

THE IMPACT OF OPEN GOVERNMENT ON INNOVATION:
DOES GOVERNMENT TRANSPARENCY DRIVE INNOVATION?

A Thesis
submitted to the Faculty of the
Graduate School of Arts and Sciences
of Georgetown University
in partial fulfillment of the requirements for the
degree of
Master of Public Policy
in Public Policy

By

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Washington, DC
April 15, 2014

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ABSTRACT

This study adds to the body of research on open government by empirically measuring the association of government transparency and innovation. The study uses Transparency International's Corruption Perceptions Index (CPI) as a proxy measure of government transparency. It assumes that an increase in government transparency increases applied innovation activity, which is measured as the number of annual patents by country residents. The study also tests whether the association is different for countries participating in the Open Government Partnership (OGP), a voluntary multi-stakeholder international collaboration of 63 countries who have committed to make their governments more transparent. The analysis uses fixed effects regression on panel data from 1996 to 2011 for 95 countries, including 54 OGP members. Although the empirical results do not support the hypothesis that transparency and innovation are positively correlated for countries participating in the OGP, this finding contributes to the literature on open government by making an initial attempt to quantify the association of transparency and innovation. Additional future research demonstrating a positive relationship between transparency and innovation could help to justify implementation of open government policies and participation in the Open Government Partnership.

This thesis is dedicated to my family – my parents, Arvind and Tatiana, and my brother, Michael – for their never-ending faith and encouragement in my academic and life pursuits.

Many thanks to the faculty and staff at the McCourt School of Public Policy, formerly known as the Georgetown Public Policy Institute, for their guidance throughout this journey. I would like to extend my sincere appreciation to my thesis advisor Dr. Robert Bednarzik for motivating me to keep digging for answers, Michael Barker for his patience, Dr. Jeffrey Mayer for his guidance, and Leslie Evertz for her support. I would also like to thank Dr. Andreas Kern and Dr. Barbara Schone for their feedback, and my mentors Dr. Judith Feder, Dr. Jason Fichtner, and Dr. Markus Jachtenfuchs for supporting my scholarly pursuits.

I would like to extend gratitude to my classmates in my thesis workshop section for their friendship and ideas in all stages of this research endeavor.

Special thanks to the open government community and researchers who were willing to answer questions about their work and provide me feedback along the way.

Finally, a heartfelt thank you to Eric Grossman for cheering for me along the way.

Thank you,
ANJELIKA A. DEOGIRIKAR

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INTRODUCTION

“Open Government” – the principle of creating a transparent, collaborative, and participatory government – has become a priority for nations around the world. Governments pursue open government and open data initiatives with the promise of increased innovation, economic growth and job creation. Research on government transparency has conventionally focused on political and social benefits, such as government accountability and civic participation. Past literature highlights public meetings and access to information legislation as examples of good governance. However, more recent discussions emphasize the potential that transparency policies and open data initiatives can spur innovation and create economic benefits.

This paper empirically examines how government transparency is related to a country’s level of innovation. Transparency International’s Corruption Perceptions Index (CPI) score is used as a proxy measure for transparency, and annual resident patent applications is used as a measure of applied innovation. The study tests the assumption that an increase in transparency increases applied innovation, particularly for those countries participating in the Open Government Partnership (OGP).

The type, quality, and adoption of transparency initiatives vary greatly across countries (Meijer, 2013). Literature in the field suggests that studies of government transparency should move towards describing how governments are collecting and disseminating aggregate data and information that are made available to the public for free, and the extent to which this material is being used (Hollyer, 2012; Grimmeliikhuijsen, 2013).

Yu et al. (2012) describe how the term “open government” was first used in the 1950s during discussions of political accountability in the context of the United States Freedom of Information

Act, which was eventually adopted in the United States in 1966 (Relly, 2009; Yu, 2012). Since then, the definition of “open government” has been expanded to include technological innovations and open government data (Yu, 2012). Yu et al. (2012) note that “there is much to like about economic opportunity, innovation, and efficiency, and a convenient label [of “open government”] could be a good way of promoting them all.”

In the United States, the Obama Administration has been committed to creating an open government through transparency and open data initiatives since the beginning of the President’s first term. On his first full day in office, the President issued *Memorandum on Transparency and Open Government* committing his administration to be transparent, participatory and collaborative (Obama, 2009). Later that year, the Office of Management and Budget issued *Open Government Directive*, which provided agencies direction to fulfill the goals of a more open and transparent government.

