DEPARTMENT OF ECONOMICS

UNIVERSITY OF OSLO

THESIS FOR THE DEGREE

MASTER OF PHILOSOPHY IN ECONOMICS

FISCAL POLICY AND INDUSTRIAL OUTPUT

Public Investment Effects on Industrial Production and Nominal Wages in a Select OECD Countries.

Author:

James Maina

Supevivor:

Yicheng Wang

MAY 2018

Public investment Effects on Industrial Production, Nominal Wages and Household Consumption Growth.

James Maina

http://www.duo.uio.no/

Print: Reprosentralen, Universitetet i Oslo

Acknowledgement

In writing this thesis it wouldn't have been easier without the help of my supervisor, Yicheng Wang. His motivation and advice are invaluable. I must also thank the OECD online support for their help in most of the many questions that I encountered on public expenditure data. And more importantly I thank the Department of Economics, University of Oslo, for the patience and understanding in allowing me the time to finish my studies, despite the very difficult personal challenges I faced during my studies.

And finally, I deeply thank my wife Mary Wairimu for her great support, love and encouragement without which, my studies and thesis would have been much more arduous. I can't thank her enough.

Table of Contents

List of Tables

List of Figures

Abstract

This paper investigates the effects of changes in public investment on industrial output, nominal industry wages and household consumption, to identify the channel through which public spending affects aggregate demand and boost industrial output and productivity. I use both Fixed effects and Instrument Variables regression on a panel for 20 select OECD countries for the period 1996-2015.

Our main results from fixed effect regression show public investment have a positive effect on industrial output and nominal industry wages. In particular, we find a 1% increase in annual public investment increases industrial production 0.027%. The effect is higher with Instrumental variables regression increasing production by 0.345%, perhaps showing public investment to be endogenous. The effect on nominal wages is about 0.027% (at 1% significant level) on fixed effects regression but negative at -0.05% with instrumental variables regression but not statistically significant even at 10% level.

The effect on household consumption on the other hand is negative with fixed effects with about -0.014% (at 1% significant level) in all our regressions. Our IV results however are not statistically different from zero even at 10% significant level. Household unlike Industrial output and wages seem to react to contemporaneous public investment and so we assume that household being a fast-moving variable, it may react faster from anticipatory effects. The results though not conclusive suggests that households react more to a negative wealth effect in expectations of higher future taxes than to increases in real interest rates' intertemporal substitution effects.

All our results on seems to suggest that public investment has only a transitory effect on industrial output, wages and household consumption and further research on its effect on total factor productivity might reveal its long-term role in industrial development.

We conclude that the reaction of industrial output, nominal industry wages and household consumption, to public investment shocks, agree with the studies that predict procyclical wages interpret the cyclicality of employment as a consequence of shifts in labour demand by firms.

1. Introduction

Infrastructure such as roads, telecommunications, energy, military and structures like hospitals and schools are some of the major components in a country's public-sector capital stock. Public investment could have a sizeable impact on economic growth, productivity and an economy's ability to structurally transform. Most sectors' production depends on infrastructure as an input. Public capital has strong explanatory power for why some countries have managed to industrialize, while others remain behind.

Economist Chalmers Johnson in his book *MITI and the Japanese Miracle*, observes that states have different approaches to private economic activities and industrial development; the regulatory orientation and the developmental orientation, which produce different kinds of business-government relationships. Japan and other Asian countries that were late to industrialize, are good examples of states in which the developmental orientation predominates. Governments in developmental states invest and mobilize much of the capital into the most promising industrial sector that will have maximum spillover effect for the society. Cooperation between the government and major industries is crucial for maintaining stable macroeconomy. The United States is a good example of a state in which the regulatory orientation predominates. Public investment therefore is a key determinant of industrial development.

Industrial growth and productivity has been sluggish since and before the Great Recession, affecting nearly every industry. The slow recovery of aggregate demand and the decline in business dynamism as well as spillover effects of productivity to other fast-emerging economies, have resulted in low growth of capital investment and thus slower industrial development. Other underlying structural issues like lack of credit for capital investment funding, resulting from the punitive prudential supervision reform measures adopted by most Central banks in the aftermath of the financial crisis of 2008, (Millar, J. and D. Sutherland, 2016), have also played a role in depressing capital investment and hence industrial growth.

There is also a possibility that the sluggish growth in aggregate demand and industrial growth could be cyclical. Some studies however, attribute the deceleration of aggregate productivity to slower multifactor productivity growth, or diminished pace of capital deepening, (Alesina and Perotti, 1996).
The quantitative and qualitative easing measures undertaken in the US, Japan and other OECD countries after the monetary policy near zero rates and liquidity trap, have not been very effective in stimulating aggregate demand, and industrial production remain low. This hence renders fiscal policy as an increasingly important tool in stimulating and stabilizing economic growth.

Understanding the effects of government spending on the economy's aggregate demand and productivity is therefore important to economists. Fiscal policy effects on the economy, though a long-studied subject in economics, has been fraught with lack of consensus among researchers and policy makers. Earlier focus was mainly on fiscal policy's effect on overall GDP growth, aggregate demand, real exchange rates or interest rates (Alesina and Perotti, 1996; Iavazzi and Pagano, 1990; Blanchard and Leigh, 2013) but over time, focus has shifted

to other GDP components like productivity of individual production inputs or the Solow residue. However, studies on the effects of government consumption and its effect on industrial production and wages, have not featured prominently in literature.

Most studies on fiscal policy effects on the economy, have varying results due to differences in approaches, from theoretical frameworks, empirical models to the methodologies used to estimate fiscal shocks and so on. (Aschauer 1988; Barro 1989; Tatom, 1991) uses a neo-classical approach with perfect competition and constant returns to scale and hypothesize that an increase in government spending has a negative wealth and intertemporal substitution effects on households from increases in interest rates, that leads to a decrease in consumption and an increase in labor supply and consequently a decrease in wages and labor productivity.

The neo-classical approach posits that public investment is mostly transitory because long run growth depends on technological progress.

New Keynesian approach however, departs from the assumption of perfect competition to imperfect competition and sticky prices and assumes that an increase in government spending leads to a contemporaneous increase in labour demand and since firms set mark ups over their marginal cost, they can hire more workers by adjusting the markups. Higher demand for labor by firms thus leads to an increase in wages.

(Rotemberg and Woodford, 1989) is one of the earliest studies on fiscal policy effects on industrial productivity and real product wages. They depart from a neoclassical theoretical framework, by assuming imperfect competition, increasing return to scale and price setting oligopolistic firms and postulate a general dynamic equilibrium model with price setting oligopolistic firms that have the power to set mark ups on prices over the perfect competitive market optimal marginal cost level, and so can employ more labour by adjust their markups without lowering the wages, following a fiscal shock. (Ramey and Shapiro, 1998) on the other hand, use a neoclassical approach modified with a two-sector economic model. They find heterogeneity in the behavior of firms after a fiscal shock and conclude that there is some rigidity in capital mobility between sectors which make it costly. They find the aggregated behavior of a one sector model difficult to reconcile with empirical findings.

The behavior of wages and household consumption is key to understanding the effects of government spending on industries and the economy in general. (Barsky and Solo, 1989) find procyclical real wages by using longitudinal micro data on a panel of industries in the US, that reveal gaps on research conducted with economy wide averaged data. They conclude that the cyclicality of employment is better explained by procyclical wages resulting from labour demand by firms. (Nekarda and Ramey, 2010) however, find that the effect of a positive fiscal shock lowers both real wages and productivity but increases output and hours worked.

Other studies investigate the influence of business cycles on the economic effects of fiscal shocks. (Aschauer, 1989; Sturm and De Haan, 1995) control for the effect of the business cycle on factor use by including the capital utilization rate. (Auerbach and Gorodnichenko, 2002) find GDP multipliers of government purchases to be larger in recessions than in booms, by studying many OECD countries, which allows the use of panel data to control for latent factors that may affect how public spending is transmitted through the economy.

Though fiscal policy effects as most literature suggest depends on business cycles, some studies (Aiyagari, Christiano and Eichenbaum, 1990) also investigate the role of government expenditure as a contributor to business cycles. We use the output gap as a percentage of real GDP to control for business cycles. Our results show a statistically substantial influence of business cycles on how fiscal shocks affect industrial output, wages and household consumption growth.
This paper uses a panel data set for 20 select OECD countries over the period 1996-2015, to empirically investigate the effects of changes in government investments, on industrial output growth by empirically estimating the effects on output, nominal wages and household consumption, in order to understand the channel through which fiscal shocks affect industrial development and growth.

Identifying exogenous government spending that best estimates fiscal multipliers is a rather a unsettled question. Early studies like Barro and Aschaeur were criticized for not accounting for changes in public spending that might be endogenous and coming from factors like increased revenue as GDP growth increases or those that purely arise out of other shocks to the economy. (Alesina and Perotti, 1995; Ardagna, 2004) use the traditional structural balance approach to identify fiscal shocks while (Romer and Romer, 2010) use the narrative approach by adding up reports adopted from actual budgets and budget documentation. We identify changes to government investments on public facilities like infrastructure to have a high degree of discretionary spending since most public investments are long term and capital-intensive projects that require legislation and huge budgetary allocations as opposed to other government spending that are influenced by the economic conditions like purchases of goods and services, unemployment benefits and other transfers to households and so on. Changes in the ratio of public investment to the real GDP could therefore be a suitable proxy for an exogenous fiscal shock.

The study also extends to other factors that might influence the effect of government investments like trade spill-overs effect proxied by the growth rate of net exports as a percentage of GDP and the impact of public debt on the level of public investment measured by net interest payment on public debt as a percentage of real GDP. (Beetsma, Giuliodori and Klaassen, 2005) use a panel analysis to investigate the trade spillovers of fiscal policy in the European Union while (Popescu and Shibata 2017) investigate the impact on external positions from a spill over resulting from US government fiscal shocks. Both studies find a substantial effect of trade spillover from fiscal shocks. This study however, does not find evidence of trade having a substantial effect on how fiscal shocks affects industrial output and wages but find net exports to have some direct explanatory power on industrial output. In particular, a 1% increase in the net exports to GDP ratio increases industrial output by about 0.3%.

Industrial growth and wage growth depend on a number of other factors like technological growth, the net flow of FDIs, net exports and other latent or unmeasurable factors that may differ from country to country like climatic conditions and geographical locations. In that light, we extend the study to investigate the effects of such factors, using Fixed and Random Effects and then compare their suitability using a Hausman test.

Public investment may also depend on industrial growth, creating an endogeneity problem. Higher industrial growth may lead to higher GDP and consequently more tax revenue which create the need for more public spending on infrastructure and other investments. Still a healthy industrial sector might lead to governments redirecting resources to other public expenditure and so causality may be bidirectional. Identifying all factors that exhaustively constitute an exogenous fiscal shock is a herculean task, thus creating a methodological problem because fiscal policy is likely to be endogenous (Holden and Sparrman, 2011). We therefore use Instrumental Variables approach to address any endogeneity problem that might arise, as well as test the robustness of the fixed effect results. Our IV results are quite different from the fixed effects results showing that public investment could indeed be endogenous.

The rest of the paper is as follows. Section **2** dwells on the literature review. Section **3** describes data sources, variables construction and trends on changes in public investments and industrial growth in the select 20 OECD countries. Section **4** outlines the empirical approach, while section **5** will be on empirical results both tabular and graphical.

In section **6**, we draw the conclusions and limitations that calls for further research. The last section is on references.

