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Essays on Regional, Resource and Public Economics

A dissertation submitted in partial fulfillment of the
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by

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Abstract

My dissertation consists of three essays that combine theories and empirical analysis from natural resource economics, regional economics, spatial economics, development economics, and public economics.

In the first essay of my dissertation, I examine the impact of mineral resource extraction (MRE) on the U.S. local labor market, and local economic development using county level data between 1970 and 2012. I use difference-in-difference methodology and spatial modeling to incorporate spatial heterogeneity and dependence among U.S. local areas that are in close geographical proximity. The results show that MRE industry employment grew faster during boom periods and slower during the bust period in MRE dependent counties. MRE earnings and earnings per worker grew slower during boom periods and faster during the bust period. The findings provide evidence of negative spatial indirect spillover effects between neighboring counties' MRE sector labor markets.

In my second essay, I analyze the price elasticity of mineral resource products in each of the mineral resource extractive industries' labor markets in Canada's provinces. I estimate the impact of shocks on employment in the mineral resource extraction industry in Canada's natural resource rich provinces using monthly employment observations for the period January 1990 to December 2012. Estimates show the responsiveness of Canada's provincial MRE employment to gold price, WTI or Alaska crude oil price fluctuations. Results from a difference-in-difference regression model show a positive growth of employment in Canada's natural resource rich provinces during boom and bust periods. The results show a significant MRE employment growth in each of Canada's provinces with more growth in magnitude in MRE dependent provinces. The results for the price effects of minerals show that employment growth was inelastic relative to mineral price changes from 1990 to 2012.

My third Chapter examines the cyclicality of public investment in African countries and the spatial spillovers from economic shocks using panel data for the 19962012 period. In addition to an overall analysis of the African continent, it also examines public investment in country sub-groups such as the WAEMU, the ECOWAS, the ECCAS, the

IGAD, and the SADEC. While the results confirm procyclicality in public investment in Africa, the degree of procyclicality varies significantly across the country groups. Procyclicality becomes less significant when spatial spillovers are considered for WAEMU, ECOWAS, CEMAC, and IGAD countries but it becomes stronger for ECCAS, and particularly SADEC countries.

Keywords: Mineral Resource Extraction (MRE); Local Economic Impact; Boom and Bust, Canadian Provinces; Boom and Bust; Price Elasticities, Public investment; Cyclicality; Africa

JEL Classification Code: R1, Q32, Q33, Q4, D40, J40. R10, Q32, Q33, Q4E62, H30, H50, H62

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Introduction

The presence of abundant natural resources in the U.S. and Canada has played an important role by contributing to local community development and government revenue collection. Activities related to Mineral Resource Extraction (MRE) generate employment, income, and contribute to the local economy and the fiscal system. Most of the mineral resources extracted are oil sand, natural gas, gypsum, iron ore, uranium, cobalt, nickel, copper, gold, lead, molybdenum, potash and silver, which rank these countries among the top five countries in terms of major mineral production. In spite of the important role that MRE has on the economy, and its relative positive spillovers on other economic sectors, there is still no consensus in the literature about the real impact of MRE on local economic growth. Previous investigations found that resource intensive areas grow slower than nonresource areas, which is referred to as the "Dutch disease" or "resource curse" phenomenon, while other studies found that resource abundance is positively correlated with economic growth. However, little is still known about its impact more broadly on the U.S. and Canada's local economic development and about its indirect spillover effects on other sectors and contiguous regions. These are reasons to investigate the resources extraction industry in order to understand how the labor market in the industry reacts to MRE output price changes.

This article consists of three essays that combine theories and empirical analysis from natural resource economics, regional economics, spatial economics, development economics, and public economics. Two of my dissertation essays shed light on the responsiveness of the economies of the U.S. and Canada to shocks in the Mineral Resource Extraction (MRE) industry. The remaining essay highlights the importance of spatial dependence on the cyclicality of public investment in Africa. That is, the spillover effects from neighboring countries make a difference while estimating the cyclicality of public investment in Africa.

In the first essay, I examine the economic impact of mineral resource extraction on the U.S. local labor market, and how it affects local communities' development using county level data between 1970- and 2012. I use difference-in-difference methodology and spatial modeling to incorporate spatial heterogeneity and dependence among U.S. local areas that are in close geographical proximity. The results show that MRE industry employment grew faster during boom periods and slower during the bust period in MRE dependent counties. MRE earnings and earnings per worker grew slower during boom periods and faster during the bust period. The findings provide evidence of negative spatial indirect spillover effects between neighboring counties' MRE sector labor markets.

In my second essay, I analyze the price elasticity of mineral resource products in each of the mineral resource extractive industries' labor markets in Canada's provinces. I estimate the impact of shocks on employment in the mineral resource extraction industry in Canada's natural resource rich provinces using monthly employment observations for the period January 1990 to December 2012. Estimates show the responsiveness of Canada's provincial MRE employment to gold price, WTI or Alaska crude oil price fluctuations. Results from a difference-in-difference regression model show a positive growth of employment in Canada's natural resource rich provinces during boom and bust periods. The results show a significant MRE employment growth in each of Canada's provinces with more growth in magnitude in MRE dependent provinces. The results for the price effects of minerals show that employment growth was inelastic relative to mineral price changes from 1990 to 2012.

The third Chapter examines how public investment reacts to the changes in GDP in African countries by employing panel data between the period 1996 and 2012. The paper also examines public investment for each regional economic community such as the Economic Community of West African States (ECOWAS), the West African Economic and Monetary Union (WAEMU), the Economic Community of Central African States (ECCAS), the Central African Economic and Monetary Community (CEMAC), the South African Development Community (SADEC) and the Intergovernmental Authority on Development in Eastern Africa (IGAD). The paper also estimates the spatial spillovers from economic shocks by employing a spatial queen contiguity matrix and a spatial distance based weighting matrix. The results confirm the presence of pro-cyclicality in public investment in Africa. However, the degree of this pro-cyclicality varies significantly across the regional economic communities. The degree of pro-cyclicality is less significant when spatial spillovers are considered for WAEMU, ECOWAS, CEMAC, and IGAD countries and stronger for ECCAS, and particularly SADEC countries.

Local Economic Impact of Boom and Bust in Mineral Resource Extraction in the United States: A Spatial Econometrics Analysis

Introduction

It is a general agreement among historians, political scientists, and economists that the presence of abundant natural resources in the U.S. has played an important role in its history since the 1700's by contributing to its economic development, growth and technological innovations. Activities related to Mineral Resource Extraction (MRE) generate employment, income, and contribute to the local economy and the fiscal system. Mineral resources extractions provide mineral, raw materials and energy that are essential to a growing economy. According to the Mine Safety and Health Administration (2011), there are more than 14,000 operations that mine for coal, metal ores and non-metallic minerals in the United States. A report of the National Mining Association (2011) shows that U.S. mining has a important impact on the national economy, providing high-wage jobs averaging $71,075 annually and generating some added value in all economic sectors. According to the National Mining Association, (2011) mineral resource operations impact local economies directly through the economic activity in those sectors. Those operations also indirectly impact local economies through economic activity of related sectors and through induced effects from spending (National Mining Association, 2011).

In spite of the important role that MRE has on the U.S. economy, and its relative positive spillovers on other economic sectors, there is still no consensus in the literature about the real impact of MRE on local economic growth. Some of these previous investigations found that resource intensive areas grow slower than non-resource areas, which is referred to as the "Dutch disease" or "resource curse" phenomenon (Matsuyama, 1992; Sachs and Warner, 1995, 1997, Kuwimb, 2010; Davis, 1995, 2003; Pegg, 2006; Black et al., 2005; Gaetano B., 2015). Other studies found that resource abundance is positively correlated with economic growth (Sarmidi et al., 2013; Boyce and Emery, 2011; Aubynn, 2009; Brunnschweiler, 2007; Aroca, 2001; Hajkowicz, 2011). However, little is still known about its impact more broadly on U.S. local economic development and about its indirect spillover effects on other sectors and contiguous regions. None of these studies on the U.S. MRE industries employed spatial models to incorporate spatial heterogeneity and dependence among U.S. local areas that are in close geographical proximity. Thus, this paper fills a gap in the literature by examining spatially the local economic impact from MRE industries in the entire United States. It also measures the impact of mineral shocks on other non-MRE economic sectors such as manufacturing, construction, services, and retail trade.

The remainder of the paper is structured as follows: the next section reviews the related literature, and sections 3 describes the boom and bust in the MRE sector and related shocks in the U.S economy that can affect the local economy. Section 4 describes the distinction between treatment and comparison counties. Section 5 provides a brief discussion of data, and presents the data analysis and the empirical models employed in the study. The results and findings are presented in Section 6. Section 7 shows a brief discussion, and section 8 provides a general conclusion.

Literature review

Mineral endowment plays an important role in local economic, social, political, and environmental conditions. Prior to the 1980’s, studies examined how local and regional labor markets responded to demand shocks and found a negative correlation between high natural resource endowment and economic growth (Baldwin, 1966; Nankani, 1979). Since the early 1990s, there has been a growing literature which supported and reinforced this idea that a large natural resource sector slows economic growth (Matsuyama, 1992; Sachs & Warner, 1995, 1997; Black & al., 2005). Although many studies investigated the impact of mining operations in developing countries, only a few studies have attempted to understand how MRE operations impact local and regional communities in the United States. Bender et al. (1985) investigated the impact of mining operations on community economic development and found that mining dependent counties had higher population growth rates, higher incomes, and fewer people receiving social security compared to nonmining dependent counties. Black et al. (2005) examined the impact of the coal boom in the 1970's and the subsequent coal bust in the 1980's on local labor markets in Kentucky, Ohio, Pennsylvania, and West Virginia, and found evidence of modest employment spillovers into sectors with locally traded goods but not into sectors with nationally traded goods. Their results showed evidence that boom in the mining sector crowded-out employment in non-mining traded sectors (Black et al., 2005). Papyraskis and Gerlagh (2007) studied variations within the U.S. and found that natural resource abundance is a significant negative determinant of growth. Their results gave evidence that natural resource abundance decreases investment, schooling, openness, and R&D expenditure and increases corruption (Papyraskis and Gerlagh, 2007). James & Aadland (2011) used U.S. county level data and found that resource-dependent counties tend to cultivate anemic growth relative to non-resource dependent counties. Deller and Schreiber (2012) explored the relationship between non-oil and gas extractions and economic growth for nonmetropolitan U.S. counties for the period 2000 to 2007. They found robust results suggesting that non-oil and gas extraction is associated with lower population growth and a positive impact on per capita income, but it is negatively correlated to employment growth (Deller and Schreiber, 2012). Many empirical studies, however, gave evidence of a positive correlation between resource abundance and economic growth (Aroca, 2001; Brunnschweiler, 2008; Aubynn, 2009; Boyce and Emery, 2011; Hajkowicz, 2011; Sarmidi et al, 2013). In the intent to explain the effects of natural resource abundance on economic growth through various channels of transmission, Boyce and Emery (2011) found that resource abundance is negatively correlated with growth rates but positively correlated with income levels, thus concluding that resource endowment is a blessing, not a curse. Brunnschweiler (2008) re-examined the effect of natural resource abundance on economic growth using new measures of resource endowment and considering the role of institutional quality. He found a positive direct correlation between natural resource abundance and economic growth (Brunnschweiler, 2008). Using annual data on drilling to identify western boom-and-bust counties, Jacobsen and Parker (2014) found substantial positive local employment and income effects during the boom. However, they found that during bust periods, incomes per capita decreased and unemployment compensation payments increased relative to what they would have been if the boom had not occurred (Jacobsen and Parker, 2014). Allcott and Keniston (2014) found that oil and gas booms increased growth rates in producer counties by 60 to 80 percent relative to non-producer counties, and local wages increased by 0.3 to 0.5 percentage points per year during a boom. Dissimilar to the finding of Black et al. (2005), they found that manufacturing growth is positively associated with natural resource booms (Allcott and Keniston, 2014).

Shocks in the MRE industry also have a significant impact on migration patterns and population growth. Thus, while estimating how shocks in the U.S. mineral resource extraction (MRE) industry impact MRE-dependent counties, it is important to take migration into consideration since it influences local labor markets. As shown by Saks and Wozniak (2011), U.S. in-migration rates are pro-cyclical, and Moretti (2012) documented that Americans have historically been mobile people, constantly looking for better economic situations. During the Great Recession, geographic relocation took place as a response to particularly strong negative local economic shocks (Mian and Sufi, 2013). Yagan (2014) showed that a smaller number of workers moved into locations most affected by the Great Recession. Monras (2015) showed that differences in population growth rates across locations are mainly explained by differences in in-migration rates rather than in out-migration rates.

Many studies have also been done to understand the correlation between MRE and economic growth in developing countries. Matsuyama (1992) and Sachs and Warner (1995, 1997) found a negative correlation between mining abundance and economic growth, suggesting that most of mining dependent developing countries are experiencing a "Resource Curse" or "Dutch Disease" phenomenon. Caselli and Michaels (2011) used variation in oil output among Brazilian municipalities to investigate the effects of resource windfalls on government behavior. They found that oil-rich municipalities experienced increases in revenue, and increases in spending on public goods and services; however, they did not find any increase in economic and social outcomes (Caselli and Michaels, 2011). Ross (2014) showed that petroleum tends to produce a "political resource curse." He showed that petroleum has at least three harmful effects: it makes authoritarian regimes more durable, increases certain types of corruption, and helps generate violent conflict in low and middle income countries (Ross, 2014). Contrary to conventional theories, recent studies documented a positive correlation between MRE and economic growth in developing countries (Ross, 2014). Focusing on the Norwegian economy, Mideksa (2013) examined the impact of petroleum endowment and found that the impact varies from year to year and remains positive and very large. According to Mideksa (2013), on average, about 20% of the annual GDP per capita increase is due to the endowment of petroleum resources such as oil, natural gas, natural gas liquids, and condensate. Aragon and Rud (2013) examined the local economic impact of Yanacocha, a large gold mine in Northern Peru using annual household data from 1997 to 2006 and found evidence of a positive effect of the mine's demand for local inputs on real income. Using a panel fixed-effects estimation and resource discoveries since 1950 in countries that were not previously resource-rich as a plausibly exogenous source of variation, Brock (2015) found a positive effect on GDP per capita levels following resource exploitation that persists in the long term. His results vary significantly between OECD and non-OECD treatment countries, with effects concentrated within the non-OECD group (Brock, 2015). Mamo et al. (2016) investigated how mining impacts on local, regional and national level living standards measured by night-time lights and found that both mineral extraction and discovery improved local living standards in a panel of 3,635 districts from 42 Sub-Saharan African countries observed between 1992 and 2012.

However, it is not clear that the "Resource Curse" or "Dutch Disease" applies to U.S local economies. Many factors such as the type of mining, the period, and the measure of economic impact play important roles in determining the real impact of mining operations on rural communities (Deller & Schreiber, 2012). According to Deller & Schreiber (2012), "there are two main reasons that demonstrates why it is inconclusive that the resource curse that dominates the international development literature applies to the U.S local and regional economies: the rigidity of the institutional rules that govern the U.S extractive industries, in order to minimize many of the negative externalities associated with mining operations, and the presence of an institutional structure to capture the economic opportunities created by extractive industries" (Deller & Schreiber, 2012).

None of the above mentioned studies on the U.S MRE industries employed county level data for the entire U.S. and spatial modeling to incorporate spatial heterogeneity and spatial dependence among U.S. local areas that are in close geographical proximity. Therefore, this paper contributes to the literature by examining the local economic impact of price shocks in the U.S. mineral resource extraction (MRE) industries using county level data between 1970 and 2012. A difference-in-difference fixed effects model and a Spatial Durbin Model (SDM) are employed in this study. The results show that MRE industry employment grew faster during boom periods and slower during the bust period in MRE dependent counties compared to non-MRE counties. MRE earnings and earnings per worker grew slower during boom periods and faster during the bust period. Local MRE sector labor markets were negatively impacted by shocks in the MRE industry of the neighboring counties. The findings show evidence of a negative correlation between MRE earnings share and MRE employment. This paper also find that booms in the MRE sector positively impacted other sectors such as manufacturing and construction, and negatively impacted services and retail trade. The results show that the male population in all cohorts grew faster, while the female population grew slower in the MRE dependent counties during both boom and bust periods.

Mineral resource extraction industry boom and bust cycles from 1970-2012

This section describes the boom and bust in the MRE sector that occurred during 1970 to 2012. This study focuses on all U.S. counties and aims to compare MRE employment, earnings and earnings per worker of MRE dependent counties to non-MRE dependent counties during boom and bust periods in the MRE industry. The MRE industry has experienced positive and negative shocks from 1970 to 2012 in each type of MRE (coal, gold, copper, oil and gas, and other non-metal mining). The fluctuation of the most traded minerals such as oil and gold have an important impact on economic growth since it affects the redistribution of employment and earnings in MRE and non-MRE sectors, as well as community development in the economy. Bhar & Malliaris (2011) noted that "oil prices may be correlated with other commodity prices such as those related to agriculture (wheat, corn, and soy bean), energy (natural gas, gasoline, and heating oil), metals (gold, silver, copper and palladium), and softs (cotton, coffee, lumber and sugar)". Thus, it is important to learn more about the effects of mineral price changes on local economic growth and more specifically the labor market. In order to be consistent with the literature, the fluctuation of gold and oil prices are used as a proxy to identify shocks in the mineral and metal ore industry. Figure 1 plots the real price of gold from 1970 to 2012. This figure shows that the gold price has increased during the periods 1970 to 1980 and 1998 to 2012 and declined on average from 1981 to 2000. Figure 2 plots the fluctuations of Alaska crude oil prices from 1978 to 2012. Alaska's crude oil price index is used as a proxy for all crude oil prices. The figure shows an increase of oil prices during the periods 1978 to 1980 and 2001 to 2012. A declining pattern can be observed on average from 1981 to 1998. Figure 4 shows an increase of MRE employment from 1970 to 1980, as well as from 2001 to 2012. An opposite effect can be seen between 1981 and 2000. With the decline of resource prices (Figures 1 and 2), a relative decline in the U.S. total MRE employment can be observed. The period of 1982 to 2002 was characterized by a low price of mineral, oil, and gas products which led to a decline of employment growth rate in the MRE industry (see also

Table 2). Changes in mineral resource prices represent exogenous labor demand shocks that induce variations in employment in the extraction sector (Gaetano Basso, 2015; Allcost and Keniston, 2014).

Table 2 shows the average annual change of the logarithm of MRE employment, earnings, and earnings per worker for three separate periods (two booms and one bust) and for the entire period (1970-2012). The results show that MRE employment grew at an average rate of 7.2% annually in MRE dependent counties, 2.7% annually in non-MRE dependent counties, and 6.2% annually at the national level. MRE employment average annual growth declined during the bust period of 1981 to 2000 by 2.7% in MRE dependent counties, 0.6% in non-MRE dependent counties, and by 2.3% at the national level. The effect of the bust was much more severe on MRE employment in treatment counties than in comparison counties. With the boom of MRE commodity prices from 2001 to 2012, MRE employment has increased with an average annual growth of 1.9% in treatment counties, 0.7% in comparison counties, and by 1.7% at the national level.

The positive price shocks in the MRE industry positively impacted MRE earnings and earnings per worker in both treatment and comparison groups. MRE earnings grew at an annual average rate of 10.9% during the first boom and 8.5% during the second boom in MRE dependent counties. In non-MRE dependent counties, MRE earnings grew at an annual average rate of 10.2% during the first boom and only 2.1% during the second boom. The magnitudes of earnings growth were higher in treatment counties than in comparison counties. During the bust period, MRE earnings declined an average of 3.7% a year in nonMRE counties compared to an average of 2.3% a year in treatment counties. MRE earnings per worker grew faster during the boom periods and declined during the bust period in both treatment and comparison counties. This can be explained by the fact that

MRE earnings increased more than employment during boom periods and declined more than employment during the bust period.

At the national level, MRE employment, earnings, and earnings per worker grew faster during the two boom periods and declined during the bust period. This is evidence that the MRE industry has experienced a negative shock during the period of 1981 to 2000 and positive shocks during the periods of 1970 to 1980 and 2001 to 2012.

For the entire period of 1970 to 2012, Table 2 shows that MRE employment, earnings, and earnings per worker had positively grown in both treatment and comparison counties and at the national level. MRE employment grew at an annual average rate of 1.9% in treatment counties, 0.7% in comparison counties, and 1.7% at the national level from 1970 to 2012. MRE earnings grew faster than employment by 4% a year in treatment counties, 1.6% a year in comparison counties, and 3.5% a year at the national level from 1970 to 2012. This led earnings per worker to grow faster in MRE dependent counties at an average of 2% a year compared to 0.9% a year in non-MRE dependent counties. These are evidence that the MRE industry has experienced a negative shock during the period of 1981 to 2000 and positive shocks during the periods of 1970 to 1980 and 2001 to 2012.

Treatment and comparison groups

In order to analyze the real impact of shocks in the MRE industries on local labor markets and local economic growth, it is important to differentiate MRE dependent counties from non-MRE dependent counties. The magnitude of shocks in the MRE sector is expected to be higher in MRE dependent counties than in non-MRE counties. In this paper, treatment counties refer to counties with large mineral resource extractions (MRE) and comparison counties refer to counties with low or no mineral resource extractions (MRE).

Based upon previous literature, the Location Quotient (LQ) measure is used in this study to define the treatment groups and the comparison groups. As a technique that mathematically indexes a region's economy to a larger reference economy, the LQ has been widely used by scholars in geography and regional economics since the 1940's (Gibson, Miller and Wright, 1991). It is a measure of spatial concentration based upon employment which is a ratio of a local industry's share of total employment to this same share in the national economy (Mack and Jacobson, 1996). Following Lesage and Reed (1989), the formula of LQ can be expressed as:

$$\mathbf{LQ_i} = \frac{\mathbf{E_{mi}}/\mathbf{E_i}}{\mathbf{E_{mn}}/\mathbf{E_n}} \qquad (1)$$

Where $\mathbf{LQ_i}$ represents the location quotient in county (i = 1, ... , n). $\mathbf{E_{mi}}$ is the total employment in the MRE sector in county i, $\mathbf{E_i}$ the total employment in county i, $\mathbf{E_{mn}}$ the national MRE total employment and $\mathbf{E_n}$ national total employment. If $\mathbf{LQ_i}$ is greater than one (>1) the county is considered to be a treatment county whereas the county is considered to be a comparison county if $\mathbf{LQ_i}$ less than or equal to one (=<). Figure 5 illustrates how U.S. MRE dependent counties and non-MRE dependent counties are distinguished based on the location quotient measure.

Data analysis, Empirical Approach and Methodology

Data analysis

This section describes the data used in this study and a brief analysis of the average annual growth of MRE industry employment, earnings, and earnings per worker at the national level as well as in treatment counties and comparison counties. Three datasets are combined to form one master dataset. The first dataset contains data of U.S. county-level annual employment and the real earnings for each sector (MRE, Manufacturing, Construction, Services and retail-trade) from 1970 to 2012, collected from the Bureau of Economic Analysis Regional Economic Information System (REIS). It also contains national tabulations of total employment and total earnings for the entire U.S. economy (Summary statistics are provided in Table 1.). The measure of MRE earnings per worker (total earnings by total employment ratio) is used to obtain a measure of earnings per MRE worker. The second dataset contains annual data of U.S. total population (1970-2012) by age and gender collected through the United States Bureau of the Census's Summary Tape Files (Summary statistics are provided in Table 1.). The U.S. Census Bureau provides data of U.S. total population (1970-2012) through the U.S. intercensal population by county and state (see Table 1). The third dataset contains county level annual observations of per capita income for the period between 1970 and 2012 collected through the Bureau of Economic Analysis Regional Economic Information System (see Table 1).

Empirical Approach and Methodology

This paper considers a Spatial Durbin Model (SDM) that incorporates spatial heterogeneity and spatial dependence between neighboring counties. Unlike the Spatial

Autoregressive (SAR) model which assumes that the dependencies in the relationship occur only in the dependent variable, the SDM assumes that the dependencies not only occur in the dependent variable, but also in the independent variables (Anselin, 1988; Brasington & Hite, 2005; Kissling and Carl, 2007, Levratto, N., 2015). This model produces unbiased coefficients in the case of problems with the data generating process, and is also not affected by the problem of bias caused by omitted variables (LeSage, 2009, Levratto, N., 2015). In order to check robustness, a state and year fixed effects regression model with no spatial effects is also employed.

This study employs a spatial a queen contiguity matrix. This type of matrix estimates the interaction between a area and its neighbors. According to the Queen contiguity matrix, two areas are neighbors when they have a common side or vertex. A min-max normalized weighting matrix used in this study.

Spatial diagnostic tests are conducted and evidence of spatial autocorrelation is found through Moran's *I* and the Lagrange multiplier tests. The Moran's *I* spatial correlogram test shows a strong spatial dependence between first order and second order neighboring counties' employment and earnings. Spatial tests of the Spatial Durbin Model against a spatial lag model and a spatial error model reveal at a 1% level of significance that the Spatial Durbin Model is the best preferable estimation model to be employed in this study[1].

