Dakota, and South Dakota, 2000-2009

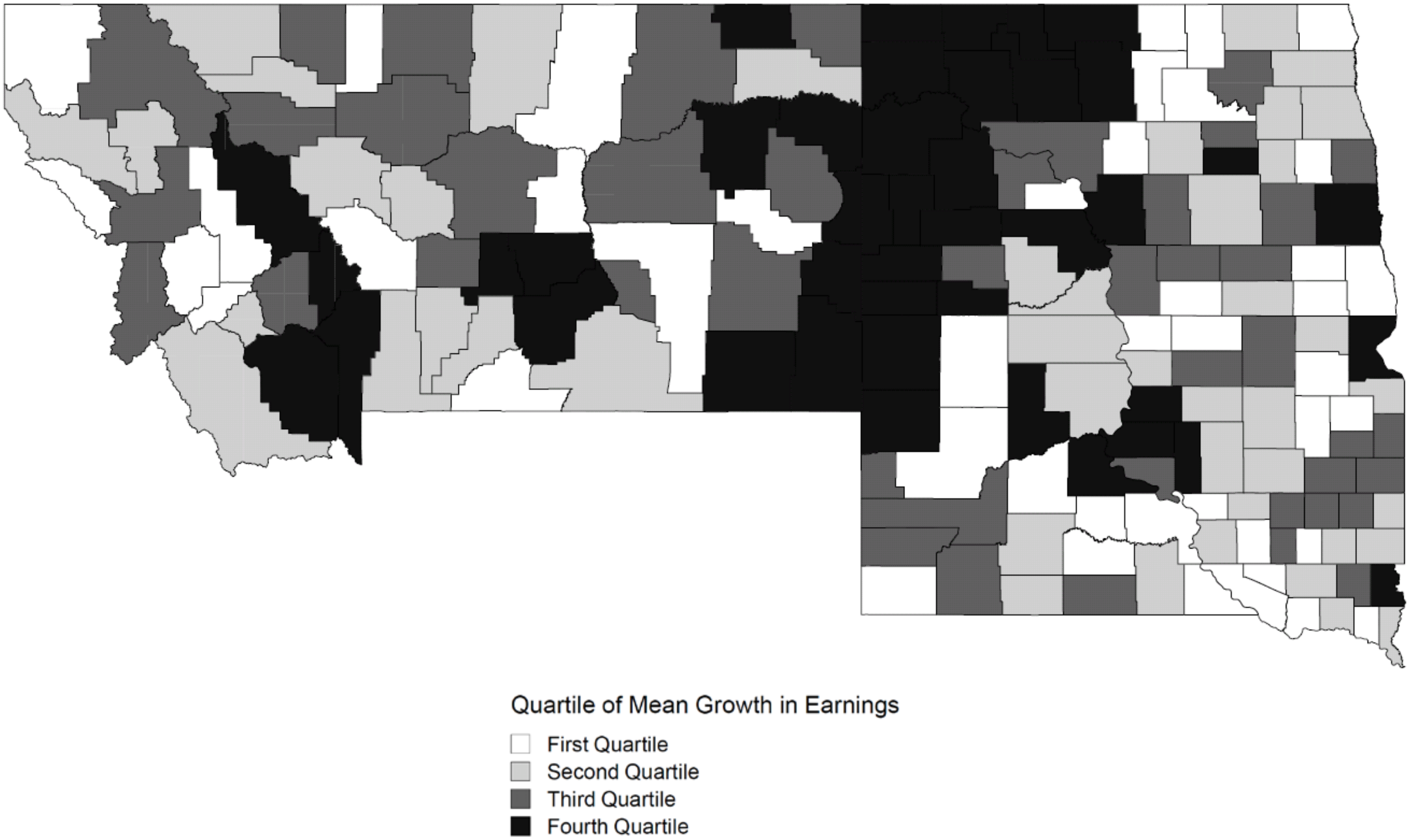


Figure 5 – Quartile of Average Annual Growth in DI Payments:
Montana, North Dakota, and South Dakota, 2000-2009