2. Literature Review

There is a substantial literature that analyzes the effects of government spending on the economy. Much of the earlier focus was mainly on fiscal policy's effect on overall GDP growth, aggregate demand, real exchange rates or interest rates (Alesina and Perotti, 1996; Iavazzi and Pagano, 1990; Blanchard and Leigh, 2013). The effects of public investment and its effects on industrial production and real product wages, have not featured prominently in literature and while most studies largely agree that a change in government spending has a contemporaneous effect on industrial output and hours worked they disagree on the effects on other variables like wages, productivity and on household consumption.

(Barro,1988; Aschaeur 1989) are some of the earliest studies that investigate government spending effects on the economy using a neoclassical model approach with constant return to scale, perfect competition and decreasing marginal returns to labour. Barro ruled out increasing returns to scale even with government spending added as a factor in the production function, due to congestion. He therefore assumes constant returns to scale for both private and public production factors. Aschaeur considers the effect of government capital investment and expenditure on good and services on the private economy and find that a 1% increase in the ratio of public to private capital stock, increases private output by about 0.39%.

(Rotemberg and Woodford, 1989, 1992) is one of the earliest studies to investigate fiscal policy effects on industrial productivity and real product wages. The study departs from a neoclassical theoretical framework, by assuming imperfect competition, increasing return to scale and price setting oligopolistic firms using a general dynamic equilibrium model with the price setting oligopolistic firms setting mark ups on prices over marginal cost and which enables firms to adjust their markups to accommodate demand for more labour following a fiscal shock, without lowering the wages. They fault the neo-classical competitive models for the assuming that changes to labor supply can only emanate from households reacting to a negative wealth effect or to expectations about future real wages, while ignoring firms' changing demand for labor from the fiscal policy demand shock. Their arguments are mostly based on the different theoretical approaches and they find that an assumption of imperfect competition and oligopolistic pricing between firms best improves the fit between theoretical model and empirical observations. They conclude that changes in aggregate demand from a discretionary government spending like military expenditure increases both labor demand by firms and real wages.

(Ramey and Shapiro, 1998) however, return to a neoclassical approach but modify it with a two-sector economic model. They find heterogeneity in the behavior of firms after a fiscal shock and conclude that there is some rigidity in capital mobility between sectors which make it costly. They therefore suggest that the aggregated behavior of a one sector model is difficult to reconcile with empirical findings and that imperfect capital mobility rather than imperfect competition, as postulated by (Rotemberg and Woodford, 1989), explains the fluctuations in business cycles better. They conclude that the exogenous and sustained

military build-ups in the post- World War II period, led to a decrease in consumption, real product wages, and manufacturing productivity.

Much of the literature that uses perfect competition models, suggest that demand shocks operate only through labor supply, and that labor demand can only change through changes in productivity and capital investment. However, evidence suggest that output fluctuations have a substantial effect on labor demand. The assumptions of oligopolistic pricing and imperfect competition draws the conclusion of procyclical real wages.

(Devereux, Head, Lapham, 1996) investigate effects of government spending in a dynamic general equilibrium model with increasing returns to scale but deviates from the oligopolistic firms' assumption, to a monopolistic competition. They find that in spite of government spending being entirely wasteful, it leads to an endogenous improvement in total factor productivity which leads to an increase in output, hours worked and wages.

At the core of neo-classical approach and decreases in real wages is the expectations of higher future taxes and negative wealth effect assumed to emanate from households due to the increase in interest rates. (Blanchard, Perotti, 2002) investigate the effect of government spending on various aggregate variables and find a positive effect of fiscal policy on short term interest rates.

(Nekarda and Ramey, 2009) investigate industry evidence of effects of government spending and in agreement with the neo-classical theory find that both output and labour increase with increased spending but both product wages and productivity decrease. Their findings however disagree with the New Keynesian hypothesis of increased real wages. The study concludes that the demand for labour increases only in some industries since government purchases targets certain industries and hence those industries might either pay a premium for the overtime to meet the increasing demand or pay an adjustment costs as labour shifts from other industries.

Several studies suggest that trade spillovers affect the effectiveness of government purchases and investment. (Popescu and Shibata, 2017) use time series data for the US to estimate the effect of trade spill-over of fiscal policy shocks and its impact on US external position. They analyse the effects of preannounced government fiscal shocks on real exchange rates and the trade balance using a VAR framework and find that preannounced public spending appreciates the real effective dollar leading to a worsening of trade balance. While the effect of fiscal shocks on trade balance is hard to identify due to the fast-moving variables like the exchange rates, (Beetsma, Giuliodori and Klaassen, 2005) study on the trade spillovers of fiscal policy in the European Union avoids the influence of exchange rates by studying trade spill-over effects in a monetary union. They find that a public spending increases equal to 1% of GDP increases foreign exports by about 2.3% over the first two years. (Clancy, Jacquinot, Lozej, 2014) also investigate trade spill-over for small open economies within a monetary union that have a limited range of stabilisation tools, as area-wide nominal interest and exchange rates do not respond to country-specific shocks. They find that complementarities between government and private consumption can substantially increase spending multipliers

and that spill-overs from a fiscal stimulus in one region of a monetary union depend on trade linkages and can be sizeable.

Our study finds a significant influence of net exports as a share of GDP on industrial output but little influence on changes in public investment. However, since the study extends to countries beyond a monetary union, without controlling for changes in real effective exchange rates and other factors, our results cannot be entirely conclusive.

Other factor that has been considered in the literature is how fiscal shocks are transmitted over business cycles. The question is whether fiscal multipliers depends on the state of the economy. (Aschauer, 1989; and Sturm and De Haan, 1995) control for the effect of the business cycle on factor use by including the capital utilization rate. (Auerbach and Gorodnichenko, 2002) find GDP multipliers of government purchases to be larger in recessions than in booms, by studying a large number of OECD countries, which allows the use of panel data to control for latent factors that may affect how public spending is transmitted through the economy. (Aiyagari, Christiano and Eichenbaum, 1990) however observe that though most studies suggest fiscal policy effects depend on business cycles, the reverse effect of government spending as a cause for business cycles is ignored in most literature. We find a significant influence of business cycles on the effects of public investment on industrial output and household consumption. However, the effect is insignificant on nominal wages perhaps due to wage rigidity.

The effects of government investments as hypothesized by neoclassical models, may be transmitted through households' reaction to changes in interest rates from a negative wealth effect or intertemporal substitution effect that may reduce current consumption and increase labour supply thus leading to a decrease in wages and labour productivity. (Aiyagari, Christiano and Eichenbaum, 1990) investigate the effect of government spending on output, employment and interest rates in a stochastic neoclassical growth framework. While they find an expansionary effect of fiscal policy on productivity that agrees with the standard neoclassical growth model approach (Hall 1980; Barro, 1981, 1987), they find permanent shocks to government spending to have more persistent effects on both output and employment than transient ones. Barro on the other hand find transient fiscal shocks to be more persistent than permanent shocks, because of the transient shocks effect on interest rates.

(Basky and Solon 1989) investigates real wages and business cycles and find evidence of substantial procyclical real wages both in the industry average wage statistics, and to a lesser extent in economy wide averages. They conclude that the procyclicality of real wages indicate that the cyclicality of employment is generated more by labour demand than labour supply which agrees with (Rotemberg and Woodford, 1989) that real wages increase due to labour demand by oligopolistic price setting firms.

(Rotemberg, 1989; Devereux, Head, and Lapham,1996) are critical of neo-classical argument about the effects of an increase in government spending on labour. The question is whether firms demand more labour or households supply more labour because the two would affect real wages differently, with neoclassicals hypothesizing that since capital and technology are slow shifting production factors, the effects on labour must be from the effects of government

spending on households' behavior and hence labour supply is likely to increase leading to a fall in real wages. Rotemberg and Devereux disagree and conclude that following an increase in government spending, household consumption, real wages and productivity actually rises.

(Ramey and Shapiro, 19989) in a two-sector neoclassical model observe that labour and capital are not perfectly mobile and its costly to shift them to the sector whose products demand is affected more by the changes in government spending. They substitute Rotember/Devereux imperfect competition for imperfect capital mobility to explain business cycles and contrary to their findings, Ramey and Shapiro show that following exogenous and sustained military buildups in the post- World War II period, consumption, real product wages, and manufacturing productivity fell.

Stochastic trends lead to estimating spurious relationships in a regression. Earlier studies (Barro 1988; Aschaeur 1989) found unrealistic relationships between public expenditure and growth for failure to account for stochastic trends. Some studies overcome the problem by first differencing time series or by use of backward looking moving averages to smoothen data and remove the stochastic trends. The problem with first differencing, is that non-stationary variables may be cointegrated and thus exhibit similar trends in the long run which may be missed in the first differenced data (Sturm and De Haan, 1995). Our dependent variables and independent variables are mostly in growth rates or first differences, so we assume the stochastic trends have been accounted for.

Other factors that may affect the impact of government investment is the endogeneity problem. A period of high industrial growth may translate to higher revenue for the government and hence higher public spending. Low industrial growth may also force the government to spend more on public investment to boost productivity and aggregate demand. (Holden and Sparrman, 2013) use instrumental variables to handle the endogeneity problem. Our study address the problem in a similar approach for all our regressions and also to test for the robustness of our fixed effects regressions.

3. Data Sources, Variables Construction and Trends

3.1 Data sources and Variables Construction:

Government investment, expenditure on good and services, public employees' salaries, transfers in kind to households etc are collected from OECD's Economic Outlook Volume 102 of November 2017. Data for our independent variable of interest as calculated below is the annual real government expenditure on capital formation harmonised across OECD to constant prices and constant PPPs OECD 2010 US dollars, collected from OECD Economic Outlook No 102.

Real GDP growth, total hours worked, and private capital growth are from the Conference Board Total Economy Database (Adjusted Version) 2017. All data is harmonised to constant prices and constant PPPs 2010 US dollars.

The independent variable of interest is the first lagged changes in public investment. We assume that public investments take time for their effects to trickle into the economy and hence current spending might not be relevant to current industrial output, wages and household consumption. However, we include current public spending as a control variable for any effect on expectations by firms and household. Changes in public spending are calculated as annual percentage change multiplied by current government spending on investments as fraction of real GDP. The size of the multiplier will be biased if we don't take into account the size of government investments as a percentage of real GDP (Holden and Sparrman, 2013), because some countries have a higher growth rate, yet public investment constitute only a tiny fraction of their Real GDP. Real government investment is in total figures rather than per capita values, so I use population growth to control for the effect of population changes. The independent variable of interest is then $\boldsymbol{\Delta Gov\_Inv}_{it-1}$

$$\Delta \boldsymbol{Gov\_Inv}_{it} = \frac{\boldsymbol{Gov\_Inv}_{it} - \boldsymbol{Gov\_Inv}_{it-1}}{\boldsymbol{Gov\_Inv}_{it-1}} * \frac{\boldsymbol{Gov\_Inv}_{it}}{Real\ GDPG_{it}} * 100$$

The industrial output is measured as the annual industrial index as reported in the OECD's Economic Outlook Volume 102 of November 2017 and then recalculated as simple annual percentage change. Nominal wages and household consumption are from the same source and they are already harmonised across OECD to reflect constant prices and constant PPPs in 2010 US dollars. I recalculate the growth rates and compare with the ready provided rates in the OECD database. The results are similar save for Australia which is calculated to the base year 2014-2015, so I have recalculated it back to the OECD base year 2010.

$$\Delta \boldsymbol{Y}_{it} = \frac{\boldsymbol{Y}_{it} - \boldsymbol{Y}_{it-1}}{\boldsymbol{Y}_{it-1}} * 100$$

Where $\boldsymbol{Y}_{it}$ the dependent variable, represents industrial index, nominal wages or households' consumption growth rates in percentages.

