THE EFFECT OF BONUS DEPRECIATION ON INVESTMENT AND COMPENSATION

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ABSTRACT

This paper analyzes the relationship between bonus depreciation policies and the level of capital expenditures and employee compensation. This paper is interested in testing the hypothesis that bonus depreciation policies lead to higher investment from firms, which in turn drives productivity and wage growth. Productivity is a measure of an economy's efficiency and is an important driver of the cost of goods and wages. Given the anemic productivity growth the U.S. economy has experienced since the Great Recession, it is imperative that policymakers find ways to induce firm-level investments in order to give productivity a much-needed boost. Currently, companies are allowed to write off 100% of their capital expenditures in the year of purchase for federal taxes. However, the bonus is set to be phased out beginning in 2022.

While bonus depreciation is in place for federal taxes, not all states have adopted the policy for their state corporate taxes. This paper uses the natural experiment resulting from this divergence and data from the Annual Survey of Manufacturers to test the correlation between adoption of bonus depreciation and levels of capital expenditures and wages in the states' manufacturing sectors. The model controls for some state economic and demographic characteristics, including population, GDP, tax rates, and the value of shipments from firms in the manufacturing sector. Ultimately, the results show that states with bonus depreciation saw, on average, 21.5 percent higher levels of capital expenditure and five percent higher compensation for workers in their manufacturing sectors. These results demonstrate that bonus

depreciation provides significant and immediate economic benefits that justify making it a permanent tax policy.

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I. Introduction

The United States has a productivity problem. Robust productivity growth has been one of the key features that has helped make the U.S. economy as large and dynamic as it is. However, since the 2007-2008 recession, the U.S. economy has seen productivity grow at half the pace at which it grew in previous periods. Meager productivity growth, besides being an indicator of anemic economic growth, also limits wage growth and output.

There are a number of potential factors that have been offered to explain this lull. One such theory has been termed by the economist Tyler Cowen as the "low-hanging fruit" problem (Evans, 2011). This theory argues that technological innovation in the United States has reached a plateau as the country has already taken economic advantage of its major assets and advancements – namely, land, expanded education, and technological breakthroughs (Evans, 2011). With these resources exhausted, the next set of innovations would require even greater investment and time to reach similar yields. Another theory is that the current standards by which we measure productivity are ill-equipped to measure the productivity gains of a service-based and increasingly digital economy (FocusEconomics, 2017). Whatever the true explanation, there is no questioning the importance of investment in driving productivity. Investment is a cornerstone of any productive and growing economy. It ensures that the economy's capital is up to date, promotes efficiency, and drives innovation. In other words, investment is one of the key catalysts of productivity.

Recognizing this need for capital investment, this paper will explore the ways in which policy might help encourage greater investment. It will do so by exploring the relationship between state tax policies' treatment of depreciation and the level of private investment and compensation in their manufacturing sectors. Given the lags in productivity and wage growth, private investment and the tax treatment of depreciation are areas that have received greater scrutiny in recent years. In exploring the relationship between depreciation policies and economic outcomes, this paper elucidates the potential benefits they can impart in solving the productivity problem.

II. Key Economic Concepts

Depreciation

It is important to first identify key concepts and policies to understand better the issues surrounding their tax treatment. At the heart of the matter is depreciation, which is the expense recorded in the accounting books of a firm related to the use of an asset. To understand better depreciation, it is crucial first to distinguish a normal expense from a capitalized cost. For the most part, expenses incurred by a firm can be recorded at the time of purchase on their income statement, which shows a company's revenues and expenses in a given time period. These expenses might include wages, utilities, and certain input materials, such as the cotton purchased for manufacturing a shirt.

Some expenditures, however, are not expensed at the time of purchase. Instead, they are capitalized – meaning that the expenditure in question is classified as an asset on the balance sheet for a value equal to the cost of the expense. These purchases are usually ones with long useful lives (the number of years, on average, the item is used) and are items from which a firm derives large value. The Internal Revenue Code has specific rules governing the items that qualify as capital assets. Examples include property used for business, accounts receivables, patents, and copyrights (26 U.S.C. § 1221). In order to account for the expense of the purchases and have them reflect on the company's income statement, these assets are depreciated (or amortized) across set amounts of time. For capital assets in use and service since 1986, the IRS uses the Modified Accelerated Cost Recovery System (MACRS) to determine the depreciation schedule for various assets (U.S. Department of Treasury, 2021). For instance, under MACRS, trucks, office machinery, dairy cattle, and furniture are considered 5-year property, which means that their assumed useful life is five year and thus their value is expensed over roughly the same period.

As the name suggests, MACRS[a] is an accelerated depreciation system. That means that a large percentage of the asset's value will be depreciated in the first half of its life. Enshrined in law with the 1986 tax law, the accelerated system was meant to induce companies to purchase more assets. The logic governing this move is simply: It was thought that giving the companies greater tax savings (through high depreciation amounts) early in the asset's life would provide a tax incentive that would encourage them to purchase more assets.

The Money Problem

There is a fundamental problem, however, with distributing the tax savings from depreciation over time. This is due to two main factors. First, there is inflation. Second, there is the problem of the time value of money, which is the concept that money today is worth more than an identical sum in the future because of its earnings potential. These two factors mean that the tax savings earned from this scheme, in real terms, will be less than the cost of the

[a] The MACRS depreciation schedule is included in Appendix A for reference. Note that the depreciation percentages extend one year beyond the asset life suggested. This is because MACRS uses a combination of two depreciation methods: declining balance method (which allows for greater depreciation early on in the asset's life) and straight-line method (where the amount depreciated is the same each year). The percentage in the out year is a mathematical plug to ensure the full value is expensed.

investment. To illustrate the phenomenon, take an example where a company purchases equipment for $1000 and capitalizes the cost. For the sake of simplicity, assume that the asset is depreciated using the straight-line method over five years. This means that the company will show a depreciation expense of $200 each year for five years. After the five years, the company will fully recover the nominal $1000 expense. However, the real value of the total tax savings will be less as the present value of the savings of each successive year will be lower than $200. For instance, assuming the risk-free rate of return (which is the rate of return one would expect from a risk-free investment, such as a U.S. treasury note) is 3 percent and that the company begins expensing the asset in the year of its purchase, the real value of the depreciation will be as follows:

Table 1. Depreciation Schedule: Nominal vs. Real Expense

Year	**Depreciation Expense (Nominal)**	**Depreciation Expense (Real)**
0	$200	$200
1	$200	$194.17
2	$200	$188.52
3	$200	$183.03
4	$200	$177.70
Total	**$1000**	**$943.42**

The present value is calculated using the following formula:

$$\mathbf{PV = CF/(1 + r)^n}$$

CF = cash flow in given year
r = risk-free rate of return
n = year

In real terms, the company has only registered a tax savings of $943.42, thus losing out on approximately 6 percent of the asset's real value. MACRS, with its accelerated depreciation schedule, remedies this issue partly by allowing for companies to depreciate a larger proportion of their assets' values in the earlier years. However, any depreciation regime that requires that amortization take place in the years following the year of purchase will impose a de facto tax.