As governments focus on publishing government data online to be made accessible to the public, “open data” falls under the umbrella of open government. Well-known examples of open government data made accessible by the U.S. Government include Global Positioning System (GPS) satellite data and weather data from National Oceanic and Atmospheric Administration, which have both been made freely available to the public.

Internationally, other countries are also moving beyond freedom of information laws to address open data policies as part of efforts to increase government transparency. In his 2010 address to the United Nations General Assembly, President Barack Obama emphasized the importance of an open government, noting, “the strongest foundation for human progress lies in open economies, open societies, and open governments... In all parts of the world, we see the

promise of innovation to make government more open and accountable” (Obama, 2010). He called on leaders to come back the following year with “specific commitments to promote transparency; to fight corruption; to energize civic engagement; to leverage new technologies” (Obama, 2010). The result of this call to action was the launch of the OGP.

In September 2011, the U.S. partnered with seven other countries in committing to the principles of an open government by endorsing the Open Government Declaration and developing specific national action plans. In addition to the U.S., founding members of the OGP included Brazil, Indonesia, Mexico, Norway, the Philippines, South Africa, and the United Kingdom. As of January 2014, 63 countries had committed to the Declaration. In signing the Declaration, member countries commit to making their governments more open and accountable, with a particular emphasis on publishing government data online, to be made accessible and free to the public. For example, since 2009, the Government of the United Kingdom has made over 37,000 datasets available online (Hammell, 2012); and as of 2013, the U.S. Government had put 75,000 datasets online on Data.gov (Obama, 2013).

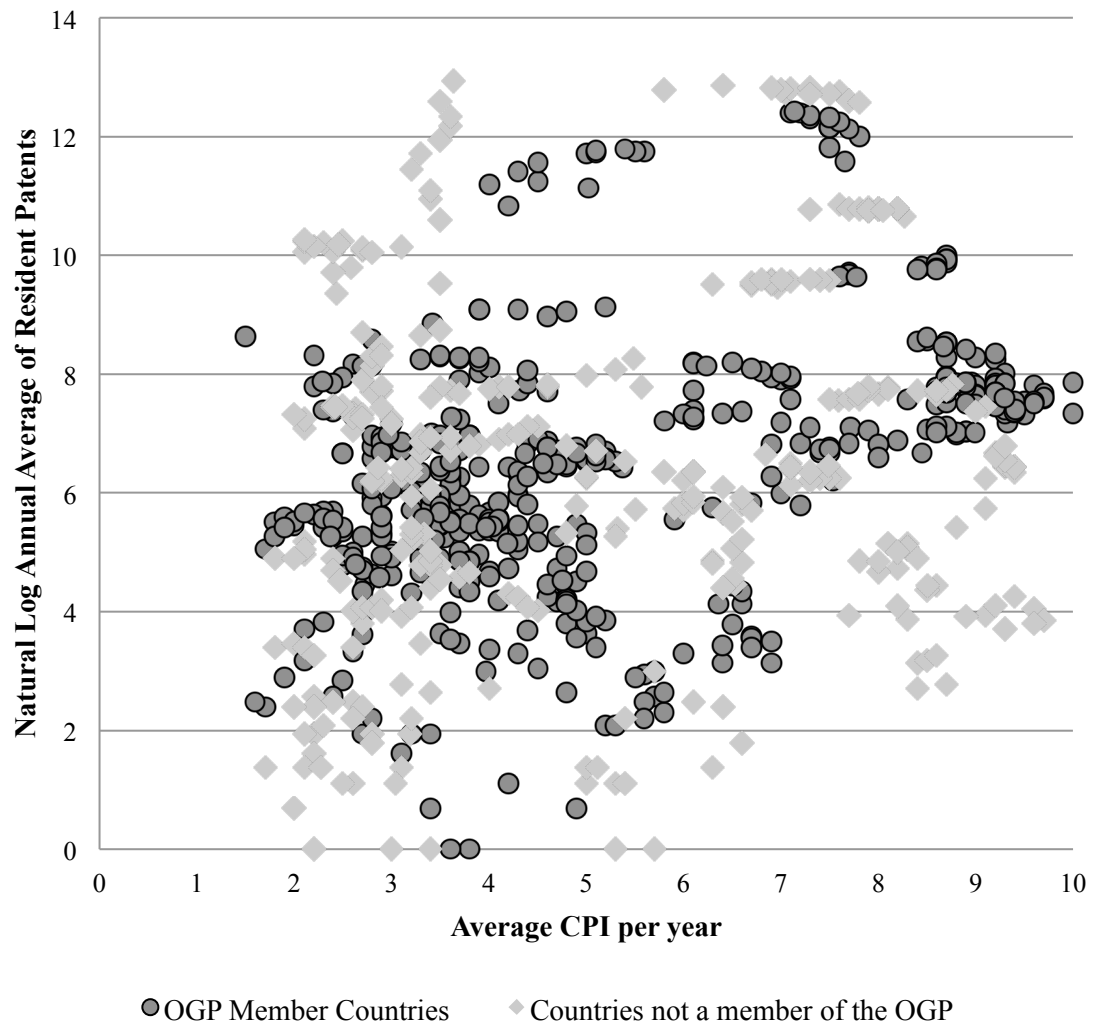
Although open data programs are perceived to be a recent phenomenon, the United Nations Millennium Development Goals, established in 2000, acknowledged that public accessibility of government information is a civil and human right (Linders, 2011). Countries have made great strides to make government data accessible and measure the number of datasets made available; yet it continues to be difficult to measure the extent of utilization of these datasets. U.S. transparency policies emphasize the positive association of government transparency and economic growth; but researchers continue to debate the issue of how to quantify this