The output gap is also as provided in the OECD database and it is measured as the difference between actual real GDP and the potential output of the total economy as a percentage of potential GDP. The short interest rates too are as reported in the database.

The influence of public debt on fiscal shocks effects is proxied by real net interest payments collected from the database as constant prices and constant PPPs 2010 USD net interest payment on public debt, then I calculate the annual percentage change multiplied by current real net annual interest payments as a fraction of real GDP. This helps to get a harmonised value across the countries as there seems to be a huge disparity between debt levels and the amount of interest rate paid on the debt due to differences in risk premia. The sample data shows a huge disparity between countries with Italy having the highest mean net interest payments of 5.4% of real GDP to the lowest, Norway at -2.2% of its GDP.

Population growth is as reported in the OECD Economic Outlook 102 database, but I use cyclically adjusted total population values to recalculate the growth rates and arrive at the same figures.

Net exports are collected from OECD as net exports as a percentage of GDP.

Household debt as a percentage of real disposable income, households' real disposable income, tax revenue as a percentage of Real GDP are all collected from OECD database.

3.2 Trends

The growth rates of industrial output, nominal wages and household consumption have been on decline over the period 1996-2015 as show below.

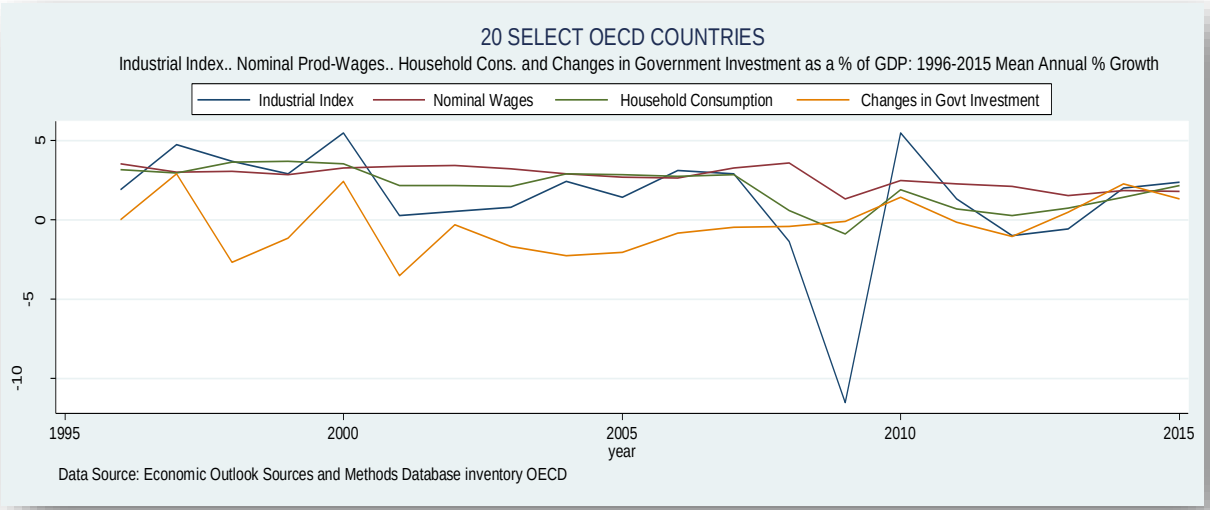
Table 1. Mean percentage Growth Rates (Standard Deviations in parenthesis**)**

	Industrial Index	Govt. Inv.	Wages	HH Cons
1996 – 2000	3.759	0.302	3.159	3.406
	(0.382)	(0.952)	(0.132)	(0.190)
2001 - 2005	1.090	-1.954	3.139	2.448
	(0.277)	(1.069)	(0.178)	(0.159)
2006 – 2010	-0.261	-0.061	2.662	1.452
	(0.723)	(0.461)	(0.215)	(0.213)
2011 – 2015	0.847	0.567	1.921	1.068
	(0.489)	(0.505)	(0.141)	(0.179)

In comparison government spending on public investments, apart from the period 2001-2005 has been steady and only growing marginally.
All the growth rates show that aggregate demand has been slower since the year before the financial crisis. Growth rates seem to be picking up in the period after 2010 from the period of the slowest growth 2006-2010.
The negative growth of changes in public investment in the period 2001-2005 seems, at least from the face value to have largely affected industrial productivity growth reducing it from a mean level of 3.759 to 1.090.
The mean growth of wages has been smoother apart from the slower growth in the aftermath of the financial crisis.

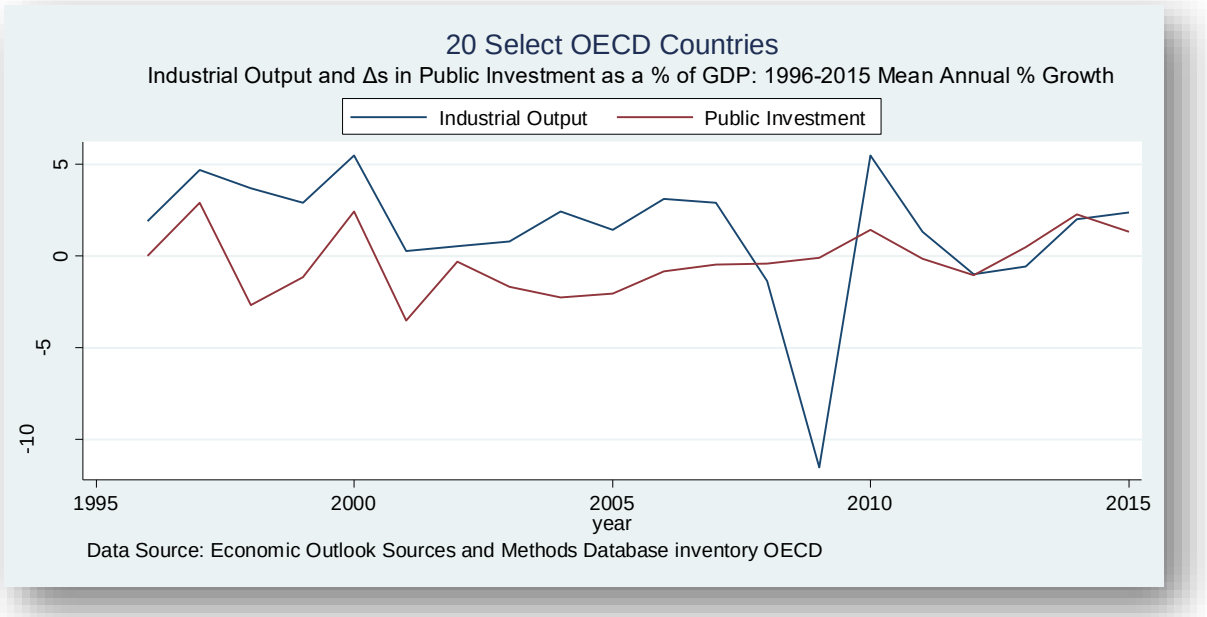
Industrial output experienced a sharp fall around the 2008-2009 showing the adverse effect of the financial crisis on aggregate demand. Industry output however returned to a positive growth albeit slower the crisis.

Figure 1. Industrial Output, Public Investment, Nominal Wages and Household Consumption Mean Percentage Growth Rates.



Industrial output and changes in public investment have first difference series that exhibit some long run cointegration.

Figure 2. Mean Percentage Growth Rates for Industrial Output and Public Investment.



Since the variables are in growth rates it means they have already been first differenced. So we do not dwell much on the issue of stochastic time series.

List of Countries

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Great Britain and USA.

Data for New Zealand for nominal wage growth is dropped from the sample and the regression for wage growth done on the rest 19 countries. The other regression are run with a balanced data set for the full 20 countries.

4. **Methodology**

To estimate the impact of changes in public capital investment on industrial output, nominal wages and household consumption, I use an empirical specification, modelling the growth rate of industrial production index, wages or household consumption growth rates as a function of the first lagged annual change in the ratio of real total public investment to real GDP. Public capital investment take time for their effects to spill over to the economy and hence lags could be more relevant than contemporaneous spending changes. Indeed, public investment in infrastructure is unlikely to lead to contemporaneous growth unless a country is poised for high growth, otherwise it only prepares the country for growth, and the effects should show up with a lag.

Further, I make two crucial adjustments. One, data on government spending in capital formation, is in gross real values and so it incorporates some aspect of population growth rate. So, I use population growth rate to control for its effect on changes in government spending. Two, the demand effects of a change in government spending will be biased if one does not consider the percentage of government spending to GDP, since though some countries have a higher growth rate, spending on public capital investment constitutes a smaller percentage of the GDP, ranging from 2.2% of real GDP for Belgium and the UK, the lowest in the sample, to 4.7% in Japan. So, I multiply the rate of growth of public investment by its ratio to the real GDP.

The baseline empirical model for this study is as follow

$$Y_{it} = \beta_0 + \beta_1 \Delta Gov\_inv_{it-1} + \beta_2 pop\_gr_{it-1} + \beta_3 X_{1,it} + \ldots\ldots + \beta_{k-2} X_{k,it} + \varepsilon_{it}$$

Where Y_{it} represents the dependent variable, the percentage growth rates of industrial output, nominal wages and household consumption, ΔGov_inv_{it-1} is the first lag of changes in government investments as stated above, pop_gr_{it-1} is the lagged population growth rate to control for the aspect of population, $X_{j,it}$ represents other explanatory and control variables that may bias our estimates if omitted from the regression. ε_{it} is the error term assumed uncorrelated with the independent variables.

For our first dependent variable **Industrial output growth,** we consider factors that could influence industrial output directly like the growth of household consumption and external demand and supply shocks proxied by net exports as a percentage of GDP. Output may also depend on business cycles (Auerbach and Gorodnichenko, 2011), we use Output gap of the total economy as a percentage of potential GDP to control for the cycles.

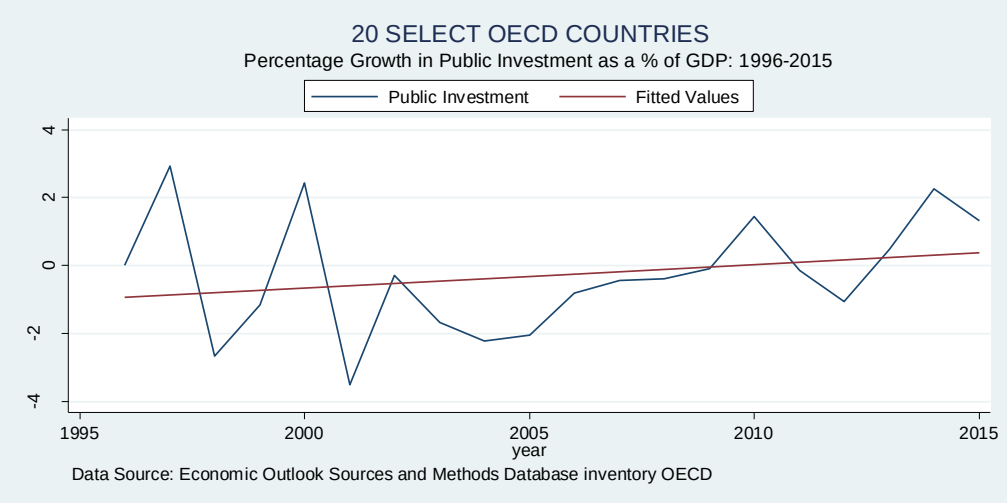
Certainly, economic development has some influence on the need to change government expenditure. As the general level of individual income rises and countries develop, the importance of government spending and its distribution changes. Lower unemployment and higher incomes may decrease government expenditure on transfers to households but rising output per capita and increasing population creates a simultaneous growth in the size and importance of urban centers and conurbations, which increase spending on infrastructure. Hence, we include other government expenditure on public employees, purchases of goods and service, transfers to households both in cash and kind etc. Household consumption

increases as real incomes increase or if households became more impatient and increased consumption. This increases industrial production and so we include contemporaneous and lagged values of household consumption growth.