The Productivity Problem

Besides the time value of money issue, this problem has another potential impact. One of the biggest problems facing the U.S. economy for the last decade has been its meager productivity growth. Productivity is a measure of the amount of output an economy generates compared to the number of labor hours worked (U.S. Bureau of Labor Statistics, n.d.). The U.S. Bureau of Labor Statistics publishes quarterly measures of productivity for the U.S. economy. In essence, a more productive economy is one that produces a larger amount of output with fewer labor hours. It is a fairly important metric of an economy's efficiency, and as this paper will explore later, it also seems to play a large role in guiding wage growth.

Since the mid-20th Century, the United States has seen extended periods with healthy gains in productivity. The period between 1990 and 2000 saw productivity in the nonfarm sector grow 2.2 percent, while 2000 to 2007 saw it grow 2.7 percent (Labor Productivity and Costs, 2020). The gains observed in the manufacturing sector were even more impressive at 3.8 and 4.4 percent, respectively (Labor Productivity and Costs, 2020). The problem is that the post-2007 recession years have seen growth rates cut by more than half or more. From 2007-2019, the nonfarm business sector only saw productivity grow 1.4 percent, while the manufacturing sector grew only 0.5 percent (Labor Productivity and Costs, 2020). Of course, there are sectoral exceptions. For instance, the information and communication technology sector saw 4.4 percent productivity growth from 2005 to 2015 ("The Productivity Puzzle," 2017). Nonetheless, overall, the U.S. economy has suffered from a historically low productivity growth rate in the years following the Great Recession.

The question of investment is an important one as it is seen as the major driver of productivity growth (Stiroh, 2001, p. 2). Capital investments, be they for physical machinery or research and development, are crucial for making the labor force more productive. Indeed, historical data show that spikes in capital are positively correlated with labor productivity gains (Owyang, 2018). They also spur technological advancement and innovation, another important driver of productivity. Thus, understanding the potential effect taxation policies have on these investments is supremely important in solving the productivity malaise the United States is currently seeing. Any policy that might impose a de facto tax savings loss on investments and alters the economic gains could deter investment and thus productivity. Indeed, this issue is precisely why the U.S. Congress has adopted new laws that give special tax status to capital investments in the past decade. While addressing this hidden tax problem might not fully resolve the meager productivity problems of the U.S. economy, it is nonetheless an important piece in solving this productivity puzzle.

Bonus Depreciation

One such policy solution implemented by Congress is called bonus depreciation. At its most basic, bonus depreciation allows companies to write off a certain percentage of the asset value in its first year of operation, thus remedying part of the time value of money issue. Bonus depreciation was first introduced in 2002 in the Job Creation and Worker Assistance Act (“Bonus Depreciation,” n.d.). The law allowed firms to write off 30 percent of the cost of the qualifying asset before standard depreciation (“Bonus Depreciation,” n.d.) The cap was increased to 50 percent in 2003 and, after it expired, again in 2008, where it remained until 2017. In 2017, the cap was set to 100 percent, where it currently stands ("IRS finalizes regulations," 2020). The new law also allows for bonus depreciation to be applied towards used property, contingent on the fact that the taxpayer acquired the asset after September 27. 2017 and that neither he/she nor the predecessor used it at any time before acquisition ("New rules and limitations," 2018). These two revisions to the policy could lead to its expanded use among firms and new capital.

In addition to bonus depreciation, the IRS also allows firms to use so-called Section 179 allowances. This policy also allows taxpayers to expense the cost of certain assets in the year they are placed in service ("IRS issues guidance on Section 179," 2018). However, unlike bonus depreciation, firms are only allowed to expense a maximum of $1 million per year using this allowance ("IRS issues guidance on Section 179," 2018).

Policy Relevance

Given past studies, the expectation is that the regression analysis will show that the states that adopted bonus depreciation policies will see higher levels of investment and compensation within their manufacturing sectors relative to those states that do not. Thus, the findings should validate the need for such policies and might even give credence to extending the expansions instituted in the 2017 tax law beyond 2023. Again, bonus depreciation is likely not the silver bullet that can solve the United States' meager productivity growth. There are other governmental polices and exogenous developments (i.e., the advent of AI and its integration into the economy) that will play a role in remedying the problem. As it is, bonus depreciation has been around in some form for over ten years and yet productivity woes remain. However, that is not proof of the policy's failure. Given the evidence offered of the tax policy's likely effect on increased investment, it might well be the case that it helped mitigate some of the productivity losses but did not resolve all of the fundamental problems driving the lag (for instance, the lowest-hanging fruit problem). Moreover, it is likely that the full effects of these policies will take time to materialize and the COVID-19 pandemic will almost certainly have large consequences on economic activity that these policies cannot overcome. Nonetheless, the expectation is these findings will serve to validate the usefulness of these policies in combatting the productivity malaise.

III. Literature Review

Key Economic Assumptions and Theories

Understanding the policy implications of this paper requires first revisiting the central economic theory driving this study. In its most essential form, the theory is that there is a casual relationship between investment, productivity, and wages. That relationship is as follows:

Investment drives productivity growth

Investments are attempts to boost production that in the long run generate positive cash flows for the company. As such, investments can take various forms including hard asset purchases, research and development programs, and building and capacity expansions. Point is, investments are meant to increase a company's production output, and since productivity is a measure of output per worker, successful investments should lead to enhance productivity ratios.