relationship since there is yet no direct measure of transparency (Orszag, 2009; Linders, 2011; Burwell, 2013).

Open government and open data policies continue to highlight the potential of such policies to spur innovation. The Open Government Declaration (2011) emphasizes that increased transparency and openness can promote innovation: “We uphold the value of openness in our engagement with citizens to improve services, manage public resources, promote innovation, and create safer communities.” Most recently, in May 2013, President Obama issued Executive Order *Making Open and Machine-Readable the New Default for Government Information* and the Administration issued *Memorandum on Open Data Policy – Managing Information as an Asset*. The latter document clearly asserts that “making information resources accessible, discoverable, and usable by the public can help fuel entrepreneurship, innovation, and scientific discovery” (Obama, 2013; Burwell, 2013).

With the international movement to increase open government policies and further promote open data initiatives, research should attempt to quantify the relationship between transparency and economic growth, and between transparency and innovation that may lead to economic growth. As mentioned previously, research on open government has traditionally focused on such benefits as government accountability and civic participation. In contrast, this study attempts to add to the body of research on open government by empirically measuring the relationship between government transparency and innovation in 95 countries, including members of the OGP. On initial evaluation, it finds a slight positive relationship (See Graph 1).

Graph 1: Average Annual Corruption Perceptions Index (CPI) and Natural log of Average Annual Resident Patents per year, 774 country-year observations of 95 countries (1996-2011)



EXAMINING THE LITERATURE

Transparency

The term “government transparency” captures a broad array of activities from access to information legislation to open data policies (Relly, 2009; Meijer, 2013). Historically, research on government transparency has focused on the political and social benefits of increasing openness. Literature on promoting good governance observes that an increase in transparency can lead to an increase in government accountability and efficiency, and increased civic participation (Chun, 2010; Grimmelikhuijsen, 2013). In addition, the literature describes how increases in government transparency can decrease corruption and, thereby, increase the public’s trust in their governments (Grimmelikhuijsen, 2013).

More recently, research has focused on how an increase in transparency stimulates economic growth, where the outcome of “public reuse of government data is anticipated to provide economic and social value to spur growth, promote a knowledge economy, and help the public help itself” (Linders, 2011). In particular, U.S. transparency policies highlight potential economic benefits of transparency, especially as a consequence of releasing data to the public (Orszag, 2009; Linders, 2011; Burwell, 2013). Former U.S. Chief Information Officer, Kundra (2012) discusses that, “there is an opportunity to create value with government data, and numerous new companies can be built on this data.”

A contemporary working definition of transparency coined by Grimmelikhuijsen et al. (2013) is that “transparency is the availability of information about an organization or actor that allows external actors to monitor the internal workings or performance of that organization.” Hollyer et

al. (2012) developed this definition further suggesting that government data collection and dissemination is a specific dimension of government transparency.

However, the quantification of contemporary government transparency initiatives continues to be debated in the research. With the exception of the Human Genome Project, there has not been extensive empirical analysis to demonstrate the economic impact of open data initiatives (Battelle, 2013).

In the place of empirical research, open government advocates have relied on case studies and anecdotes to showcase how open data and transparency initiatives spur innovation and drive economic growth. For example, the Open Data 500 project at New York University's the Governance Lab (GovLab) is working to compile a list of companies throughout the U.S. that use open data. Jetzek (2012) notes the anticipated outcomes of sharing more government data:

As most OGD [open government data] initiatives are relatively recent, the key questions regarding the value proposition and return on investment of these initiatives remain unanswered... [Nevertheless,] we expect OGD initiatives to generate value and substantial returns through increased transparency, efficiency of government activities, citizen participation, and entrepreneurial activity.