The effect of government investments on the economy may be affected by its public debt since higher debt levels deplete resources that could otherwise go to public infrastructure and other investment. As stated earlier we use the growth rate of net interest payments as a percentage of GDP to gross public debt due to huge differences in risk premia facing different countries.

Output in the industrial sector in a particular year, may be correlated with its leads or lags, which means its values may be serially correlated. A Levin-Lin-Chu unit-root test for autoregressive model above, finds serial correlation up to the second lag meaning that the growth rate of industrial output has an AR(2) autoregressive unit root. So, I include 2 lags of the dependent variable in the regression.

Figure 3: Fitted Values for lagged changes in Public investment.



For **Hourly Wages,** we use most of the variables in the output regression with a few additions. (Basky and Solon 1989) tests the dependence of real wages on its lagged values and find some serial correlation. Expectations of future real wages may alter household consumption decisions and hence influence aggregate demand that may affect future values of real wages. As in output regression we include first lagged values of changes in public investment, since as observed before government spending from previous years is likely to be more relevant to current economic development. We also add real interest rates, other government expenditure and household consumption growth.

Household consumption will also inherit most of the variables in the industrial output and wages regression with a few alterations. For households, contemporaneous government spending might be relevant if agents react by adjusting their consumption in expectations of higher future taxes or higher interest rates. Household net financial wealth affects consumption as an increase in household net financial wealth leaves the household feeling wealthier and inclined to consume more.

Other factors like increase in household real disposable income affect consumption and might result in omitted variables bias if left out.

Omitting relevant latent explanatory facotrs may lead to misspecification of the model.

There are also other latent or unmeasurable factors like total factor productivity, climate, geographical location, entry barriers and so on……that may influence industrial productivity. Public sector performance is influenced by institutional and structural factors or other country-specific features that may determine the effectiveness of public spending, which lead to omitted variables bias in our estimates. Here we can think of factors such as government bureaucratic inefficiency, corruption, managerial ineptitudes and even climate. Some of these factors are not just controls in the regression but could also be correlated with the error term. I therefore use both Random effects and Fixed effects regression and then use the Hausman test to check the suitability of both approaches.

Fixed effects estimator

$$Y_{it} = \boldsymbol{X}'_{it}\,\beta + c_i + \delta_t + \varepsilon_{it}$$

The first assumption is heterogeneity or that the latent or observable but unmeasurable country-specific effects represented by c_i are freely correlated with the independent variables $E\,[c_i|x_{it}] \neq 0$ and the second, the assumption of strict exogeneity i.e. $E\,[\varepsilon_{it}|x_{it}, c_i] = 0$ which means, that the current disturbance is uncorrelated with the independent variables or the latent factors in every period, past, present, and future. Satisfying these two conditions enables an estimate of β_i that is consistent

$$\beta_i = \partial E[Y_{it}|c_i, x_{it}]/\partial x_{it}$$

The fixed effects formulation implies that differences across groups can be captured in differences in the constant term c_i. FE considers those latent time-invariant characteristics idiosyncratic to individual countries, allowing us to sieve out the net influence of those factors on the independent variable. Under FE model we also add time-effects δ_t to have a time and entity fixed effects regression model. However, one problematic feature of FE models is that they cannot be used to investigate the explanatory power of the time-invariant factors on the dependent variable. Factors like climatic conditions may not only influence the effect of government expenditure on industrial output but may as well affect industrial production directly. This leads to a correlation between x_{it} and ε_{it}, so we turn to random effects regression.

Random effects on the other hand departs in that the entity fixed effect is assumed to be random and uncorrelated with the independent variables included in the model. An example is the case where idiosyncratic climatic conditions or technological levels may have a causal effect on industrial production capacity and no correlation with public investment.

$$Y_{it} = \boldsymbol{X}'_{it}\,\beta + \alpha + u_i + \varepsilon_{it}$$

u_i is deemed as between-entity error and ε_{it} is the within-entity error. The component u_i is the random heterogeneity specific to the ith observation and is constant through time. This error introduces contemporaneous cross-correlations across the entities.
Random effects make two assumption, u_i is uncorrelated with x_{it} and second as in fixed effects, the strict exogeneity $E\ [\varepsilon_{it}|x_{it}] = 0$.
To test for the more robust specification between fixed effects and random effects regression we run a **Hausmann test** (Green, 2008) where the null hypothesis is that the preferred model is random effects. It basically tests whether the unique errors are correlated with the regressors and the null hypothesis is that they are not. The baseline model specification results from Fixed and Random effects model and the subsequent Hausman test.

Table 2. Hausman test

	FE	RE	Difference	S.E.
Industry Index growth$_{t-1}$	0.129	0.261	-0.132	0.014
Δ Govt. Investments $_{t-1}$	0.071	0.080	-0.009	0.007
Δ Govt. Investments$\|_{t-2}$	-0.057	-0.064	0.007	0.007
Population Growth rate$_t$	-1.250	0.250	-1.501	0.441

Our test for a balanced sample, Ho: the difference in coefficients is not systematic **chi2=97.64 and Prob >chi2 = 0.0000** which is less than 0.05 significant level. Under Ho of no correlation, there should be no difference in the two estimators. Hence the Hausman test does not fail to reject the null hypothesis and hence we assume the unique errors u_i are freely correlated with x_{it}. Therefore, we use the fixed effects regression.

Instrumental Variables Estimator. Even after controlling for time and entity invariant factors that influence the effect of public investments on industrial output, nominal wages and household consumption, it's difficult to exhaustively identify all the omitted factors and there could still exist some endogeneity between our independent variable of interest and the dependent variable. Instrumental variables regression may be suitable here.

The idea is to find factors that are correlated with changes in government investment but uncorrelated with the dependent variable and the error term ε_{it}. Government spending is highly correlated to the level of indebtedness and public debt may thus be a suitable instrument. (Holden and Sparrman 2011) use lagged values of public debt as a percentage of GDP as an instrument to isolate the exogenous aspect of government spending. I extend the same here but note that the last 20 years has seen the risk premia on public debt rise drastically for some countries and so they pay more relative to other countries. So, I use the growth rate of real net interest payments as a percentage of real GDP. The sample data show a huge disparity between countries, with Italy having the highest mean of 5.4% real net interest payments as percentage of real GDP to the lowest, Norway at –2.2%.

Public investments are usually long-term projects and so current investments may be highly correlated with previous years investment levels. I therefore include 2 lags to government investments and since the independent variable of interest is first lagged changes in government investments, the instruments then are its second and third lagged values.

The first assumption of instrumental variable regression is that there is correlation between the independent variable and the error term hence Cov(x_{it} ε_{it}) $\neq 0$. The idea is to identify an instrument denoted by z_{it}, that is exogenous and highly correlated with the independent variable but not with the dependent variable or the error term i.e. Cov(z_{it} x_{it}) $\neq 0$ but Cov(z_{it} ε_{it}) $= 0$. The higher the correlation between z_{it} and x_{it} the smaller the IV standard errors since the instruments skim out the factors that create disparities in the level of public investment.

Our IV regression results also help us to check the robustness of our fixed or random effects regression.

5. RESULTS

5.1 Industrial Output – Public Investment Estimates

In the first fixed effects regression in table 3 we find a statistically significant positive increase in industrial output from changes in public investments. A 1% change in the ratio of government investments to Real GDP in the previous year increases industrial output the following year by 0.067%. The effect is small but relatively substantial considering that public investment constitutes only about 3.5% of Real GDP on average across the 20 select OECD countries. Some of its effect however is scaled down when we consider the effect of the first lag of the dependent variable which lowers the coefficient to 0.047%. Effects of second lagged values of changes in government investments are negative about -0.07% (at 1% significance level) for all our regressions. The results remain constant throughout even after including all other control and explanatory variables. This means that the positive effects of public investment could be transitory and probably crowds out industrial output after 2 years.

As observed earlier, the effects of changes in public investment depends on whether the economy is operating below or above its potential. Including output gap to control for the effects of business cycles seems to have a substantial impact on the coefficient of changes in government investments, lowering it by half from 0.047% to a statistically significant 0.026%. That means that the effects of government investments depend on the state or level of the economy. (Auerbach and Gorodnichenko, 2011) find fiscal multipliers to be large during recessions and our results seem to agree with their findings. We find a 0.55% showing that government investments are likely to be more effective when the economy has some spare capacity. Business cycles may also affect industrial output directly, but the effect is tempered a little because we use annual data which aggregates output levels and conceal seasonal cyclicality that may be present in monthly or quarterly data. However, our simple empirical specification is not able to investigate any possible causality that might run from changes in government investments to business cycles. (Aiyagari, Christiano and Eichenbaum, 1990) find that most literature ignore the study of fiscal shocks as causes of business cycles.

Table 5 has the results for public investment effects over time. The differences in coefficients for different periods might point to differences in public investments effects over different levels of development or business cycles. Public investment has a higher pay-offs in low income economies but as economies develop it may result in negative economic and social benefits as costs exceeds gains. The effects are even higher when the economy is growing faster as witnessed in the Asian Tigers.

Public debt might have an influence on the effects on government spending as highly indebted countries have less resources for public investments. The inclusion of real net interest rates payments as a percentage of Real GDP as a proxy for public debt effects, does not show a statistically significant effect from the fixed effects regression, neither does it

have a substantial influence as an instrument in the instrumental variables regression. Regressions using lagged values of public debt as a percentage of Real GDP also yield insignificant results. The result means public debt might not have much impact on public investments, first because it constitutes only a small percentage of GDP and second, because public investments are long term projects that most governments might not easily readjust and probably finding it more prudent to cut costs on recurrent expenditures like public employment, transfers to households and purchases of goods and services, which constitute a relatively higher share of the GDP.

Is there any evidence of trade spill-overs of fiscal policy? (Beetsma, Giuliodori and Klaassen, 2005) find a 1% of GDP spending increase in Germany, on average raises the GDP of trading partners by 0.23% over the first two years. The study is based on a EU monetary union, so it does not take into account the effects of the volatile changes in real exchange rates. (Adina Popescu and Ippei Shibata, 2017) find an increase in public spending of 1% of GDP would appreciate the dollar by up to 7 percent over 1.5 years and worsen net exports by 0.65 percentage points over the course of 2–3 years. Controlling for trade spill-over of fiscal shocks by net exports as a percentage of real GDP, we find little impact on the coefficient of changes in government investments. However, it has a positive and statistically significant coefficient meaning that net exports might have an explanatory power on industrial output, since an increase in net exports has a positive effect on local production. We find a1% increase in a country's net exports as a fraction of its GDP, to have about 0.3% increase in industrial output. However, changes in public investment and exports may be correlated if we assume public expenditure improves industrial productivity lowering the cost of production and hence increasing the competitiveness of local production in the export market. Our regression results do not show any change on the coefficient of changes in public investments when we include net exports in the regression, and therefore we assume there is no evidence of trade spill-overs of fiscal policy.