The Breusch-Pagan Lagrangian multiplier test shows some evidence of heteroskedasticity. The F tests for the dependent variables also rejected at a 1% level of significance the null hypothesis of homogeneity. The Hausman test strongly suggests at a

[1] The SDM is the best model for this study compared to the SAR and the SEM.

1% level of significance the fixed effects method than the random effects method. Following Lesage (1999, 2009), Yu et al., (2008) and Elhorst (2010), the SDM can be expressed as:

$$\Delta \ln(y_{it}) = \rho_j \sum_{j=1}^{3} W_{iz} \Delta \ln(y_{it}) P_j + \sum_{i=1}^{3} X_{it} P_j \beta_j + \sum_{j=1}^{3} W_{iz} X_{it} P_j \theta_j + \varepsilon_i \quad (2)$$

Where $\mathbf{y_{it}}$ represents the dependent variables employment, total earnings and earnings per worker in county (i = 1, … … . , n) at year(t = 1, … … . , T). $\mathbf{X_{it}}$ represents the independent variables such as treatment dummy $\mathbf{T_{it}}$,with (**i = 1**, … … . , **n**) and (**t = 1**, … … . , **T**) and takes the value 1 if a county is a MRE dependent county or the value zero otherwise, and a set of control variables such as the MRE earning share (Earnshare), total population (pop) and per capita income (capinc) in county(**i = 1**, … … . , **n**) at year(**t = 1**, … … . , **T**) . P_j is an indicator of the time periods, where P_1 the period 1970-1980 is the first boom, P_2 the period 1982-2000 is the bust, and P_3 the period 2001-2012 represents the second boom period. β_j is a (kx1) regression parameter. The coefficient β_j measures the difference of the dependent variables between the treatment and comparison counties during boom and bust periods. A positive value of β_j means that during that given time period, there was a particular increase in MRE's employment, real earnings, or earnings per worker in treatment counties compared to the comparison counties. A negative sign would have the opposite meaning. W_{iz} represents a (nxn) spatial weighting matrix.

$W_{iz}\Delta \ln(y_{it})$ denotes the endogenous interaction effects among the dependent variables and

$W_{iz}X_{it}P_j\theta_j$the exogenous interaction among the independent variables during boom and bust cycles. ρ_j is the spatial auto-regressive coefficient. It measures the strength of the spatial

dependence between counties. θ_j measures the interaction effects among the exogenous variables during boom and bust cycles. ε represents the disturbance term with $\varepsilon \sim_{nx1}; \sigma^2 I_n$). It assumes that $E(\varepsilon) = 0$ and $var(\varepsilon) = \sigma_\varepsilon^2$ and $E(\varepsilon_{it}, \varepsilon_{zs}) = 0$ whenever $i \neq z$ and $t \neq s$.

Results

Direct, indirect and total impact on MRE labor market from 1970 to 2012

Table 3 shows strong spatial dependence with a significant value of the spatial rho ($\boldsymbol{\rho}$) coefficients which range between 0.34 and 0.42 from 1970 to 2012. The highest value of the spatial rho ($\boldsymbol{\rho}$) with MRE earnings and earnings per worker is a proof that there is a strong correlation between counties MRE' earnings and earnings per worker when compared to MRE employment.

The direct effects in Table 3 show that MRE employment grew 0.002% faster in MRE dependent counties compared to non-MRE dependent counties from 1970 to 2012. MRE earnings grew on average 0.018% faster while earnings per worker declined an average of 0.014% in MRE counties. MRE earnings grew faster than employment, which led to an increase in the earnings per worker in MRE dependent counties. The indirect effect results show a negative spatial heterogeneity and dependence between neighboring counties' MRE sector employment, earnings, and earnings per worker. The total effects show that the results did not significantly grow in MRE counties compared to non-MRE counties. The results show a positive direct correlation between local MRE employment and local MRE earning share. However, the results also show a negative indirect spatial correlation between neighboring counties' MRE employment and earning share.

Table 4 shows that MRE industry's employment grew faster during boom periods and slower during the bust period in MRE dependent counties. The indirect effect results did not show a significant spatial dependence between neighboring counties' MRE average employment growth during both boom periods. However, the results show a significant negative spatial correlation between MRE average employment growths of neighboring counties during the bust period. Overall, MRE-employment did not significantly grow in treatment counties compared to comparison counties during both boom periods. During the bust period, MRE employment declined on average by 0.02% in MRE dependent counties. There was a negative spatial dependence between MRE sector employments of neighboring counties as shown by the significant coefficient of 0.015. As a result, MREemployment grew on average 0.035% slower in treatment counties compared to comparison counties during the bust period. The SDM results in Table 4 show a direct, indirect and total negative correlation between MRE employment and MRE earning share during the bust period and no statistical significant difference during both boom periods. These results are supported by Jacobsen and Parker (2014) who found that the increase of local employment during a boom period is smaller than the decline of employment that follow a bust.

The direct effect results in Table 5 show that MRE dependent counties have experienced an increase of MRE sector's earnings during the bust and the last boom period, but not a significant change during the first boom period. The indirect spillover effects derived from neighboring counties were negative and statistically significant during both boom periods, which led to a total decline of MRE real earnings during boom periods but not during the bust period. The negative earnings spatial spillover effects can be explained in part by the increase of labor supply, which migrated from non-MRE dependent counties into treatment counties during boom periods. Consequently, real earnings per worker fell down and led to a slower increase of MRE real earnings in treatment counties compared to comparison counties.

Table 6 shows that positive shocks in the MRE sector generated a decline of MRE earnings per worker in treatment counties. Analyzing the direct effect, MRE earnings per worker grew slower during both boom periods and faster during the bust period in MRE dependent counties. The indirect spillover effects from the neighboring counties were also negative and statistically significant during both boom periods, but not during the bust period, which led earnings per worker to grow 0.057% slower during the first boom and 0.035% slower during the second boom in MRE dependent counties. In contrast, MRE earnings per worker grew 0.036% faster during the bust period in treatment counties. This negative correlation between MRE sector's price shocks and real earnings per worker is the result of changes in labor supply and the migration patterns during boom periods. MRE employment grew slower during the bust period and real earnings did not significantly grow during the bust period, which led to an increase of MRE real earnings per worker during the bust period in MRE dependent counties. The decline of MRE real earnings and the increase of MRE employment induced MRE real earnings per worker to grow slower in MRE dependent counties during boom periods. These results can also be explained by the influence of the migration patterns. As documented by Yagan (2014), a small number workers moved into the regions most affected by the Great Recession. Black et al. (2005) also found that there is a general increase of in-migration patterns into MRE dependent areas during boom periods and an increase of out-migration during bust periods.

Testing for spillover effects in non-MRE sectors

This section examines how price shocks in the MRE sector affected non-MRE sectors in the treatment counties compared to the comparison counties. Table 7 reports the average annual growth rates of the non-MRE sectors' employment, earnings, and earnings per worker during boom and bust periods. A Spatial Durbin regression model (SDM) is used for this estimation.[2] The dependent variables are the logarithm change of non-MRE sectors, manufacturing, construction, services, and retail-trade sectors employment, earnings, and earnings per worker. A set of control variables such as the MRE earning share, the growth rate of total county population and per capita income have been included in this regression.

The results in Table 7 show that non-MRE employment grew 0.002% slower during the first boom (1970-1980), and 0.002% faster during the bust (1982-2000). Non-MRE real earnings and real earnings per worker grew faster during both boom periods, and did not statistically change during the bust period in MRE dependent counties compared to nonMRE counties. The fact that differences in growth rates of non-MRE employment, real earnings and earnings per worker were small and statistically insignificant for some periods suggests that MRE dependent counties and non-MRE dependent counties experienced similar economic growth during these periods.

In order to identify boom and bust effects on specific non-MRE sectors, the approach in Black et al. (2005) was used by dividing non-MRE sectors into manufacturing, construction, services, and retail-trade. The results show that manufacturing employment grew significantly faster during the bust period, which led to a slow grow of the sector's

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[2] Since this study is more interested in estimating the spillover effects on local non-MRE sectors' labor markets, only the main results in Table 7 are reported.

earnings per worker. Positive shocks in the MRE sector had no effect on the manufacturing sector labor market; however, negative shocks had a positive effect. Similar to the findings of Black et al. (2005), the results show that manufacturing growth is negatively associated with natural resource booms. Construction employment did not grow significantly in MRE dependent counties for the entire period. However, construction sector's earnings and earnings per worker grew significantly faster during both boom periods but not during the bust period. These findings suggest that construction earnings and earnings per worker growth were positively associated with natural resource booms. The results show that the service sector's employment, earnings and earnings per worker grew slower in general during both boom and bust periods in MRE dependent counties. The abundance of mineral resources in treatment counties crowded-out employment and earnings in the service sector. The results did not show a strong correlation between price shocks in the MRE sector and retail trade sector's employment and real earnings, especially during the bust and the last boom periods. However, retail trade earnings per worker grew significantly faster during the first boom due to the decline of the sector's employments and significantly slower during the bust period. The results show that shocks in the MRE sector were positively correlated with the retail trade sector's earnings per worker growth and negatively correlated with the retail trade sector's employment growth.

Estimating the magnitude of the spillover effects

While it is important to know whether shocks in the MRE sector had some spillover effects on other non-MRE sectors, it is also essential to know the magnitude of these spillovers. Following a model used by Black et al. (2005), and Marchand (2012), the magnitude of the spillover effects from the MRE sector are estimated to show how many non-MRE sector jobs are created or destroyed for each MRE sector job created. The regression specification is:

$$\Delta \ln(\text{Local\_emp}_{it}) = \beta_0 + \beta_i[\Delta\ln(\text{Mine\_emp}_{ist})\, W_{it}] + (\text{county}_i\text{year})\, \emptyset + \varepsilon_{it}\ , \qquad (3)$$

Where $W_{it} = \text{Mine\_emp}_{i,t-1}/\text{Local}_{empi,t-1}$ and Local_emp_{it} represents the total employment in the local goods sector such as manufacturing, construction, services, and retail-trade in county $(i = 1, \ldots \ldots, n)$ at year $(t = 1, \ldots \ldots, T)$. The instruments for the weighted change in logarithm of MRE employment are TP_1, TP_2, and TP_3, where T stands for treatment group which takes the value 1 if a county is a MRE dependent county, and takes the value zero otherwise. P_1, P_2, P_3 are indicators of the time periods. P_1 represents the period 1970-1980 which is the first boom, P_2 represents the period 1982-2000 which is the bust, and P_3 represents the period 2001-2012, which represents the second boom period, (Black et al. 2005). The weighting of the independent variable allows us to interpret β_j as the number of local jobs created or destroyed for each new MRE job created (Black et al.
2005).

The Instrument (IV) for the weighted variable is:

$$\Delta \ln(\text{Mine\_emp}_{it}) = \sum \beta_j \left(T_i P_j\right) + (\text{county}_i \text{year}_t)\emptyset + \varepsilon_{it} \qquad (4)$$

The results reported in Table 8 confirm the findings of Black et al. (2005) that MRE boom and bust indeed generated employment spillovers in local non-MRE sectors. The results show that for each additional MRE job created, the number of jobs lost in non-MRE sectors during the first boom was 0.963, and the number of jobs created in non-MRE sectors during the second boom was 0.939. During the bust period, each MRE job lost led to the loss of

2.277 jobs in the county. Breaking the non-MRE sector into its different components, the results show that during the first boom each additional job creation generated 0.111 jobs in the manufacturing sector, 0.142 jobs in construction sector, 0.51 jobs lost in the services sector, and 0.334 jobs lost in the retail trade sector. During the bust period, each MRE job lost cost the county 0.243 jobs in the construction sector, 0.719 jobs in the service sector and 0.434 jobs in the retail trade sector. During the second boom, the multiplier of job creation was 0.122 jobs in the manufacturing sector and 0.521 jobs in the construction sector. Shocks in the MRE sector were negatively correlated with the service sector. There was a loss of 1.363 jobs in the service sector for each job creation during the second boom period. As shown in the results, each additional job creation in the MRE sector during boom periods generated little job creation in the manufacturing (0.111 to 0.22) compared to the construction sector (0.142 to 0.521) in treatment counties. Job creation in the MRE sector during boom periods crowded out service sector's employment and generated a negative spillover effect on the retail-trade sector. Given that jobs lost in non-MRE sectors during both boom and bust periods are higher than jobs created in services and retail trade sectors, it is conclusive that the MRE sector crowds out employment in those sectors.

Impact on population change

This section estimates the population change in MRE dependent counties compared to non-MRE counties by gender and age groups. It aims to show how shocks in the MRE industry affected population change and consequently how this change impacted local job markets in MRE dependent counties. Population change in the local county can also influence some of the effects estimated in the local county's labor market during shocks in the MRE sector. A positive shock would most likely be associated with an increase of inmigration into MRE counties due to employment opportunities and higher relative earnings, while negative shocks would have the opposite effect (Black et al., 2005). In order to estimate the effects of population change in treatment counties, the SDM specified in equation (2) is employed to estimate the impact of boom and bust cycles in population change. Although, the SDM provides the direct, indirect and total effect, only the main coefficients are reported in this study since we are most interested with the direct local impact of shocks.

Following Lesage, (1999, 2009), Yu et al., (2008) and Elhorst (2010), the SDM empirical model is the following:

$$\boldsymbol{\Delta}\ln(\mathrm{pop_{ci}}) = \rho_j \sum_{j=1}^{3} W_{iz}\Delta\ln(y_{it})P_j + \sum_{i=1}^{3} X_{it}P_j\,\beta_j + \sum_{j=1}^{3} W_{iz}X_{it}P_j\theta_j + \varepsilon_i \quad (5)$$

Where $\mathbf{pop_{ci}}$ is the population for cohort c in county $\mathbf{i}$ for the four prime aged cohorts: population ages 10–19, 20-29, 30-39 and 40-49. $\mathbf{X_{it}}$ is a 1*k row vector of explanatory variables such as the treatment dummy $\mathbf{T_{it}}$ ($\mathbf{i = 1}$, … … . , $\mathbf{n}$) at year($\mathbf{t = 1}$, … … . , $\mathbf{T}$) that takes the value 1 if a county is a MRE dependent county, and takes the value zero otherwise. A set of control variables such the MRE earning share (**Earnshare**), total population (**pop**) and per capita income (**capinc**) in county($\mathbf{i = 1}$, … … . , $\mathbf{n}$) at year ($\mathbf{t = 1}$, … … . , $\mathbf{T}$) have been included in the regression. However their coefficients have not been reported in Table 9. This study is more focused on understanding the inmigration and outmigration patterns of the U.S. population in different age groups during boom and bust cycles in MRE dependent counties. P_j is an indicator of the time periods. P_1 is for the period

1970-1980 which is the first boom, P_2 is for the period 1982-2000 which is the bust, and P_3 is for the period 2001-2012, which represents the second boom period. The coefficients of β_j measure the population growth between the treatment and comparison counties during boom and bust periods. A positive sign of $\boldsymbol{\beta}$ means that during boom or bust periods there was a greater increase of in-migration in the treatment counties than in the comparison counties. A negative sign would have the opposite meaning. $\mathbf{W_{iz}}$ is the spatial weighing matrix. μ_i is a county unobserved heterogeneity term and ε_{it} is the disturbance term.

Table 9 shows that during the first boom in the MRE sector, the male population of the 10-19 year old cohort grew 0.005% faster, while the female population of the same cohort did not significantly grow in the treatment counties compared to the non-MRE counties. The male and female populations of the 20-29 year old cohort grew faster during the first boom in the treatment counties. The male population of the 10-19 year old cohort, and both the male and female populations of the 29-29 year old cohort increased due to a high level of in-migration in MRE dependent counties to benefit employment and earnings opportunities generated by the boom in the MRE sector. The male and female populations of both 30-39 and 40-49 year old cohorts did not significantly grow in MRE dependent counties compared to non-MRE counties.

During the first bust period (1981-2000), the male population grew 0.018% faster in the 10-19 year old cohort, 0.024% faster in the 20-29 year old cohort, 0.014% faster in the 30-39 year old cohort, and 0.016% faster in the 40-49 year old cohort MRE dependent counties than in non-MRE counties. The highest growth was registered in the 20-29 year old cohort, followed by the 10-19 year old cohort. The female population of the 30-39 year old cohort significantly declined by 0.012% during the bust period, while the female population of the 40-49 year cohort old grew 0.004% slower (not significant) during the bust period in MRE dependent counties. During the second boom period, the male population grew 0.018% faster in the 20-29 year old cohort, 0.017% faster in the 30-39 year old cohort, and 0.02% faster in the 40-49 year old cohort in MRE dependent counties. The population in the 40-49 year old cohort grew faster compared to the population growth in the other cohorts. The increase can be explained by a higher rate of in-migration of the male population of these age groups into the MRE dependent counties to benefit employment and earnings opportunities. The MRE industry is mostly composed of a higher proportion of male workers than female. And as shown in the results, the male populations in the 20-29, 30-39 and 40-49-year-old cohorts grew significantly during the second boom in MRE dependent counties.

Table 9 shows that the male populations in all cohorts (10-19, 20-29, 30-39 and 40-49 year old) did not significantly grow in MRE dependent counties for the entire period 1970-2012. However, the results show that the female populations had declined in all different age groups from 1970 to 2012. These coefficients are significant for the 30-39 and 40-49year old cohorts but not for the 10-19, and 20-29 year old cohorts. The female population out-migrated more in MRE dependent counties. This out-migration can be explained by education or by the higher marital formation with partners from non-MRE counties (Black et al, 2005). It can also be explained by the fact that the female populations may have difficulties finding jobs in the MRE sector. Since services and the retail trade grew slower in MRE counties, it was more likely for the female population to out-migrate MRE areas to find jobs in non-MRE counties.

Discussion

This study compares MRE dependent to non-MRE dependent counties in the U.S. by employing county level data for the entire U.S. and also spatial modeling to incorporate spatial heterogeneity and spatial dependence among U.S. local areas that are in close geographical proximity in order to estimate spatial spillovers from MRE industry shocks. The results show that spatial heterogeneity and spatial dependence make a difference and should be taken into account for policy considerations and in future studies.

This paper shows that booms in the MRE industry are accompanied by an increase of MRE employment and a decrease of MRE real earnings and earnings per worker. These results confirm the findings of Jacobsen and Parker (2014) who showed that local employment increases during booms. However, that increase is smaller than the declines in employment that follow a bust. Moreover, the findings in this paper provide evidence of negative spatial spillover effects on MRE sector employment, earnings, and earnings per worker in neighboring counties during boom periods. In MRE dependent counties nonMRE sector employment grew slower during boom periods and faster during the bust period. Positive shocks in the MRE sector had no effect on the manufacturing sector labor market; however, negative shocks had a positively effect. Like the findings of Black et al. (2005), the results show that manufacturing growth is negatively associated with natural resource booms. Shocks in the MRE industry have positive effects on the construction sector's earnings and earnings per worker but not a significant effect on the sector's employment. Positive shocks in the MRE sector negatively affect the service and retail trade sectors' employment, earnings, and earnings per worker during both boom and bust periods in MRE dependent counties. The results also provide evidence of an increase in male population during boom and bust periods in MRE dependent counties. In contrast, female population out-migrates MRE dependent counties during both boom and bust periods.

To the question of whether boom in the MRE industry is a blessing, the answer tends to be “no”. There is little evidence to conclude that booms in the MRE industry positively impacted the MRE industry and other non-MRE sectors’ labor markets between 1970 and 2012. In contrast, booms in the MRE industry decreased the industry real earnings and earnings per worker and generated negative spatial spillover effects from neighboring counties into treatment counties. Also, the impact of the booms on other nonMRE sectors tend to be negative. As compared to the findings of James & Aadland (2011), this paper finds that resource-dependent counties tend to cultivate anemic growth relative to nonresource dependent counties. Thus, unlike Brunnschweiler (2008) and Boyce and Emery (2011), this paper does not find a positive direct correlation between natural resource abundance and economic growth.

Summary and Conclusions

This paper examines how boom and bust cycles in the MRE industry affected the U.S. MRE dependent counties during the 1970 to 2012 period. First, this paper employed a fixed effects model without spatial dependence as proposed by Black et al. (2005). Then, a Spatial Durbin Model (SDM) was employed to incorporate the spatial heterogeneity and dependence as proposed by LeSage and Pace (2009) and Elhorst (2010). Gold and Alaska crude oil real price fluctuations from 1970 to 2012 are used as proxies to define three boom and bust cycles for the MRE industry. The 1970-1980 period is defined as the first boom period, the 1981-2000 period is defined as the bust period, and the 2001-2012 period is defined as the second boom period. The location quotient measure was used to distinguish between the treatment and comparison counties. A county is defined as treatment if its location quotient is greater than one. Otherwise, the county is defined as a comparison.

The results show that MRE industry employment grew faster during boom periods and slower during the bust period in MRE dependent counties. MRE earnings grew slower during boom periods and faster during the bust period leading to a decline in earnings per worker in MRE counties during boom periods. During the bust period, MRE employment grew slower than earnings and led to an increase in earnings per worker. The findings provide evidence of a negative spatial heterogeneity and dependence between neighboring counties' MRE sector employment, earnings, and earnings per worker. The SDM results show a direct, indirect and total negative correlation between MRE employment and MRE earning share during the bust period and no statistically significant difference during both boom periods. An analysis of the effect of price shocks in the MRE sector on the non-MRE sectors shows that non-MRE employment grew slower during boom periods and faster during the bust period. Non-MRE real earnings and earnings per worker grew faster during both boom periods, and stay unchanged during the bust period in MRE dependent counties. Non-MRE sectors' employment grew slower than earnings on average in treatment counties. Consequently, non-MRE sectors' earnings per worker grew faster in MRE dependent counties compared to non-MRE dependent counties. Breaking down the nonMRE sector into its different components, the results show that negative shocks in the MRE sector impacted positively the manufacturing sector's employment and negatively the manufacturing sector's earnings per worker in MRE dependent counties. However, there is no evidence of a significant growth in manufacturing employment, earnings, and earnings per worker during both boom periods in MRE dependent counties. Booms in the MRE sector positively impacted the construction sector earnings and earnings per worker, while negatively affecting the service and retail trade sectors' employment, earnings, and earnings per worker during both boom and bust periods in MRE dependent counties. The results also provide evidence of an increase in male population during boom and bust periods in MRE dependent counties. In contrast, female population out-migrated MRE dependent counties during both periods.

Given that the negative effects of the bust surpass the positive effects during the boom periods, public policies could target distribution of tax revenues during the boom years to counter the negative effects during bust periods (Matsen and Torvik, 2005). The results suggest that local policy makers could promote investment in human capital and local infrastructure from the revenues generated through tax collections and royalties in the MRE industry during boom periods. In order to improve the long run effects of resource busts on local labor markets, policies maker could promote skill acquisition through education. Policies such as technology innovation, revenues redistribution, and the reduction of environment could be promoted in MRE dependent counties. Migration policies that aim at reducing in-migration during boom periods and out-migration during bust periods may help to mitigate the long run negative effects of shocks on local labor markets.

Several questions on the impact of shock in the MRE industry on local development still need to be answered. As data becomes available, a future extension can be done to estimate the local impact by dividing MRE industry into its different components and by specifying the study on four U.S. census regions and divisions. Future extensions are also needed to estimate how shocks in MRE industry impact environmental damage, education, local crime, transportation and public finances. It would be interesting to see how shocks in the MRE industry impact local tax revenue and how the public spending of these tax revenues affect local community development.

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Mineral Resource Extraction in Canadian Provinces: An Analysis of Employment Impacts and Price Elasticities

Introduction

Canada is an advanced economy with large mineral resource extraction industries. The mineral resources are oil sand, natural gas, gypsum, iron ore, uranium, cobalt, nickel, copper, gold, lead, molybdenum, potash and silver, which ranks Canada among the top five countries in terms of major mineral production. Mineral Resource Extraction Industry (MRE) industries contribute greatly to Canada's economic strength. According to a recent study by the Mining Association of Canada (MAC) in 2014, the industry employs 418,000 workers across the country in mineral extraction, smelting, mining, fabrication and manufacturing. The industry contributed up to $52.6 billion to Canada's gross domestic product in 2002 which include $20.5 billion in mineral extraction, and over $32 billion in mineral processing and manufacturing (MAC, 2014). According to Infomine (2008), Canada is also classified among the largest countries which produce oil and the third largest in natural gas production (mining.com).

This high abundance of natural resources, along with the fact that the MRE sector greatly contributes to Canada's economy are reasons to investigate the resources extraction industry in order to understand how the labor market in the industry reacts to MRE output price changes in Canada's nine provinces which include Newfoundland and Labrador, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Colombia. These nine provinces vary in what mineral resources they predominantly extract based on availability. For instance, British Columbia and Alberta are ranked among the top producers of coal. Copper is mined in British Columbia, Ontario, Quebec, and

Manitoba. Ontario is classified as the leading province in terms of gold and diamond resource sites. Oil sand industries are extracted in Alberta, while mineral and metals such as iron ore, nickel, lead, zinc, stone, gravel and other non-metallic minerals (petroleum and gas) are mainly extracted in Newfoundland and Labrador, Nova Scotia, New-Brunswick and Manitoba. Uranium mining operations are all located in Saskatchewan.