In addition to the definition of transparency being imprecise, there is also great variability in how and to what extent transparency programs are implemented across various countries (Yu, 2012; Meijer, 2013). One of the challenges that this creates is that "the absence of formal definitions, criteria, and metrics around government openness deprives agencies of clear guidance and milestones" (Linders, 2011). However, since the measurement of transparency remains "elusive," the term continues to be used with "great liberty" (Hollyer, 2012; Grimmelikhuijsen, 2013).

The predominant method in the literature is to use corruption as a proxy for transparency (Mauro, 1995; Zhao, 2003; Varsakelis, 2006; Bertot, 2010; Broberg, 2012; Hollyer, 2012). Researchers measure government transparency as the extent of corruption using Transparency International's Corruption Perceptions Index (CPI) score (Varsakelis, 2006; Broberg, 2012; Zhao, 2003). Mauro argues that "corruption lowers private investment, thereby reducing economic growth" (Mauro, 1995; Furman, 2002; Zhao, 2003). In the present study, a decrease in corruption is used as a proxy for an increase in transparency; therefore, the assumption is that an increase in transparency is predicted to increase innovation.

Innovation

There are also limitations in measuring innovation outputs because of the complexity of defining innovation. The literature has traditionally measured innovation by the amount of public budget allocated to R&D or the number of research articles published (Furman, 2002; Varsakelis, 2006; Broberg, 2012; Dutta, 2012).

Broberg (2012) shows how formal government structures lead to increased innovation by examining how political institutional structures can positively promote private sector innovation. As a consequence, research on national innovative activity focuses on how political and institutional infrastructure can spur innovation (Furman, 2002; Varsakelis, 2006; Broberg, 2012).

Broberg (2012) finds that variation in national public institutional structure affects two types of innovation – the number of scientific articles published and the number of patents granted. The number of scientific and technical articles is used as a measure of "basic innovative

activity;” whereas the number of patents by residents of a country describes “applied innovative activity” (Broberg, 2012).

Innovation research differentiates outcomes based on creation of knowledge versus creation of businesses or products. Basic innovative activity leads to the creation of knowledge; whereas applied innovation focuses on the potential economic impact that the innovations might bring, such as the creation of new products or businesses (Broberg, 2012; Dutta, 2012). As a result, the predominant method in the literature to measure applied innovation activity is to use resident patents (Furman 2002; Varsakelis, 2006; Broberg, 2012).

In those countries with strong judicial systems, Varsakelis (2006) argues there is a positive relationship between these more developed governmental institutions on innovative activity. In his research, Varsakelis (2006) designated the number of resident patents as a measure of innovation and concluded that developed governmental institutions are more likely to protect and enforce patent laws, and therefore, promote innovation. Researchers have debated the limitations of measuring innovative activity, as the number patent applications since this measure does not capture all the nuances of innovation (Griliches, 1998; Furman, 2002). Nevertheless, in this study, “resident patent applications” are used to measure applied innovation activity. As government policies highlight the benefit of openness to increase innovation, this study attempts to examine the association on government transparency on innovation. In addition, this paper attempts to determine if there is a difference for countries participating in the OGP.

DATA AND METHODOLOGY

Data

This study uses a sample of 95 countries from 1996 to 2011 to test the association of transparency and innovation using panel data methodology. 54 countries in the sample are members of the Open Government Partnership (OGP) (See Appendix A, Exhibit A.1). The study uses the World Bank Open Data STATA module to access World Bank databases, accessed as of April 2014, including data from World Intellectual Property Organization (WIPO) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. Data on corruption from Transparency International's Corruption Perceptions Index (CPI) score were obtained directly from Transparency International's research team in August 2013.

Based on literature on innovation and government transparency, control variables that have been included are: 1) drivers of innovation using research and development expenditures as a percentage of GDP, and GDP per capita; and 2) perception of governance using the Worldwide Governance Indicator "Voice and Accountability."