Introducing other government expenditure on purchases and other expenses like public employment and transfers to households both current and up to the 3rd lags, into the regression does not have statistically significant effects in both fixed effects and instrumental variables regressions. The result might not be surprising considering that other public expenditures which are relatively larger, could result in a negative wealth effect on households thus cancelling out any direct increase on industrial output from the fiscal demand shock.

Changes in household consumption either from changes in real interest rates, time-discount rate or other factors, affects industrial production directly and so we include current household consumption percentage growth rate and its first lag as explanatory variables in the regression. The variables may be correlated with government investments if as postulated by neoclassical theory, public expenditure increases the marginal utility of wealth and therefore reduces households' consumption. The coefficient on current household consumption growth in table 3 columns 5, 6 and 7 is positive and statistically coefficient at 5% confidence level.

As expected growth in household consumption has a positive effect on industrial output.

Our results from all fixed effects regression show that changes in public investment have a positive and statistically significant effect on industrial output. The results remain robust even after controlling for several relevant factors and all time and entity fixed effects. The coefficient is higher when we use Instrumental variables regression meaning there could be some endogeneity bias. The IV results seem to agree with most studies.

Table 3. Fixed Effects - Industrial Output and Changes in Public Investments.

Dependent Variable: Industrial Output Percentage Growth, 1996-2015							
Variables	**Fixed Effect Regression**						
Industry Index growth$_{t-1}$		0.301**	0.223*	0.218*	0.174	0.160	0.170*
		(0.152)	(0.143)	(0.140)	(0.115)	(0.105)	(0.110)
Change in Govt. Investment $_{t-1}$	***0.067******	***0.046******	***0.026******	***0.028******	***0.027******	***0 .030******	***0.032******
	(0.003)	(0.007)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
Change in Govt. Investment $_{t-2}$		-0.069***	-0.078***	-0.076***	-0.075 ***	-0.070***	-0.070***
		(0.012)	(0.014)	(0 .014)	(0.012)	(0.013)	(0.013)
Change in Govt. Investment $_{t-2}$		0.001	-0.006	-0.007	-0.007	-0.006	-0.007
		(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Population Growth rate $_{t-1}$	-1.352	-0.532	-1.736	-1.740*	-1.237	-1.323	-1.149
	(0.699)	(0.681)	(0.987)	(1.032)	(0.805)	(0.838)	(0.830)
Output Gap			0.548***	0.491 ***	0.541 ***	0.543***	0.599***
			(0.172)	(0.168)	(0.194)	(0.211)	(0.201)
Net Interest payment/GDP $_{t-1}$				-0.655			
				(0.419)			
Net Exports/Real GDP $_{t}$					0.308**	0.294**	0.288**
					(0.129)	(0.128)	(0.128)
Household Consumption growth $_{t}$						0.259**	0.332**
						(0.132)	(0.140)
Household Consumption growth $_{t-1}$							-0.240**
							(0.121)
Constant	2.227***						
	(0.429)						
No. of Observation (1996-2015)	400	400	400	400	400	400	400
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.0006	0.6427	0.6699	0.6724	0.6895	0.6928	0.6951
(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.							

Table 4. Instrumental Variables Regression - Public Investment and Industrial Output Growth.

Dependent Variable: Industrial Output Percentage Growth, 1996-2015							
Specification	**i**	**ii**	**iii**	**iv**	**v**	**vi**	**vii**
Industry Index growth$_{t-1}$		0.303**	0.266*	0.222*	0.269**	0.224**	0.215**
		(0.152)	(0.155)	(0.171)	(0.120)	(0.110)	(0.110)
Change in Govt. Investment $_{t-1}$	***0.285****	***0.454****	***0.293***	***0.318****	***0.465****	***0 .242****	***0.348****
	(0.149)	(0.201)	(0.229)	(0.194)	(0.188)	(0.126)	(0.147)
Population Growth rate $_{t-1}$	-0.662**	-0.769	-1.141	-0.571*	-0.051	-0.286	-0.527
	(0.864)	(0.799)	(1.436)	(1.321)	(0.615)	(0.696)	(0.673)
Output Gap			0.197	0.267			
			(0.527)	(0.496)			
Net Exports/Real GDP $_{t}$				0.320**	0.313**	0.263**	0.287**
				(0.138)	(0.144)	(0.131)	(0.134)
Household Consumption growth $_{t}$						0.554***	0.453***
						(0.148)	(0.113)
Household Consumption growth $_{t-1}$						-0.219	
						(0.188)	
No. of Observation (1996-2015)	400	400	400	400	400	400	400
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.5283	0.4452	0.5536	0.5568	0.4547	0.6118	0.5429
F-Statistic	468.70	408.66	486.98	569.27	564.30	95.92	120.65

Instruments IV regressions - **Δ Govt. Investment** $_{t-2}$**, Δ Govt. Investment** $_{t-3}$ **and Net Interest payment/GDP**
(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.

Table 5. Fixed Effects - Public Investment and Industrial Output Growth over time.

Dependent Variable: Industrial Output Percentage Growth						
Variables			**Fixed Effects**			
	i	**ii**	**iii**	**iv**	**v**	**vi**
Change in Govt. Investment **(1996-2005)**	**0.020****					
	(0.008)					
Change in Govt. Investment **(2006-2015)**		**0.116*****				
		(0.026)				
Change in Govt. Investment **(1996-2000)**			***0.057******			
			(0.021)			
Change in Govt. Investment **(2001-2005)**				**0.085**		
				(0.073)		
Change in Govt. Investment **(2006-2010)**					**0.307*****	
					(0.056)	
Change in Govt. Investment **(2011-2015)**						**0.002**
						(0.039)
Change in Govt. Investment $_{t-2}$	-0.058***	-0.115***	-0.049***	-0.004	-0.115	-0.057***
	(0.008)	(0.017)	(0.017)	(0.033)	(0.074)	(0.025)
Population Growth rate $_{t-1}$	-0.453	-2.402**	-0.417	0.279	0.106	-2.583**
	(0.830)	(0.937)	(3.228)	(0.841)	(1.417)	(1.286)
Output Gap	0.343	1.191**	0.508 ***	0.881**	1.798***	2.289 ***
	(0.260)	(0.487)	(0.311)	(0.515)	(0.371)	(0.816)
Net Exports/Real GDP $_{t}$	0.313***	0.577*	0.381***	0.585**	-0.199	1.406***
	(0.121)	(0.324)	(0.136)	(0.212)	(0.182)	(0.429)
Household Consumption growth $_{t}$	0.393**	0.272	0.344	0.026	-1.130**	0.389*
	(0.198)	(0.282)	(0.355)	(0.415)	(0.491)	(0.232)
Household Consumption growth $_{t-1}$	0.081	-0.315	-0.235	0.266	-0.970***	-0.269
	(0.351)	(0.230)	(0.282)	(0.479)	(0.274)	(0.358)
No. of Observation (1996-2015)	200	200	100	100	100	100
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.6695	0.7278	0.8140	0.6204	0.8683	0. 7808
(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.						

Robustness Check using Instrumental Variables on Industrial Output Growth Regression

Our estimates on the effects of changes in government investments on industrial output shows a statistically significant fixed effects results at 1% significance level. However, fixed effects regression does not consider that causality might also be bidirectional. A period of high industrial output growth means higher tax revenues for the government and hence more resources for public expenditure.
So, we turn to instrumental regression. The idea here is to isolate factors that could influence changes in government investments but are not correlated with the error term. (Holden and Sparrman, 2013) uses lagged first difference of the changes in government purchases and the ratio of public debt to GDP. We follow a similar approach with a few adjustments as stated in the methodology.
Our first stage regression results show a strong correlation between changes in government investments and it's first and second lags but a weak correlation with the real net interest payments as a percentage of real GDP.
Table 4 has the results of our comparison between fixed effects and instrumental variables regressions with the latter showing a 1% increase in the ratio of government investments to the GDP increases industrial output by 0.3% (at 10% significant level). The results are quite different from our fixed effects regression showing that changes in government investments could be endogenous. The F-statistic at 152.13 exceeds 10 shows the instruments, the lagged values changes in government investments are not weak.

Curiously, the effects of business cycles proxied by the output gap become insignificant in IV regression perhaps reinforces the endogeneity of public investments. Industrial output fluctuates a lot with the cycles and if causality runs back to public investment, the effects of the cycles on public investment may be weeded out. We drop output gap from our IV regression in table 4 in the last column because the coefficient is statistically insignificant even at 10% level.

Our instrumental variables regression results are more appealing, practical and in tandem with most studies. Our coefficient from IV regression in the last column of table 4, is 0.275 (at 1% significant level) and with an F-statistic at 152.13 well above 10, our regression is robust.

Table 6. A Comparison. Fixed Effects and Instrumental Variables Regressions – Public Investment and Industrial Output Growth.

Dependent Variable: Industrial Output Percentage Growth, 1996-2015						
		Fixed Effects			**IV**	
Specification	**Coeff.**	**Std**	**P-Value**	**Coeff.**	**Std**	**P-Value**
Industry Index growth$_{t-1}$	0.173	0.110	0.117	0.212	0.112	0.075
Δ in Govt. Investment $_{t-1}$	***0.032***	***0.010***	***0.001***	***0.305***	***0.182***	***0.110***
Δ in Govt. Investment $_{t-2}$	-0.069	0.013	0.000			
Δ in Govt. Investment $_{t-3}$	-0.008	0.007	0.289			
Population Growth rate $_{t-1}$	-1.127	0.846	0.183	-0.514	1.258	0.687
Output Gap	0.570	0.200	0.004	0.215	0.516	0.681
Net Interest payment/GDP $_{t-1}$	-0.534	0.413	0.196			
Net Exports/Real GDP $_{t}$	0.280	0.128	0.029	0.288	0.129	0.038
Household Consumption growth $_{t}$	0.317	0.148	0.033	0.508	0.284	0.089
Household Consumption growth $_{t-1}$	-0.281	0.126	0.026	-0.329	0.149	0.039
Austria	-1.321	1.548	0.393	-0.528	1.808	0.770
Belgium	-2.336	1.556	0.133	-1.359	1.796	0.449
Canada	-2.213	0.749	0.003	-1.823	0.865	0.035
Denmark	-4.627	1.700	0.006	-3.876	2.068	0.061
Finland	-2.861	1.580	0.070	-2.365	1.704	0.165
France	-4.066	1.120	0.000	-3.164	1.582	0.045
Germany	-3.537	1.100	0.077	-2.393	2.411	0.321
Ireland	4.105	1.081	0.000	-3.939	1.066	0.000
Italy	-4.217	1.165	0.000	-3.182	1.553	0.041
Japan	-4.586	1.757	0.009	-0.528	3.181	0.868
Netherlands	-4.904	1.929	0.011	-4.004	2.135	0.061
New Zealand	-1.485	0.303	0.000	-1.096	0.629	0.082
Norway	-6.917	2.148	0.001	-7.311	2.259	0.001
Portugal	-2.344	0.818	0.004	-1.307	1.704	0.443
Spain	-1.529	0.328	0.000	-1.389	0.343	0.000
Sweden	-4.207	1.665	0.012	-4.038	1.763	0.022
Switzerland	-4.199	2.201	0.056	-3.752	2.209	0.089
GBR	-2.918	0.724	0.000	-2.259	1.232	0.067
USA	-0.835	0.478	0.080	-0.470	0.632	0.457
No. of Observation (1996-2015)		400			400	
State Effect		Yes			Yes	
Time Effects		Yes			Yes	
Clustered Errors		Yes			Yes	
R^2		0.6966			0.5770	
F-Statistic					137.90	

IV Instruments: **Δ Govt. Investment** $_{t-2}$**, Δ Govt. Investment** $_{t-3}$ **and Net Interest payment/GDP** $_{t-1}$
New Zealand removed from the sample for lack of data on some variables.