Most of these mineral resources are non-renewable, and their prices change not only based on the demand-supply mechanism of the market, but also based on the political, cultural, and religious factors. The exchange rate fluctuations and the economic conjuncture in countries like the U.S., Japan, and China affect the value of metals, fuels, and other minerals produced and their respective prices. For instance, West Texas Intermediate (WTI) oil price (adjusted for inflation), which was $33.67 per Barrel in average in 1990 and around $16.83 per Barrel in average in 1998, has increased up to about $92.31 per barrel in early 2008, decreased to $56.71 per Barrel from 2008 to 2009 due to the recession, and later increased to $82.30 per barrel from 2009 to 2012. Gold, which is the most traded precious metal, has also experienced significant fluctuation in price which has increased from $297.61 per ounce in average in 2001 to $1459.55 per ounce in average in 2012. Thus, this study aims to estimate the elasticities of price change on the MRE industries total employment from 1990 to 2012. It is important to notice that the world mineral, metal and oil prices have experienced two principal negative price shocks (1990 to 2000 and 2008 to 2009) and two principal positive price shocks (2002 to 2007 , 2010 to 2012).

This study first estimates the impact of positive and negative shocks on employment in the MRE industry in Canada's natural resource rich provinces. Secondly, it estimates the mineral price elasticities, which provide the percentage change of the growth rate of Canada's MRE employment per 1% change of gold price, WTI and Alaska crude oil price.

Real gold prices, WTI and Alaska crude oil real price fluctuations from January, 1990 through December, 2012 are used as a proxy to estimate these elasticities. Through a difference-in-difference regression model, the findings show a positive growth of employment in Canada's natural resource rich provinces during boom and bust periods. The results also show a significant MRE employment growth in each of Canada's provinces with more growth in magnitude in MRE dependent provinces. Estimating the mineral price effects on each of Canada's provinces in the MRE sector labor market, the results show that employment growth is inelastic relative to mineral price changes from 1990 to 2012.

The next section summarizes prior research concerning the relationship between minerals resource endowment and economic growth, mining boom and bust cycles and the local labor market, and also how mineral price fluctuations affect mineral resource extraction profits, and the provincial labor market. The second section examines the relationship between oil and gold prices, and also presents an overview of these price fluctuations from 1990 to 2012. Section three explains how the location quotient model is used to distinguish the treatment from the comparison provinces. Section four presents the data analysis, and section five shows my empirical regression models and my main findings. Section six concludes with the major findings, addresses the limitations of this study, and gives some suggestions for future research.

Literature review

Up until now, only a few pieces of empirical research have been conducted in Canada's MRE industries and very few when it comes to the estimation of price elasticities on MRE employment during boom and bust periods. Since the early 1990's, there has been a growing body of research which refuted the idea that the presence of mineral resources in an area is a source of growth, and much research has supported the idea that the presence of a large natural resource sector slows economic growth (Matsuyama 1992; Sacks and Warner, 1995, 1997; Black et al. 2005). Deller and Schreiber (2012) found some robust results suggesting that non-oil and gas extraction is associated with lower population growth and a positive impact on per capita income, but have no impact on employment growth. Papyraskis and Gerlagh (2007) found a negative correlation between natural resource abundance and investment, schooling, openness, and R&D expenditure, and James & Aadland (2011) found that resource-dependent counties tend to cultivate anemic growth relative to non-resource dependent counties.

Many empirical studies came out and refuted most of the long held general theory about the MRE sector's impact on economic growth. These research papers found a positive correlation between resource abundance and economic growth (Sarmidi et al., 2013; Boyce & Emery, 2011; Brunnshweiler, 2008; Aroca, 2001). Using annual data on drilling to identify western boom-and-bust counties, Jacobsen and Parker (2014) found significant positive local employment and income effects during the boom. Allcott and Keniston (2014) documented that Oil and gas booms increased local wages and economic growth rates in mining dependent counties compared to non-mining counties.

Despite the fact that the literature is mixed and divided about the real correlation between MRE and economic growth, Canada's economy has experienced a positive economic growth in the long run despite its high mineral industry endowment and the positive and negative shocks in the mineral industry. The fluctuation of the most traded minerals commodities such as oil and gold greatly affects economic growth since it affects the relocation of employment and earnings in MRE and non-MRE sectors, as well as community development in the economy. Canada's mineral resource extraction industry extracts many types of mineral output such as metals, non-metals, oil and gas, but the most traded resources are oil and gold. These two commodities have played a very important role in designing many countries economy, history and politics. The fluctuation of oil and gold prices has historically affected other mineral and non-mineral commodity prices, which has generated some changes in the structure of many economic activities, as well as the redistribution of employment and earnings throughout local economies. The fluctuation also affected the world macroeconomic indices and policies due to the fact that there is a strong historical relationship between the U.S dollar exchange rate and the price of gold. Since oil is mostly bought and sold on the world market using the U.S. dollar, there has also been an indirect relationship between oil prices and gold prices. The empirical results of Cashin et al. (1999) and Pindyck and Rotemberg (1990) have also revealed the existence of a strong correlation between oil and gold. Countries with a high demand for gold include East Asia, India and the Middle East where gold plays an important cultural and religious role. Since most of the leading world producers of oil are the OPEC countries, they have historically exchanged oil for gold. Therefore any increase (decrease) of oil prices increases (decreases) oil exporters' net revenues, and this in return greatly affects the price of gold (Gaetano Basso, 2015). According to Bhar and Malliaris (2001), oil prices may be correlated with other commodity prices such as agricultural, energy, metals and soft products; and all these commodities are influenced by common macroeconomic factors such as interest rates, personal income, industrial production exchange rates and inflation. They also noted some relationships between mineral products, since some of them are inputs in the production of others (oil, silver, copper) or complementary (silver and copper) and substitutes in consumption (gold and silver) (Bhar and Malliaris, 2011). Thus, it is important to learn more about the effects of mineral price changes on local economic growth and more specifically the labor market. Changes in mineral resource prices represent exogenous labor demand shocks that induce variations in employment in the extraction sector first and then in the local services and non-tradable manufacturing sectors (Gaetano Basso 2015; Allcost & Keniston, 2014). According to economic theory, the ability of a mine to survive during a bust period depends largely on its variable production costs. Given that labor accounts for an important share of the variable costs of mining, a mine that enters a recession with a high labor productivity and achieves to raise its labor productivity during the recession would be more likely than other mines to avoid reducing employment and closure (Tilton, 2001).

It is important to notice that MRE industry direct employment is vulnerable to price change, and only very few studies have attempted to estimate the price elasticities relative to MRE industry employment. Thus, the purpose of this study is to estimate the real impacts of boom and bust cycles in the mineral extraction sector on its direct total employment in each of Canada's provinces. Additionally, this study aims to estimate the elasticity of mineral prices such as gold, the WTI and Alaska crude oil relative to MRE industry employment in each of Canada's provinces.

Oil and gold price fluctuations from 1990 to 2012

This section presents the changes of oil and gold prices from 1990 to 2012. This study uses oil and gold price as a proxy for all other mineral prices since the change of these commodities greatly affects all other mineral and non-mineral products as noted above. It uses the gold price set by the London Fix which is determined by the London gold market fixing LTD. The use gold price is considered in this study because gold as a precious metal is different from the other minerals due to the fact that gold is used for industrial purposes and also as a form of storing wealth. There are different markets of crude oil throughout the world such as the WTI crude oil market, the Alaska crude oil market, the North Sea oil market, and the Russian oil market. This study also uses the WTI and Alaska crude oil prices as a proxy of all other oil prices. It is important to keep in mind that Canada and other mineral extraction countries such as the U.S., Australia, and China's mineral resource extraction (MRE) industries experienced difficulties with the decline of prices for many mineral products in the 1990's. Mineral prices were stable for some of these products and lower for others. The consequences of this negative shock included the closure of some mines in Canada. The volume of production of MRE output has fallen since the early 1990's, which generated a decline of the added value of about 6% (Source: Natural resources Canada and British Columbia Ministry of Energy, Mines and Petroleum Resources, 2007). Figures 1, 2 and 3 report the price of gold, WTI and Alaska crude oil during the period 1990 to 2012. Figure 1 shows that gold price (adjusted for inflation) has decreased from $527.77 per ounce in 1990 to $297.61 per ounce on average in 2001 which represents a 43.60% decrease during this period (see Table 11). Gold prices have steadily increased from $297.61 per ounce in 2001 to $1459.55 per ounce in 2012 which represents a 390% increase in gold prices. During this period (2000-2012) these results reveal a decrease of other metals' product price such as the platinum and the platinum prices during the Great Recession from 2008 to 2009. (Figure 6 in appendix).

WTI oil prices (adjusted for inflation) have declined from $33.67 per barrel in 1990 to $16.83 per barrel in 1998 and Alaska oil prices (adjusted for inflation) have declined from $20.89 per barrel in 1990 to $9.84 per barrel in 1998. Oil prices grew steadily from 2002 to 2007. This period represents a great boom in the oil extraction industry. Oil prices declined later in the period 2008 to 2009, and rose again from 2010 to 2012. As noted in Table 11, Alaska and WTI crude oil prices declined at an annual average of 0.9% from

2008 to 2009 and later increased at an annual average of 0.7% for Alaska crude oil price and 0.3% for WTI price from 2010 to 2012. Table 11 shows that the world's most traded mineral prices grew up from 2001 to 2007, and 2010 to 2012. Mineral prices grew slower during the period 1990 to 2000 and 2008 to 2009. These results demonstrate that world mineral prices have experienced two negative shocks (1990-2000, 2008-2009) and two positive shocks (2001-2007,2010-2012) representing the two boom and bust cycles that the MRE industries went through from 1990 to 2012.

Treatments and comparison groups

In order to analyze the real impact of MRE sector shocks in the local labor market and local economic growth, it is important to differentiate MRE intensive provinces from non-MRE provinces. To accurately estimate this impact, this study is referring to high intensive mining provinces as treatment groups, and low or non-MRE provinces as comparison groups. With this distinction, this study estimates the effects of any boom and bust in the local economy through its direct effects on MRE employment.

A very important question to address is how treatment provinces are distinguished from comparison provinces. The natural resource literature is mixed when it comes to separating these groups from each other. Based upon previous literature, the location quotient measure is used to define the treatment groups and the comparison groups.

Export base model/location quotient

The regional economics literature has divided economic activities into two main sectors: the basic sectors that produce goods and services for export outside of the local economy, and the non-basic on non-export sectors that produce goods for local consumption (Andrews, 1970; North, 1955; Tiebout, 1956). According to the literature, the basic sector produces dollar flows into the local economy which positively impact economic development. Thus, activities in the non-basic sector depend on basic sector exports for their development (Krikelas, 1992; Harris, 1999).

Based upon previous literature, the Location Quotient (LQ) measure is used in this study to define the treatment groups and the comparison groups. As a technique that mathematically indexes a region's economy to a larger reference economy, the LQ has been widely used by researchers in geography and regional economics since the 1940s (Gibson, Miller and Wright, 1991). It is a measure of spatial concentration based upon employment as well as a ratio of a local industry's share of total local employment to this same share in the larger economy (Mack and Jacobson, 1996). Following Lesage and Reed (1989), the formula of LQ can be expressed as:

$$\mathbf{LQ_i} = \frac{\mathbf{E_{mi}} / \mathbf{E_i}}{\mathbf{E_{mn}} / \mathbf{E_n}} \qquad (1)$$

Where $\mathbf{LQ_i}$ represents the location quotient in province (i = 1, … … . , n). $\mathbf{E_{mi}}$ is the total employment in the MRE sector in province i, $\mathbf{E_i}$ the total employment in province i, $\mathbf{E_{mn}}$ the national MRE total employment and $\mathbf{E_n}$ national total employment**.**

If $\mathbf{LQ_i}$ is greater than one (>1) the province is considered as treatment province whereas the county is considered as comparison county for $\mathbf{LQ_i}$ less than or equal to one (=<).

Data analysis

Three datasets were combined: (1) The monthly data of employment of each of Canada's provinces' Mineral Resource Extraction (MRE) sector from January, 1990 to December, 2012 collected from the CANSIM tables of Canada Statistics; (2) the monthly data of Cushing OK West Texas Intermediate (WTI) spot price FOB Dollars per Barrel and

Alaska North slope first Purchase Price dollar per Barrel from January, 1990 to December, 2012 collected from the U.S Energy Information Administration (eia.gov); (3) the monthly data of Gold, Silver, Rhodium, Palladium, and Platinum prices from January, 1990 to December, 2012 collected from KITCO (www.kitco.com).

Table 10 presents the average monthly change in the logarithm of mining employment, gold price, Cushing OK West Texas Intermediate (WTI) spot price FOB Dollars per Barrel and Alaska North slope first Purchase Price dollar per Barrel (adjusted for inflation). Canada's MRE total direct employment has been affected by the price fluctuations seen above. In Canada's mineral resource extraction industry, most jobs are located in the mining industries (metals, non-metals and coal). This is due to the fact that mining industries demand a large labor workforce as an input of production. Manual extraction of minerals from the ground, operation of equipment for extractions, removing and loading the mining output into trucks require a large workforce. Mineral exploration and development is Canada's second largest source of employment, while oil and gas extraction industries are the third largest source of employment where less labor is required to extract the natural resources from the ground. Oil and gas extraction employs important investments in capital equipment as factors of production, but not as much investment in labor. This is why a shock in the MRE industry will affect more mining extraction industry employment than employment in the oil and gas industries. As shown in Table 10, Canada's MRE employment declined about 0.1 % during the first bust between 1990 and2000, and later rose during the first boom between 2001 and 2007. These periods were associated with an increase of mineral prices. The Great Recession of 2008 and 2009 generated a decline of employment at 0.4% at the national level. Employment rose later during the last boom of prices (2010-2012).

Dividing Canada's provinces into treatment provinces with high MRE activities and comparison provinces with low MRE activities, Table 10 shows that MRE employment grew much more during boom periods than the bust periods in both groups. Comparing treatment and comparison provinces, Table 10 shows that MRE employment grew much more in magnitude in treatment provinces, with an average growth of 0.6% to 0.1% in both boom periods compared to non-MRE provinces where employment grew an average of 0.02% to 0.3%. During the two bust periods, MRE employment still experienced a small positive growth (0.1% to 0.3%) in treatment provinces, and declined from 1.1% to 0.5% in comparison groups. These results suggest that a negative shock in the MRE sector negatively impacted non-MRE sectors activities provinces more significantly compared to high MRE provinces. For the overall period 1990 to 2012, employment grew much slower in comparison provinces while it increased in treatment provinces (see Table 10).

Empirical model

Working with time series data requires testing such as tests for autocorrelation and serial correlation, tests for stationary and co-integration between the variables, and a Granger causality test between the dependent and the independent variables.

The Dickey-Fuller test for unit root was run to test for stationary and integration of the logarithm of several variables including MRE employment, gold prices, WTI and Alaska crude oil prices. The results show that the logarithm of MRE employment is stationary significant at a 10% level of significance while the logarithm gold price, WTI and Alaska crude oil prices are all stationary at 1% level of significance. The augmented Dickey-Fuller test for unit root was conducted to test the stationary relationship between the regression variables and found that the logarithms of MRE employment and gold prices are co-integrated at a 1% level of significance. The logarithms of MRE employment and

WTI oil prices on the one hand, and the logarithms of MRE employment and Alaska oil prices on the second hand are also co-integrated at a 10% level of significance.

Since this paper aims to estimate the price elasticities and the boom and bust impact on employment growth, the Dickey-Fuller test and the augmented Dickey-Fuller test for unit root was run on the first differential of the logarithms of all variables. The results show that the first differentials of MRE employment, gold price, and WTI and Alaska oil prices are all stationary at a 1% level of significance. The augmented Dickey-Fuller test shows that the annual growth rate of MRE employment is co-integrated with the annual growth rate of mineral prices at a 1% level of significance.

Second, this study tests for serial correlation of each variable using the white noise test to prove the hypothesis that a variable does not have autocorrelation. It also employs the Breush-Godfrey and Durbin-Watson tests to test for serial correlation between the MRE employment and mineral prices. The white noise test identifies a presence/absence of serial correlation for each logarithm of MRE employment, gold price, WTI and Alaska crude oil prices. The white noise test supported the null hypothesis that the first differential of each of the variables does not have autocorrelation. This result suggests that there is no serial correlation between the growth rate of MRE employment and the mineral prices. The Breush-Godfrey and Durbin-Watson tests reveal the presence of serial correlation between the log of the dependent variable (MRE employment) and the logarithm form of all the independent variables (mineral prices). However, these tests show that there is no serial correlation for the regression of growth rates of the MRE employment and each of the growth rates of gold prices, WTI, and Alaska crude oil prices.

In order to confirm a causal relation between the MRE employment growth rate and each of the mineral prices, the Granger causality test is run using an OLS model. The results suggest that the null hypothesis that all the coefficients of the log form of all mineral prices are equal to zero (0) cannot be rejected. That is, the logarithm of gold price, WTI oil price and Alaska oil price do not Granger-cause the log of MRE employment. However the test rejects the hypothesis that the first differential of all mineral prices do Grangercause the differential of MRE employment at a 1% level of significance. In summary, the results demonstrate that using the monthly growth rates of each variable would be the best model to estimate the price elasticities and the impact of booms and busts on Canada's average employment growth.

Direct effects on MRE employment of positive and negative shocks in the MRE industries

In this study, a provincial and monthly fixed effect model is used to estimate the effect of any shock in the MRE industry on its direct average employment growth. Equation (7) reports the difference in monthly growth in total employment between treatment and comparison provinces throughout province, year and monthly fixed effects. This model has previously been employed by Dan, Black et al., (2005) and Marchand (2011).

$$\Delta \ln(y_{itm}) = \sum \beta_j (T_i P_j) + (province_i year_t month_t)\emptyset + \varepsilon_{itm} \qquad (7)$$

Were: $\Delta \ln(y_{itm})$ is the first differential of MRE total employment in province i, in year t and in month "m". T_i is a dummy variable which takes the value 1 if a province has a high level of MRE production, and takes the value zero otherwise. P_j is an indicator of time period. With P_1 for the first bust period (1990-2000), P_2 for the first boom period (20022007), P_3 for the second bust (2008-2009) and P_4 for the second boom (2010-2012).

$Province_i$ is a vector of province indicator variables, $year_t$ is a vector of yearly indicator variables and $month_m$ is a vector of monthly indicator variables. $\emptyset$ represents the province and time fixed effects coefficient. These provinces, annual and monthly fixed effects control for anything that varies over each year and each month at the provincial level.

Table 12 shows that Canada's mineral extraction dependent provinces have experienced an increase of MRE employment growth during the two bust and boom periods in the MRE sector. In other words, Canada's mineral industry employment still grew up despite the negative shocks in minerals prices. These results are not surprising since in the MRE industry higher (or lower) prices mean higher(or lower) profits for the industry but the level of output produced is not rising at the same rate and the industry employment grow slower than the growth of the volume produced. MRE employment grew at 5.9% on average from 1990 to 2012 in MRE dependent provinces compared to the comparison provinces. During the boom periods, employment grew at an average of 12.5% for the first boom (2001-2007) and 9.2% for the second boom (2010-2012). Table 12 shows that employment grew slower during the bust periods with an average growth of 6% during the first bust and 2.3% during the second bust. Using a provincial fixed effect in my regression equation, this study estimates the average MRE employment growth for each province during the boom and bust cycle in the MRE sector. The results show that, on average, employment grew between 11% to 12.5% during the first boom and 8% to 10% during the second boom in each province. MRE employment growth declined during the first bust with an average growth between 6% and 10% in each province. During the second bust (2008-2009), the results do not show any significant growth neither in treatment provinces nor in each individual province. For the overall period (1990-2012), this study finds a significant MRE employment growth in each province with relatively more growth in MRE dependent provinces.

In Canada's MRE industry, about two third of the industry total value added comes from oil and gas extraction, while about a quarter comes from mining industries and the remaining from industries providing mining related services such as drilling and exploring for minerals (Mining Association of Canada (MAC), 2011, 2014). Thus a negative price shock will affect more mining industries employment compared to oil and gas industries. Minerals extraction employment grew at a lower rate than the volume of MRE output produced. As a consequence, a shock of mineral price will affect the level of output produced. Given that the level of output produced is rising (or declining) at the same rate as the prices and employment grew (or declined) much slower than the volume of production, MRE employment may remain stable or even increase due to the fact that MRE industries may not have the incentive to lose their skilled workforce. Rather they may increase their labor force productivity and minimize their costs in order to survive during the recession. According to Tilton (2001), "since labor accounts for an important share of the variable costs of mining, an MRE industry that enters a recession with high labor productivity is likely than other industries to avoid cutbacks and closure". That is why Canada's MRE industry labor productivity is high and above the countries average. Consequently, Canada's MRE sector's share of total GDP is much greater than its employment share. This may be explained by the higher wages paid to workers and the type of technology used in the industry.

Estimation of the mineral price elasticities

In order to investigate how MRE employment react at any 1% change of gold price, WTI and Alaska crude oil price, this study estimates the elasticities of the price change impact employment for each province individually and also at the national level. This study uses a provincial and time fixed model. Equation (8) is a fixed effect growth model which estimate what will be the percentage change of the growth rate of Canada's MRE employment for a 1% change of gold oil price, WTI price and Alaska oil price. Following Dan, Black et al., (2005) the model is:

$$\Delta \ln(y_{itm}) = \sum \beta_j (\Delta X_{tm} P_j) + (province_i year_t month_t)\emptyset + \varepsilon_{itm} \qquad \textbf{(8)}$$

Were $\Delta \ln(y_{itm})$ is the first differential of MRE total employment in province i, in year t and in monthly m. ΔX_{tm} represents the first differential of mineral prices such as gold price, WTI and Alaska crude oil price. T_i is a dummy variable which takes the values 1 if a province has a high level of MRE production, and takes the value zero otherwise. P_j is an indicator of time period. With P_1 for the first bust period (1990-2000), P_2 for the first boom (2002-2007), P_3 for the second bust (2008-2009) and P_4 for the second boom (2010-2012). $Province_i$ is a vector of province indicator variables, $year_t$ is a vector of yearly indicator variables and $month_m$ a vector of monthly indicator variables. $\emptyset$ represents the province and time fixed effects coefficient. These provinces, year and monthly effects control for anything that varies over each year and each month at the provincial level.

The results are posted in the Appendix from Table 13 to Table 22. At the national level, reported in Table 13, this study does not find a significant price elasticity effect for all mineral prices during the boom and bust periods from 1990 to 2012. It finds a negative relationship between gold price and MRE employment during the last boom (2010-2012).

That is a 1% increase of gold price lead to 0.2% decrease of MRE employment from 20102012. The labor demand was less responsive and inelastic to any increase of price during this period at the national level. As noted above, mineral price changes will affect Canada's MRE employment less since the volume of output produced grows less than the price growth rate, and employment grows much slower than the volume of output. Further, oil and gas require less labor workforce to the extent that employment stays unaffected to any change of oil price. Table 14-22 reports the price elasticities for each province for the period 1990-2012. In the sub-sections to follow, this study summarizes the findings of analyzing the price elasticities for each of Canada's provinces.

Newfoundland and Labrador province

The Newfoundland and Labrador province is one of Canada's mining dependent provinces. Various minerals such as copper, nickel, lead, zinc, stone, sand, gravel, and ceramic are mined in this province and represent 95% of the province mineral activities (Mining Association of Canada (MAC), 2011). Newfoundland and Labrador is the largest iron ore producing province in Canada. Gold and silver also are mined in this province but in a small quantity (only 1%), (Mining Association of Canada (MAC), 2011). In Table 14, the results show that the MRE labor demand was more responsive during the first bust with a decrease of 3.69% of employment for any 1% decrease in gold price. Labor demand was quite unit elastic during the first boom, that is a 1% increase of gold price leads to a 1.021% increase of MRE employment. MRE labor demand was less responsive to gold price chance during the second bust. A 1% decrease of the gold price generated 0.88% decrease of MRE employment from 2008 to 2009. MRE employment was more responsive during the first bust to WTI and Alaska crude oil price changes but not in all other periods. These results can be explained by the fact that the Newfoundland and Labrador province has more mining industries than oil and gas extraction industries. Iron-ore, nickel, lead, zinc, stone, gravel are mainly extracted in Newfoundland and Labrador and these commodities prices are highly correlated to the fluctuation of gold price. These mining industries demand an intensive labor workforce so that a shock in the oil or gold price will affect industries output and employment. The province employment to be sensitive to mineral price fluctuations. According to the Annual Edition Labour Market Bulletin - Newfoundland and Labrador (2013) "due to the decline of mineral prices in early 2014, two mines announced their closure: Teck's Duck Pond mine (with 300 employees) in central Newfoundland and Wabush Mines (with 400 employees) in Labrador. A third mine, Labrador Iron Mines' James operation in northwestern Labrador, has stated it is underperforming and has laid off almost half of its 64 full-time/full-year employees." Estimating the price elasticity of the Newfoundland and Labrador province for the entire period (1990-2012), the results show that MRE labor demand was less responsive to gold price changes in the Newfoundland and Labrador province. That is a 1% increase of gold price leads to a 0.46% increase of Newfoundland and Labrador province's MRE employment. However, the results do not show any significant response of MRE labor demand related to WTI and Alaska crude oil prices.