Productivity growth leads to wage growth

If a worker's wage is their marginal revenue product of labor (defined as the additional revenue a firm generates by hiring one employee), then increasing their marginal product of labor would increase their wage. More simply put, the more a worker is able to produce, the more he/she will be paid.

The relationships described above are widely accepted as sound economic theories, albeit with some degree of differences.

The investment-productivity relationship is generally uncontested and might arguably be considered a bedrock economic assumption. Economists generally identify three major factors that influence productivity: changes in physical capital, changes in human capital, and changes in technology (Wolla, 2017, p. 2). All three of these changes require investments from firms. Even the contending theories that explain how productivity growth is achieved – either by technical advances made possible through private investment or through scientific breakthroughs that occur outside of the business sector – both acknowledge the role that investments play in stimulating the change.

The productivity-wage relationship, while perhaps a bit more contended, is still widely accepted. A notable recent study by Anna Stansbury and Lawrence Summers (2017) found that a one percentage point growth in productivity was linked to about a one percentage point compensation growth. Arguments against this relationship, like that of Jared Bernstein (2018) of the Center on Budget and Policy Priorities, note that there is a growing gap between productivity growth and wages. Bernstein (2018) argues that this growing gap shows that productivity growth alone is not sufficient to achieve wage growth, especially for low- and middle-income workers, even if, as Bernstein concedes, it is a necessary factor. However, Stansbury and Summers (2017) show that changing the measurements of productivity and wage can close the size of the gap and show a robust correlation. As Michael Strain (2019) highlights of Stansbury and Summers' (2017) study, accounting for net output from the total economy, including full-time and part-time workers, changing the inflation metric by which wages are deflated, and expanding measures of earnings ultimately close the gap almost completely and show that "trends in compensation and productivity have been very similar over the past several decades."

Past Studies on Tax Policy and Output

Let's begin with a discussion of policies that governments can institute to induce greater investment. While there is limited research specifically focused on bonus depreciation policies, the studies that do exist suggest that there is a robust correlation between these accelerated depreciation policies and greater economic production and wage growth. Eric Zwick and James Mahon (2017), for instance, studied the relationship between bonus depreciation policies of the 2000s and firm investment trends. Using firms in industries that have "most of their investment in short duration categories" as a control group, they showed that the tax policy increased firms' investment in qualifying assets by nearly 17 percent relative to non-qualifying assets between 2008 and 2010. (Zwick and Mahon, p. 218). Meanwhile, Eric Ohrn (2017 and 2019) conducted two studies both of which focused on bonus depreciation. His studies used state tax policy differences between 2001 and 2014 and state-level manufacturing data between 1997 and 2013 to study these relationships. Much like this paper, Ohrn (2017 and 2019) sort between those states that conformed to Federal Government tax policies on depreciation and those that had not. Ohrn's 2017 analysis shows that bonus depreciation policies are correlated with a statistically significant 17.5 percent gain in investment in the year of adoption and 2.5 percent increase in compensation. His 2019 study, which used altered the model slightly by swapping out a few independent variables, produced similar results: Bonus depreciation was correlated with an 18 percent increase in investment and just under 2 percent increase in compensation.

Further proof of the relationship comes from Christopher House and Matthew Shapiro's study from 2008, which focuses on the microeconomic level and estimates the sensitivity of supply of investment goods following the bonus depreciation changes of the 2000s. They projected the supply of these goods was highly sensitive to these policies and that "[c]apital that benefited substantially from the policy saw sharp increases in investment" (House and Shapiro, 2008, p. 762). All in all, these analyses show a clear correlation between tax policies and sector- and economy-wide changes in investment and wages. To be sure, they do not directly measure the relationship between these policies and productivity growth as firm and sector-specific productivity are hard to measure. However, as established before, it is likely that increases in investment led to boosts in productivity, so measuring investment is likely sufficient to show a correlation also exists with productivity.

Goals and Research Needs

Approaching this topic from the macroeconomic level, this paper will not necessarily be breaking new ground in exploring these relationships and showing that accelerated depreciation tax policies are associated with greater firm production and wage increases. It will, however, distinguish itself from the present literature in a few notable ways.

First, it will look exclusively at the relationship between these economic measures and bonus depreciation. Ohrn's study explores the relationship between output and both depreciation tax policies: bonus depreciation and section 179 allowances. He argues that a change in one policy alters the use of the other. The reason this paper will focus exclusively on bonus depreciation is twofold. First, the 2017 tax law increased bonus depreciation allowance to 100 percent of the asset's value. Second, the tax law also made it so that bonus depreciation can apply to previously used capital instead of just new purchases ("New rules and limitations," 2018). Prior to 2017, bonus depreciation applied exclusively to new, non-used assets. The likely sum total effect of these two changes is that firms will use bonus depreciation to a greater extent relative to section 179 allowances. Thus, while this paper will not be exploring the relationship between the 2017 bonus depreciation policy on economic output as there is not yet sufficient data to conduct such a study, it is important, given the anticipated expanded adoption, to understand and isolate the historical correlation between this policy and the economic measures identified.

Second, this paper will be using output and compensation data from the U.S. manufacturing sector. There are two main reasons for studying this industry specifically. First, manufacturing is a fairly capital-intensive sector, so it should be more responsive to tax policies like bonus depreciation. Second, the U.S. Census Bureau conducts the Annual Survey of Manufacturers (ASM), so there is an abundance of state-level economic data from the industry. Notably, Ohrn's study also uses data from the ASM. Zwick and Mahon, on the other hand, use firm-level data from across all industries and instead make certain assumptions about the capital intensity of each industry in judging whether to categorize firms in the control group. Using such a metric is potentially subjective, so instead this paper, like Ohrn, will use differences in state tax policies (specifically, whether they adopted bonus depreciation) to create its control and experimental groups.

Lastly, unlike Ohrn, this paper uses data available from the most recent ASM (2016) to study the relationship between bonus depreciation and investment, production, and wages. By focusing on these parameters, this paper seeks to isolate bonus depreciation from other accelerated depreciation policies and to test whether its adoption on the state level holds a statistically significant and positive correlation with higher levels these economic measures. Knowing the changes that occurred in 2017, understanding these relationships may help in predicting future changes in these economic measures given bonus depreciation's expanded cap and anticipated wider use.