Based on a review of the literature and theory, Exhibit 1 outlines the expected relationships between the dependent and the independent variables:

Exhibit 1: Hypothesized effects and rationale of variables selected for this study

Variable Description	Variable Name	Source	Expected Sign	Rationale
Dependent Variable				
Natural log of patent applications of residents of that country	lnpatentres	World Intellectual Property Organization (WIPO) – World Intellectual Property Indicators	N/A	Varsakelis (2006); Furman (2002)
Primary Independent Variable				
Corruption Perceptions Index score	CPI	Transparency International (Note: 0-10 scale, 0=highly corrupt, 10=“clean”/least corrupt)	Positive	Varsakelis (2006); Zhao (2003); Shim (2008)
Control Variables				
Research and development expenditure as a percentage of GDP	research	United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics	Positive	Varsakelis (2006); Furman (2002); Broberg (2012)
Natural log of GDP per capita (current US\$)	lnGDP	World Bank national accounts data, and OECD National Accounts data files	Positive	Relly (2008); Furman (2002); Broberg (2012); Mauro (1995)
World Governance Indicator – Voice and Accountability	voiceacct	World Bank World Governance Indicators research project	Positive	Varsakelis (2006); Relly (2008)

Dependent Variable

The dependent variable used in this study is the number of patent applications by country residents. This measure of applied innovation activity is in natural log form to address nonlinearity (Stock, 2011). The source of the data is the World Intellectual Property Indicators from the World Intellectual Property Organization. The World Bank Catalog describes:

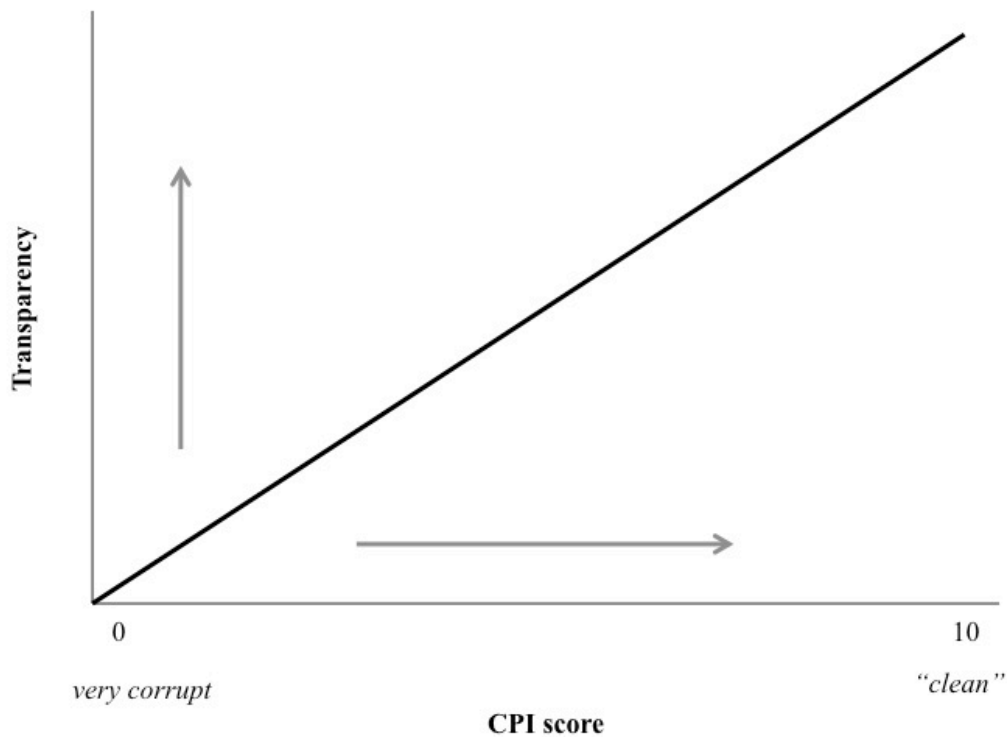
Resident patent applications [as] those for which the first-named applicant or assignee is a resident of the State or region concerned. Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office.

Primary Independent Variable

Research on government transparency has regularly used Transparency International's CPI score as a measure for corruption. In this study, a decrease in corruption is used as a proxy for an increase in government transparency as the primary independent variable.

CPI is a composite score of perceptions on corruption based on a survey of individuals from the public and private sectors. CPI has been measured annually since 1995. The index is compiled from the surveyed perceptions and is reported on a scale of 0 to 10, where 0 is a country that is perceived to be very corrupt and 10 is a country perceived to be "clean" of corruption. Therefore, an increase in the CPI score to 10 means that the country is less corrupt and is therefore considered to be more transparent. The relationship between CPI score and transparency is illustrated in Exhibit 2. In 2012, Transparency International implemented a new testing methodology; therefore, this study only uses CPI scores through 2011.