Nova-Scotia province

Table 15 shows that the Nova-scotia labor demand was positive and less responsive to changes in gold, WTI and Alaska crude oil prices in the first bust (1990-2000). That is, a 1% decrease in gold prices led to a 0.69% decrease of employment, a 1% decrease of Alaska crude oil price led to a 0.35% decrease of employment, and a 1% decrease of WTI crude oil prices led to a 0.51% decrease of employment. The change of gold price in the later period did not have any significant effect on Nova-Scotia MRE labor demand. This result can be explained by the fact that Nova-Scotia does not have gold mining activities. According to Mining Association of Canada (2011, 2014) its main mineral resource extractions are stone, sand, gravel and ceramics (79% of the province's mineral extractions) and non-metallic mineral operations such as oil and gas (21% of the province's mineral extractions). That is why Nova-Scotia's MRE labor demand was more responsive to increases in Alaska and WTI crude oil prices from 2010 to 2012. A 1% price increase of Alaska oil generated a 1.53% increase of Nova-Scotia's MRE labor demand, and a 1% price increase of WTI oil increased MRE labor demand by 1.23%. The overall period (1990-2012) did not show a significant response of Nova-Scotia's MRE employment due to price changes of gold and Alaska crude oil, but the results did show that Nova-Scotia's MRE labor demand was significantly inelastic to WTI price changes from 1990-2012.

New Brunswick province

New Brunswick's main mineral resource extractions are copper, nickel, lead, zinc, and potash. It has few mining operations of gold, silver, stone, sand, gravel, ceramics and other non-metallic minerals. This province is the second largest potash-producing province in Canada and almost 47% of New Brunswick's mineral extractions are copper, nickel, lead and zinc (Mining Association of Canada, (2011, 2014)). Gold and oil operations represent a few shares in the province's mineral extractions. Even though it has mineral resource operations, New Brunswick is not classified as a dependent province. Table 16 shows that New Brunswick's MRE labor demand was significantly responsive to only gold price changes from 2010 to 2012. New Brunswick is not a mining dependent province and has few MRE industries. The prices of other minerals such as silver, stone, sand, gravel, ceramics and other non-metallic minerals may explain this atypical result. The findings about the coefficients of the other periods confirm the lack of correlation between New Brunswick's MRE employment and mineral price changes. That is, a 1% increase of gold price led to a 2.23% decrease of New Brunswick's MRE labor demand. The other periods were not significantly responsive to changes in prices of gold, Alaska, and WTI crude oil.

Quebec province

According to Infomine (mining.com, 2008), the province of Quebec accounts for about 14% of Canada's mineral production. In 2006, employment in Canada's mineral extraction and concentration totaled 49.2% employees, and the province of Quebec was second with 18.9% of MRE employment (Infomine, 2008). The province of Quebec has many sites of mineral resource operations such as copper, nickel, lead, zinc, gold, silver, stone, sand, gravel and non-metallic minerals such as oil and gas. Quebec is Canada's largest copper-producing province, and the second largest iron producing province. The results in Table 17 do not show a significant responsiveness of Quebec's MRE labor demand to MRE price changes for the period 1990 to 2012, and for some boom and bust periods. Table 17 shows that a 1% decrease of gold price from 1990 to 2000 led to a 1.61% increase of Quebec's MRE employment. A 1% decrease of Alaska oil price led to an inelastic response of 0.69% increase of labor demand, and a 1% decrease of WTI price nearly led to a unit increase of MRE employment. During the price boom of 2001 to 2007, Quebec's MRE employment experienced a decline despite the high growth of oil prices. MRE labor demand was less responsive with a 0.3% decrease for any 1% increase of Alaska oil price. These results are due to the fact that Quebec has fewer oil extraction activities as compared to metal mining.

Ontario province

Many mineral resource extraction industries are located in Ontario province. Mineral resources such as gold, silver, copper, nickel, lead, zinc, oil and gas are extracted in Ontario. Ontario has the second largest diamond production industry in Canada after the Northwest Territories where diamonds are produced in great quantity, and the second largest copper-producing province after Quebec according to Infomine, (2008). Ontario is Canada's leading gold producer and account for over half of the total national gold production. According to Infomine (mining.com, 2008), the Ontario province accounted for 27% of Canadian mineral production, and 29% of Canadian MRE employment in 2006. Although Ontario possesses a large mineral resource extraction industry, its economy sectors are more diversified so that the province is not a MRE dependent province. The results in Table 18 confirmed that changes of MRE price do not significantly affect Ontario's MRE employment. From 2001 to 2012, the fluctuations of MRE prices did not significantly affect Ontario's MRE labor demand except during the first bust period. MRE labor demand was inelastic to Alaska and WTI crude oil prices during this period. A 1% decrease of Alaska and WTI oil prices led to a 0.43% to 0.61% increase of labor demand and a 1% decrease of gold price generated a 1.02% decrease of MRE employment.

Manitoba province

Manitoba accounts for significant copper production in Canada. Copper production represents 78% of Manitoba's mineral extraction (Infomine, 2008). Gold and silver production represents almost 12% of Manitoba's mineral production while stone, sand, gravel and ceramics account for only 7% (Infomine, 2008). The estimation of Manitoba's MRE labor demand elasticity in Table 19 reveals that Manitoba's MRE employment was more responsive to changes in gold price than oil price in the first bust (1990-2000). A 1%

decrease of gold price generated a 1.11% decrease of MRE's employment, while a 1% decrease of Alaska and WTI oil prices led to an inelastic response of 0.5% to 0.71% decrease of Manitoba's MRE employment from 1990-2000. The non-statistical significance of the coefficients' elasticities from 2001 to 2007, and also for the entire period 1990 to 2012, suggest that Manitoba's MRE employment has not been significantly affected by changes in MRE prices.

Saskatchewan province

The province of Saskatchewan is classified as a mineral resource dependent province. Its location quotient (LQ) for the MRE industry is greater than one. This result means that Saskatchewan's MRE industry is a basic sector that produces minerals to export outside of its local economy. This produces dollar flows into the local economy which positively impacts its economic development. According to Infomine (2008) Canada is the world's leading producer of uranium which accounts for about one-third of total global output, and thus all operating uranium mines in Canada are in Saskatchewan. Saskatchewan is also Canada's largest potash-producing province. The share of gold, silver, oil and gas extractions combined is less than 2% of the province's total mineral operations (Infomine, 2008). Hence, in an attempt to estimate the MRE labor demand elasticity to any change of mineral prices, the results in Table 20 show a negative and inelastic relationship between Saskatchewan's MRE employment and mineral prices from 1990-2000. That is, a 1% decrease of gold price during the first bust generated a 0.705% increase of employment and a 1% decrease of Alaska and WTI oil price led to 0.30% to

0.43% increase of MRE employment. During the first boom, a 1% increase of gold price generated an increase of 0.22% in employment, while a 1% increase of Alaska oil price generated a 0.11% increase in MRE employment. MRE employment did not show a significant response to mineral price fluctuations from 2008 to 2012. These results suggest that even though Saskatchewan does not have large gold and oil extraction industries, uranium and potash labor markets are influenced by changes of gold and oil prices. However the MRE labor market is less responsive to these price changes.

Alberta province

In Table 21, the results show that Alberta's MRE employment was less responsive to any change of mineral prices from 1990 to 2012, with the only significant response occurring during the first bust (1990-2000). A 1% decrease of gold price generated a 0.916% increase of Alberta's MRE employment, and a 1% decrease of Alaska and WTI price induced a 0.40% to 0.57% increase of Alberta's MRE employment from 1990 to 2000. From 2001 to 2009, the MRE labor market was inelastic to mineral price fluctuations, but these coefficients are not statistically significant. These results can be explained by the fact that Alberta possesses a large resource extraction sector which is not easily affected by the change of mineral prices. The oil sand industry demands less labor so that any change in price may affect the level of production but not the industry's employment. Oil sand extraction accounts for 22.2% of Alberta's total mineral activities and 15% of Canada's crude oil activities (Infomine, 2008). Stone, sand, gravel and ceramic mining represents 71.8% of the province's mineral operations (Infomine, 2008). The location quotient of these MRE industries is greater than one, and this means that the MRE industry is an export based sector which produces dollar flows into the local economy. This explains why Alberta's MRE labor market is less responsive to gold and oil price fluctuations.

Province of British Colombia

British Columbia is Canada's largest coal producer which represents about 64% of the province's resource extraction activities. Copper, nickel, iron-ore, lead and zinc account for 23%, oil and gas 9%, while gold and silver account for about 4% of the province's mineral extraction activities (Infomine, 2008). British Columbia is the largest copperproducing and the second largest iron producing province in Canada (Infomine, 2008). An estimation of price elasticities in Table 22 shows a positive correlation between British Columbia's MRE employment and mineral price variations from 1990 to 2000. A 1% decrease of gold price induced a 2.12% decrease of MRE employment. This may be explained by the positive correlation between gold price and other minerals such as coal and copper prices, and also by the fact that mineral mining requires a large labor force compared to other non-mineral mining extractions. That is, if coal and copper prices decline, MRE industries lower their employment level for profit maximization purposes. MRE employment is more responsive to WTI oil price compared to Alaska oil price. A 1% decrease of WTI oil price generated a 1.21% decrease of employment, while a 1% decrease of Alaska oil induced a 0.86% decrease of employment from 1990 to 2000. The results show a negative and inelastic relationship between British Colombia's MRE employment and WTI crude oil price for the entire period (1990-2012).

Summary and Conclusions

This paper measures how boom and bust cycles in the Mineral Resource Extraction (MRE) industry affect Canada's MRE dependent provinces during the period January, 1990 to December, 2012 using a difference-in-difference provincial, time-fixed effect econometric model. Gold, WTI and Alaska crude oil real price fluctuations from January, 1990 to December, 2012 are used as a proxy to define the boom and bust cycles in the MRE industry since they provide positive and negative shocks (variation of MRE prices) in the industry which can affect local employment. The location quotient measure is used to distinguish the treatment group from the control group. A province is defined as a treatment (comparison) province if its location quotient is greater (smaller) than one. The differential growth between these two groups is used to identify the effects of shocks on the MRE labor market in the treatment provinces compared to the comparison provinces.

The results show that Canada's mineral extraction dependent provinces experienced an increase of MRE employment growth during the two busts and boom periods in the MRE sector. Canada's mineral industry employment still rose despite the negative shocks in mineral prices. MRE employment grew at 5.9% on average from 1990 to 2012 in MRE dependent provinces compared to the comparison provinces. During the boom periods, employment grew at an average of 12.5% for the first boom (2001-2007) and 9.2% for the second boom (2010-2012). During bust periods, MRE employment still grew, but at a decreasing rate with an average growth of 6%. For the entire period 1990-2012, the results show significant MRE employment growth in each of Canada's provinces with more growth in magnitude in MRE-dependent provinces.

In order to understand how Canada's MRE labor market varied for any shock in mineral prices, this study estimates the mineral price elasticities which provide the percentage change of the growth rate of Canada's MRE employment for a 1% change of gold price as well as WTI and Alaska crude oil prices. Gold prices, WTI and Alaska crude oil real price fluctuations from January, 1990 to December, 2012 are used as a proxy to estimate these elasticities. From Table 14 to 22, the results show that MRE employment was more responsive (elastic) to mineral price changes during the first bust (1990-2000) than the other boom and bust periods from 2002 to 2012. The results also show that the

MRE labor market was not significantly responsive to mineral price fluctuations from 2002 to 2012. Comparing the magnitudes of the responsiveness of the MRE labor markets due to any change in price, the results show that MRE employment was more elastic to gold price variations compared to WTI and Alaska oil price variations which generated inelastic elasticities of MRE employment for most of the coefficients. These results are not surprising since oil extraction industries require less labor compared to mining industries. Furthermore, about two thirds of the MRE industries' total extractions comes from oil and gas extraction industries. Also, even though higher (or lower) prices can lead to higher (or lower) profits for these industries, the volume of the outputs is not rising at the same rate as the prices. This means that any change of prices have few effects on the employment growth rate. The lower responsiveness of MRE employment can be explained by the fact that large mining, oil and gas extraction activities require an important investment in their labor training and formation in order to increase their labor productivity. This happens so that during bust periods the industries would not cut back their highly skilled labor. The industries would rather increase their labor productivity, minimize the other costs of production by reducing their capital investment, and reduce the number of contracts with non-MRE sectors (such as manufacturing, construction, and utility sectors) indirectly related to MRE industries in order to avoid cutbacks and closure.

Many other questions on the Mineral Resource Extraction in Canadian Provinces still need to be answered. There are room for future studies how MRE industry in Canada affects local economic development by dividing the industry into its different components. Other questions such as how the natural resources rent in Canada impact local and provincial tax revenues, education and environmental damage are subject to be investigated.

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Cyclicality of Public Investment in Africa

Introduction

The financial crisis of 2008 has revealed new challenges for monetary and economic unions. The literature highlights, for example, difficulties in the Euro area in addressing the dichotomy between northern and southern economies in dealing with external current account deficit, high levels of asset bubbles and unsustainable levels of debt. The Euro area countries face these challenges despite a common monetary policy and full central bank independence and a significant level of economic integration (i.e. full factor mobility).[3]

Although fiscal policy is the only instrument for countries in a union to counter shocks, research on cyclicality indicates that it has typically been pro-cyclical: expansionary in good times and contractionary in bad times (Talvi and Vegh, 2005; Dessus and Varoudakis, 2013; Tosun and Yilmaz, 2016). The difficulty of access to international capital markets during bad times only exacerbates the situation (Aizenman et al., 2000; Gavin and Perotti, 1997).

In Africa, an important component of the fiscal policy is public infrastructure investment which is central to economic growth. For African economies to be competitive there needs to be investments in infrastructure to boost productivity and to close the infrastructure gap. However, fiscal policies of African economies are also pro-cyclical (Thornton, 2008; Lledo et al., 2011). In times of fiscal stress, infrastructure investments are usually cut back first before other expenditures.

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[3] See Borio, C., "The financial cycle and macroeconomics: what have we learnt?", BIS Working Papers, No 395, December 2012.

This paper examines the cyclicality of public investment in African countries using panel data for the 1996-2012 period. In addition to an overall analysis of the African continent, this study also examines public investment in country sub-groups such as SubSaharan Africa (SSA), the West African Economic and Monetary Union (WAEMU), the Central African Economic and Monetary Community (CEMAC), the South African Development Community (SADEC), the Economic Community of West African States (ECOWAS), the Economic Community of Central African States (ECCAS) and the Intergovernmental Authority on Development in Eastern Africa (IGAD). This study analyzes spatial spillovers from economic shocks using contiguity and distance based spatial weighting. While our results confirm procyclicality in public investment in the African region, the degree of procyclicality varies significantly across the country groups. Procyclicality becomes less significant when spatial spillovers are considered for WAEMU, CEMAC, ECOWAS, and IGAD countries but it becomes stronger for ECCAS, and particularly SADEC countries. In the next section we provide a short discussion of the literature on cyclicality of fiscal policy, which is followed by a section on data, empirical methodology that explains the specific spatial models used in our regressions, and our empirical results. We provide our concluding remarks in the last section of the paper.

Cyclicality of Fiscal Policy

In monetary unions countries give up monetary policy making power for the benefit of greater economic integration associated with the union. However, if the economies in a union are significantly different from each other, not all the countries in the union benefit from economic integration equally. More importantly, countries in the union might be affected from shocks asymmetrically in times of crisis. In this case, affected countries in a monetary union will find it harder to adjust to shocks than those countries that are not in a union. The countries that are not in a union (i.e. countries with monetary policy making power) can devalue or revalue their currency to make relative price adjustments. In the absence of national monetary policy making power, countries in a union use national fiscal policy in cushioning idiosyncratic shocks.

Cyclicality of fiscal policy has been an important part of policy debates recently. While many argue that fiscal policy should be countercyclical, a number of studies find evidence of procyclicality (Agenor et al., 1999; Gavin et al., 1996; Gavin and Perotti, 1997; Mpatswe et al., 2011; Stein et al., 1999; Talvi and Vegh, 2000; Hallerberg and Strauch, 2002). Political and other institutional characteristics can also contribute to procyclicality in developing countries (Tornell and Lane 1999; Talvi and Vegh, 2005; Alesina et al., 2008; Frankel et al., 2011). However, there is also similar evidence even for the developed countries. Lane (2003), for example, finds inverse relation between political power and cyclicality of public expenditures in OECD countries: politically more dispersed political systems are marked by more pro-cyclical expenditure flows. The literature finds evidence of pro-cyclical fiscal policy in developing countries and points to difficulty with availability of capital in the international capital markets as one important culprit (Talvi and Vegh, 2005; Aizenman et al., 2000; Gavin and Perotti, 1997). In the case of monetary and economic unions, like WAEMU, CEMAC, SADEC, ECOWAS, ECCAS and IGAD,

fiscal rules lead to limited policy options for those countries as they try to respond to economic shocks (De Grauwe, 2007). The outcome is the pro-cyclicality of public infrastructure investments. In WAEMU zone, for example, public investment spending is more pro-cyclical than in other African countries (Guillaumont-Jeanneney and Tapsoba, 2011). A number of studies find that African countries are particularly pro-cyclical in their fiscal policies (Thornton, 2008; Lledo et al., 2011).

Procyclicality of fiscal policy is important for developing countries because it limits the ability to counteract shocks which could impede public investment significantly. There could even be significant negative spillovers to private investment and spatial spillovers to other countries in the same region. For example, Eden and Kraay (2014) note that "an extra dollar of government investment raises private investment by roughly two dollars, and output by 1.5 dollars".

Data, Empirical Methodology and Results

Data and Descriptive Statistics

This paper examines the reactions of public investment to fluctuations in the economy and also controls for demographic and institutional factors. It mainly used data from the World Bank data (World Development and Worldwide Governance Indicators) for 37 African countries over the period 1996-2012.[4] Table 23 shows the list of countries included in our analysis. It also shows which country groups each country belongs.

Figure 7 and 8 show that both public investment and GDP have grown in real terms from 1996 to 2012, which have produced a relatively modest increase in the share of public investment in GDP over that period. That is shown in Figure 9. While Figure 9 shows a relatively modest but stable increase in public investment, individually countries differ from each other quite significantly. Table 23 shows the average annual growth rates in GDP

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[4] The spatial regression analysis requires a balanced panel of countries so Algeria, Angola, Equatorial Guinea, Gabon, Libya, Namibia, Somalia, South Sudan, and Tunisia have been excluded for missing data. The study also excluded Botswana and South Africa as they are significantly different from other African countries in terms of their economic development.

and public investment for specific African countries. A significant variation in both growth rates across countries, including negative growth rates for public investment in few of the countries can be observed. It is also important to note that the standard deviation in growth rates is significantly higher for public investment compared to GDP. Public investment seems to be much more volatile. Among the country groups WAEMU and ECOWAS countries seem to have lower average growth in GDP and public investment than the average growth for Africa. On the other hand, IGAD and SADEC countries have higher growth rates than other African country groups. CEMAC countries have the highest average public investment growth among the countries. Maps in Figures 10 and 11 show the spatial pattern in public investment growth and GDP growth. Both maps indicate that the growth rates are not randomly distributed.[5] While the exact relationship between public investment growth and GDP growth is not clear in these maps, there seems to be spatial patterns. For example, Figure 10 shows that public investment growth is lower in WAEMU countries. On the other hand, GDP growth rates of countries belonging to smaller country groups (WAEMU, CEMAC and SADEC) are quite similar. The study provides descriptive statistics for our regression variables in Table 24.

The dependent variable is Public Investment, for which the gross public fixed capital formation in real terms is used. The paper also uses a number of other explanatory variables. Fiscal Rule is a dummy variable that indicates whether there is a fiscal rule in that country. This could be an important limiting factor for public investment particularly if a country has a strict rule regarding government expenditures, government revenues, and or fiscal balance. This study uses Share of Urban Population as a control for the level of

[5] This study also ran spatial diagnostic tests and found evidence of spatial autocorrelation through Moran's I test statistic.

urbanization, and Share of Population 15-64 and Share of Population 65+ as control for the demographic structure. Both urbanization and rising young and (possibly) elderly population are expected to have correlations with public investment and overall public expenditures.

This study also uses other variables such as voice and accountability, political stability and absence of violence or terrorism, government effectiveness, regulatory quality, rule of law, and Control of corruption to control for institutional factors. These variables are collected from the Worldwide Governance Indicators (WGI) where -2.5 is an indicator of a weak governance performance and 2.5 a strong governance performance.

Empirical Approach and Methodology

Previous studies on the volatility and pro-cyclicality of public investment of African countries have used conventional regression models, which assume that countries are independent from each other. However, in reality there is a spatial heterogeneity and dependence between countries or regions. As was noted in Tobler (1970), "everything is related to everything else, but near things are more related than distant things." (Tobler, 1970: 236) Thus, it is important to consider the indirect spillover effects coming from neighboring countries while estimating the variation of public investment of the local economy. Failing to assume the spatial heterogeneity and dependence between countries will produce estimates that are biased and inconsistent Lesage, (1999, 2009), Yu et al., (2008) and Elhorst (2010).

Spatial econometrics are designed to incorporate spatial dependence among countries or regions that are in close geographical proximity. Extending the standard linear regression model, spatial methods identify countries of "nearest neighbors" and allow for dependence between these countries (Anselin, 1988; LeSage, 2005, 2008).

This paper uses spatial econometrics to incorporate spatial dependence among countries that are in close geographical proximity. This study considers a Spatial Durbin Model (SDM) since it incorporated spatial heterogeneity and spatial dependence. Unlike the Spatial Autoregressive (SAR) model, which assumes that the dependencies in the relationship occur only in the dependent variable, the SDM assumes that the dependencies can occur not only in the dependent variable but also in the independent variables (Anselin, 1988; Brasington & Hite, 2005; Kissling and Carl, 2007, Levratto, N., 2015). It produces unbiased coefficients in the case of problems with the data generating process; more importantly, it reduces biases from omitted variables (LeSage, 2009, Levratto, N., 2015). This study also employs a Spatial Error Model (SEM), which provides unbiased coefficients. SEM does not estimate the indirect spillover effects from neighbouring countries; it takes into consideration random shocks spreading to neighbouring countries (Levratto, N., 2015). For robustness check, a simple fixed effects regression model with no spatial effects is also employed.

The Following SDM empirical models (equations (9) through (24)) are constructed based on Lesage, (1999, 2009), Yu et al., (2008) and Elhorst (2010) models:

$$\Delta \ln(y) = \rho W \Delta \ln(y) + X\beta + WX\theta + \varepsilon \qquad (9)$$

$\Delta \ln(y)$ is the change in the natural logarithm of the dependent variable public investment. X is a (nxk) matrix of exogenous variables such as the real GDP growth

(dlnkgdp), one year lag of the real GDP growth (laglnkgdp), fiscal rule (fiscalrule), share of urban population in total population (urbanpop), share of the population of the cohort 15 to 64 years old (pop1564), the share of the cohort 65 years old and over in total population (pop65), voice and accountability (voice), political stability and absence of violence/terrorism (polstability), government effectiveness (goveffectiveness), regulatory quality (reqquality), rule of law (ruleoflaw), and control of corruption (controlofcorruption). W represents a (nxn) spatial weighting matrix. $W\Delta \ln(y)$ denotes the endogenous spatial interaction effect among the dependent variable and WX denotes the exogenous interaction among the independent variables. ρ is the spatial auto-regressive coefficients. It measure the strength of the spatial dependence between countries. β is a (kx1) regression parameters. θ measures the interaction effects among the exogenous variables. ε represents the disturbance term with $\varepsilon \sim (0_{nx1} ; \sigma^2 I_n)$. It assumes that $E(\varepsilon) = 0$ and $var(\varepsilon) = \sigma_\varepsilon^2$ and $E(\varepsilon_{it}, \varepsilon_{js}) = 0$ whenever $i \neq j$ and $t \neq s$.

Solving equation (9) for $\Delta \ln(y)$, the model become:

$$\Delta \ln(y) - \rho W \Delta \ln(y) = X\beta + WX\theta + \varepsilon \quad (10)$$

$$\Delta \ln(y) (I_n - \rho W) = X\beta + WX\theta + \varepsilon \quad (11)$$

$$\Delta \ln(y) = (I_n - \rho W)^{-1} X\beta + (I_n - \rho W)^{-1} WX\theta + (I_n - \rho W)^{-1}\varepsilon \quad (12)$$

With $\varepsilon \sim (0_{nx1} ; \sigma^2 I_n)$

Equation(12) states that the dependent variable (Public investment) in each country is related to the average of the dependent variable (public investment) from neighbouring countries.