IV. Hypothesis

The hypothesis guiding this study is that states with bonus depreciation policies will see appreciably higher levels of capital expenditures and compensation for workers in the manufacturing sector. Due to the immediacy of the tax benefits obtained from the policy and the delayed effect capital expenditures and productivity growth have on wage growth, it is likely that the correlation between the policy and wages would be more muted than that between the policy and capital expenditures.

V. Model

As mentioned, this paper is interested in studying the relationship between states' adoption of bonus depreciation allowances and the level of investment and wages in their respective manufacturing sectors. This paper is grounded on the theory that higher levels of private investment lead to productivity growth, which in turn leads to wage growth. Thus, changes in these measurements should parallel changes in productivity levels, offering an indirect look into the relationship between this tax policy and productivity growth.

This study seeks to understand the most appropriate policies for boosting investment and wages. As such, there are two dependent variables, one relating the chosen independent variables to investment (capital expenditures) and another relating them to average hourly wage. They will be presented with two different models. Exhibit 1 offers an overview of the models' independent variables and their expected relationship with the dependent variables. The models are also presented in parameter form below.

Table 2. Model Matrix

	Definition	Variable Name & Expected Sign	Justification
Dependent Variables			
Y_1	Log of the level of investment in manufacturing sector in given year	lCapExpen	
Y_2	Log of the average yearly compensation of employees in manufacturing sector in given year	lcomp_yearly	
Independent Variables			
X_1	Dummy variable indicating whether state adopted federal bonus depreciation policy in 2012	conformity Y_1: + Y_2: +	Ohrn, 2017 In line with the hypothesis, this variable should carry a positive relationship with the dependent variables.
X_2	Log of the population of state in given year	lpop Y_1: + Y_2: +	Population is a measure of output, and larger output means higher investment.
X_3	Highest marginal state corporate tax rate in given year	CTR Y_1: - Y_2: -	Gale, Krupkin, & Rueben, 2015
X_4	Log of the overall GDP of state in given year	lGDP Y_1: - Y_2: N/A	States lacking conformity are, on average, economically larger
X_5	Log of the proportion of GDP belonging to manufacturing sector output in given year	lGDP_Manu Y_1: + Y_2: +	States with relatively larger manufacturing sectors should see more investment and higher wages.
X6	Log of the total value of shipments and receipts for services in the manufacturing sector in a given year.	lshipments Y_1: N/A Y_2: +	States with relatively higher value of goods sold should see higher wages.

Model 1 in Parameter Form

$Y_1 = ß_0 + ß_1 X_1 + ß_2 X_2 + ß_3 X_3 + ß_4 X_4 + ß_5 X_5 + E$

Where:

Y_1 = lCapExpen

Log of the level of investment in manufacturing sector in given year. Data spans from 2013 to 2016.

> *Source: Annual Survey of Manufactures 2013, 2014, 2015, and 2016. U.S. Census Bureau*

X_1 = conformity

Dummy variable indicating whether state adopted federal bonus depreciation policy in 2012. Value of 1 indicates conformity. Value of 0 indicates non-conformity or not state corporate tax.

> *Source: Keiter CPA*

X_2 = lpop

Log of the population of state in given year. Data spans from 2013 to 2016.

> *Source: U.S. Census Bureau*

X_3 = CTR

Highest marginal state corporate tax rate in given year. Data spans from 2013 to 2016.

> *Source: The Tax Foundation*

X_4 = lGDP

Log of the overall real GDP of state in given year. Data spans from 2013 to 2016.

Source: Bureau of Economic Analysis

X_5 = lGDP_Manu

Log of the proportion of GDP belonging to manufacturing sector output in given year. Data spans from 2013 to 2016.

Source: Bureau of Economic Analysis

E = Error term

$ß_0$ = Y-intercept

Model 2 in Parameter Form

$Y_2 = ß_0 + ß_1 X_1 + ß_2 X_2 + ß_3 X_3 + ß_4 X_4 + ß_5 X_5 + E$

Where:

Y_2 = lcomp_yearly

Log of the average yearly compensation of employees (payroll/workers) in manufacturing sector in given year. Data spans from 2013 to 2016.

> *Source: Annual Survey of Manufactures 2013, 2014, 2015, and 2016. U.S. Census Bureau*

X_1 = conformity

Dummy variable indicating whether state adopted federal bonus depreciation policy in 2012. Value of 1 indicates conformity. Value of 0 indicates non-conformity or not state corporate tax.

> *Source: Keiter CPA*

X_2 = lpop

Log of the population of state in given year. Data spans from 2013 to 2016.

> *Source: U.S. Census Bureau*

X_3 = CTR

Highest marginal state corporate tax rate in given year. Data spans from 2013 to 2016.

> *Source: The Tax Foundation*

X_4 = lGDP_Manu

Log of the proportion of GDP belonging to manufacturing sector output in given year. Data spans from 2013 to 2016.

Source: Bureau of Economic Analysis

X_5 = lshipments

Log of the total value of shipments and receipts for services in a given year. Data spans from 2013 to 2016.

Source: Annual Survey of Manufactures 2013, 2014, 2015, and 2016. U.S. Census Bureau

E = Error term

$ß_0$ = Y-intercept

VI. Variables

Dependent Variables

In this case, the models will measure the variables' relationships with two dependent variables. The first model will measure the correlation between the set of independent variables and the level of investment in the manufacturing sector. Investment here is defined as the total capital expenditures in the manufacturing sector in a given year. The second model will measure the correlation between these variables and the average hourly wage of workers in the manufacturing sector. Wage is calculated using the total compensation paid to "productive workers" divided by the total number of workers and number of hours worked in a given year.