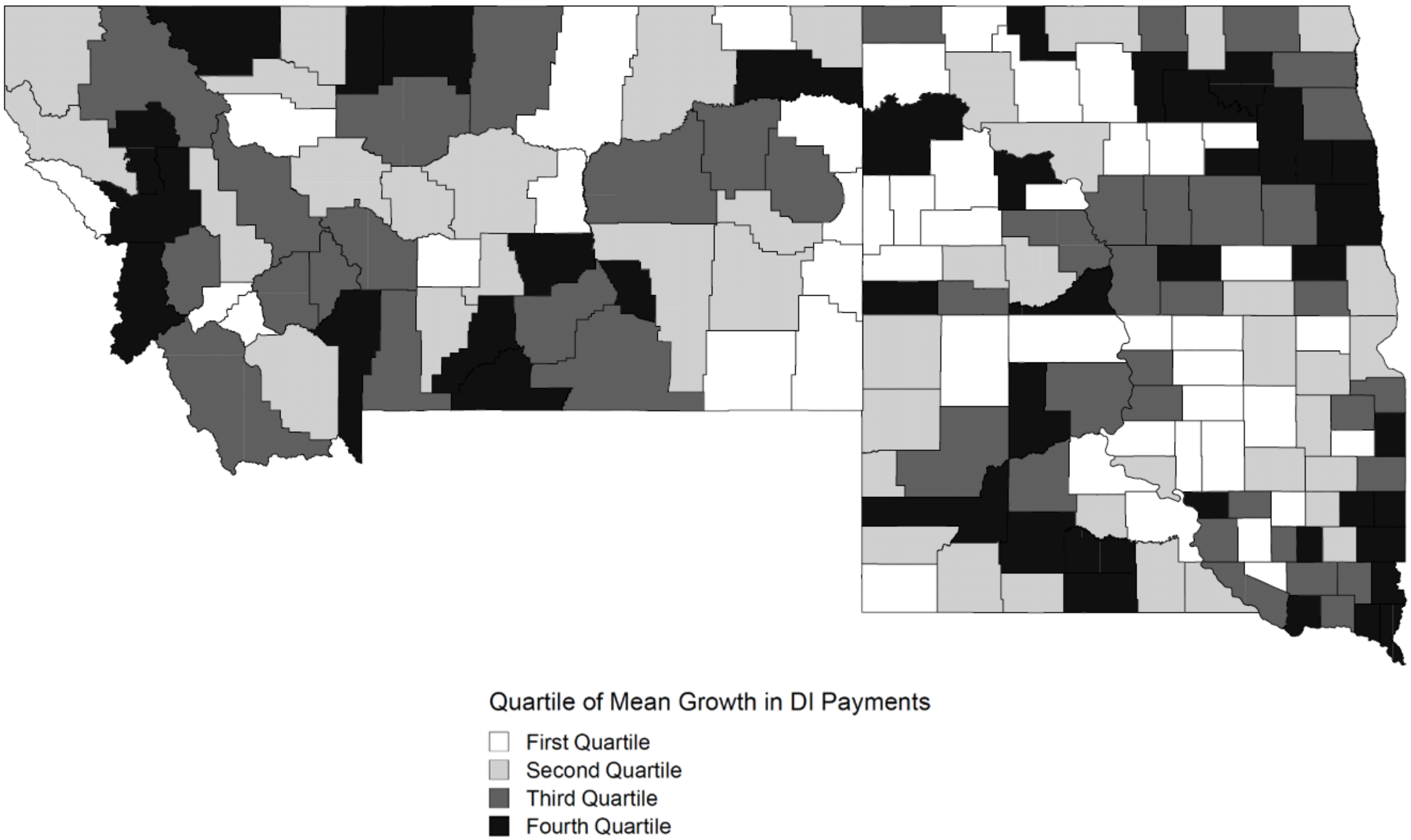


Table 1 - Summary Statistics of Sample by Period:
Montana, North Dakota, and South Dakota, 2000-2004 and 2005-2009

Variables	All Counties (1)	Oil Counties (2)	No Oil Counties (3)	p-value (4)
	Early Oil Boom (2000-2004)			
Logarithmic difference in DI payments	0.045	0.040	0.046	0.605
	(.110)	(.147)	(.100)	
Logarithmic difference in county earnings	0.012	0.020	0.010	0.033
	(.046)	(.046)	(.046)	
Logarithmic difference in population	-0.006	-0.010	-0.005	0.002
	(.016)	(.014)	(.016)	
Logarithmic difference in real price of oil	0.054			
	(.163)			
Logarithmic difference in oil reserve value	0.010	0.055	0	
	(.075)	(.168)	(0)	
Fraction of workers in manufacturing (1999)	0.075	0.023	0.087	0.001
	(.144)	(.025)	(.157)	
Fraction of counties with an MSA (1999)	0.057	0	0.070	0.001
	(.232)	(0)	(.255)	
Population	13237.5	7750.0	14465.4	
	(23427.04)	(10509.86)	(25277.60)	
	Late Oil Boom (2005-2009)			
Logarithmic difference in DI payments	0.044	0.025	0.048	0.013
	(.107)	(.160)	(.090)	
Logarithmic difference in county earnings	0.018	0.037	0.013	0.001
	(.042)	(.043)	(.041)	
Logarithmic difference in population	-0.002	-0.0004	-0.002	0.303
	(.017)	(.018)	(.017)	
Logarithmic difference in real price of oil	0.053			
	(.275)			
Logarithmic difference in oil reserve value	0.010	0.054	0	
	(.121)	(.279)	(0)	
Population	13765.8	7731.9	15116.1	
	(25364.7)	(10692.53)	(27424.36)	
Number of Counties	175	32	143	

Notes: Standard deviations are in parentheses. Oil counties are those counties that have positive reserves. No Oil counties have no oil reserves.