The variations of the dependent variable in the local country "i" are influenced by the average change from its neighboring countries, which in turn influence countries that are neighbours to country "i" , which will in turn influence neighbours of the neighbours, and so on (Lesage, 1999, 2008). The expected value of $\Delta \ln(y)$ will depend on the mean value of Xβ and WXθ plus a linear combination of values taken by neighboring observations scaled by the dependent parameters ρ and θ (LeSage, 2008). The following steps explain how the dependent variable $\Delta \ln(y)$ is affected by the average change of the dependent variable from the neighboring countries. W represents the first order neighbors countries to country"i", W^2 represents the second order neighbours countries and W^n represents the n^{th} order neighbours countries.

$$(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots\ldots\ldots + \rho^n W^n \qquad (13)$$

Substituting into equation(12) leads to the following equation:

$$\Delta \ln(y) = X\beta + \rho WX\beta + \rho^2 W^2 X\beta + \rho^3 W^3 X\beta + \ldots\ldots + WX\theta + \rho W^2 X\theta + \rho^2 W^3 X\theta + \rho^3 W^4 X\theta + \ldots + \varepsilon + \rho W\varepsilon + \rho^2 W^2 \varepsilon + \rho^3 W^3 \varepsilon + \ldots\ldots \qquad (14)$$

W represents the first order neighbors countries to country "i", W^2 represents the second order neighbors countries and W^n represents the n^{th} order neighbors countries. Since $-1 < \rho < 1$ we can conclude that $\lim_{n \to \infty} \rho^n W^n \approx 0$. That is nearest countries will have an important impact on country "i" than distant countries (Tobler, 1970: 236) .

Equations (9) through (14) assume that the dependent and independent variables do not change overtime. In reality, dependent variable level at any time "t" is influenced by its previous level of "$t - 1$". Taking into consideration time effects in our model, we have:

$$\Delta\ln(y_{t-(n-1)}) = \rho W \Delta\ln(y_{t-n}) + X\beta + WX\theta + \varepsilon_{t-(n-1)} \quad (15)$$

By itinerary substitution of equation (15) becomes:

$$\Delta\ln(y_t) = (I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots\ldots + \rho^n W^n)X\beta + \rho^n W^n \Delta\ln(Y_{t-n}) + (I_n + \rho W + \rho^2 W^2 + \ldots + \rho^n W^n)\, WX\theta + \mu \qquad (16)$$

Where

$$\mu = \varepsilon_t + \rho W \varepsilon_{t-1} + \rho_2 W_2 \varepsilon_{t-2} + \rho_3 W_3 \varepsilon_{t-3} + \ldots\ldots + \rho_{n-1} W_{n-1} \varepsilon_{t-(n-1)} \qquad (17)$$

$$E(\varepsilon_{t-i}) = 0 \text{ with } i = 0, 1, 2, \ldots\ldots.., n \text{ consequently } E(\mu) = 0$$

By definition $-1 < \rho < 1$ and $W \leq 1$ Thus $\lim_{n\to\infty} \rho^n W^n \approx 0$

Therefore in the long run toward the steady state, equation (16) can be reduced to equation (20).

$$\lim_{n\to\infty} \Delta\ln(y_t) = (I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots\ldots + \rho^n W^n) X\beta + \rho^n W^n \Delta\ln(Y_{t-n}) + (I_n + \rho W + \rho^2 W^2 + \ldots + \rho^n W^n) WX\theta + \mu \qquad (18)$$

$$\lim_{n\to\infty} \Delta\ln(y_t) = (I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots\ldots + \rho^n W^n) X\beta + (I_n + \rho W + \rho^2 W^2 + \ldots + \rho^n W^n) WX\theta \qquad (19)$$

Equation (20) represents the steady-state level of the Spatial Durbin Model.

$$\lim_{n\to\infty} \Delta\ln(y_t) = (I_n - \rho W)^{-1} X\beta + (I_n - \rho W)^{-1} WX\theta \qquad (20)$$

The model become a spatial autoregressive model (SAR) if we assume that there is no interaction effect between the exogenous variables. That is $\theta = 0$. Equation (21) represents the steady-state level of the Spatial Autoregressive Model (SAR).

$$\lim_{n\to\infty} \Delta\ln(y_t) = (I_n - \rho W)^{-1} X\beta \qquad (21)$$

This paper also uses a spatial error model (SEM) which provides unbiased coefficients at the local level. If we assume that there is no spatial dependence between public investment of African countries, that is $\rho = 0$, the model become at the steady state level:

$$\lim_{n \to \infty} \Delta \ln(y_t) = (I_n)^{-1} X\beta \tag{22}$$

Equations (20) — (22) show that variations of public investment in the local country "i" depend on the average change of the same variables of neighboring countries. In turn, variations of public investment in the neighboring countries are also influenced by changes of public investment in country "i" (LeSage, 2008). There is a simultaneous feedback effects between country "i" and its neighboring countries (LeSage, 2008).

Following Elhorst (2010), the general form of the SEM model employed in this study is:

$$\Delta \ln(y_{it}) = \sum_{i=1}^{n} X_{it} \beta_j + u_{it} \tag{23}$$

$$u_{it} = \lambda \sum_{j=1}^{n} W_{iz} v_{it} + \varepsilon_{it} \quad i = 1, \ldots \ldots, n \quad t = 1, \ldots \ldots, T \tag{24}$$

$\Delta \ln(y)$ is the change in the natural logarithm of the dependent variable and X is a (nxk) matrix of exogenous variables which were described above after equation 1. W represents a (nxn) spatial weighting matrix. β is a (kx1) regression parameters. λ is the spatial error coefficient. μ_i represents the countries unobserved heterogeneity term and ε_{it} is the disturbance term with $\varepsilon \sim (0_{nx1} ; \sigma^2 I_n)$.. It assumes that $E(\varepsilon) = 0$ and $var(\varepsilon) = \sigma_\varepsilon^2$ and $E(\varepsilon_{it}, \varepsilon_{zs}) = 0$ whenever $i \neq z$ and $t \neq s$.

Empirical Results

The regression results are shown in Tables 25 through 38. In the first set of results, the paper run regressions for all African countries in our data sample, and separately for countries in specific country groups such as the WAEMU, the ECOWAS, the ECCAS, the CEMAC, the IGAD, and the SADEC. In the regressions for specific country groups, this study interacts a dummy for the specific group with change in the log of real GDP (dlnkgdp) to understand how the results for cyclicality for that specific group differs from the rest of Africa. The main results in the first three columns are for the Spatial Durbin Model (SDM) explained in the previous section and depicted specifically in equation (1). This study also shows results for the Spatial Error Model (SEM) in column 4 and the regular fixed effects model without spatial effects in column 5 to compare our results. One important feature of the SDM is that the results can be broken down as "Direct," which indicates the direct impact on the country experiencing the economic shock, and "Indirect" which indicates the spillover effect from the economic shock on the countries in close proximity. The overall total effect is the sum of the direct and indirect effects, which is reported separately in the third column.

Table 25 shows that the direct effect from change in real GDP is positive, significant, and is very similar to estimates for SEM and regular fixed effects regressions. This points to procyclicality in public investment in African countries. At the same time, the indirect effect is negative but not statistically significant. The negative coefficient estimate points to negative spillover from an economic shock on the neighboring region. For example, when a country experiences economic growth that could draw the economic activity away from neighboring countries. Then it would be important to look at the overall impact, which takes into consideration both the direct and indirect effects at the same time. The total effect is still positive but smaller than the direct effect and is no longer statistically significant. This would mean that the procyclical result from regular fixed effects or the SEM regression is less pronounced when the spatial spillovers are considered.

Procyclicality of public investment is also evident in regressions where specific country groups are considered. Results in Tables 26 through 31 show that procyclicality is significantly stronger for WAEMU, ECCAS, CEMAC and SADEC groups. On the other hand, indirect effects point to negative spillovers that go against the procyclical results. While the total effects are not statistically significant, they turn negative for WAEMU, ECCAS, CEMAC and IGAD countries in Tables 26, 28, 29 and 30, respectively.

The second set of regressions included more variables to control for other demographic and institutional factors that may also explain changes in public investment. The regression results are shown in Tables 32 through 38. Table 32 shows that the direct effect is very similar to the one in Table 25, pointing again to procyclicality in public investment. Interestingly the indirect effect has turned positive but it is still not statistically significant. The total effect is showing even stronger procyclicality compared to the result in Table 26. Procyclicality is also much stronger in the SDM model than in the SEM and regular fixed effects regressions. The control variables are generally not significant except for voice and accountability and the share of urban population both of which seem to have negative spatial spillovers. Similar result are also seen for the WAEMU, CEMAC and IGAD countries in Tables 33, 35, 36 and 37, respectively but this time the total effect remained positive, but not significant, for all except IGAD countries. For ECOWAS countries, procyclicality is now significantly weaker, and the total effect now turned negative in Table 34 whereas it was positive in Table 27. Results are quite different for ECCAS and SADEC countries in Tables 35 and 38. For countries in these two groups, both direct and indirect effects are positive which produce a very strong positive total effect. In the case of SADEC countries the total effect is positive, very high and statistically significant. It is also important to note that there is a positive lagged indirect effect, which is also different from the results for other country groups. SADEC countries seem to be unique in terms of how public investment responds to economic shocks. Procyclicality of public investment becomes much more pronounced for those countries.

Summary of Results and Conclusions

This paper examines the cyclicality of public investment in African countries. A panel data on 37 countries for the 1996-2012 period is employed. In addition to an overall analysis of a sample of African countries, the paper also examines public investment for specific country sub-groups such as the West African Economic and Monetary Union (WAEMU), the Economic Community of West African States (ECOWAS), the Economic Community of Central African States (EECAS), the Central African Economic and Monetary Community (CEMAC), the Intergovernmental Authority on Development in Eastern Africa (IGAD), and the South African Development Community (SADEC). The paper also estimates the spatial spillovers from economic shocks by employing a spatial queen contiguity matrix and a spatial distance based weighting matrix. The results confirm the presence of pro-cyclicality in public investment in Africa. However, the degree of this pro-cyclicality varies significantly across the regional economic communities. The degree of pro-cyclicality is less significant when spatial spillovers are considered for WAEMU, ECOWAS, CEMAC, and IGAD countries and stronger for ECCAS, and particularly SADEC countries. It is possible that some of these country groups are more closely aligned in terms of their economies and fiscal policies, which help with risk sharing. For example, WAEMU and ECOWAS countries are closer to each other geographically and more homogenous than SADEC countries. This paper examines the response of public investment to changes in GDP and control for a number of other demographic and institutional factors that may explain the changes in public investment. Our results are consistent with results in other studies.[6] At the same time, our study is unique as it compares different country groups in Africa and considers spatial spillovers from economic shocks. The results show that spatial spillovers indeed make a difference, and should be taken into consideration in future studies.

It is important to counteract economic shocks to maintain public investment in Africa. Public investment is a prerequisite for accelerating economic growth in the region. However, our results suggest that public investment in Africa is significantly procyclical. We also find significant variation in procyclicality in different regions in Africa. As others have noted, there are possible policy responses such as solidarity funds to share the risk of shocks among group of countries. It is also important that official development assistance becomes more counter-cyclical.

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Appendix

Tables

Table 1: Descriptive Statistics

Variables	*Mean*	*Standard Deviation*	*Number of Observations*	*Min*	*Max*
MRE Employment	1,172.64	2,232.90	14,319	11	42,721
MRE Real Earnings	65,727.31	183,868.2	14,319	138.24	5,561,166
Manufacturing Employment	6,160.35	23,330.22	14,319	0	950,200
Manufacturing Earnings	310,087.9	1,285,238	14,319	0	47,600,000
Construction Employment	2,456.36	7,848.24	14,319	0	244,874
Construction Earnings	110,430.9	4,302,591	14,319	0	14,000,000
Service Employment	13,567.55	59,888.81	14,319	0	2,600,000
Service Earnings	484,556.6	2,801,477	14,319	0	122,000,000
Retail-Trade Employment	6,295.90	21,279.63	14,319	0	775,289
Retail-Trade Earnings	146,972.6	569,460.3	14,319	0	23,600,000
County Total Employment	51,132.3	80,064.37	14,319	1,067	643,000
County Total Earnings	1,326,205	24,68256	14,319	7,823.67	28,400,000
County per capita Income	23,180.06	7,706.38	14,319	5,543.225	77,211.49
County total population	100,817.2	140,578.6	14,319	1,610	948,000
County male population 10-19 years old	8,118.31	28,389.12	14,319	0	1,500,000
County female population 10-29 years old	3,241.70	20,228.77	14,319	0	769,426
County male population 20-29 years old	7,957.49	30,293.38	14,319	0	1,500,000
County female population 20-29 years old	6,293.06	30,293.82	14,319	0	812,459
County male population 30-39 years old	7,560.08	29,252.06	14,319	0	1,600,000
County female population 30-39 years old	5,955.09	21,094.87	14,319	0	811,600
County male population 40-49 years old	7,041.63	26,678.88	14,319	0	1,500,000
County female population 40-49 years old	5,352.20	18,043.64	14,319	0	720,552

Author's calculations, REIS data.

Table 2: Growth in MRE Employment, Earnings, and Earnings per Worker in Treatment, comparison Counties and at the National level, 1970–2012

Average annual growth	Treatment	Comparison	National
Total Employment			
Bust, 1970-1980	**0.072**	**0.027**	**0.062**
	(0.206)	(0.310)	(0.222)
N	2789	874	3663
Boom, 1981-2000	**-0.027**	**-0.006**	**-0.023**
	(0.161)	(0.169)	(0.163)
N	5218	1442	6660
Bust, 2001-2012	**0.052**	**0.010**	**0.043**
	(0.161)	(0.195)	(0.169)
N	3192	804	3996
Total, 1970-2012	**0.019**	**0.007**	**0.017**
	(0.179)	(0.206)	(0.185)
N	11199	3120	14,319
Earnings			
Bust, 1970-1980	**0.109**	**0.102**	**0.107**
	(0.261)	(0.310)	(0.274)
N	2789	874	3663
Boom, 1981-2000	**-0.023**	**-0.037**	**-0.026**
	(0.271)	(0.374)	(0.296)
N	5218	1442	6660
Bust, 2001-2012	**0.085**	**0.021**	**0.072**
	(0.306)	(0.313)	(0.308)
N	3192	804	3996
Total, 1970-2012	**0.040**	**0.016**	**0.035**
	(0.285)	(0.347)	(0.300)
N	11199	3120	14,319
Earnings per worker			
Bust, 1970-1980	**0.036**	**0.075**	**0.045**
	(0.168)	(0.307)	(0.210)
N	2789	874	3663
Boom, 1981-2000	**0.004**	**-0.031**	**-0.003**
	(0.220)	(0.339)	(0.251)
N	5218	1442	6660
Bust, 2001-2012	**0.033**	**0.011**	**0.029**
	(0.242)	(0.296)	(0.254)
N	3192	804	3996
Total, 1970-2012	**0.020**	**0.009**	**0.018**
	(0.216)	(0.322)	(0.243)
N	11199	3120	14,319

Author's calculations, REIS data. Table reports average annual differences in the logarithm of MRE earnings, MRE employment and earnings per MRE worker.

Table 3: Growth in Employment, Earnings and Earnings per worker in Treatment and Comparison Counties, 1970–2012

	Employment		**Earnings**		**Earnings per worker**	
	F.E	SDM	F.E	SDM	F.E	SDM
Spatial ρ		0.343***		0.415***		0.390***
		(0.019)		(0.019)		(0.019)
Direct Eff						
t	0.002	0.002	0.022***	0.018***	0.016***	0.014***
	(0.004)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)
Earnrate	0.015***	0.005				
	(0.004)	(0.004)				
dlnpop	0.935***	1.037***	1.103***	1.076***	0.204***	0.052
	(0.076)	(0.068)	(0.096)	(0.084)	(0.076)	(0.071)
dlncapinc	0.529***	0.700***	0.875***	1.334***	0.341***	0.638***
	(0.038)	(0.030)	(0.049)	(0.045)	(0.035)	(0.038)
Indirect Eff						
t		-0.005		-0.024***		-0.016***
		(0.004)		(0.007)		(0.006)
Earnrate		-0.012*				
		(0.007)				
dlnpop		0.306***		-1.100		-0.420***
		(0.093)		(0.171)		(0.142)
dlncapinc		0.273***		0.737***		0.470***
		(0.033)		(0.060)		(0.051)
Total Eff						
t		-0.002		-0.005		-0.001
		(0.006)		(0.010)		(0.008)
Earnrate		-0.007				
		(0.009)				
dlnpop		1.343***		0.976***		-0.368**
		(0.117)		(0.195)		(0.162)
dlncapinc		0.974***		2.072***		1.108***
		(0.042)		(0.066)		(0.056)
N	17114	14319	17114	14319	17114	14319

Author's calculations, REIS data. Table reports the difference in average annual changes in the logarithm of MRE total employment, earnings and earnings per worker between treatment and comparison counties. Regressions include stateyear dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 4: Growth in Employment, Treatment and Comparison Counties, 1970–2012

	Boom 1970-1980		Bust 1981-2000		Boom 2001-2012	
	F.E	SDM	F.E	SDM	F.E	SDM
Spatial ***ρ***		0.124***		0.251***		0.488***
		(0.043)		(0.030)		(0.036)
Direct Eff						
t	0.028***	0.030***	-0.020***	-0.020***	0.017***	0.015**
	(0.008)	(0.009)	(0.004)	(0.005)	(0.005)	(0.006) -
Earnrate	0.012**	0.006	0.009	0.017**	0.036***	0.001
	(0.005)	(0.006)	(0.0.007)	(0.007)	(0.012)	(0.015)
dlnpop	0.860***	1.000***	0.941***	1.019***	0.846***	1.064***
	(0.143)	(0.143)	(0.096)	(0.093)	(0.114)	(0.139)
dlncapinc	0.343***	0.386***	0.629***	0.858***	0.581***	0.879***
	(0.068)	(0.064)	(0.050)	(0.044)	(0.067)	(0.057)
Indirect Eff						
t		-0.004		-0.015**		-0.003
		(0.013) -		(0.006)		(0.010) -
Earnrate		0.011		0.017*		0.033
		(0.010)		(0.010)		(0.028) -
dlnpop		0.547***		0.276***		0.029
		(0.176)		(0.106)		(0.186)
dlncapinc		0.027		0.424***		0.271***
		(0.066)		(0.046)		(0.069)
Total Eff						
t		0.026		-0.035***		0.012
		(0.017) -		(0.009)		(0.014) -
Earnrate		0.004		0.034**		0.035
		(0.014)		(0.013)		(0.037)
dlnpop		1.548***		1.295***		1.034***
		(0.229)		(0.131)		(0.261)
dlncapinc		0.413***		1.282***		1.151***
		(0.091)		(0.059)		(0.083)
N	4378	3663	7960	6660	4776	3996

Author's calculations, REIS data. Table reports the difference in average annual changes in the logarithm of MRE total employment between treatment and comparison counties. Regressions include state-year dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 5: Growth in Earnings, Treatment and Comparison Counties, 1970–2012

	Boom 1970-1980		**Bust 1981-2000**		**Boom 2001-2012**	
	F.E	SDM	F.E	SDM	F.E	SDM
Spatial ρ		0.395***		0.21***		0.359***
		(0.040)		(0.031)		(0.037)
Direct Eff						
t	0.005	0.000	0.015**	0.022***	0.046***	0.025***
	(0.008)	(0.010)	(0.007)	(0.008)	(0.008)	(0.010)
dlnpop	0.936***	0.927***	0.212***	1.153***	1.370***	1.800***
	(0.154)	(0.137)	(0.164)	(0.137)	(0.154)	(0.177)
dlncapinc	0.515***	0.562***	0.873***	1.367***	1.484***	2.426***
	(0.075)	(0.077)	(0.078)	(0.082)	(0.098)	(0.088)
Indirect Eff						
t		-0.036**		-0.014		-0.058***
		(0.017)		(0.010)		(0.013)
dlnpop		0.513*		-0.215		0.446
		(0.292)		(0.222)		(0.321)
dlncapinc		0.148		0.692***		1.261***
		(0.109)		(0.097)		(0.113)
Total Eff						
t		-0.036*		0.008		-0.032*
		(0.021)		(0.014)		(0.017)
dlnpop		1.441***		0.937***		2.247***
		(0.338)		(0.249)		(0.385)
dlncapinc		0.711***		2.060***		3.687***
		(0.136)		(0.105)		(0.119)
N	4.378	3663	7960	6660	4776	3996

Author's calculations, REIS data. Table reports the difference in average annual changes in the logarithm of MRE total earnings between treatment and comparison counties. Regressions include state-year dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 6: Growth in Earnings per worker, Treatment and Comparison Counties, 1970– 2012

	Boom 1970-1980		Bust 1981-2000		Boom 2001-2012	
	F.E	**SDM**	**F.E**	**SDM**	**F.E**	**SDM**
Spatial ***ρ***		0.367***		0.198***		0.455***
		(0.040)		(0.031)		(0.036)
Direct Eff						
t	-0.029***	-0.033***	0.034***	0.039***	0.024***	0.009
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
dlnpop	0.073	-0.062	0.287**	0.157	0.510***	0.743***
	(0.109)	(0.107)	(0.145)	(0.120)	(0.125)	(0.154)
dlncapinc	0.165***	0.177***	0.246***	0.507***	0.866***	1.541***
	(0.046)	(0.059)	(0.062)	(0.072)	(0.081)	(0.076)
Indirect Eff						
t		-0.023*		-0.002		-0.045***
		(0.013)		(0.008)		(0.012)
dlnpop		-0.120		-0.509***		0.477
		(0.224)		(0.193)		(0.295)
dlncapinc		0.112		0.251***		1.036***
		(0.084)		(0.087)		(0.102)
Total Eff						
t		-0.057***		0.036***		-0.035**
		(0.016)		(0.012)		(0.016)
dlnpop		-0.183		-0.351		1.221***
		(0.261)		(0.218)		(0.356)
dlncapinc		0.289***		0.758***		2.577***
		(0.104)		(0.095)		(0.110)
N	4378	3663	7960	6660	4776	3996

Author’s calculations, REIS data. Table reports the difference in average annual changes in the logarithm of MRE real earnings per worker between treatment and comparison counties. Regressions include state-year dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 7: Testing for Spillover Effects into the Non-MRE Sector and by sector, 1970– 2012

Avg Annual Growth of	Boom 1970-1980	Bust 1981-2000	Boom 2001-2012
Employment			
Non-MRE sector	-0.002*	0.002***	0.001
	(0.001)	(0.000)	(0.001)
Manufacturing	0.008	0.006**	-0.002
	(0.005)	(0.003)	(0.004)
Construction	0.004	0.005	0.005
	(0.006)	(0.003)	(0.003)
Services	-0.010***	-0.003**	-0.008
	(0.002)	(0.001)	(0.007)
Retail-Trade	-0.008***	0.001	0.000
	(0.002)	(0.001)	(0.003)
Earnings			
Non-MRE sector	0.012***	0.002	0.009***
	(0.003)	(0.001)	(0.002)
Manufacturing	0.013**	0.003	0.001
	(0.006)	(0.003)	(0.005)
Construction	0.010	0.001	0.013**
	(0.008)	(0.005)	(0.005)
Services	-0.001	-0.004**	-0.012
	(0.002)	(0.001)	(0.009)
Retail-Trade	-0.001	-0.001	0.004
	(0.002)	(0.001)	(0.003)
Earnings per Worker			
Non-MRE sector	0.016***	0.000	0.008***
	(0.002)	(0.001)	(0.002)
Manufacturing	0.004	-0.003*	0.003
	(0.003)	(0.002)	(0.003)
Construction	0.006*	-0.003	0.007**
	(0.003)	(0.002)	(0.003)
Services	-0.006	-0.009**	-0.017*
	(0.007)	(0.004)	(0.009)
Retail-Trade	0.007***	-0.002**	0.003
	(0.001)	(0.001)	(0.002)
N	2838	5160	3096

Table reports the difference in average annual changes in the logarithm of total earnings, total earning, and earnings per worker in non-MRE sectors between treatment and comparison counties. Regressions include state-year dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 8: Instrumental Variables Estimates of Spillover Effects

Annual growth	Non-MRE sector	Manufacturing	Construction	Services	Retail-trade
Boom,1970-1980	**-0.963*** **	**0.111*** **	**0.142*** **	**-0.510*** **	**-0.334*** **
	(0.268)	(0.042)	(0.076)	(0.086)	(0.068)
N	4796	4707	4785	4763	4796
Bust, 1981-2000	**2.277*** **	**0.016**	**0.243*** **	**0.719*** **	**0.434*** **
	(0.288)	(0.026)	(0.050)	(0.103)	(0.064)
N	8720	8609	8599	8610	8720
Boom,2001-2012	**0.939*** **	**0.122** **	**0.521*** **	**-1.363*** **	**0.096**
	(0.332)	(0.050)	(0.113)	(0.485)	(0.137)
N	5232	5025	5030	5226	5172

Author's calculations, REIS data. Dependent variable is annual change in logarithm of local or traded employment. Independent variable is annual change in logarithm of MRE employment multiplied by ratio of MRE to local or traded employment in previous year. Instrument is a set of interactions of treatment dummy and dummy variables for boom, and bust period. Regressions include a set of county-year dummy variables. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 9: Population Growth by Gender, 1970–2012

Avg Anuual Growth of	Male **Treatment Dummy Variable**	Female **Treatment Dummy Variable**	**N**
Cohort ages 10-19			
Boom,1970-1980	**0.005****	**0.003**	**3690**
	(0.002)	(0.002)	
Bust, 1981-2000	**0.018*****	**0.002**	**7380**
	(0.007)	(0.002)	
Boom,2001-2012	**0.015**	**-0.002**	**4428**
	(0.010)	(0.003)	
Total, 1970-2012	**0.000**	**-0.001**	**15498**
	(0.003)	(0.001)	
Cohort ages 20-29			
Boom,1970-1980	**0.010*****	**0.006****	**3690**
	(0.003)	(0.002)	
Bust, 1981-2000	**0.024*****	**0.002**	**7380**
	(0.008)	(0.005)	
Boom,2001-2012	**0.018***	**0.002**	**4428**
	(0.010)	(0.007)	
Total, 1970-2012	**0.001**	**-0.002**	**15498**
	(0.003)	(0.002)	
Cohort ages 30-39			
Boom,1970-1980	**-0.001**	**-0.002**	**3690**
	(0.002)	(0.002)	
Bust, 1981-2000	**0.014****	**-0.012*****	**7380**
	(0.006)	(0.004)	
Boom,2001-2012	**0.017***	**-0.000**	**4428**
	(0.010)	(0.006)	
Total, 1970-2012	**-0.004**	**-0.011*****	**15498**
	(0.003)	(0.002)	
Cohort ages 40-49			
Boom,1970-1980	**0.001**	**0.001**	**3690**
	(0.002)	(0.002)	
Bust, 1981-2000	**0.016****	**-0.004**	**7380**
	(0.006)	(0.002)	
Boom,2001-2012	**0.020****	**0.000**	**4428**
	(0.010)	(0.004)	
Total, 1970-2012	**0.000**	**-0.004****	**15498**
	(0.003)	(0.001)	

Author’s calculations, REIS data. *, ** and *** respectively 1%, 5% and 10% level of significance.