Independent Variables

The most important independent variable is the one that signals if the state adopted the federal government's 50% bonus depreciation policy in 2012. In the models, this is a dummy variable that takes on a value of 1 if the state adopted the measure or 0 if it did not. Notably, a few states do not have any corporate taxes. While on the whole this might prove favorable to firms, it means that the companies in those states do not have any additional tax inducements to boost investment. For this reason, these states are also given the value of 0 for this variable. Table 1 provides a breakdown of conformity by state. This variable is expected to have a positive correlation with capital expenditures and compensation. However, expectations are that this latter relationship will only be marginally positive, as suggested by Eric Ohrn's studies that explored these relationships. In his studies, while the correlation between state bonus depreciation policies and capital expenditure levels was statistically robust, their relationship with compensation was weaker (only statistically significant at the 10% level) and fairly small in terms of magnitude (Ohrn, 2019, p. 19). The positive relationship between bonus depreciation and capital expenditures can also be explained by basic economic logic, which would suggest that firms will aim to reduce their tax burden and thus engage in greater private investment.

The other independent variables are included to control for variances in state characteristics that might be correlated with the dependent variables. For instance, state population size should be positively correlated with capital expenditures given that larger states are likelier to boast larger economies. Meanwhile, the evidence on states' corporate tax rates' effect on economic output and performance is fairly mixed (Gale, Krupkin, & Rueben, 2015, p.6). Given the uncertainty, the model includes the rates as an independent variable, although its predicted coefficient is negative and the variable might prove statistically insignificant. This model uses the highest marginal corporate tax rate charged by the state in the given year.

GDP should theoretically work in a similar fashion as population: states with higher GDP levels should have higher investment levels. However, the data presented in Table 2 suggests these variables might share an inverse relationship. The table demonstrates that the mean capital expenditures of the states that did not adopt bonus depreciation actually decreased from 2013 to 2016. The data also show that non-conforming states have, on average, larger economies. Thus, it is expected that the sign of this coefficient will be negative. Additionally, this model controls for the relative size of each state's manufacturing sector. To do this, it uses a variable that is a ratio of the manufacturing sector's GDP to the state's overall GDP. The logic behind including this variable is that states with relatively larger manufacturing sectors as a proportion of their overall economy would also see relatively higher levels of investment. As such, the sign of this coefficient should be positive.

Lastly, the shipments variable measures the total net sales value of goods and services sold by firms in the manufacturing sector (United States Census Bureau, n.d.). It is similar to GDP in that both are means of measuring the value of firms' output. Unlike GDP though, the total value of shipments represents the gross receipts of sales without accounting for intermediate inputs, which are the goods and services used in the production process ("*What is gross output,"* 2018). GDP, on the other hand, is the net income (profit less the cost of the intermediate inputs) that is retained by the firms, distributed to workers as salaries, and paid to the government as taxes. As discussed later in the paper, the GDP variable coefficient was not statistically significant in the compensation model. Given that both variables measure output and that firm output likely affects compensation, the shipments variable was included in the model.

Predicting the relationship of these variables with annual compensation is decidedly more complex. For instance, it is not clear if there is an intuitive relationship between population and wages as there is between population and capital expenditures. As the tables in Appendix B show, the average compensation between the two cohorts is roughly even with the non-conforming states slightly edging out conforming states. Table 2 meanwhile shows that wage growth in both cohorts was basically equal. It is easy to tell a story in either direction, but ultimately this paper assumes that the lpop coefficient will carry a negative sign. Compensation should also have a positive relationship with lGDP_Manu. The GDP variable is not included in the compensation model. Instead, the compensation model incorporates a variable to control for the value of all shipments and services rendered in a given year. As discussed later, this was done to improve the model's robustness.

Data Sources

All GDP data were sourced from the U.S. Department of Commerce's Bureau of Economic Analysis. GDP figures are real and chained to 2012 dollars. State bonus depreciation conformity came from a September 2012 report from Keiter entitled "State Treatment of Federal Bonus Depreciation and Increased 179 Expensing Amounts for 2012." Population data were sourced from the U.S. Census Bureau, while corporate tax rates came from The Tax Foundation. Finally, capital expenditure, shipments, and compensation data came from the Annual Survey of Manufacturers, which is conducted by the U.S. Census Bureau.

VII. State Cohort Characteristics and Economic Context

The summary data (Appendix B) show that the manufacturing sector in states that do not conform to bonus depreciation, on average, have much higher capital expenditures and marginally higher wages. While on the surface that might suggest that the model will produce results contrary to expectations, there are a few confounding factors that explain the differences. Namely, the economic and demographic composition of the state cohorts are not the same. The cohort of states that do not conform boast larger populations, economies, and manufacturing sectors (as measured by the various economic metrics including real GDP and value of shipments and receipts). This is not surprising given the makeup of states that constitute this cohort, which includes the large states of California, Texas, New York, and Florida. In fact, the only state among the bonus depreciation adopters that ranked among the top 10 in the country in terms of population is Illinois. The next largest state is Missouri, which during this time ranked as about the 18^{th} largest state. Table 1 includes the list of states in each cohort along with their average population during the study period. These variances illustrate why it is important to control for demographic and economic differences among the cohorts.

Table 3. States and Their Average Population from 2013-2016			
Non-Conforming States		***Conforming States***	
State	**Population**	**State**	**Population**
California	38,735,730	Illinois	12,864,766
Texas	27,207,266	Missouri	6,056,216
Florida	20,053,513	Colorado	5,402,244
New York	19,640,898	Alabama	4,846,938
Pennsylvania	12,782,931	Louisiana	4,652,826
Ohio	11,607,820	Oklahoma	3,891,808
Georgia	10,130,024	Utah	2,964,556
North Carolina	9,990,664	Kansas	2,903,38
Michigan	9,931,300	New Mexico	2,090,691
New Jersey	8,865,068	Nebraska	1,885,373
Virginia	8,333,834	West Virginia	1,844,119
Washington	7,119,267	Montana	1,026,693
Arizona	6,783,481	Delaware	936,559
Massachusetts	6,773,437	North Dakota	741,984
Indiana	6,601,271	Alaska	738,076
Tennessee	6,568,186		
Maryland	5,967,339		
Wisconsin	5,755,462		
Minnesota	5,467,334		
South Carolina	4,859,401		
Kentucky	4,420,792		
Oregon	3,997,870		
Connecticut	3,588,657		
Iowa	3,113,670		
Mississippi	2,988,897		
Arkansas	2,973,690		
Nevada	2,844,525		
Idaho	1,643,939		
Hawaii	1,418,098		
New Hampshire	1,334,655		
Maine	1,329,525		
Rhode Island	1,055,963		
South Dakota	852,107		
District of Columbia	668,531		
Vermont	625,074		
Wyoming	583,620		

Table 2 explores the cohort differences on capital expenditures and compensation by year. It shows that non-conforming states actually saw mean capital expenditure levels decrease between 2013 and 2016 by about 8%, while conforming states saw investment increase by roughly 8% on average over the same time period. The cohorts saw no such diversion in terms of compensation. Table 2 shows that wage growth in the manufacturing sector in both sets of states was equal from 2013 to 2016.