5.2 Nominal Wages – Public Investments Estimates

Our fixed effects estimates, in table 7, for the effect on nominal wages from government investment shocks, follow a similar approach with our output regression. The baseline model specification with the first lag of changes in government investment shows a statistically significant positive effect. A 1% change in public investment, increases nominal wages in the industrial sector by 0.028% (statistically significant at 1% level). The effect is low but again relatively large when we consider the low levels of the ratio of government investments to GDP. The results are however inconclusive without considering other factors that may influence wage growth. (Basky and Solon 1989) test the dependence of wages on its lagged values and find some serial correlation. Expectations of future wages may alter household consumption decisions and hence influence aggregate demand that may affect future values of wages. The first lagged nominal wage growth has a positive and statistically significant coefficient of about 0.13% with a p-value of 0.06 increases in nominal wages have a persistent positive effect on the following years wages. This may be explained by the fact that if we hold other factors like real wages and wealth utility constant, an increase in nominal wages may feed back into the system through increased aggregate demand and hence affect future wages.

The coefficient on changes in government investments does not fluctuate much when we include other factors like business cycles, net exports, real interest rates, other government expenditure or household consumption. The results are not surprising considering that most OCED countries have strong labour unions that safeguard workers interests and hold wage growth relatively constant. While public investments may be affected by these factors, its effect on industrial wages might be minimal due to wage rigidity and labour unions' influence.

The effects of changes in government investments seem to fizzle out within a year and the first lagged values of public investment are not statistically different from zero in all our regressions. The effects from the second lag is curiously strong and statistically significant in all regressions. The effect at -0.006% is small and statistically significant at 1% level in all our regressions.

The other variables included in the regression may serve as explanatory variables and so have a causal effect on wages. Business cycles could influence wages as periods of high output put pressure on labour demand which raises wages. Our 3rd fixed effect regression has a 0.115% (at 5% significance level). The effect is cancelled out when we include other government expenditures and household consumption growth. This could be from the fact that changes in household consumption growth incorporate the business cycles volatility.

Real short interest rates don't have substantial effect on wages. The neo classical theory hypothesize that deficit financed government expenditures have an effect on interest rates which increase the marginal utility of wealth and hence drive households to supply more labour and which reduces wages. Our results do not reflect that. However, without considering real product or consumption wages, the results are inconclusive.

Other factors like other contemporaneous government expenditures and first lagged values of household consumption growth have a strong effect on wage growth as expected. The coefficient on other government expenditure like public employees' salaries, government

purchases of goods and services, intermediate consumption, transfers in kind and cash to households have a statistically significant effect on nominal wages. A 1% increase in public spending increase wages by about 0.3% (at 1% significant level). And while recurrent government expenditure has a contemporaneous effect on wages household consumption has a rather slow effect on wages and current consumption doesn't seem to affect wages. 1% increase in lagged household consumption has a 0.18% with a p-value of 0.009 effect on wages.

(Barsky and Solon, 1988) find evidence of moderate wage procyclicality in aggregate data and strong procyclicality in microdata Panel Study of Income Dynamics and conclude that it is a consequence of shifts in labour demand generated by either real or nominal disturbances. Our data being aggregate might not capture the effects of heterogeneity in the industrial sector but using panel data and fixed effects regression helps to mitigate for the latent heterogeneity.

Table 7. Fixed Effects Regressions – Public Investment and Nominal Wage Growth.

Dependent Variable: Hourly Nominal Wages Percentage Growth, 1996-2015							
Specification	**i**	**ii**	**iii**	**iv**	**v**	**vi**	**vii**
Wage Growth $_{t-1}$		0.182**	0.165**	0.159**	0.154**	0.140*	0.144**
		(0.080)	(0.080)	(0.079)	(0.079)	(0.074)	(0.073)
Change in Govt. Investment $_{t-1}$	***0.028******	***0.030******	***0.025******	***0 .024******	***0.024******	***0.023******	***0.025******
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Change in Govt. Investment $_{t-2}$	0.008***	0.003	0.001	0.001	0.001	0.003	0.003
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Change in Govt. Investment $_{t-3}$	**-0.005*** **	-0.006***	-0.007***	-0.006***	-0.006***	-0.005***	-0.006***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Population Growth rate $_{t-1}$	0.729***	0.564**	0.338	0.370	0.340	0. .238	0.228
	(0.349)	(0.263)	(0.234)	(0.248)	(0.241)	(0.215)	(0.216)
Output Gap			0.115**	0.101**	0.071	0.005	
			(0.052)	(0.052)	(0.049)	(0.080)	
Short Interest Rates				0.159*	0.142	0.133	
				(0.088)	(0.092)	(0.101)	
Δ Other Govt. Expenditures $_{t}$					0.482***	0.278***	0.342***
					(0.176)	(0.131)	(0.131)
Household Consumption growth $_{t}$						0.039	
						(0.104)	
Household Consumption growth $_{t-1}$						0.167**	0.194***
						(0.066)	(0.057)
Constant	2.250***						
	(0.211)						
No. of Observation (Groups=19)	370	370	370	370	370	370	370
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.5102	0.5355	0.5434	0.5482	0.5544	0.5675	0.5634
F-Statistic	117.46						
(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.							

Table 8. IV regression - Public Investment and Nominal Wage Growth.

Dependent Variable: Hourly Product Wage Percentage Growth, 1996-2015							
Specification	**i**	**ii**	**iii**	**iv**	**v**	**vi**	**vii**
Change in Govt. Investment $_{t-1}$	***-0.002***	***-0.019***	***-0.099***	***-0.083***	***-0 .081***	***-0.050***	***-0.051***
	(0.077)	(0.050)	(0.090)	(0.082)	(0.017)	(0.056)	(0.032)
Population Growth rate $_{t-1}$	0.759***	0.758***	0.219	0.298	0.348	0.191	0.334
	(0.269)	(0.273)	(0.210)	(0.222)	(0.242)	(0.217)	(0.212)
Output Gap			0.273***	0. 231***	0.199**	0.105	
			(0.103)	(0.089)	(0.086)	(0.085)	
Short Interest Rates				0.253**	0.236**	0.197**	0.218**
				(0.082)	(0.102)	(0.099)	(0.095)
Δ Other Govt. Expenditures $_{t}$					0.476***	0.283*	0.362**
					(0.169)	(0.163)	(0.143)
Households consumption growth $_{t-1}$						0.198***	0.242***
						(0.075)	(0.072)
No. of Observation (Groups=19)	371	371	371	371	371	371	371
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.4986	0.4681	0.3253	0.3711	0.3827	0.4661	0.4601
F-Statistic	81.20	66.03	56.81	62.75	10.11	22.58	49.40

Instruments Baseline IV - **Δ Govt. Investment** $_{t-2}$**, Δ Govt. Investment** $_{t-3}$ **and Net Interest payment/GDP** $_{t-1}$

(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.

Robustness Check using Instrumental Variables on Nominal Wage Growth Regression. The results from the instrumental variables regression are radically different from our fixed effects regression, posting a -0.043% versus our earlier results of 0.03%. The coefficient is statistically insignificant even at 10% confidence level in all the IV regressions, so we may not may be able to make an informed conclusion. However, similar to the results from the industrial output regression, changes in government investments could be endogenous and other underlying factors could have been omitted from the regression or simply from measurement errors.

One observation from the fixed effect regression is that lagged values of changes in government investment have a causal effect on wage growth. We find a statistically significant negative effect of third lagged changes in government investments on real wages. So, our results from instrumental variables might be unreliable if we consider the variable, the third lagged changes to public investment used as an instrument in our instrumental variable regression, to be correlated with the error term.

Table 9. A Comparison. Fixed Effects and Instrumental Variables Regressions – Public Investment and Nominal Wage Growth.

Dependent Variable: Product Wage Percentage Growth, 1996-2015						
	Fixed Effects			**IV**		
Specification	**Coeff.**	**Std**	**P-Value**	**Coeff.**	**Std**	**P-Value**
Wage Growth $_{t-1}$	0.138	0.073	0.059	0.088	0.082	0.293
Δ in Govt. Investment $_{t-1}$	***0.023***	***0.003***	***0.000***	***-0.043***	***0.051***	***0.413***
Δ in Govt. Investment $_{t-2}$	0.002	0.002	0.324			
Δ in Govt. Investment $_{t-3}$	-0.005	0.002	0.001			
Population Growth rate $_{t-1}$	0.230	0.224	0.303	0.136	0.216	0.536
Output Gap	0.014	0.061	0.813	0.081	0.095	0.403
Short Interest Rates	0.131	0.010	0.190	0.185	0.094	0.062
Δ Other Govt. Expenditures $_{t}$	0.299	0.123	0.015	0.265	0.146	0.084
Household Consumption growth $_{t-1}$	0.180	0.069	0.009	0.194	0.076	0.019
Austria	0.016	0.354	0.964	-0.014	0.370	0.970
Belgium	-0.181	0.344	0.599	-0.224	0.363	0.544
Canada	-0.997	0.245	0.000	-1.075	0.273	0.001
Denmark	0.472	0.355	0.183	0.497	0.382	0.209
Finland	0.333	0.345	0.335	0.362	0.357	0.323
France	-0.028	0.333	0.934	-0.065	0.349	0.854
Germany	-0.125	0.429	0.772	-0.204	0.446	0.653
Ireland	0.066	0. 229	0.774	0.093	0.223	0.682
Italy	0.269	0.338	0.426	-2.596	0.367	0.000
Japan	-1.086	0.522	0.049	-1.858	0.711	0.017
Netherlands	-0.292	0.361	0.420	-0.336	0.384	0.393
New Zealand	-0.327	0.117	0.005	-0.473	0.131	0.002
Norway	0.694	0.172	0.000	0.822	0.201	0.001
Portugal	-2.127	0.478	0.000	-2.266	0.473	0.000
Spain	0.489	0.263	0.081	0.591	0.319	0.079
Sweden	0.262	0.285	0.359	0.322	0.308	0.309
GBR	0.228	0.245	0.353	0.170	0.248	0.501
USA	-0.521	0.228	0.022	-0.553	0.238	0.031
No. of Observation (1996-2015)		380			380	
State Effect		Yes			Yes	
Time Effects		Yes			Yes	
Clustered Errors		Yes			Yes	
R^2		0.5669			0. 4927	
F-Statistic					38.31	

IV Instruments: **Δ Govt. Investment** $_{t-2}$**, Δ Govt. Investment** $_{t-3}$ **and Net Interest payment/GDP** $_{t-1}$
New Zealand removed from the sample for lack of data on some variables.

5.3 Household Consumption

Table 10 contains the fixed effect results for household consumption growth and annual changes in public investment. First lagged changes in government investments have a slightly negative effect on current household consumption growth. We find a -0.013% growth from a 1% increase in public investments. All our estimates are statistically significant at 1% level even after controlling for several related and relevant factors. The result may as theory suggest households react to public expenditure by reducing consumption but noting that real interest rates seems to have no significant effect on the regression we assume the reduction of consumption is from a negative wealth effect rather than intertemporal substitution effect.