Table 10: Growth in Mining Employment; National, Treatment and Comparison Provinces, 1990–2012

Average annual growth	Treatment	Comparison	National
Total Employment			
Bust, 1990-2000	0.003	-0.011	-0.001
	(0.008)	(0.006)	(0.029)
N	499	689	131
Boom, 2001-2007	0.010	0.0002	0.005
	(0.004)	(0.127)	(0.027)
N	260	496	84
Bust, 2008-2009	0.001	-0.005	-0.004
	(0.005)	(0.120)	(0.025)
N	102	138	24
Boom, 2010-2012	0.006	0.003	0.004
	(0.042)	(0.121)	(0.019)
N	110	214	36
Total Period, 1990-2012	0.005	-0.004	0.001
	(0.004)	(0.003)	(0.001)
N	947	1537	275

Author calculations. Canada Statistic and Kitco.com data.

Table 11: Average annual growth of Gold prices, WTI, and Alaska crude oil prices 1990–2012

Average annual growth	Gold	Alaska crude oil	WTI crude oil
Total Employment			
Bust, 1990-2000	-0.004	0.001	0.0001
	(0.002)	(0.010)	(0.007)
N	131	131	131
Boom, 2001-2007	0.010	0.015	0.011
	(0.004)	(0.008)	(0.007)
N	84	84	84
Bust, 2008-2009	0.013	-0.009	-0.009
	(0.010)	(0.030)	(0.029)
N	24	24	24
Boom, 2010-2012	0.009	0.007	0.003
	(0.006)	(0.008)	(0.010)
N	36	36	36
Total Period, 1990-2012	0.003	0.005	0.003
	(0.002)	(0.006)	(0.005)
N	275	275	275

Author calculations. Canada Statistic and Kitco.com data.

Table 12: Growth in Employment between Treatment and Comparison Provinces, 1990–2012

Growth rate of Total Employment	1stBust 1990-2000	1st Boom 2001-2007	2nd Bust 2008-2009	2nd Boom 2010-2012	All period 1990-2012
Treatment	0.060***	0.125***	0.023	0.092***	0.059***
	(0.012)	(0.042)	(0.051)	(0.036)	(0.010)
New Foundland and La	0.0006	0.002	0.008	0.002	0.001
	(0.008)	(0.013)	(0.017)	(0.011)	(0.005)
Nova Scotia	0.069**	0.117***	0.021	0.095*	0.060***
	(0.034)	(0.045)	(0.062)	(0.053)	(0.021)
New Brunswick	0.065**	0.111***	0.016	0.087***	0.056***
	(0.033)	(0.039)	(0.020)	(0.028)	(0.020)
Quebec	0.10***	0.120***	0.022	0.087**	0.074***
	(0.037)	(0.043)	(0.054)	(0.040)	(0.022)
Ontario	0.095***	0.118***	0.024	0.085**	0.071***
	(0.035)	(0.043)	(0.053)	(0.038)	(0.021)
Manitoba	0.067**	0.116***	0.024	0.091**	0.058***
	(0.034)	(0.043)	(0.053)	(0.038)	(0.020)
Saskatchewan	0.037	-0.001	0.008	-0.002	0.016
	(0.031)	(0.014)	(0.011)	(0.008)	(0.015)
Alberta	0.038	0.0002	-0.002	0.001	0.017
	(0.031)	(0.004)	(0.009)	(0.005)	(0.015)
British Columbia	0.07*	0.125***	0.028	0.095**	0.063***
	(0.038)	(0.044)	(0.054)	(0.040)	(0.012)
R^2	0.0503	0.0578	0.0869	0.0388	0.0390
N	1188	756	216	324	2484

Author calculations. Canada Statistic data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 13: Canada's MRE elasticity to minerals prices changes, 1990–2012

	Price Growth rate Model			Price Log Model		
Average annual Employment growth	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	0.042	-0.001	-0.014	0.05	0.047**	-0.070**
	(0.083)	(0.023)	(0.034)	(0.067)	(0.019)	(0.029)
N	131	131	131	132	132	132
Boom, 2001-2007	0.008	-0.023	-0.015	-0.115	-0.057**	-0.061**
	(0.068)	(0.041)	(0.038)	(0.090)	(0.027)	(0.031)
N	84	84	84	84	84	84
Bust, 2008-2009	0.109	0.031	0.031	-0.21***	-0.058***	-0.063***
	(0.119)	(0.061)	(0.060)	(0.060)	(0.014)	(0.015)
N	24	24	24	24	24	24
Boom, 2010-2012	-0.202**	0.072	0.080	0.066	0.156**	0.186**
	(0.086)	(0.084)	(0.059)	(0.100)	(0.073)	(0.075)
N	36	36	36	36	36	36
Total, 1990-2012	-0.010	0.002	0.001	0.023	-0.045***	-0.051***
	(0.041)	(0.017)	(0.019)	(0.038)	(0.011)	(0.014)
N	275	275	275	276	276	276

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 14: Newfoundland and Labrador's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	**Price Growth rate Model**			**Price Log Model**		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	3.69***	1.62***	2.30**	0.799***	0.004	-0.054
	(0.373)	(0.595)	(0.984)	(0.208)	(0.044)	(0.075)
N	132	132	132	132	132	132
Boom, 2001-2007	1.021***	0.099	0.180	1.20***	-0.154	-0.147
	(0.322)	(0.235)	(0.209)	(0.317)	(0.096)	(0.112)
N	84	84	84	84	84	84
Bust, 2008-2009	0.888*	0.275	0.230	0.085	0.017	0.020
	(0.456)	(0.215)	(0.242)	(0.250)	(0.055)	(0.063)
N	24	24	24	24	24	24
Boom, 2010-2012	-0.171	0.053	-0.019	0.504***	0.469***	0.279**
	(0.324)	(0.223)	(0.196)	(0.158)	(0.110)	(0.140)
N	36	36	36	36	36	36
Total, 1990-2012	0.466***	0.000	0.048	1.06***	0.259**	0.348***
	(0.172)	(0.071)	(0.073)	(0.364)	(0.133)	(0.147)
N	163	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 15: Nova Scotia's MRE elasticity to minerals prices changes, 1990–2012

	Price Growth rate Model			Price Log Model		
Average annual Employment growth	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	0.696***	0.356***	0.573***	-0.799***	0.219***	0.337***
	(0.169)	(0.134)	(0.191)	(0.332)	(0.066)	(0.100)
N	132	132	132	132	132	132
Boom, 2001-2007	0.165	-0.004	0.066	1.03	0.484***	0.622***
	(0.568)	(0.286)	(0.244)	(0.671)	(0.144)	(0.170)
N	84	84	84	84	84	84
Bust, 2008-2009	0.358	-0.194	-0.406	-0.115	-0.048	-0.063
	(0.696)	(0.427)	(0.419)	(0.290)	(0.066)	(0.072)
N	24	24	24	24	24	24
Boom, 2010-2012	-1.557	1.531*	1.23*	-2.161	0.142	0.692
	(1.578)	(0.859)	(0.709)	(0.808)	(0.553)	(0.671)
N	36	36	36	36	36	36
Total, 1990-2012	-0.432	0.146	0.267*	-0.732	-0.386**	-0.274
	(0.314)	(0.121)	(0.148)	(0.472)	(0.207)	(0.233)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 16: New Brunswick's MRE elasticity to minerals prices changes, 1990–2012

	Price Growth rate Model			Price Log Model		
Average annual Employment growth	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	-0.062	0.015	-0.061	0.338	0.001	0.010
	(0.079)	(0.044)	(0.074)	(0.353)	(0.054)	(0.085)
N	132	132	132	132	132	132
Boom, 2001-2007	-0.452	0.055	0.033	0.080	0.408***	0.470***
	(0.527)	(0.264)	(0.278)	(0.553)	(0.126)	(0.158)
N	84	84	84	84	84	84
Bust, 2008-2009	0.915	0.029	0.236	2.64***	0.686***	0.755***
	(1.021)	(0.389)	(0.391)	(0.388)	(0.188)	(0.212)
N	24	24	24	24	24	24
Boom, 2010-2012	-2.35***	-1.04	-0.679	-0.995	-0.849	-0.369
	(0.781)	(0.649)	(0.557)	(0.613)	(0.553)	(0.572)
N	36	36	36	36	36	36
Total, 1990-2012	-0.173	0.133	0.094	0.093	0.316**	0.421***
	(0.239)	(0.108)	(0.124)	(0.353)	(0.156)	(0.168)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 17: Quebec's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	Price Growth rate Model			Price Log Model		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	-1.61***	-0.692***	-1.03**	0.077	-0.146**	-0.24**
	(0.173)	(0.277)	(0.434)	(0.282)	(0.068)	(0.111)
N	132	132	132	132	132	132
Boom, 2001-2007	-0.064	-0.302*	-0.239	0.240	0.210**	0.248**
	(0.328)	(0.176)	(0.180)	(0.327)	(0.109)	(0.128)
N	84	84	84	84	84	84
Bust, 2008-2009	-0.116	0.039	-0.102	0.193	0.051	0.047
	(0.298)	(0.224)	(0.182)	(0.162)	(0.041)	(0.042)
N	24	24	24	24	24	24
Boom, 2010-2012	0.079	0.004	0.096	1.28***	0.813**	0.361
	(0.421)	(0.307)	(0.256)	(0.413)	(0.405)	(0.441)
N	36	36	36	36	36	36
Total, 1990-2012	-0.049	-0.062	-0.109	-0.278	-0.356**	-0.313*
	(0.185)	(0.078)	(0.088)	(0.436)	(0.167)	(0.175)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 18: Ontario's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	**Price Growth rate Model**			**Price Log Model**		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	-1.02***	-0.436**	-0.619**	0.059	0.002	0.007
	(0.138)	(0.188)	(0.305)	(0.108)	(0.032)	(0.046)
N	132	132	132	132	132	132
Boom, 2001-2007	0.228	0.004	0.063	-0.339	-0.072	-0.104
	(0.227)	(0.098)	(0.105)	(0.277)	(0.073)	(0.086)
N	84	84	84	84	84	84
Bust, 2008-2009	0.067	0.028	0.114	0.36***	0.096**	0.110**
	(0.553)	(0.203)	(0.215)	(0.092)	(0.034)	(0.040)
N	24	24	24	24	24	24
Boom, 2010-2012	0.055	0.240	0.136	-0.073	0.069	0.315
	(0.347)	(0.259)	(0.233)	(0.244)	(0.235)	(0.207)
N	36	36	36	36	36	36
Total, 1990-2012	0.152	-0.011	0.015	-0.484*	-0.276**	-0.291**
	(0.118)	(0.042)	(0.048)	(0.256)	(0.121)	(0.130)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 19: Manitoba's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	Price Growth rate Model			Price Log Model		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	1.11***	0.504***	0.716***	0.237	-0.135***	-0.196***
	(0.134)	(0.180)	(0.297)	(0.216)	(0.039)	(0.058)
N	132	132	132	132	132	132
Boom, 2001-2007	-0.183	0.025	-0.032	-0.463	-0.043	-0.016
	(0.244)	(0.126)	(0.121)	(0.316)	(0.086)	(0.101)
N	84	84	84	84	84	84
Bust, 2008-2009	0.442	-0.152	-0.123	-0.176	-0.083	-0.093
	(0.564)	(0.212)	(0.228)	(0.206)	(0.052)	(0.057)
N	24	24	24	24	24	24
Boom, 2010-2012	-0.025	-0.422	-0.186	0.231	-0.046	0.160
	(0.480)	(0.307)	(0.298)	(0.258)	(0.268)	(0.195)
N	36	36	36	36	36	36
Total, 1990-2012	0.047	0.045	0.032	-0.81***	-0.269*	-0.242
	(0.142)	(0.057)	(0.062)	(0.329)	(0.154)	(0.185)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 20: Saskatchewan's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	**Price Growth rate Model**			**Price Log Model**		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	-0.705***	-0.306***	-0.437**	-0.151	-0.037	-0.032
	(0.069)	(0.114)	(0.186)	(0.166)	(0.029)	(0.047)
N	132	132	132	132	132	132
Boom, 2001-2007	0.219*	0.112*	0.062	0.064	-0.009	-0.025
	(0.130)	(0.064)	(0.057)	(0.147)	(0.056)	(0.063)
N	84	84	84	84	84	84
Bust, 2008-2009	-0.007	0.053	0.068	-0.243*	-0.056	-0.059
	(0.215)	(0.091)	(0.078)	(0.133)	(0.037)	(0.039)
N	24	24	24	24	24	24
Boom, 2010-2012	0.001	0.025	-0.010	0.116	0.110	0.036
	(0.153)	(0.082)	(0.084)	(0.081)	(0.073)	(0.077)
N	36	36	36	36	36	36
Total, 1990-2012	0.073	0.000	-0.013	0.889***	0.150*	0.178**
	(0.089)	(0.034)	(0.038)	(0.301)	(0.089)	(0.091)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 21: Alberta's MRE elasticity to minerals prices changes, 1990–2012

Average annual Employment growth	**Price Growth rate Model**			**Price Log Model**		
	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	-0.916***	-0.402***	-0.572**	-0.043	-0.022	-0.036
	(0.109)	(0.155)	(0.255)	(0.063)	(0.017)	(0.026)
N	132	132	132	132	132	132
Boom, 2001-2007	0.092	-0.000	-0.002	-0.123	-0.073	-0.075**
	(0.088)	(0.058)	(0.049)	(0.114)	(0.034)	(0.040)
N	84	84	84	84	84	84
Bust, 2008-2009	0.004	0.015	0.031	-0.276***	-0.070**	-0.076**
	(0.163)	(0.085)	(0.082)	(0.077)	(0.026)	(0.029)
N	24	24	24	24	24	24
Boom, 2010-2012	-0.205	0.103	0.106	-0.017	0.089	0.101
	(0.125)	(0.081)	(0.066)	(0.128)	(0.110)	(0.119)
N	36	36	36	36	36	36
Total, 1990-2012	-0.048	-0.005	-0.007	0.802***	0.167**	0.201***
	(0.055)	(0.023)	(0.024)	(0.300)	(0.083)	(0.083)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 22: British Columbia's MRE elasticity to minerals prices changes, 1990–2012

	Price Growth rate Model			Price Log Model		
Average annual Employment growth	Gold	Alaska crude oil	WTI crude oil	Gold	Alaska crude oil	WTI crude oil
Bust, 1990-2000	2.128***	0.864**	1.21**	0.558*	-0.254***	-0.375***
	(0.189)	(0.373)	(0.607)	(0.330)	(0.052)	(0.086)
N	132	132	132	132	132	132
Boom, 2001-2007	0.130	-0.024	-0.062	-0.858**	-0.424***	-0.471***
	(0.325)	(0.207)	(0.201)	(0.414)	(0.127)	(0.147)
N	84	84	84	84	84	84
Bust, 2008-2009	0.553	0.144	0.050	-1.341***	-0.378***	-0.414***
	(0.517)	(0.229)	(0.215)	(0.327)	(0.056)	(0.058)
N	24	24	24	24	24	24
Boom, 2010-2012	-0.548	-0.179	-0.043	0.02	0.331	0.606**
	(0.649)	(0.404)	(0.318)	(0.355)	(0.245)	(0.272)
N	36	36	36	36	36	36
Total, 1990-2012	0.004	-0.088	-0.137*	-0.446	-0.154	-0.240
	(0.195)	(0.079)	(0.084)	(0.351)	(0.199)	(0.189)
N	263	263	263	264	264	264

Author calculations. Canada Statistic and Kitco.com data. The regression include province, year and monthly dummy variables. *, **, *** respectively represent 1%, 5%, and 10% level of significance.

Table 23. GDP and Public Investment Growth Rates in African Countries (1996- 2012)

Country Name	GDP growth		Public Investment Growth	
	Average	St. Deviation	Average	St. Deviation
Benin (WAEMU, ECOWAS)	0.040	0.010	0.027	0.276
Burkina Faso (WAEMU, ECOWAS)	0.059	0.020	0.077	0.159
Burundi (ECCAS)	0.023	0.033	0.060	0.359
Cameroon (CEMAC, ECCAS)	0.038	0.009	0.109	0.181
Central Afr Rep. (CEMAC, ECCAS)	0.017	0.039	0.001	0.581
Chad (CEMAC, ECCAS)	0.059	0.076	0.131	0.171
Dem Rep. of Congo (SADEC, ECCAS)	0.024	0.049	0.086	1.145
Republic of Congo (CEMAC, ECCAS)	0.037	0.032	0.137	0.543
Cote d'Ivoire (WAEMU, ECOWAS)	0.017	0.038	0.015	0.314
Djibouti (IGAD)	0.026	0.025	0.109	0.346
Egypt	0.047	0.016	-0.003	0.141
Eritrea (IGAD)	0.017	0.061	-0.022	0.324
Ethiopia (IGAD)	0.068	0.048	0.167	0.271
Gambia (ECOWAS)	0.036	0.037	0.076	0.422
Ghana (ECOWAS)	0.058	0.022	0.072	0.322
Guinea (ECOWAS)	0.032	0.014	0.048	0.286
Guinea-Bissau (WAEMU, ECOWAS)	0.011	0.088	-0.057	0.729
Kenya (IGAD)	0.037	0.019	0.041	0.074
Lesotho (SADEC)	0.039	0.015	-0.006	0.330
Madagascar (SADEC)	0.028	0.054	-0.019	0.325
Malawi (SADEC)	0.042	0.036	0.035	0.335
Mali (WAEMU, ECOWAS)	0.044	0.032	-0.010	0.299
Mauritania	0.036	0.033	0.124	0.208
Morocco	0.043	0.031	0.046	0.114
Mozambique (SADEC)	0.080	0.027	0.057	0.196
Niger (WAEMU, ECOWAS)	0.047	0.045	0.098	0.292
Nigeria (ECOWAS)	0.067	0.040	0.069	0.340
Rwanda	0.081	0.029	0.105	0.170
Senegal (WAEMU, ECOWAS)	0.038	0.016	0.086	0.161
Sierra Leone (ECOWAS)	0.032	0.126	0.063	0.476
Sudan (IGAD)	0.097	0.123	0.165	0.405
Swaziland (SADEC)	0.020	0.013	0.128	0.224
Sao Tome & Principe (ECCAS)	0.038	0.029	0.139	0.193
Tanzania (SADEC)	0.058	0.013	0.139	0.193
Togo (WAEMU, ECOWAS)	0.024	0.026	0.096	0.393
Uganda (IGAD)	0.065	0.017	0.082	0.097
Zambia (SADEC)	0.048	0.022	0.029	0.224
Average of Africa	0.040	0.048	0.059	0.365
Average of WAEMU	0.035	0.043	0.042	0.363

Average of ECOWAS	0.039	0.040	0.051	0.344
Average of ECCAS	0.034	0.038	0.095	0.453
Average of CEMAC	0.032	0.026	0.099	0.294
Average of IGAD	0.043	0.034	0.075	0.222
Average of SADEC	0.042	0.035	0.084	0.445

Table 24. Descriptive Statistics

Variables	**Units**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**	**Number of Obs.**
Real GDP	Billions of U.S dollars	2,617.42	3,983.48	0.440	22,123.12	527
Real Public Investment	Billions of U.S dollars	165.87	262.54	0.262	1,681.18	527
Urban Population(% of total)	% of total	35.66	14.325	11.74	77.16	527
Population over 65 years old (% of total)	% of total	3.125	0.672	1.688	5.645	527
Population between 15 to 64(% of total)	% of total	53.66	3.494	47.403	67.172	527
Voice and Accountability	Real Number	-0.685	0.630	-2.175	0.986	486
Political Stability and Absence of Violence/Terrorism	Real Number	-0.594	0.827	-2.994	1.122	486
Government Effectiveness	Real Number	-0.780	0.460	--1.974	0.347	486
Regulatory Quality	Real Number	-0.679	0.463	-2.412	0.305	486
Rule of Law	Real Number	-0.731	0.510	-2.205	0.637	486
Control of Corruption	Real Number	-0.633	0.448	--1.899	0.863	486

Source: Authors calculations

Table 25. Public Investment in Africa

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
dlnkgdp	2.513***	-0.440	2.072	2.503***	2.510***
	(0.402)	(1.513)	(1.601)	(0.401)	(0.416)
Lagdlnkgdp	-0.478	-0.401	-0.879	-0.442	-0.435
	(0.301)	(1.458)	(1.476)	(0.354)	(0.367)
rho	-6.445				
	(7.105)				
lambda				-6.006	
Constant					-0.0175
					(0.0257)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses

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

Table 26. Public Investment in Africa: Interaction with dummy for WAEMU Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-WAEMU)*dlnkgdp	2.137***	0.242	2.379	2.049***	2.048***
	(0.502)	(2.069)	(2.082)	(0.498)	(0.518)
WAEMU*dlnkgdp	3.392***	-5.655	-2.263	3.501***	3.543***
	(0.652)	(3.507)	(3.514)	(0.767)	(0.795)
(1-WAEMU)*Lagdlnkgdp	-0.286	0.0263	-0.259	-0.270	-0.269
	(0.425)	(1.614)	(1.668)	(0.419)	(0.435)
WAEMU*Lagdlnkgdp	-0.255	-5.630*	-5.885*	-0.256	-0.218
	(0.839)	(3.251)	(3.239)	(0.782)	(0.812)
rho	-6.518				
	(7.101)				
lambda				-5.366	
				(7.018)	
Constant					-0.0159
					(0.0259)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses

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

Table 27. Public Investment in Africa: Interaction with dummy for ECOWAS Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-ECOWAS)*dlnkgdp	3.126***	-4.739*	-1.613	2.890***	2.991***
	(0.596)	(2.479)	(2.396)	(0.580)	(0.605)
ECOWAS*dlnkgdp	1.821***	-0.307	1.514	1.858***	1.895***
	(0.474)	(1.314)	(1.329)	(0.560)	(0.584)
(1-ECOWAS)*Lagdlnkgdp	-0.182	3.115	2.934	-0.0765	-0.140
	(0.500)	(2.087)	(2.045)	(0.486)	(0.507)
ECOWAS*Lagdlnkgdp	-0.869	1.756	0.887	-0.882*	-0.986*
	(0.572)	(1.181)	(1.250)	(0.529)	(0.547)
rho	-12.63*				
	(6.711)				
lambda				-11.30*	
Constant					-0.0182
					(0.0257)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 28. Public Investment in Africa: Interaction with dummy for ECCAS Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Direct	Indirect	Total	Main	Fixed Eff.
(1-ECCAS)*dlnkgdp	2.221***	-1.422	0.799	2.151***	2.219***
	(0.424)	(1.446)	(1.441)	(0.421)	(0.437)
ECCAS*dlnkgdp	5.111***	-5.471	-0.360	4.680***	4.918***
	(1.115)	(3.452)	(3.261)	(1.269)	(1.334)
(1-ECCAS)*Lagdlnkgdp	-0.438	2.119*	1.681	-0.448	-0.514
	(0.384)	(1.157)	(1.175)	(0.369)	(0.383)
ECCAS*Lagdlnkgdp	-0.0110	1.802	1.791	0.151	-0.0253
	(1.311)	(3.128)	(3.135)	(1.219)	(1.277)
rho	-12.78*				
	(6.710)				
lambda				-11.50*	
				(6.742)	
Constant					-0.0194
					(0.0257)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 29. Public Investment in Africa: Interaction with dummy for CEMAC Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Direct	Indirect	Total	Main	Fixed Eff.
(1-CEMAC)*dlnkgdp	2.465***	-0.680	1.785	2.461***	2.466***
	(0.412)	(1.680)	(1.673)	(0.408)	(0.425)
CEMAC*dlnkgdp	3.642**	-11.37	-7.729	3.744*	3.798*
	(1.728)	(12.70)	(12.56)	(2.025)	(2.105)
(1-CEMAC)*Lagdlnkgdp	-0.478	-0.222	-0.700	-0.493	-0.488
	(0.376)	(1.305)	(1.324)	(0.360)	(0.374)
CEMAC*Lagdlnkgdp	1.403	-10.21	-8.805	1.149	1.180
	(2.058)	(11.06)	(10.99)	(1.879)	(1.953)
rho	-6.729				
	(7.136)				
lambda				-5.761	
				(7.016)	
Constant					-0.0212
					(0.0260)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 30. Public Investment in Africa: Interaction with dummy for IGAD Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Direct	Indirect	Total	Main	Fixed Eff.
(1-IGAD)*dlnkgdp	2.451***	-1.435	1.016	2.414***	2.473***
	(0.461)	(1.358)	(1.335)	(0.454)	(0.475)
IGAD*dlnkgdp	2.499***	-6.421	-3.922	2.383***	2.503***
	(0.763)	(4.451)	(4.406)	(0.886)	(0.924)
(1-IGAD)*Lagdlnkgdp	-0.474	1.940*	1.467	-0.452	-0.546
	(0.459)	(1.123)	(1.113)	(0.432)	(0.449)
IGAD *Lagdlnkgdp	-0.248	2.303	2.055	-0.143	-0.220
	(0.703)	(3.274)	(3.294)	(0.667)	(0.698)
rho	-12.61*				
	(6.720)				
lambda				-11.99*	
				(6.785)	
Constant					-0.0141
					(0.0270)
Observations	555	555	555	555	555
Number of id	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses

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

Table 31. Public Investment in Africa: Interaction with dummy for SADEC Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-SADEC)*dlnkgdp	2.269***	-1.004	1.265	2.274***	2.283***
	(0.440)	(1.892)	(1.904)	(0.435)	(0.452)
SADEC*dlnkgdp	3.592***	-1.353	2.239	3.621***	3.643***
	(0.873)	(4.145)	(4.088)	(1.024)	(1.066)
(1-SADEC)*Lagdlnkgdp	-0.540	-0.967	-1.507	-0.564	-0.551
	(0.397)	(1.401)	(1.430)	(0.378)	(0.392)
SADEC*Lagdlnkgdp	0.377	1.967	2.344	0.306	0.286
	(1.082)	(3.839)	(3.858)	(1.000)	(1.041)
rho	-7.378				
	(7.1930				
lambda				-6.186	
				(7.055)	
Constant					-0.0230
					(0.0260)
Observations	555	555	555	555	555
Number of countries	37	37	37	37	37
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 32. Public Investment in Africa (with Control Variables)

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
dlnkgdp	2.565***	1.240	3.805**	2.529***	2.513***
	(0.434)	(1.710)	(1.786)	(0.431)	(0.454)
laglnkgdp	-0.682*	-0.311	-0.993	-0.702*	-0.693
	(0.350)	(1.532)	(1.502)	(0.407)	(0.430)
voice	0.0101	-0.918**	-0.908**	0.0306	0.0426
	(0.0891)	(0.421)	(0.440)	(0.0818)	(0.0857)
polstability	0.0668	0.0353	0.102	0.0449	0.0469
	(0.0517)	(0.177)	(0.186)	(0.0460)	(0.0484)
goveffectiveness	-0.132	0.512	0.380	-0.140	-0.145
	(0.143)	(0.448)	(0.501)	(0.122)	(0.128)
regquality	0.111	0.199	0.310	0.132	0.124
	(0.108)	(0.377)	(0.385)	(0.103)	(0.109)
ruleoflaw	0.0128	0.508	0.521	-0.0461	-0.0502
	(0.125)	(0.567)	(0.591)	(0.120)	(0.126)
controlofcorruption	0.123	-0.498	-0.375	0.127	0.130
	(0.0949)	(0.378)	(0.377)	(0.0937)	(0.0996)
pop1564	0.00297	0.151	0.154	-0.0112	-0.0110
	(0.0166)	(0.121)	(0.126)	(0.0162)	(0.0172)
pop65	-0.0862	-0.116	-0.202	-0.218	-0.222
	(0.151)	(0.773)	(0.817)	(0.146)	(0.153)
urbanpop	0.0107	-0.0803	-0.0696	0.00285	0.00334
	(0.0163)	(0.0524)	(0.0523)	(0.00988)	(0.0108)
fiscalrule	-0.00660	0.000906	-0.00570	-0.0578	-0.0516
	(0.0827)	(0.177)	(0.176)	(0.0678)	(0.0733)
rho	-10.73				
	(8.383)				
lambda				-9.321	
				(8.515)	
Constant					1.275*
					(0.732)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 33. Public Investment in Africa: Interaction with dummy for WAEMU Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-WAEMU)*dlnkgdp	2.286***	1.736	4.021*	2.136***	2.114***
	(0.541)	(2.278)	(2.338)	(0.533)	(0.564)
WAEMU*dlnkgdp	3.104***	-2.623	0.482	3.461***	3.485***
	(0.660)	(4.473)	(4.484)	(0.778)	(0.822)
(1-WAEMU)*Lagdlnkgdp	-0.548	-0.276	-0.823	-0.605	-0.603
	(0.450)	(1.908)	(2.009)	(0.437)	(0.462)
WAEMU*Lagdlnkgdp	-0.191	-5.814	-6.005	0.0499	0.161
	(1.576)	(5.145)	(5.177)	(1.434)	(1.522)
voice	-0.0265	-0.936**	-0.963**	0.0311	0.0411
	(0.0981)	(0.371)	(0.385)	(0.0815)	(0.0858)
polstability	0.0687	0.0780	0.147	0.0401	0.0417
	(0.0468)	(0.209)	(0.217)	(0.0460)	(0.0486)
goveffectiveness	-0.117	0.456	0.339	-0.139	-0.145
	(0.125)	(0.450)	(0.476)	(0.123)	(0.130)
regquality	0.0929	0.0901	0.183	0.141	0.135
	(0.0994)	(0.348)	(0.366)	(0.104)	(0.111)
ruleoflaw	-0.0110	0.632	0.621	-0.0742	-0.0791
	(0.104)	(0.554)	(0.558)	(0.121)	(0.128)
controlofcorruption	0.163	-0.529	-0.366	0.135	0.139
	(0.110)	(0.415)	(0.426)	(0.0937)	(0.0998)
pop1564	0.00244	0.156	0.158	-0.0117	-0.0117
	(0.0191)	(0.129)	(0.135)	(0.0162)	(0.0172)
pop65	-0.0692	-0.0333	-0.102	-0.219	-0.223
	(0.170)	(0.817)	(0.864)	(0.146)	(0.153)
urbanpop	0.00770	-0.0745	-0.0668	0.00255	0.00303
	(0.0136)	(0.0530)	(0.0553)	(0.00989)	(0.0108)
fiscalrule	-0.00231	-0.0274	-0.0297	-0.0618	-0.0573
	(0.0701)	(0.197)	(0.194)	(0.0678)	(0.0735)
rho	-10.17				
	(8.373)				
lambda				-8.555	
				(8.490)	
Constant					1.310*
					(0.733)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	SEM
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 34. Public Investment in Africa: Interaction with dummy for ECOWAS Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Direct	Indirect	Total	Main	Fixed Eff.
(1-ECOWAS)*dlnkgdp	3.579***	-1.759	1.820	3.345***	3.429***
	(0.614)	(3.267)	(3.232)	(0.600)	(0.640)
ECOWAS *dlnkgdp	1.147**	-1.820	-0.673	1.257**	1.367**
	(0.512)	(1.495)	(1.527)	(0.599)	(0.630)
(1- ECOWAS)*Lagdlnkgdp	-0.392	2.849	2.458	-0.379	-0.402
	(0.522)	(2.387)	(2.404)	(0.512)	(0.546)
ECOWAS *Lagdlnkgdp	-1.146	2.455	1.309	-1.419**	-1.574**
	(0.721)	(1.848)	(1.853)	(0.653)	(0.690)
voice	0.0947	0.110	0.205	0.0561	0.0608
	(0.0975)	(0.291)	(0.289)	(0.0804)	(0.0860)
polstability	0.0869*	0.170	0.257	0.0716	0.0698
	(0.0445)	(0.183)	(0.186)	(0.0453)	(0.0481)
goveffectiveness	-0.209*	-0.248	-0.458	-0.121	-0.114
	(0.123)	(0.410)	(0.424)	(0.120)	(0.127)
regquality	0.167*	0.755**	0.923**	0.139	0.119
	(0.100)	(0.384)	(0.398)	(0.102)	(0.108)
ruleoflaw	-0.0207	-0.238	-0.259	-0.0469	-0.0477
	(0.103)	(0.415)	(0.404)	(0.118)	(0.126)
controlofcorruption	0.104	-0.563*	-0.458	0.0892	0.0945
	(0.111)	(0.295)	(0.296)	(0.0918)	(0.0994)
pop1564	-0.0144	-0.0516	-0.0660	-0.0118	-0.0102
	(0.0185)	(0.118)	(0.118)	(0.0160)	(0.0171)
pop65	-0.115	2.253***	2.137**	-0.167	-0.196
	(0.154)	(0.829)	(0.856)	(0.145)	(0.152)
urbanpop	0.00517	0.00276	0.00794	-0.00227	-0.00234
	(0.0141)	(0.0389)	(0.0413)	(0.00915)	(0.0106)
fiscalrule	0.0920	0.164	0.256	0.0540	0.0572
	(0.0719)	(0.188)	(0.178)	(0.0626)	(0.0705)
rho	-21.33***				
	(7.658)				
lambda				-15.02**	
				(7.629)	
Constant					1.333*
					(0.726)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 35. Public Investment in Africa: Interaction with dummy for ECCAS Countries

VARIABLES	Direct	Indirect	Total	Main	Fixed Eff.
(1-ECCAS)*dlnkgdp	1.889***	-2.310	-0.422	1.817***	1.944***
	(0.446)	(1.641)	(1.677)	(0.447)	(0.470)
ECCAS *dlnkgdp	7.524***	0.231	7.755	7.497***	7.530***
	(1.112)	(5.210)	(4.943)	(1.288)	(1.386)
(1- ECCAS)*Lagdlnkgdp	-0.399	2.443	2.044	-0.552	-0.641
	(0.424)	(1.547)	(1.626)	(0.415)	(0.441)
ECCAS *Lagdlnkgdp	-0.897	-2.083	-2.981	-1.052	-0.933
	(1.411)	(5.144)	(5.023)	(1.296)	(1.385)
voice	0.0577	0.358	0.416	0.0230	0.0206
	(0.0952)	(0.281)	(0.278)	(0.0787)	(0.0845)
polstability	0.0894**	0.157	0.247	0.0712	0.0676
	(0.0432)	(0.177)	(0.180)	(0.0448)	(0.0475)
goveffectiveness	-0.200*	-0.299	-0.499	-0.112	-0.105
	(0.119)	(0.395)	(0.412)	(0.118)	(0.126)
regquality	0.156	0.839**	0.996***	0.120	0.0977
	(0.103)	(0.339)	(0.362)	(0.102)	(0.108)
ruleoflaw	-0.0821	-0.293	-0.375	-0.0941	-0.0926
	(0.0996)	(0.421)	(0.410)	(0.116)	(0.124)
controlofcorruption	0.141	-0.551**	-0.411	0.120	0.129
	(0.110)	(0.281)	(0.279)	(0.0903)	(0.0982)
pop1564	-0.0153	0.00808	-0.00720	-0.0105	-0.00924
	(0.0182)	(0.111)	(0.109)	(0.0159)	(0.0169)
pop65	-0.154	2.019**	1.865**	-0.199	-0.232
	(0.151)	(0.792)	(0.814)	(0.143)	(0.151)
urbanpop	0.00119	-0.0123	-0.0112	-0.00433	-0.00425
	(0.0139)	(0.0388)	(0.0414)	(0.00901)	(0.0105)
fiscalrule	0.0764	0.0644	0.141	0.0377	0.0432
	(0.0739)	(0.163)	(0.142)	(0.0617)	(0.0703)
rho	-22.63***				
	(7.590)				
lambda				-16.93**	
				(7.616)	
Constant					1.412*
					(0.721)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 36. Public Investment in Africa: Interaction with dummy for CEMAC Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-CEMAC)*dlnkgdp	2.480***	1.295	3.775*	2.446***	2.429***
	(0.443)	(2.141)	(2.200)	(0.439)	(0.464)
CEMAC*dlnkgdp	4.686***	-0.161	4.525	4.961**	4.959**
	(1.775)	(14.02)	(13.81)	(2.119)	(2.248)
(1-CEMAC)*Lagdlnkgdp	-0.635	0.0558	-0.579	-0.739*	-0.729*
	(0.431)	(1.670)	(1.785)	(0.416)	(0.440)
CEMAC*Lagdlnkgdp	0.585	-10.83	-10.24	0.441	0.472
	(2.020)	(13.16)	(13.07)	(1.814)	(1.923)
voice	-0.0165	-0.967***	-0.984***	0.0269	0.0383
	(0.0974)	(0.361)	(0.374)	(0.0816)	(0.0858)
polstability	0.0648	0.0224	0.0872	0.0469	0.0487
	(0.0465)	(0.202)	(0.208)	(0.0459)	(0.0485)
goveffectiveness	-0.119	0.372	0.253	-0.142	-0.148
	(0.123)	(0.459)	(0.500)	(0.122)	(0.128)
regquality	0.0963	0.152	0.248	0.137	0.130
	(0.102)	(0.355)	(0.374)	(0.103)	(0.109)
ruleoflaw	0.0279	0.647	0.675	-0.0457	-0.0493
	(0.104)	(0.571)	(0.581)	(0.120)	(0.127)
controlofcorruption	0.134	-0.507	-0.373	0.124	0.127
	(0.109)	(0.400)	(0.410)	(0.0936)	(0.0997)
pop1564	0.00341	0.139	0.142	-0.0118	-0.0115
	(0.0191)	(0.126)	(0.132)	(0.0162)	(0.0172)
pop65	-0.0732	-0.0244	-0.0976	-0.210	-0.214
	(0.167)	(0.804)	(0.853)	(0.146)	(0.153)
urbanpop	0.00969	-0.0716	-0.0619	0.00264	0.00324
	(0.0135)	(0.0514)	(0.0533)	(0.00987)	(0.0108)
fiscalrule	0.00732	-0.0443	-0.0370	-0.0509	-0.0456
	(0.0686)	(0.207)	(0.203)	(0.0679)	(0.0735)
rho	-11.41				
	(8.449)				
lambda				-9.198	
				(8.494)	
Constant					1.273*
					(0.732)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 37. Public Investment in Africa: Interaction with dummy for IGAD Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-IGAD)*dlnkgdp	2.412***	-1.279	1.133	2.243***	2.324***
	(0.499)	(1.709)	(1.761)	(0.496)	(0.523)
IGAD *dlnkgdp	2.523***	-7.763	-5.240	2.674***	2.803***
	(0.830)	(4.811)	(4.755)	(0.955)	(1.018)
(1- IGAD)*Lagdlnkgdp	-0.644	2.742*	2.098	-0.849*	-0.930*
	(0.548)	(1.626)	(1.720)	(0.511)	(0.544)
IGAD *Lagdlnkgdp	-0.311	3.523	3.212	-0.390	-0.463
	(0.779)	(4.046)	(3.964)	(0.737)	(0.787)
voice	0.0821	0.242	0.324	0.0431	0.0454
	(0.0983)	(0.295)	(0.296)	(0.0813)	(0.0871)
polstability	0.0903**	0.176	0.267	0.0657	0.0635
	(0.0445)	(0.190)	(0.194)	(0.0458)	(0.0485)
goveffectiveness	-0.197	-0.384	-0.582	-0.115	-0.105
	(0.121)	(0.425)	(0.445)	(0.122)	(0.129)
regquality	0.196*	0.699**	0.896**	0.153	0.136
	(0.101)	(0.357)	(0.379)	(0.103)	(0.109)
ruleoflaw	-0.0567	-0.226	-0.282	-0.0679	-0.0712
	(0.102)	(0.449)	(0.442)	(0.119)	(0.127)
controlofcorruption	0.116	-0.492*	-0.376	0.110	0.114
	(0.112)	(0.298)	(0.301)	(0.0927)	(0.101)
pop1564	-0.0133	0.0345	0.0212	-0.0123	-0.0109
	(0.0186)	(0.125)	(0.125)	(0.0162)	(0.0172)
pop65	-0.135	2.079**	1.943**	-0.165	-0.196
	(0.155)	(0.817)	(0.847)	(0.146)	(0.154)
urbanpop	0.000998	-0.0168	-0.0158	-0.00182	-0.00204
	(0.0144)	(0.0421)	(0.0454)	(0.00923)	(0.0107)
fiscalrule	0.107	-0.0109	0.0961	0.0494	0.0604
	(0.0734)	(0.163)	(0.147)	(0.0632)	(0.0712)
rho	-19.86***				
	(7.616)				
lambda				-15.36**	
				(7.629)	
Constant					1.360*
					(0.737)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

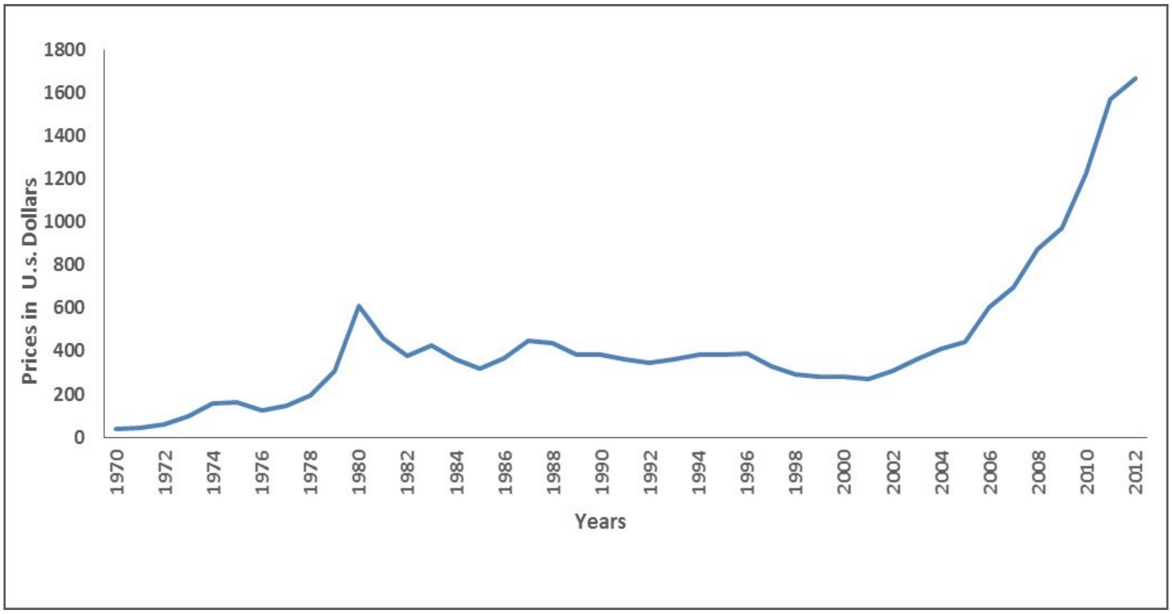
Table 38. Public Investment in Africa: Interaction with dummy for SADEC Countries

VARIABLES	(1) Direct	(2) Indirect	(3) Total	(4) Main	(5) Fixed Eff.
(1-SADEC)*dlnkgdp	2.084***	0.0365	2.120	2.134***	2.127***
	(0.463)	(1.971)	(2.017)	(0.463)	(0.488)
SADEC*dlnkgdp	5.063***	6.205	11.27**	4.817***	4.774***
	(0.916)	(4.524)	(4.443)	(1.063)	(1.129)
(1-SADEC)*Lagdlnkgdp	-0.599	-0.761	-1.360	-0.781*	-0.755
	(0.445)	(1.555)	(1.612)	(0.434)	(0.460)
SADEC*Lagdlnkgdp	0.122	7.647*	7.768**	0.127	0.00642
	(1.158)	(4.014)	(3.929)	(1.049)	(1.112)
voice	-0.0149	-0.949***	-0.964***	0.0144	0.0297
	(0.0965)	(0.342)	(0.355)	(0.0815)	(0.0855)
polstability	0.0585	-0.0638	-0.00534	0.0404	0.0428
	(0.0461)	(0.182)	(0.187)	(0.0457)	(0.0483)
goveffectiveness	-0.115	0.253	0.137	-0.129	-0.134
	(0.120)	(0.381)	(0.412)	(0.121)	(0.128)
regquality	0.109	0.563*	0.672**	0.125	0.112
	(0.101)	(0.311)	(0.327)	(0.103)	(0.109)
ruleoflaw	0.0290	0.646	0.675	-0.0487	-0.0522
	(0.102)	(0.481)	(0.483)	(0.119)	(0.126)
controlofcorruption	0.143	-0.464	-0.320	0.118	0.121
	(0.107)	(0.357)	(0.367)	(0.0930)	(0.0993)
pop1564	0.00501	0.104	0.109	-0.00937	-0.00907
	(0.0186)	(0.112)	(0.116)	(0.0161)	(0.0171)
pop65	-0.0986	-0.197	-0.295	-0.212	-0.218
	(0.165)	(0.728)	(0.769)	(0.145)	(0.152)
urbanpop	0.00923	-0.0817*	-0.0724	0.000796	0.00174
	(0.0133)	(0.0461)	(0.0474)	(0.00980)	(0.0108)
fiscalrule	0.0205	0.134	0.154	-0.0546	-0.0478
	(0.0679)	(0.183)	(0.175)	(0.0669)	(0.0730)
rho	-17.49**				
	(8.832)				
lambda				-11.22	
Constant					1.178
					(0.731)
Observations	468	468	468	468	468
Number of countries	36	36	36	36	36
Model	SDM	SDM	SDM	SEM	FE
Country FE	YES	YES	YES	YES	YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

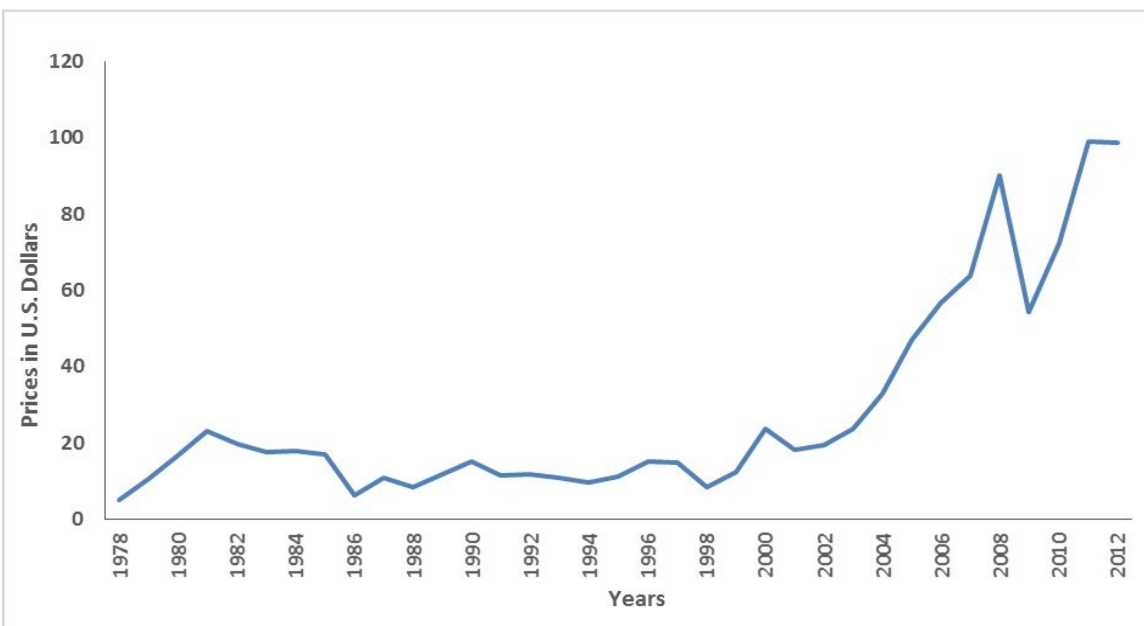
Figures

Figure 1: Gold Price



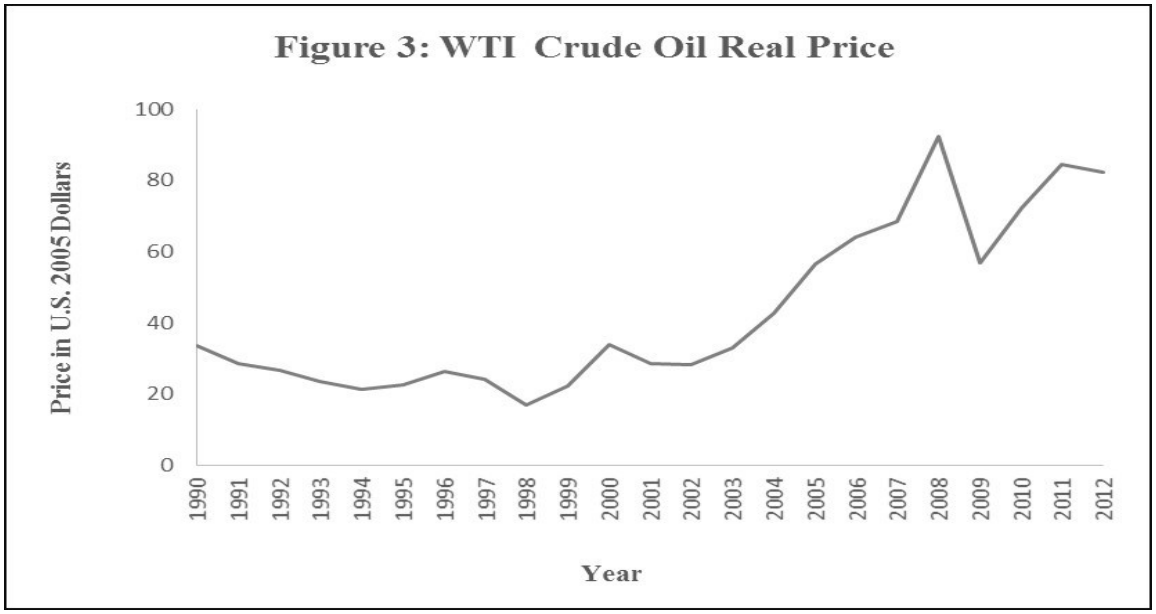
Author's calculations based on Kitco.com data.