Table 2 - OLS Estimates of the Impact of Earnings Growth on the Change in Disability Insurance Payments: Montana, North Dakota, and South Dakota, 2000-2009

	(1)	(2)
Change in county's earnings	-0.152	-0.156
	(.102)	(.103)
Controls:		
State-year dummies	Yes	Yes
County contains MSA	No	Yes
County's population	No	Yes
Change in county's population	No	Yes
Fraction of workers in manufacturing (1999)	No	Yes
Number of observations	1575	1575

Notes: DI payments are log differences in real values (not including spousal or child benefits). Robust standard errors are in parentheses. Standard errors are clustered at the county level to adjust for possible nonindependence. There are 175 counties in the three-state region.

Table 3 - 2SLS Estimates of he Impact of Earnings Growth on the Change in Disability Insurance Payments: Montana, North Dakota, and South Dakota, 2000-2009

	(1)	(2)
Change in county's earnings	-1.206	-1.039
	(.470)	(.434)
Controls:		
State-year dummies	Yes	Yes
County contains MSA	No	Yes
County's population	No	Yes
Change in county's population	No	Yes
Fraction of workers in manufacturing (1999)	No	Yes
Instruments: Change in value of oil reserves and two lagged values	Yes	Yes
Kleibergen-Paap rk LM statistic[a]	23.138	23.135
	[0.0001]	[0.0001]
Hansen J statistic[a]	0.304	0.162
	[0.8589]	[0.9224]
First-stage F-statistic on excluded instruments	10.42	11.37
Number of observations	1225	1225

Notes: DI payments are log differences in real values (not including spousal or child benefits). Robust standard errors are in parentheses. Standard errors are clustered at the county level to adjust for possible nonindependence. There are 175 counties in the three-state region.

[a] P-values are in square brackets.

Table 4 - OLS Estimates of the Impact of Earnings Growth on the Change in Disability Insurance Beneficiaries: Montana, North Dakota, and South Dakota, 2000-2009

	(1)	(2)
Change in county's earnings	-0.164	-0.169
	(.063)	(.062)
Controls:		
State-year dummies	Yes	Yes
County contains MSA	No	Yes
County's population	No	Yes
Change in county's population	No	Yes
Fraction of workers in manufacturing (1999)	No	Yes
Number of observations	1575	1575

Notes: DI bebeficiiaries are log differences in the number of beneficiaries (not including spousal or child benefits). Standard errors are in parentheses. Robust standard errors are clustered at the county level to adjust for possible nonindependence. There are 175 counties in the three-state region.

Table 5 - 2SLS Estimates of the Impact of Earnings Growth on the Change in Disability Insurance Beneficiaries: Montana, North Dakota, and South Dakota, 2000-2009

	(1)	(2)
Change in county's earnings	-0.827	-0.670
	(.356)	(.323)
Controls:		
State-year dummies	Yes	Yes
County contains MSA	No	Yes
County's population	No	Yes
Change in county's population	No	Yes
Fraction of workers in manufacturing (1999)	No	Yes
Instruments: Change in value of oil reserves and two lagged values	Yes	Yes
First-stage F-statistic on excluded instruments	10.42	11.37
Number of observations	1225	1225

Notes: DI bebeficiiaries are log differences in the number of beneficiaries (not including spousal or child benefits). Standard errors are in parentheses. Robust standard errors are clustered at the county level to adjust for possible nonindependence. There are 175 counties in the three-state region.

Table 6 - Comparisons of 2SLS Estimates of the Impact of Oil Shocks on Disability Insurance Payments using Different Income Measures: Montana, North Dakota, and South Dakota

	IRS Wage and Salary Income		SSA Medicare Taxable Earnings				SSA OASDI Taxable Earnings			
	2000-2009		2000-2009		2000-2010		2000-2009		2000-2010	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Change in county's earnings	-1.130	-0.981	-0.557	-0.455	-0.561	-0.553	-0.769	-0.659	-0.619	-0.624
	0.385	0.337	0.352	0.308	0.352	0.348	0.440	0.396	0.383	0.394
Controls:										
State-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County contains MSA	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
County's population	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Change in county's population	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Fraction of workers in manufacturing (1999)	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Instruments: Change in value of oil reserves and two lagged values	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage F-statistic on excluded instruments	7.47	9.80	1.11	1.20	1.11	1.20	1.01	1.01	1.01	1.01
Number of observations	945	945	945	945	1080	1080	945	945	1080	1080

Notes: Columns (1) and (2) present estimates using IRS wage and salary income as the income variable. Columns (3) through (6) present estimates using SSA Medicare Health Insurance taxable income as the income variable. Columns (7) through (10) present estimates using SSA Old Age Survivors, and DIsability Insurance (OASDI) taxable income. IRS wage and salary income data is avaialble through 2009. SSA OASDI and Medicare taxable earnings data are available through 2010. Columns (3), (4), (7), and (8) represent the estimates for the timeframe of the primary sample with IRS earnings data, 2000 through 2009. Columns (5), (6), (9), and (10) represent the estimates for 2000-2010, the years for which SSA earnings data are available. Robust standard errors are in parentheses. Standard errors are clustered at the county level. I drop all 40 counties for which SSA Medicare and OASDI earnings are censored to avoid disclosure. There are 135 out of 175 counties in the three-state area represented in the samples.