The effect also changes over the years. In the results from table 12, coefficient of public investment was -0.008 (at 5% significant level) during the period 1996-2005 but higher at -0.03(at 1% significant level) in the period 2006-2015. The effects thus depend on other economic factors.

The effect of changes in public investment is also highly persistent after two years with almost similar effect like the effect of the first lag. However, the effect fizzles out after the 3rd year and all our estimates post no effect from the 3rd lag of public investment. We conclude the effects of public investment on household consumption are transitory and actually affect consumption negatively after 2 years. Unlike industrial output and wages, household consumption reacts to contemporaneous public investment. We find a 0.005% effect with a p-value of 0.006 and a standard deviation of 0.002 in all fixed effects regressions. We assume household consumption is a fast-moving variable that can be affected by anticipatory effects in the short run.

Our results in table 12, find serial correlation between current and previous year household consumption growth. (Carroll, Slacalek and Sommer, 2010) investigate the degree of 'stickiness' in aggregate consumption growth for thirteen advanced economies and find a high degree of autocorrelation, with a stickiness parameter of about 0.7 on average across countries with quarterly data. Our estimates find about 0.3% effect on current levels from a 1 % increase in the previous year consumption growth.

Controlling for business cycles using output gap as in earlier regressions shows a substantial influence of cycles on public investment effects of household consumption. Introducing the control variable reduce the effect from -0.005% to -0.013% (at 1% significant level). Household consumption react to economic conditions and level of development and hence public investment effects depends on those economic conditions.

Other than lagged values of consumption growth and government investment, we find no evidence of the effects of other government expenditure on household consumption neither do we find an effect from interest rates. However, household debt has a negative statistically significant effect on consumption posting a -0.011% with a p-value of 0.004. The effect remains significant in all our regressions. (Fagereng and Halvorsen, 2016) find support for the hypothesis that consumption expenditure growth is lower among households with high debt. Our results show the effect is also found in averaged aggregate data on country level.

Another factor that we consider is the effect of net household financial wealth on consumption. (Fagereng and Halvorsen, 2016) again find net financial wealth as a percentage of real disposable income had between 0.112% to 0.194% positive effect on household consumption over the period 2005-2009. We find a significant effect in our results with 1% increase in net financial wealth have a 0.19% with a p-value of 0.001 and a standard deviation of 0.05 in all our regressions. The effects remain robust even in IV regression.

Our IV regression results are similar to the fixed effects results apart from the effect of public investment which remains statistically insignificant in all IV regression. This may mean that public investment is endogenous and correlated with factors that also determine household consumption that are omitted from the fixed effects regression. But this should be mitigated to some extent by the use of panel data over the 20 years period for the 20 OECD countries and the use of time and entity fixed effects. So, we assume the fixed effects results are more robust and conclude that lagged changes to public investment have a negative effect on household consumption, and without any positive effect of interest rates in our regression, we conclude that households react to a negative wealth effect.

Table 10. Fixed Effects – Public Investment and Household Consumption Growth.

Dependent Variable: Household Consumption Percentage Growth, 1996-2015							
Specification	**i**	**ii**	**iii**	**iv**	**v**	**vi**	**vii**
HHs consumption growth $_{t-1}$		0.481***	0.499***	0.399***	0.363***	0.252***	0.252***
		(0.074)	(0.082)	(0.084)	(0.083)	(0.079)	(0.077)
HHs consumption growth $_{t-2}$			**-0.049**	**-0.137*** **	**-0.160*** **	**-0.185*** **	**-0.190*** **
			(0.049)	(0.048)	(0.046)	(0.058)	(0.064)
Δ Govt. Investment $_{t}$		0.012***	0.012***	0.004*	0.004**	0.005***	0.004**
		(0.002	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Δ Govt. Investment $_{t-1}$	***-0.003*** **	***-0.005****	***-0.005****	***-0.013*** **	***-0.013*** **	***-0.013*** **	***-0.014*** **
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Δ Govt. Investment $_{t-2}$		-0.012***	-0.012***	-0.016***	-0.016***	-0.012***	-0.012***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Population Growth rate $_{t-1}$	1.044***	0.277	0.325	-0.034	-0.057	0.170	0.178
	(0.329)	(0.208)	(0.208)	(0.222)	(0.213)	(0.331)	(0.327)
Output Gap				0.297***	0.274***	0.272***	0.262***
				(0.057)	(0.053)	(0.066)	(0.063)
Δ Other Govt. Expenditures $_{t}$					**0.490**	0.022	
					(0.504)	(0.382)	
Δ Other Govt. Expenditures $_{t-1}$					0.425**	0.281	
					(0.202)	(0.240)	
Δ Other Govt. Expenditures $_{t-2}$					-0.262	-0.398**	
					(0.308)	(0.192)	
Short Interest Rates $_{t}$						-0.079	
						(0.077)	
Household Debt/Income $_{t}$						-0.011***	-0.011***
						(0.004)	(0.004)
Net Household Financial Wealth $_{t}$						0.193***	0.196***
						(0.056)	(0.059)
No. of Observation (1996-2015)	400	400	400	400	400	400	400
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.6135	0.6938	0.6945	0.7209	0.7298	0.7633	0.7593
(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.							

Table 11. Instrumental Variables Regression – Public Investment and Household Consumption Growth.

Dependent Variable: Household Consumption Percentage Growth, 1996-2015							
Specification	**i**	**ii**	**iii**	**iv**	**v**	**vi**	**vii**
HHs consumption growth $_{t-1}$		0.480***	0.366***	0.330***	0.367***	0.255***	0.255***
		(0.053)	(0.077)	(0.081)	(0.085)	(0.081)	(0.082)
HHs consumption growth $_{t-2}$						-0.190**	-0.197***
						(0.059)	(0.064)
Δ Govt. Investment $_{t}$						-0.011	-0.011
						(0.024)	(0.117)
Δ Govt. Investment $_{t-1}$	***0.129***	***0.004***	***-0.002***	***0.003***	***-0.006***	***0.005***	***0.003***
	(0.092)	(0.053)	(0.077)	(0.069)	(0.078)	(0.003)	(0.009)
Population Growth rate $_{t-1}$	0.989***	0.261	-0.096	-0.109	-0.108	0.186	0.192
	(0.311)	(0.204)	(0.283)	(0.257)	(0.267)	(0.346)	(0.291)
Output Gap $_{t}$			0.241**	0.217**	0.257**	0.262***	0.252***
			(0.115)	(0.102)	(0.109)	(0.075)	(0.151)
Δ Other Govt. Expenditures $_{t}$				0.477		0.029	
				(0.536)		(0.384)	
Δ Other Govt. Expenditures $_{t-1}$				0.306		0.272	
				(0.190)		(0.236)	
Δ Other Govt. Expenditures $_{t-2}$				-0.318		-0.397	
				(0.291)		(0.190)	
Short Interest Rates $_{t}$					-0.027	-0.082	
					(0.076)	(0.076)	
Household Debt/Income $_{t}$						-0.011***	-0.012***
						(0.004)	(0.004)
Net Household Financial Wealth $_{t}$						0.195***	0.198***
						(0.056)	(0.059)
No. of Observation (1996-2015)	350	350	350	350	350	350	350
State Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.4636	0.6895	0.7108	0.7165	0.7116	0.7612	0.7572
F-Statistic	27.82	48.30	43.54	438.41	62.63	45.39	94.44

Instruments: **Δ Govt. Investment $_{t-2}$, Δ Govt. Investment $_{t-3}$ and Net Interest payment/GDP $_{t-1}$**

(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.

Table 12. Fixed Effects Household Consumption Growth Stickiness and Over time

Dependent Variable: Household Consumption Percentage Growth, 1996-2015						
Specification	**FE**	**FE**	**IV**	**IV**	**FE (1996-2005)**	**FE (2006-2015)**
HHs consumption growth $_{t-1}$		0.259***	0.248***	0.239***	0.200*	0.144*
		(0.081)	(0.078)	(0.081)	(0.189)	(0.093)
HHs consumption growth $_{t-2}$	0.208***	-0.191***	-0.192***	-0.185***	-0.138*	-0.311***
	(0.078)	(0.064)	(0.065)	(0.071)	(0.080)	(0.069)
Δ Govt. Investment $_{t-1}$	***-0.014******	***-0.014******	***0.031***	***0.084******		
	(0.003)	(0.002)	(0.045)	(0.023)		
Δ Govt. Investment $_{t-2}$	-0.014***	-0.012***			-0.008***	-0.009***
	(0.003)	(0.003)			(0.008)	(0.007)
Δ Govt. Investment $_{t-3}$	0.001	0.001				
	(0.002)	(0.002)				
Population Growth rate $_{t-1}$	0.028	0.168	0.274	0.389	0.117	0.430
	(0.246)	(0.326)	(0.392)	(0.419)	(0.425)	(0.481)
Output Gap	0.215***	0.265***	0.212**	0.156	0.139	0.379***
	(0.067)	(0.062)	(0.101)	(0.114)	(0.100)	(0.080)
Household Debt/Income	-0.011***	-0.012***	-0.012***	0.012***	-0.004*	-0.032**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.010)	(0.009)
Net Household Financial Wealth	0.197***	0.195***	0.193***	0.188***	0.197***	0.154***
	(0.059)	(0.058)	(0.058)	(0.061)	(0.049)	(0.089)
Δ Govt. Investment (1996-2005)					***-0.008****	
					(0.003)	
Δ Govt. Investment (2006-2015)						***-0.030******
						(0.008)
No. of Observation (1996-2015)	400	400	400	400	200	200
State Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Errors	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7482	0.7592	0.5559	0.6363	0.7058	0.7717
F-Statistic			21.46	106.30		

Instruments: **Δ Govt. Investment $_{t-2}$, Δ Govt. Investment $_{t-3}$ and Net Interest payment/GDP $_{t-1}$**

IV (iv): **Δ Govt. Investment $_{t-2}$, Δ Govt. Investment $_{t-3}$ and Net Public Debt/GDP $_{t-1}$**

(***(1%), **(5%) and *(10%) Statistically different from zero significant levels.

Table 13. A Comparison. Fixed Effects and Instrumental Variables Regressions – Public Investment and Household Consumption Growth.