Exhibit 2: Illustrated relationship of Corruption Preceptions Index (CPI) score and transparency



Control Variables

The present study's control variables include research and development expenditure measured as a percentage of GDP, Gross Domestic Product (GDP) per capita, and the World Bank Worldwide Governance Indicators (WGI) governance indicator "Voice and Accountability."

Research and development expenditure data are from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. The source of GDP per capita data is the World Bank national accounts data and OECD National Accounts data.

At the time of Varsakelis' research (2006), there were not enough country-year observations from the WGI, so he used governance indicators from Freedom House. WGI covers 212 countries on six different governance indicators: Voice and Accountability, Rule of Law, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, and Regulatory Quality. Prior to 2002, WGI was only measured every alternate year. Since 2002, however, WGI has been measured annually. WGI is used in this study, instead of using the Freedom House governance indicators, because WGI provides sufficient country-year observations. Specifically, WGI's Voice and Accountability estimates are used as a control variable in this study. Based on Varsakelis' (2006) research, Rule of Law was considered as an additional control variable but was not included in the final model in the present study because it demonstrates high correlation with the primary independent variable of interest CPI (See Appendix B – Diagnostics). The World Bank Database describes Voice and Accountability as "the process by which governments are selected, monitored, and replaced." This variable captures "perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media" (Kaufmann, 2010).

Open Government Partnership

In order to determine OGP membership, countries were designated an OGP member country if that country had signed the Open Government Declaration as of January 2014. This variable was set as a dummy variable indicating whether the country was a member of the OGP or not. Of the 63 countries that currently participate in the OGP, 51 are included in the dataset, since there were data available on both patents and CPI for these countries.

Model Specification

This paper uses fixed effects regression to evaluate the association of government corruption and innovative activity and to test whether the association is different for countries participating in the OGP. Again, innovative activity is measured by the number of patent applications of residents of that country (Varsakelis, 2006; Broberg, 2012; Furman 2002), while corruption is measured using Transparency International's CPI score (Varsakelis, 2006; Broberg, 2012; Zhao, 2003).

After post-estimation tests, an initial regression was further refined (See Exhibit 3, and see Appendix B – Diagnostics). Model diagnostics indicate several potential problems with the model: heteroscedasticity, multicollinearity, and model misspecification (See Appendix B for details of diagnostic tests). The data are declared to be panel data because the f-test null hypothesis, that there is no difference between the countries, is rejected. In addition, country and year fixed effects are included to take into consideration the variability of the data over time. Since the data are not homoscedastic, the regression includes robust standard errors. Additional control variables were also tested to address model specification problems. The addition of trade and labor force education level considerably dropped the number of country-year observations, and did not substantially change the outcome of this study. In addition, the WGI "Rule of Law" was considered but was not included since this variable demonstrated high correlation with the primary independent variable of interest CPI (See Appendix B – Diagnostics). The model includes the interaction term OGP member and CPI to test if there is a difference for countries participating in the OGP (See Exhibit 3).

Exhibit 3: Model and variable definitions

Model: $\ln\text{patentres}_{it} = \beta_0 + \beta_1(\text{CPI}_{it}) + \beta_2(\text{researchexp}_{it}) + \beta_3(\ln\text{GDP}_{it}) + \beta_4(\text{voiceacct}_{it}) + \beta_5(\text{OGPmember}_{it}) + \beta_6((\text{OGPmember} * \text{CPI})_{it}) + \alpha_i + u_t + \varepsilon_{it}$	
Observations: 774 country-year observations of 95 countries from 1996 – 2011	
Variable Name	Definition
lnpatentres	Natural log of annual patent applications by residents of that country
CPI	Corruption Perceptions Index score (primary independent variable of interest)
research	Research and development expenditure (percentage of GDP)
lnGDP	Natural log of GDP per capita (current US\$)
voiceacct	Voice and Accountability World Governance Indicator estimate
OGPmember	Dummy variable indicating if country is a member of OGP
OGPmember*CPI	Interaction term of OGPmember and CPI to test the difference in the association of transparency and innovation for members of the OGP
β_j	Coefficients of each variable (j=1-5); Constant (j=0)
α_i	Unobserved country specific fixed effects (i=1-95)
u_t	Unobserved year specific fixed effects (t=1-13)
ε_{it}	Random variation

EMPIRICAL RESULTS AND ANALYSIS

This study examines the association of government transparency and innovation activity. Using corruption as a proxy for transparency and patents as a measure of innovation, the study tests the assumption that an increase in transparency increases applied innovation, particularly for those countries participating in the Open Government Partnership (OGP).