Table 4. Average Capital Expenditures and Annual Compensation by Cohort and Year				
	Average Capital Expenditures ($1000)		**Average Annual Compensation ($1,000)**	
Year	**Yes[1]**	**No[1]**	**Yes[1]**	**No[1]**
2013	$2,052,724	$4,043,848	$52.10	$53.57
2014	$2,270,986	$3,867,927	$53.67	$55.59
2015	$2,391,332	$3,913,468	$54.89	$56.40
2016	$2,224,463	$3,731,983	$55.81	$57.39
Percent Change between 2013 and 2016	*8.37%*	*-7.71%*	*7.13%*	*7.14%*

[1] The data in the "Yes" columns represent the averages for states that adopted bonus depreciation. Those in the "No" columns are averages from states that did not have the policy.

Economic Context

Overall, this post-recession period was one that saw moderate economic growth. Real GDP annual growth rates from 2013 to 2016 ranged from 1.4 percent to a peak of 4.1 percent in Q1 of 2015 (Bureau of Economic Analysis, *Real Gross Domestic Product*, 2021). By contrast, the manufacturing sector's growth was more modest. Table 3 shows the real GDP for the sector by year chained to 2012 dollars. From 2013 to 2016, GDP in this sector grew by about 2.3 percent (Bureau of Economic Analysis, *Real Gross Domestic Product by Industry*, 2021).

Table 5. Real GDP for U.S. Manufacturing Sector by Year	
Year	**Real GDP ($Millions)**
2013	$1,986,179
2014	$2,020,172
2015	$2,048,404
2016	$2,032,409

Despite the relatively meager growth, it is worth noting that this is not a signal that manufacturing is declining in the United States or growing at a slower pace than the overall economy. In fact, from 1947 to 2015, the industry's share of overall real GDP remained fairly flat, while its share of nominal GDP decreased over the same period (Chien, 2017). The fact that manufacturing has maintained roughly the same share of the U.S. economy suggests that the sector's price level (i.e., the value of the good produced) has increased at a slower pace than that of the overall economy, leading to a lower nominal GDP value. In real terms though, the manufacturing sector has not shrunk. These lower prices for manufacturing goods might be the result of increased productivity. Indeed, the sector has seen a declining share of overall employment in the economy and maintained a constant share of real GDP, offering proof that it has seen robust increases in productivity over the decades (Chien, 2017).

VIII. Results

The results show that the capital expenditures of the manufacturing sector in states that adopt bonus depreciation were, on average, 21.5 percent[b] higher than those that did not have the tax policy. The model in this case controls for state population, the highest corporate tax rate, state GDP, and manufacturing sector GDP. Meanwhile, the results show that, on average, yearly

[b] Because the dependent variables are in log form, the percent change is calculated using the exponential function e^x-1, where x equals the coefficient output from the model. In this case, $e^{0.195}-1 = 0.215$, thus translating to level of capital expenditure that is, on average, 21.5 percent higher in conforming states.

compensation for manufacturing workers in states with the policy were about 5 percent higher.[c] This second model controls for population, the highest corporate tax rate, manufacturing sector GDP, and the value of all shipments and receipts of services within the sector. In short, both models show that bonus depreciation bears a statistically significant positive correlation with levels of capital expenditures and compensation. Table 4 provides a summary of the results from the models. Model 1 is the capital expenditures regression and Model 2 is the compensation one. The results from both models are robust, while the capital expenditures model has a particularly high R-squared, suggesting high explanatory power.

Table 6. Base Model Regression Results

VARIABLES	(1) Model 1 *Capital Expenditures*	(2) Model 2 *Compensation*
conformity	0.195***	0.0505***
	(0.0485)	(0.0154)
lpop	0.586***	-0.0879***
	(0.149)	(0.0179)
CTR	-1.216	-0.635**
	(1.080)	(0.265)
lGDP	-0.782***	
	(0.114)	
lGDP_Manu	1.086***	0.335***
	(0.0493)	(0.0399)
lshipments		-0.255***
		(0.0355)
Constant	4.315***	6.617***
	(0.824)	(0.367)
Observations	203	203
R-squared	0.953	0.351
F Statistic	678.37	19.35

Robust standard errors in parentheses[d]
*** p<0.01, ** p<0.05, * p<0.1

[c] $e^{0.0505}-1 = 0.05$, suggesting compensation is, on average, about 5 percent higher in conforming states.

[d] Robust standard errors were used in order to account for any biases in them. Potential errors with the models are discussed further in the following section.

The results track well with the previous studies conducted on this topic. Zwick and Mahon (2017), Ohrn (2017), and Ohrn (2019) found a similar significant relationship between bonus depreciation polices and levels of investment. Ohrn (2017 and 2019) also showed that the policy had a statistically significant, if more muted, correlation with compensation. The notable diversion between this paper and the past literature is that this study finds a larger and more statistically robust relationship between the policy and employee compensation. In both studies, Ohrn found bonus depreciation correlated with about a 2 percent increase in compensation, and his 2019 study showed the result was only statistically significant at the 10 percent level. The result of this model shows a 5 percent difference and is significant at the 1 percent level. Both studies, however, confirm the hypothesis that the size of bonus depreciation's correlation with compensation is smaller than its one with capital expenditures.

In Model 1, most of the variables share statistically significant relationships with levels of capital expenditures. However, CTR, which represents the highest corporate tax rate in each state, does not. The term's inclusion is discussed in the section below. The model results show that population and the manufacturing sector GDP are as expected positively correlated with capital expenditures. Surprisingly, GDP was negatively correlated with capital expenditures. However, state size and strength of manufacturing sector growth are important to manufacturing investment. In small states with little growth in manufacturing, there could be little overall investment even in good economic times. For example, the relationship turns positive only once the variables for population and the manufacturing sector GDP are removed from the model (Table 5).