Figure 2: Alaska North Crude Oil Price



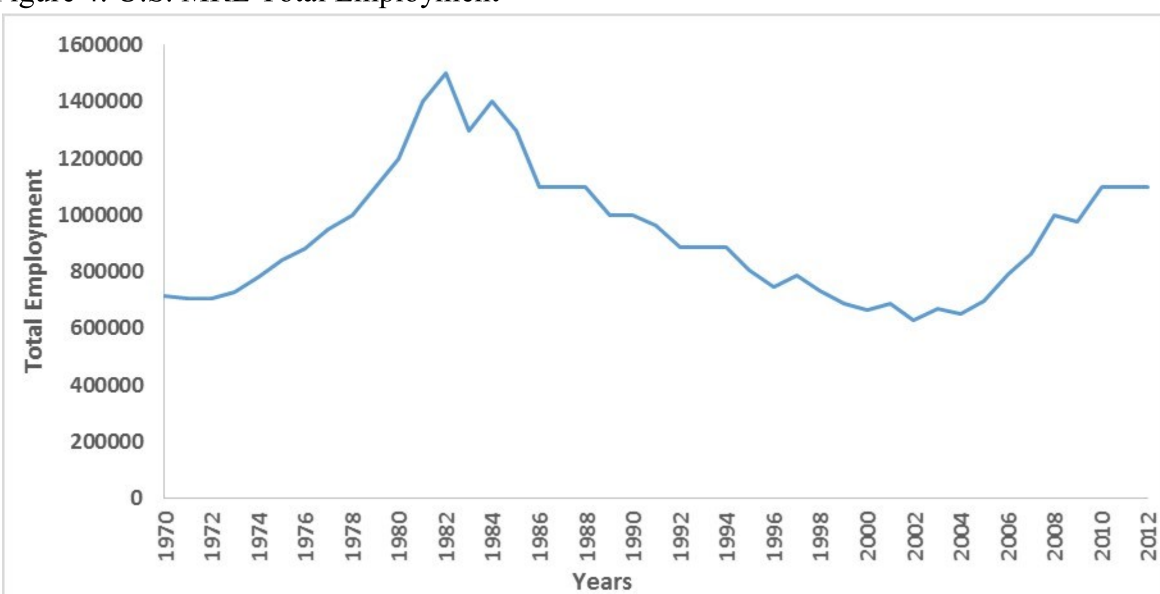
Author's calculations based on Kitco.com data.

Figure 3: WTI Crude Oil Price



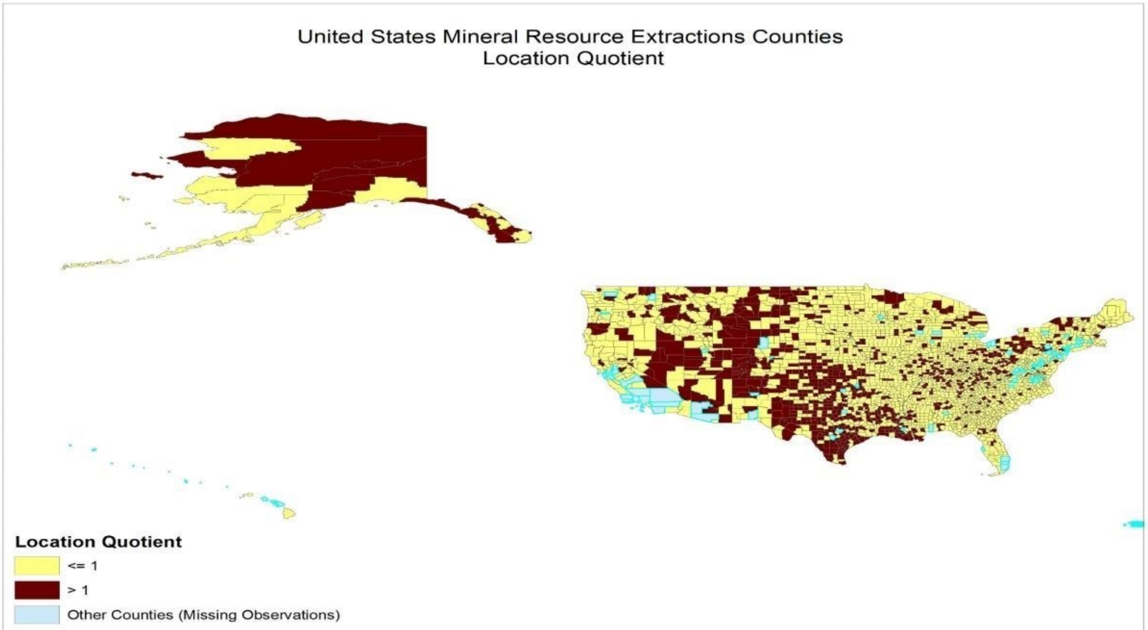
Authors calculations, U.S Energy Information Administration data. Graph reports Cushing OK WTI spot FOB Price in U.S. 2005 Dollars per Barrel for the period 1990-2012

Figure 4: U.S. MRE Total Employment



Author's calculations based on REIS data. Graph reports U.S total employment of MRE industry for the period 1970-2012

Figure 5: MRE dependent counties vs non-MRE dependent counties



Author's calculations based on REIS data. Graph reports U.S mineral resource rich counties.

Figure 6: Other Minerals Prices

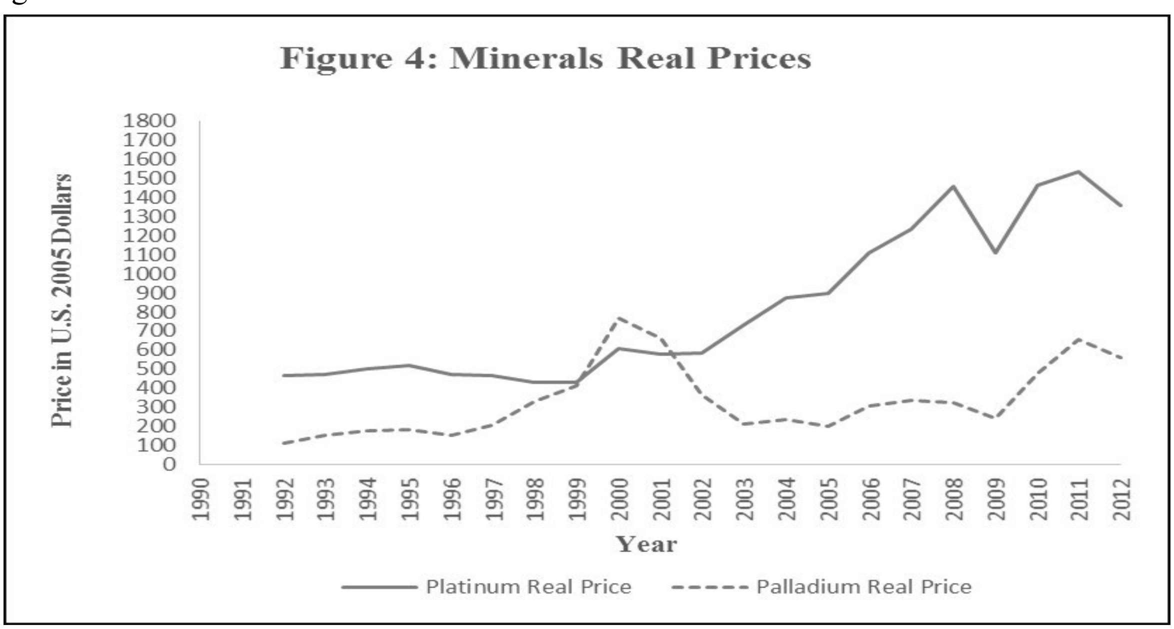


Figure 7. Public Investment (1996-2012)

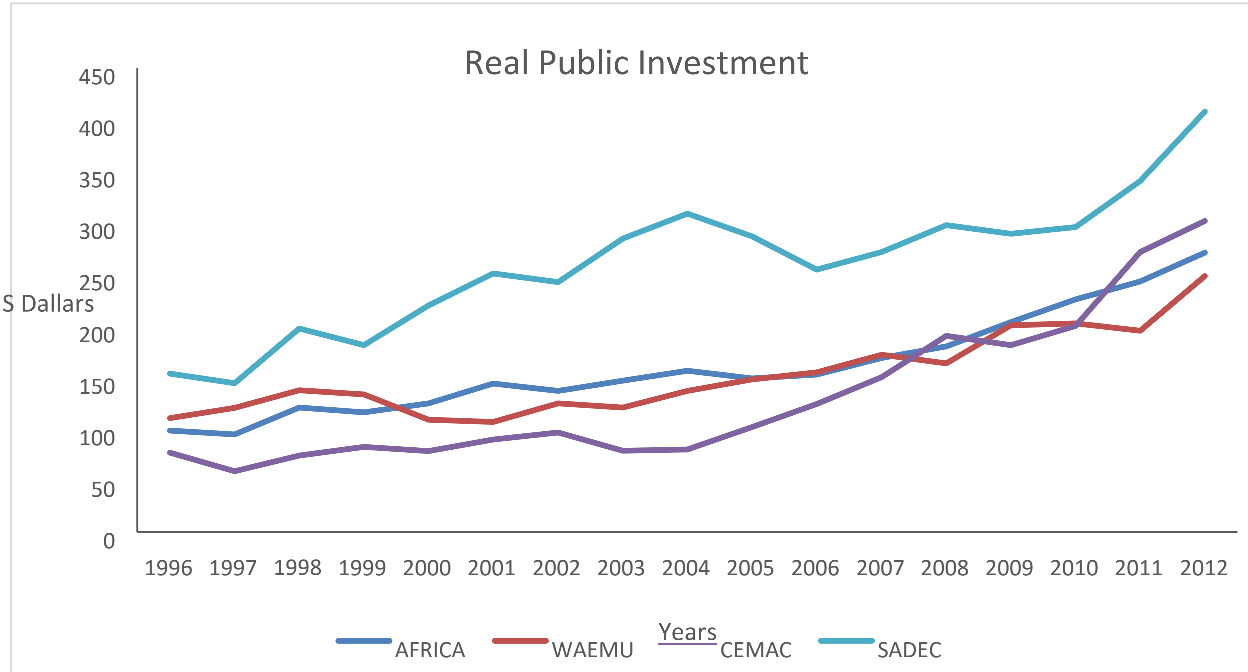


Figure 8. Gross Domestic Product (1996-2012)

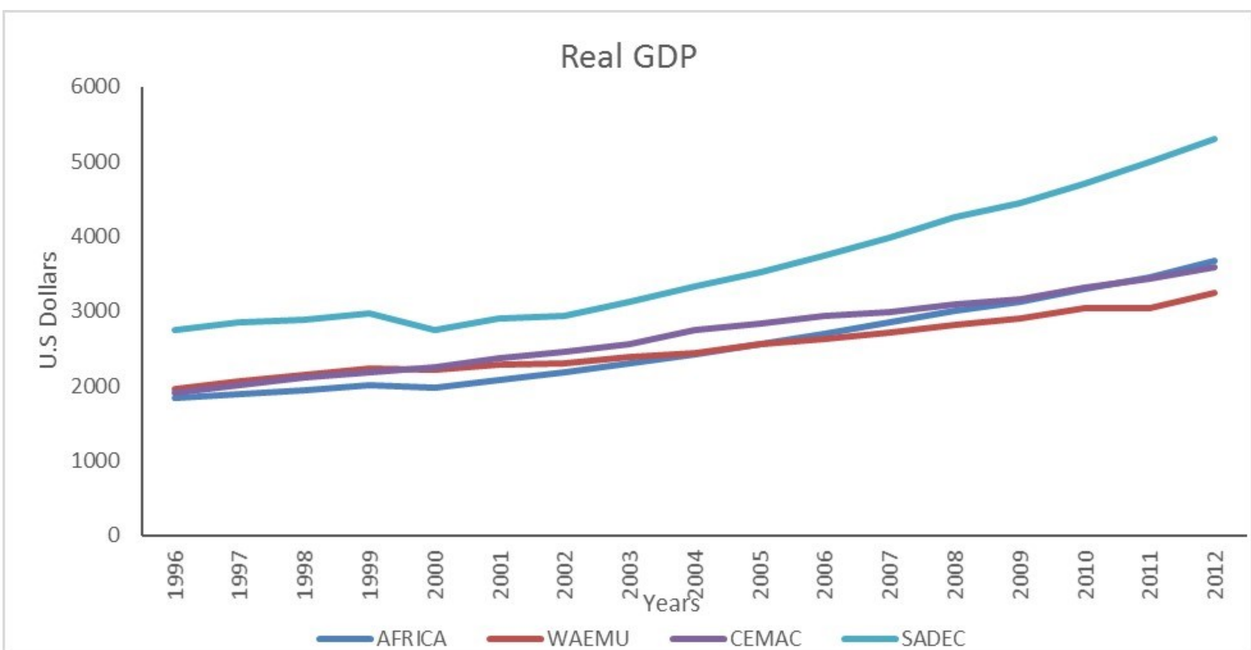


Figure 9. Share of Public Investment in GDP (1996-2012)

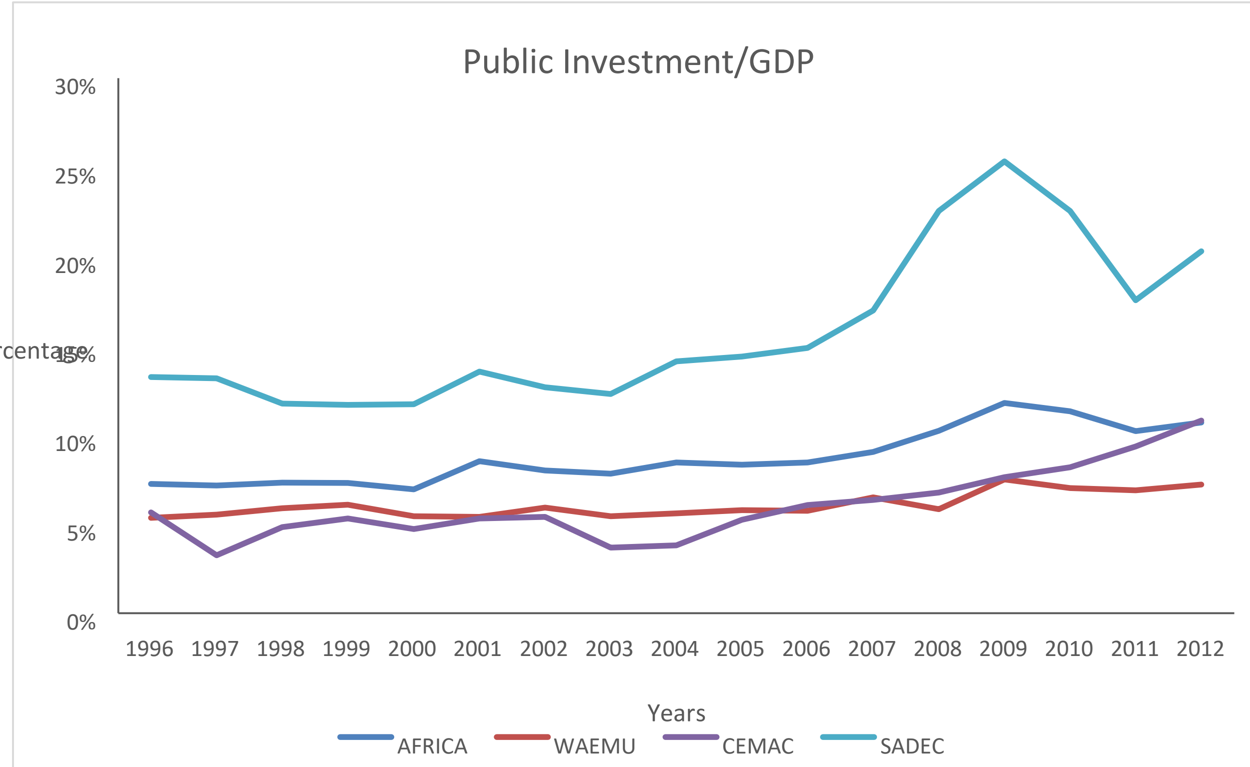


Figure 10. Public Investment in Africa (% of GDP in 2012)

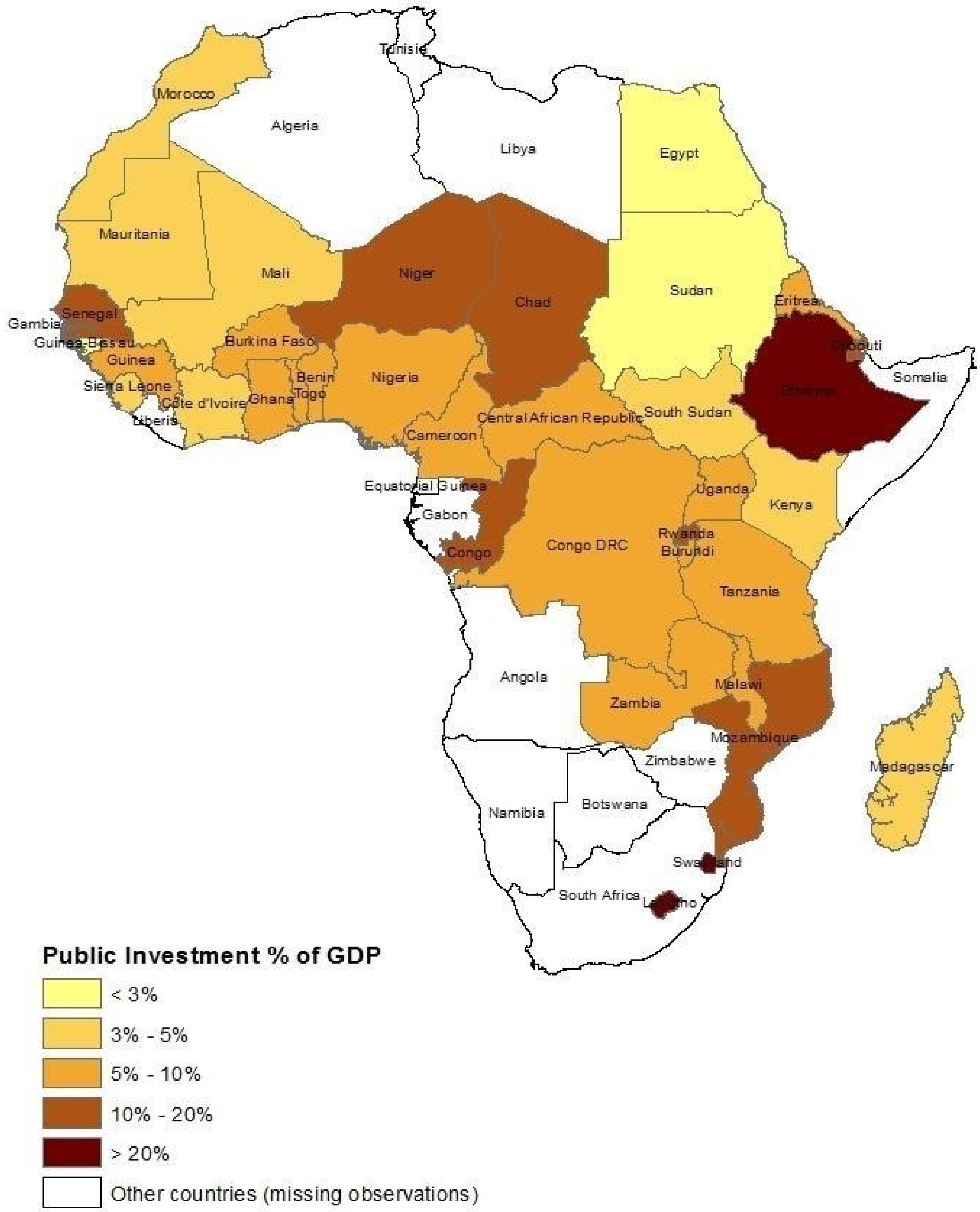


Figure 11. Public Investment in Africa (Average Annual Growth, 1996-2012)

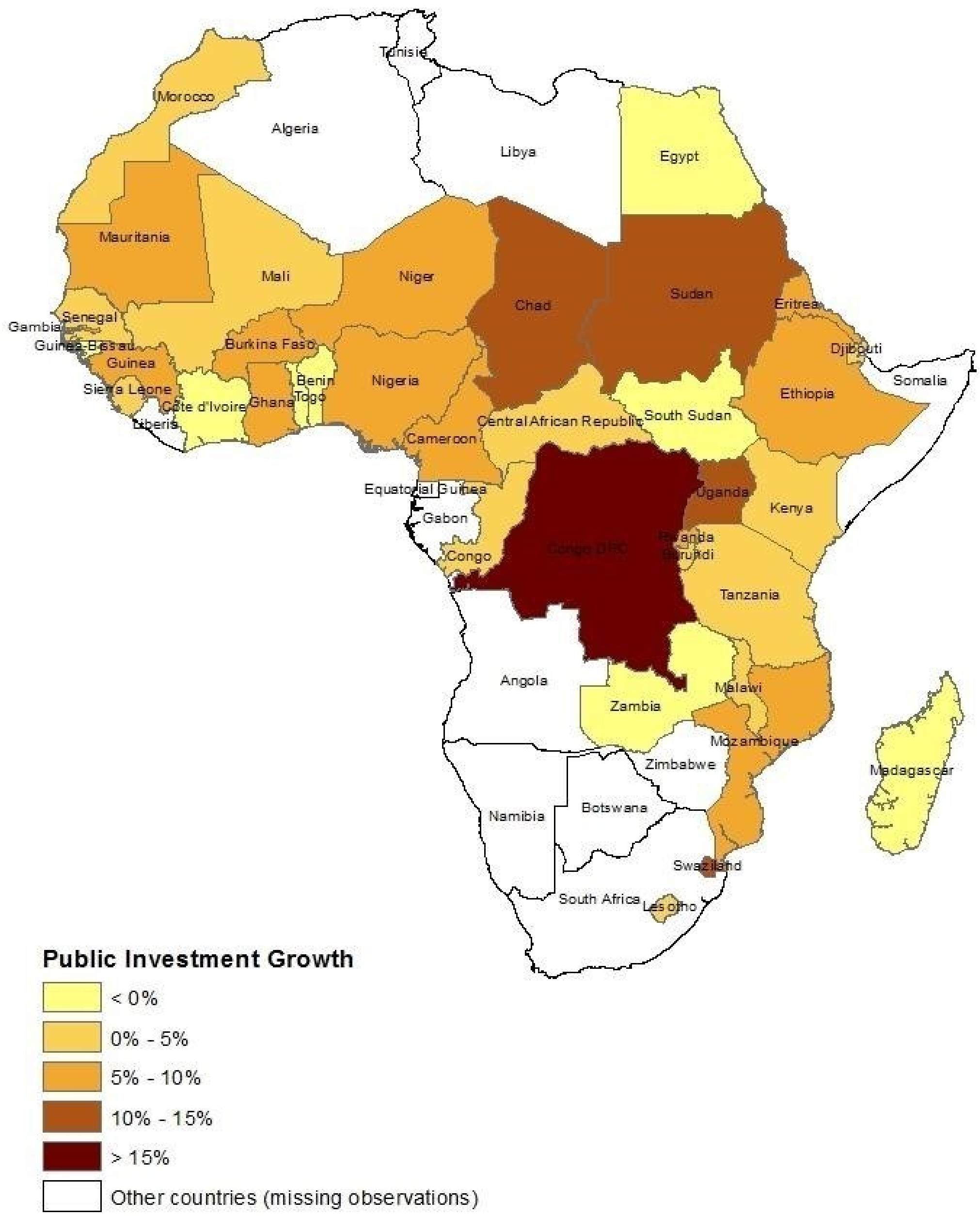


Figure 12. Real GDP Growth in Africa (% growth in 2012)