Table 1 presents the results of the regression analysis. The interaction term OGPmember*CPI is added to understand if the effective CPI is different for members of the OGP versus those countries that are not members. Model 1 presents results from the OLS regression, Model 2 shows estimates from the random coefficients model, and Model 3 shows results from the fixed effects model.

The results from the OLS regression (Model 1) do not control for the unobservable characteristics for each country and time period, therefore random coefficients and fixed effects regression models were also examined. A random coefficients model (Model 2) was estimated because it appeared that the coefficients on CPI would change by country. The random coefficients model estimates the distribution for a coefficient, instead of a point estimate. In Model 2, the variability on the coefficient for each country is the estimated standard deviation of the coefficient (CPI SD = 0.272, research SD = 0.755, lnGDP SD = 0.194, voiceacct SD = 0.601, constant SD = 1.56).

The fixed effects model (Model 3) was estimated because the random coefficients model can not control for country fixed effects. In addition, if there are time invariant unobservable characteristics that differ across countries, the fixed effects model will control for them. The estimated coefficients are similar in both models; therefore, the results will be interpreted using

Model 3, the fixed effects model. Note that the variable on OGP membership is excluded from the fixed effect regression because OGP membership status does not change in this model.

Recall that countries were determined to be a member of the OGP based on whether or not that country had signed the Open Government Declaration in January 2014.

Table 1: Multiple regression models for panel data of 774 country-year observations +

Variable Description	Variable Name	Model 1	Model 2	Model 3
		OLS model	Random coefficient model	Fixed effects Model
Corruption Perceptions Index score	CPI	-0.63*** (-7.51)	0.01 (0.12)	0.005 (0.05)
Membership to the OGP (Dummy Variable)	1.OGPmember	-1.31*** (-3.66)	0.12 (0.21)	
Interaction term of OGPmember and CPI	1.OGPmember#c.CPI	0.24*** (3.96)	0.04 (0.4)	0.11 (0.88)
R&D expenditure (% of GDP)	research	1.90*** (10.2)	0.57*** (3.80)	0.54*** (2.84)
Natural log of GDP per capita (current US\$)	lnGDP	0.53*** (4.6)	0.07 (1.36)	0.12 (1.51)
World Governance Indicator – Voice and Accountability	voiceacct	-0.17 (-1.38)	0.12 (0.9)	-0.11 (-0.5)
Constant	Constant	2.76*** (3.20)	4.22*** (7.9)	4.38*** (5.09)
Observations		774	774	774
Number of countries		95	95	95
R-squared		0.42		0.35#

+ Robust t-statistics in parentheses

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

Reported the between R-squared value

The results do not support the hypothesis that transparency and innovation are positively correlated for OGP members because the results are not statistically significant. The null hypothesis that CPI and the interaction between CPI and OGP membership are jointly equal to zero can not be rejected ($p\text{-value} = 0.31$). For non-OGP members, the results are also not statistically significant.

The signs on the coefficients of the drivers of innovation – research and development expenditures as a percentage of GDP, and GDP per capita – are consistent with the original hypothesis that these variables would have a positive effect on innovation (See Exhibit 1). On the other hand, the coefficient on the Worldwide Governance Indicator “Voice and Accountability” did not have positive effect on innovation, which was inconsistent with the original hypothesis (See Exhibit 1). Yet, only the coefficient on research and development expenditures as a percentage of GDP is statistically significant indicating that the payoff in increasing R&D investment is an increase in innovation (See Table 2).

As many open government policies and transparency initiatives highlight the potential of such transparency initiatives to increase innovation, economic growth and job creation, one possible explanation for the outcome of this study is omitted variable bias. As mentioned earlier, trade, level of labor force education, and the government indicator “Rule of Law” were considered for this study but were not pursued because these controls either did not pass diagnostic tests or did not substantially change the outcome of the study. Since transparency and innovation are multidimensional, additional variables might be considered in future studies to further control the model.

POLICY IMPLICATIONS

Research on government transparency has traditionally focused on political and social benefits, such as government accountability and civic participation. However, current government transparency policies in the U.S. highlight the potential economic benefits of transparency, particularly as a result of releasing data to the public (Orszag, 2009; Linders, 2011; Burwell, 2013). Although the policies associate government transparency with positive economic growth, additional research is needed to fully understand the nature of the association.

Currently, transparency policies are focused on increasing the *amount* of data that are made available to the public. Since open data and open government policies have only been recently implemented, future research should assess how the amount and extent of use of open data are driving innovation and improving economies. By demonstrating a positive relationship between transparency and innovation, additional research could justify the implementation of additional open government and open data policies.