Dependent Variable: Household Consumption Percentage Growth, 1996-2015						
		Fixed Effects			**IV**	
Specification	**Coeff.**	**Std**	**P-Value**	**Coeff.**	**Std**	**P-Value**
HHs consumption growth $_{t-1}$	0.208	0.078	0.008	0.203	0.081	0.022
Δ in Govt. Investment $_{t-1}$	***-0.015***	***0.002***	***0.000***	***0.034***	***0.048***	***0.491***
Δ in Govt. Investment $_{t-2}$	-0.017	0.003	0.000			
Δ in Govt. Investment $_{t-3}$	0.001	0.002	0.698			
Population Growth rate $_{t-1}$	0.011	0.246	0.964	0.115	0.325	0.728
Output Gap	0.222	0.068	0.001	0.168	0.102	0.116
Short Interest Rates	-0.081	0.069	0.240	-0.115	0.090	0.217
Household Debt/Income	-0.011	0.004	0.002	-0.011	0.003	0.004
Real Household Income Growth	0.200	0.058	0.001	0.199	0.059	0.003
Austria	-2.197	0.317	0.000	-2.217	0.331	0.000
Belgium	-2.248	0.333	0.000	-2.269	0.349	0.000
Canada	-0.711	0.157	0.000	-0.739	0.181	0.001
Denmark	-0.358	0.548	0.514	-0.334	0.558	0.556
Finland	-1.399	0.253	0.000	-1.436	0.269	0.000
France	-2.066	0.297	0.000	-2.084	0.313	0.000
Germany	-2.296	0.282	0.000	-2.275	0.315	0.000
Ireland	-0.444	0. 222	0.046	-0.499	0.245	0.056
Italy	-2.557	0.359	0.000	-2.596	0.367	0.000
Japan	-2.457	0.361	0.000	-1.828	0.502	0.002
Netherlands	-0.528	0.422	0.211	-0.492	0.439	0.275
Norway	-0.062	0.157	0.693	-0.164	0.175	0.361
Portugal	-1.698	0.231	0.000	-1.682	0.265	0.000
Spain	-1.462	0.252	0.000	-1.590	0.340	0.000
Sweden	-0.965	0.173	0.000	-1.038	0.213	0.000
Switzerland	-1.079	0.308	0.000	-1.166	0.362	0.004
GBR	-0.901	0.147	0.000	-0.869	0.176	0.000
USA	-1.061	0.198	0.000	-1.109	0.224	0.000
No. of Observation (1996-2015)		380			380	
State Effect		Yes			Yes	
Time Effects		Yes			Yes	
Clustered Errors		Yes			Yes	
R^2		0.7491			0. 0.7167	
F-Statistic					38.28	

IV Instruments: **Δ Govt. Investment** $_{t-2}$**, Δ Govt. Investment** $_{t-3}$ **and Net Interest payment/GDP** $_{t-1}$
New Zealand removed from the sample for lack of data on some variables.

6. Conclusion

The motivation for this study is from the fact that the role of public investment for industrial output and growth has not featured prominently in much of the literature on fiscal policy and economic growth.

The summary of our results shows an increase in industrial output and nominal wages but a decrease in household consumption from lagged values of changes in public investment. The results from the IV regression are substantially different from the fixed effects results and so we assume public expenditure is endogenous.

Our main results, the fixed effects results show a positive and statistically significant explanatory power of public investment on industrial output and growth. With a balanced panel data for 20 select OECD countries, for the period 1996-2015. A 1% change in lagged public investment increase industrial output by about 0.03% (at 1% significant level) effect on industrial in all our regressions. The effect however, depend on the level of economic and industrial development and business cycles with public investments being more effective when the economy has spare capacity.

Our result seems to agree with the neoclassical theory, that increases in public investment have only a transitory effect and without further investigation on the behaviour of total factors productivity we cannot make any assumption on the effects of public investment in the long-run growth.

Public investment effects also fluctuate over time and this is an important observation for economists and policy makers in designing public investment reaction functions. It's not farfetched to imagine that for low income countries, public investment is highly complementary and has higher pay-offs, while at high incomes, substitutions effects dominate, and pay-offs are lower. Beyond a certain optimal threshold, public capital investments may result in a negative net benefit to society as economic and social benefits are exceeded by related costs (Agénor, Bayraktar and El Aynaoui, 2008). The low 0.03% increase in industrial growth in our results for the OECD countries most of which have high incomes, seems to suggest that the benefits of public capital in the economy are almost exhausted or near the optimal threshold.

The behaviour of nominal wages and household consumption growth household consumption regression shows that households react more to a negative wealth effect or increase in marginal utility of wealth in expectation of higher future taxes, than movements in intertemporal substitution from changes in interest rates, because we don't find any effect of interest rates on consumption growth. This is further reinforced by the behaviour of wages, since as theories predict procyclical wages interpret the cyclicality of employment as a consequence of shifts in labour demand by firms.

Other factors like effects of household debt and financial wealth are important factors for policy makers while designing public investment projects as their effects depend on household consumption behaviour and understanding it helps in designing optimal investment plans.

Our IV results also suggest that public investment is endogenous, and the bidirectional causality should be closely studied as some benefits could be ignored or overlooked and thus underestimated.

Further Research

This paper has generally dealt with simple country level aggregates assuming a representative industrial firm and a homogeneous good or easily substitutable goods. Industries however exhibit substantial heterogeneity and products are usually not perfect substitutes. Understanding the heterogeneity in the industry sector and across countries is crucial in the study of how capital and labour as well as aggregate demand move after a fiscal shock.

A comparison between study with aggregate data and unaggregated industry level data would shed more light on the source of disagreements in many studies.

Further, the study was simple and the period of study not long enough to gauge the long run estimates of public investment effects. The approach of the study was purely empirical and comparison with prominent theoretical frameworks has not featured much. Further research on how empirical evidence compares to theory on a more micro setting like industry level data will shed more light on the forces of fiscal shocks and aggregate demand.

The decomposition of public investment into its components; Infrastructure such as roads, telecommunications, energy, military and structures like hospitals and schools, would also reveal the optimal combination that would give optimal spill-over effect on the society.

References

Adina Popescu and Ippei Shibata, 2017, “Spillovers From US Government Spending Shocks: Impact on External Positions, Spillover Task Force, International Monetary Fund.

Alan J. Auerbach and Yuriy Gorodnichenko, 2011, “Fiscal Multipliers in Recession and Expansion,” NBER Working Paper 17447.

Alberto Alesina Roberto Perotti, 1996, “Fiscal Adjustment in OECD Countries: composition and Macroeconomic Effects,” NBER Working Paper 5730.

Alberto F. Alesina and Silvia Ardagna, 2009, “Large Changes in Fiscal Policy: Taxes Versus Spending,” Nber Working Paper Series 15438.

Andreas Fagereng And Elin Halvorsen, 2016, “Debt and household consumption responses,” a STAFF MEMO NO. 1 | 2016 Norges Bank.

Anja Baum, Marcos Poplawski-Ribeiro, and Anke Weber, 2012, “Fiscal Multipliers and the State of the Economy,” IMF Fiscal Affairs Department Working Paper WP/12/286.

Barth, Marvin J. and Valerie A. Ramey, 2002. “The Cost Channel of Monetary Transmission.” In NBER Macroeconomics Annual 2001, University of Chicago Press.

C. J. Nekarda and V. A. Ramey, 2010, “Industry Evidence on the Effects of Government Spending,” Finance and Economics Discussion Series, Federal Reserve Board, Washington, D.C.

Carlo Favero Francesco Giavazzi, 2007, “Debt and The Effects of Fiscal Policy,” Nber Working Paper 12822.

Chad Syverson, 2011, “What Determines Productivity?” Journal of Economic Literature

Christopher D. Carroll, Jiri Slacalek and Martin Sommer, 2010, “International Evidence on Sticky Consumption Growth,”

Daragh Clancy, Pascal Jacquinot and Matija Lozej, 2014, “The Effects of Government Spending in A Small Open Economy Within A Monetary Union,” Working Paper Series No 1727 / August 2014, EU Central Bank.

Daragh Clancy, Pascal Jacquinot and Matija Lozej, 2014, “The Effects of Government Spending in a Small Open Economy within a Monetary Union,” European Central Bank working paper series no 1727.

David Alan Aschauer, 1988, “Is public expenditure productive,” Federal Reserve Bank of Chicago, USA.

Evi Pappa, 2009, “The effects of fiscal expansions: An international comparison”

Galí, Jordi, J. David López-Salido, and Javier Vallés, 2007. “Understanding the Effects of Government Spending on Consumption.” Journal of the European Economic Association 5(1): 227–70.

Giancarlo Corsetti, Andre Meier, and Gernot J. Müller, 2012, “What Determines Government Spending Multipliers?” WP/12/150 IMF Working Paper.

Glenn Otto and Graham Voss, 1995, “Public Infrastructure and Private Production,” Agenda, Volume 2, Number 2, 1995, pages 181-189.

James H. Stock and Mark W. Watson, “Introduction to Econometrics,” Updated Third Edition. Global Edition.

John A. Tatom, 1991, “Public Capital and Private Sector Performance.”

Jonathan Millar, Douglas Sutherland, 2016, “Unleashing private sector productivity in the United States,” OECD Economics Department Working Papers No. 1328.

Kenneth A. Bollen and Jennie E. Brand**,** 2011**, “**A General Panel Model With Random And Fixed Effects: A Structural Equations Approach,” Soc Forces.

Martin Eichenbaum and Jonas D. M. Fisher, “How does an increase in government purchases affect the economy?”

Mercedes Garcia-Escribano and Fei Han, September 2015, “Credit Expansion in Emerging Markets: Propeller of Growth?” IMF Working Paper WP/15/212.

Michael B Devereux, Allen C Head, Lapham, Beverly J, 1996, “Monopolistic Competition, Increasing Returns, and the Effects of Government Spending.” Journal of Money, Credit, and Banking; May 1996; 28, 2; ABI/INFORM Global pg. 233

Nicolas Carnot, Francisco de Castro, 2015, “The Discretionary Fiscal Effort: an assessment of Fiscal Policy and its Output Effect,” EU Economic Papers 543.

OECD Economic Outlook No 102 - November 2017: Economic Outlook Sources and Methods, Database inventory.

Parantap Basu Robert Kollmann, 2009, “Productive Government Purchases and the Real Exchange Rate,” Department of Economics and Finance, Durham University.

Patrick Moran and Albert Queralto, 2017, “Innovation, Productivity, and Monetary Policy,” International Finance Discussion Papers 1217.

Pedro R. D. Bom Jenny E. Ligthart, 2008, “How productive is public capital? A meta-analysis,” Cesifo Working Paper No. 2206.

Pedro R.D. Bom Jenny E. Ligthart, 2017, “What Have We Learned from Three Decades of Research on the Productivity of Public Capital?” ECFIN Workshop Deusto Business School.

Prof. Dr. Thomas Steger Advanced Macroeconomics I | Lecture | SS 13 Institut für Theoretische Volkswirtschaftslehre Makroökonomik.

Robert Barsky and Gary Solon, 1989, “Real Wages Over the Business Cycle” Nber Working Paper Series No. 2888

Robert F. Engle and C. W. J. Granger, 1987, “Cointegration and Error Correction: Representation, Estimation and Testing,” Econometrica Vol. 55 pg 251-276

Roel Beetsma, Massimo Giuliodori and Frank Klaassen, 2005, “Trade Spillovers of Fiscal Policy in the European Union: A Panel Analysis,” DNB Working Paper No. 052/2005.

Rotemberg and Woodford, 1992, “Oligopolistic Pricing and the Effects of Aggregate Demand on Economic Activity.”
S Rao Aiyagari, Lawrence J. Christiano and Martin Eichenbaum, 1990, “The Output, Employment and Interest Rates Effect of Government Consumption,” NBER Working Paper No. 3330.

Silvio Contessi and Ariel Weinberger, 2009, “Foreign Direct Investment, Productivity, and Country Growth,” Federal Reserve Bank of St. Louis Review, 2009, 91(2), pp. 61-78

The Conference Board (2010) Total Economy Database - Output, Labor and Labor Productivity, 1950-2017 (Adjusted version).

Tobias Cwik and Volker Wieland, November 2010, “Keynesian Government Spending Multipliers and Spill overs in the Euro area,” European Union Bank Working Paper Series No 1267
Ulrike Mandl, Andrian Dierx and Fabienne Ilzkovitz, 2008, “Effectiveness and Efficiency in Public Spending,” Economic Papers 301, European Commission.

Valerie A. Ramey and Matthew D. Shapiro, 1998, “Costly capital reallocation and the effects of government spending,” Carnegie-Rochester Conference Series on Public Policy 48 (1998) 145-194

Valerie A. Ramey and Sarah Zubairy, “Government Spending Multipliers in Good Times and in Bad: Evidence from U.S. Historical Data.”