Table 7. Capital Expenditures Regression Not Controlling for Manufacturing Sector GDP and Population

VARIABLES	(1) Model 1
conformity	0.266*
	(0.146)
lGDP	1.084***
	(0.0537)
CTR	-4.475
	(2.732)
Constant	1.340**
	(0.627)
Observations	203
R-squared	0.565

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Meanwhile, all of the controlling variables hold statistically significant correlations with annual compensation for manufacturing sector workers. Here, again, there are some confounding relationships: Population size and the value of shipments are negatively correlated with compensation. This implies that bigger states with large service sectors can hold down manufacturing wages. These relationships turn positive (but lose their robustness) when the manufacturing sector GDP variable is removed (Table 6). Thus, both models illustrate that the size of a state's manufacturing sector appears to be a major driver of investment and wages.

Table 8. Compensation Regression Not Controlling for Manufacturing Sector GDP

VARIABLES	(2) Model 1
conformity	-0.00842
	(0.0163)
lpop	0.0311*
	(0.0160)
lshipments	0.00212
	(0.0121)
CTR	-0.0926
	(0.307)
Constant	3.504***
	(0.143)
Observations	203
R-squared	0.098

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

IX. Model Enhancements and Limitations

The first attempt at the model had both dependent variables regressed on the same set of independent variables. The results returned from the capital expenditures model were fairly robust and the current version largely reflects this original one. The model does include the variable CTR, which is not statistically significant. Attempts to run the model excluding it, however, seemed to present other problems, namely in the form of omitted variable bias. For this reason, as well as the literature, it is included in the regression.

The compensation model, however, presented some specification problems. Diagnostics testing indicated that the model contained some errors, while the coefficient for conformity was not statistically significant. To account for the problems, new variables were introduced to the model. Given that education and wages are likely correlated, one version included a variable that measured the proportion of the state population that had received at least a high school degree.[e] However, the term was not statistically significant and did not seem to improve the overall robustness of the model (Model 1 in Table 3 in Appendix C). Model quality was greatly improved by including the shipments term and removing the GDP variable. As mentioned, both variables measure the value of firms' output, with shipments representing the total value of gross sales and GDP taking into account the costs of production. Given this similarity and the fact that wages in a firm should be tied to output, the term was included in this model. In this current form, all variables are statistically significant at the 0.05 level or above. (It should be noted that adding the shipments variable in the capital expenditures model did not improve its quality and the term was not statistically significant.)

Despite the improvements, diagnostics still suggest that the model might suffer from some errors. Table 1 in Appendix C shows the results from the linktest conducted on both models. Linktest helps detect potential specification errors with regressions. Ideally, the _hat coefficient would be statistically significant and the _hatsq coefficient would not. The results indicate that compensation model might be missing variables or have them in their incorrect form (i.e., log vs. linear). Experimenting with various models each containing different combinations of the variables in log and linear form, however, did not produce better results and often led to a loss in statistical robustness.

Instead, attention was turned to the possibility the model was missing a variable. While the results of the Ramsey Reset Test, included in Table 2 in Appendix C, do not necessarily suggest that it is (a statistically insignificant result means the model has no omitted variables), it

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[e] Data is sourced from the U.S. Department of Commerce, Census Bureau and the National Center for Education Statistics.

is nonetheless conceivable that it is failing to account for some other factor that would have an effect on compensation. To address the problem, various versions of the model were tested by adding new variables. These models can be found in Table 3 in Appendix C. As already noted, including an education variable did not improve the results. Meanwhile, experimenting with an interaction term (in this case, multiplying lGDP_Manu by lshipments on the theory that the value of shipments would be dependent on GDP levels or vice versa) did not materially improve the test results or enhance the model. While the model's explanatory power overall improved, other model diagnostics suggested that the model was missing a variable. To account for this, another version of the model was tested that included the interaction term and a measure of the proportion of the states' population that had a bachelor's degree or higher.[f] While the missing variable error seemed to be resolved, the effect was that some of the variables lost a bit of their robustness relative to the base case. The education term itself was not statistically significant. The base case used in the study is included as Model 4 for comparison. Ultimately, these alterations did not help boost the model's overall quality and, in some cases, reduced its robustness.

One possibility is that the model is missing a term that cannot be measured. For instance, it would be valuable to include the level of productivity growth observed by each state's economy. As noted, productivity has a direct effect on wages and a model such as this would ideally control for it. However, the U.S. Bureau of Labor Statistics, which measures productivity levels on a quarterly basis, does not offer state-level data. Despite the issues, the important takeaway is that all of the iterations of the model reaffirm the basic hypothesis and show a

[f] Data is sourced from the U.S. Department of Commerce, Census Bureau and the National Center for Education Statistics.

statistically significant positive relationship between having bonus depreciation policy and the level of compensation in the manufacturing sector.

X. Conclusion

In 2017, the Tax Cuts and Jobs Act increased bonus depreciation allowance from 50% to 100%. In other words, firms are allowed to write off all of the asset's value in the year of purchase from their taxes. The policy is mathematically prudent, given that smaller bonus allowances do not let firms capture the full cost of their capital purchases, thus imposing a hidden additional tax. However, the 100% allowance is set to expire in 2022, after which it will be phased out completely by 2026. This will almost certainly have a major effect on the amount companies budget for capital expenditures. Companies tend to plan their capital budgets years in advance, so it is plausible that the policy's 2022 expiration is already having an effect on capital purchases. Failure to extend the policy could ultimately prove detrimental to investment and productivity growth in the coming years.

The results from this study paint a clear picture that the policy helps boost private investment, providing further justification for its implementation beyond the mathematical and economic arguments presented. Further, its correlation with higher compensation arguably represents indirect evidence that the policy helps enhance productivity growth. It is worth noting that the data from the results were taken at a time when bonus depreciation allowance was set at 50% of expenditures. The current policy of full allowance might well enhance the magnitude of effect the policy has on these outcomes and should be a focus of research.

Given the extended period of low productivity growth the U.S. economy has experienced, it is incumbent that policymakers expand their arsenal of policy tools that they can implement to boost investment and reverse the current trends. This paper shows that bonus depreciation should be considered an important policy lever in that cache. As such, the U.S. government should make the current 100% bonus depreciation allowance permanent. This would allow for firms to plan their capital expenditures without concern or doubt over their tax implications. This is especially important at this moment as the economy is likely entering into the pandemic recovery phase. States should also adopt the policy. While state corporate tax rates are lower than federal rates, states might risk losing out on private investment and wage growth. As it is, the net effect this policy will have on tax revenue is minimal. While the timing of collection will change, the difference in real revenue collected between a tax write-off that follows a traditional depreciation schedule and one that allows full expensing in the year of purchase would be relatively small. It is a small difference that could have larger implications for a state's economic fortunes.

Appendix A
IRS Modified Accelerated Cost Recovery System (MACRS) Schedule

Table A.1. 3-, 5-, 7-, 10-, 15-, and 20-Year Property Half-Year Convention

Year	Depreciation rate for recovery period					
	3-year	5-year	7-year	10-year	15-year	20-year
1	33.33%	20.00%	14.29%	10.00%	5.00%	3.750%
2	44.45	32.00	24.49	18.00	9.50	7.219
3	14.81	19.20	17.49	14.40	8.55	6.677
4	7.41	11.52	12.49	11.52	7.70	6.177
5		11.52	8.93	9.22	6.93	5.713
6		5.76	8.92	7.37	6.23	5.285
7			8.93	6.55	5.90	4.888
8			4.46	6.55	5.90	4.522
9				6.56	5.91	4.462
10				6.55	5.90	4.461
11				3.28	5.91	4.462
12					5.90	4.461
13					5.91	4.462
14					5.90	4.461
15					5.91	4.462
16					2.95	4.461
17						4.462
18						4.461
19						4.462
20						4.461
21						2.231

Source: https://www.irs.gov/pub/irs-pdf/p946.pdf

Appendix B
Summary Statistics Tables

Table B.1. Summary Statistics for Conforming States				
	Average	**Standard Deviation**	**Min**	**Max**
Capital Expenditures ($1000)	2,235,053	2,287,657	102,491	8,727,256
Yearly Salary ($1000)	54.09	5.46	42.69	70.30
GDP ($Millions)	177,346.16	171,570.93	42,429.70	747,666.80
GDP of Manufacturing Sector ($Millions)	21,625.07	24,633	1,346.60	99,612.30
Population	3,480,148	3,056,100.90	722,036	12,895,129
Corporate Tax Rate	6.88%	1.46%	4.31%	9.50%
Value of Shipments ($1000)	74,782,037.58	76,799,913.15	6,003,375.00	283,768,708.00

Table B.2. Summary Statistics for Non-Conforming States				
	Average	**Standard Deviation**	**Min**	**Max**
Capital Expenditures ($1000)	3,889,307	4,170,573	3,551	19,745,790
Yearly Salary ($1000)	55.74	6.72	41.91	71.95
GDP ($Millions)	397,094.80	474,156.50	28,367.90	2,519,134.60
GDP of Manufacturing Sector ($Millions)	47,069.03	55,544.02	207.8	285,326.3
Population	7,405,940	7,931,096.28	582,122	39,167,117
Corporate Tax Rate	6.28%	3.22%	0%	12.0%
Value of Shipments ($1000)	125,231,801.55	136,630,998.36	314,602.00	731,607,660.00

Appendix C
Model Enhancements and Limitations Tables

Table C.1. Linktest for Models

Model 1 – Capital Expenditures

lCapExpen	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
_hat	1.04784	.1728697	6.06	0.000	.7069587	1.388721
_hatsq	-.0017792	.0064028	-0.28	0.781	-.0144049	.0108465
_cons	-.3166094	1.161526	-0.27	0.785	-2.607018	1.9738

Model 2 - Compensation

lcomp_yearly	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
_hat	-11.59523	7.686534	-1.51	0.133	-26.75228	3.56182
_hatsq	1.574892	.9610406	1.64	0.103	-.3201806	3.469964
_cons	25.17524	15.36736	1.64	0.103	-5.127593	55.47807

Table C.2. Ramsey Reset Test

Model 1 – Capital Expenditures

H_0: model has no omitted variables	
F(3, 194) =	1.98
Prob > F =	0.1187

Model 2 – Compensation

H_0: model has no omitted variables	
F(3, 194) =	1.69
Prob > F =	0.1706

Table C.3. Regression Results for Alternative Versions of the Compensation Model

VARIABLES	(1) Model 1	(2) Model 2[b]	(3) Model 3	(4) Model 4[a]
conformity	0.0505***	0.0465***	0.0427**	0.0505***
	(0.0156)	(0.0162)	(0.0173)	(0.0154)
lpop	-0.0875***	-0.0627***	-0.0592***	-0.0879***
	(0.0197)	(0.0175)	(0.0183)	(0.0179)
lGDP_Manu	0.335***	0.501***	0.486***	0.335***
	(0.0432)	(0.0609)	(0.0638)	(0.0399)
lshipments	-0.255***	-0.186***	-0.139**	-0.255***
	(0.0375)	(0.0372)	(0.0596)	(0.0355)
CTR	-0.635**	-0.636**	-0.720**	-0.635**
	(0.273)	(0.275)	(0.290)	(0.265)
HSplus[a]	0.000109			
	(0.00293)			
GDPMxShip[a]		-0.00950***	-0.0107***	
		(0.00251)	(0.00271)	
BAplus[a]			0.00242	
			(0.00186)	
Constant	6.600***	5.061***	4.452***	6.617***
	(0.566)	(0.540)	(0.788)	(0.367)
Observations	203	203	203	203
R-squared	0.351	0.394	0.400	0.351

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[a] *GDPMxShip is the interaction term that multiplied lGDP_Manu and lshipments. HSplus is the proportion of the state population that holds a high school degree or higher. BAplus is the proportion of the state population that holds a bachelor's degree or higher. Model 4 is the base model used in the study.*

[b] *While the coefficient for GDPMxShip is statistically significant and the model boasts a higher R-squared, the p-value for conformity is slightly below its value in the base case. Additionally, the Ramsey Reset Test with this model yields a statistically significant result, suggesting that the model might suffer from omitted variable bias. Either way, both models show that bonus depreciation bears a statistically significant positive relationship with compensation levels.*

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