Although open government initiatives are shifting to data collection and dissemination, there is yet no direct measure of this dimension of transparency. Although using corruption as a proxy for transparency is an established method in government transparency and open government research, researchers agree that there needs to be a more direct measure of transparency, particularly to capture the extent of data dissemination and utilization.

Some researchers have tried to create new measures and indexes of transparency, although these are seemingly narrow in focus. For example, Hollyer et al. (2013) have recently developed an alternative measure of transparency, referred to as the “HRV Index,” which focuses on “the collection and dissemination of credible economic data by national statistical offices” (Hollyer,

2013). However until an alternate measure better represents transparency over time, corruption is likely to continue to be used as a proxy in transparency research.










In addition, researchers have debated the limitations on measuring innovative activity as the number patents applications since this measure does not capture the nuances of innovation (Griliches, 1998; Furman, 2002). Research conducted by a consortium of organizations, including INSEAD and the World Intellectual Property Organization, developed the Global Innovation Index (GII) to attempt to measure innovation more holistically. Launched in 2007, this index examines a country's innovation on multiple parameters from the public and private sector and takes into consideration the importance of innovation to drive economic growth.

The present study attempts to add to the body of research on open government and to empirically evaluate the association of government transparency and innovation and to examine the difference in association for countries participating in the OGP. Although the results are not statistically significant, the study makes an initial attempt to quantify the association of government transparency and innovation. Additional research would help justify the implementation of open government policies and encourage more countries to participate in the Open Government Partnership.

APPENDIX A

*Exhibit A.1: Number of years of data from 1996 – 2011 available for Open Government Partnership (OGP) member countries (54 countries) and countries not participating in OGP (41 countries)**

OGP Member	Country Name	Number of Years	96	98	00	02	03	04	05	06	07	08	09	10	11
Yes	Canada	13													
Yes	Czech Republic	13													
Yes	Finland	13													
Yes	Hungary	13													
Yes	Ireland	13													
Yes	Israel	13													
Yes	Mexico	13													
Yes	Netherlands	13													
Yes	Spain	13													
Yes	United Kingdom	13													
Yes	United States	13													
Yes	Bulgaria	12													
Yes	Colombia	12													
Yes	Denmark	12													
Yes	Estonia	12													
Yes	Korea (South)	12													
Yes	Latvia	12													
Yes	Romania	12													
Yes	Slovakia	12													
Yes	Turkey	12													
Yes	Ukraine	12													
Yes	Croatia	11													
Yes	Lithuania	11													
Yes	Argentina	10													
Yes	Azerbaijan	10													
Yes	Brazil	10													
Yes	Norway	10													
Yes	Armenia	9													
Yes	Moldova	9													
Yes	Sweden	9													
Yes	Australia	8													
Yes	Serbia	8													
Yes	Italy	7													
Yes	South Africa	7													
Yes	Uruguay	7													
Yes	Guatemala	6													
Yes	Macedonia, FYR	6													
Yes	Tunisia	6													
Yes	Greece	5													
Yes	Malta	5													
Yes	Mongolia	5													

No	Morocco	3					
No	Ethiopia	2					
No	Burkina Faso	1					
No	Jamaica	1					
No	Mauritius	1					
No	Vietnam	1					

* Country is designated an OGP member country if that country has signed the OGP declaration as of January 2014, based on information provided at <http://www.opengovpartnership.org/countries>

APPENDIX B – DIAGNOSTICS

Poolability

The Wald test on the interaction of country indicators and CPI indicates that the slopes of CPI for each country are different (Table B.1). The null hypothesis of this test is whether the CPI and the country indicators are jointly equal to zero. Although the effects in each country are different ($p < 0.001$), the data are pooled in this study to determine the overall effect of CPI on all countries.

Table B.1: Wald Test to determine poolability

Test			Interpretation
Wald Test of list of the interactions between CPI and country indicators	F-statistic	Prob>F	Reject the null hypothesis
	8643.62	<0.001	

Multicollinearity Examination

The original model for this study included two governance indicators, as recommended by Varsakelis (2006): World Bank World Governance Indicators “Voice and Accountability” and “Rule of Law.” Upon examination of the correlation coefficients between the independent variables, the control variable “Rule of Law” (rulelaw) was removed from regression analysis because this variable demonstrates a 94 percent correlation with the primary independent variable of interest CPI (Table B.2).

*Table B.2: Descriptive statistics and correlation coefficients between independent variables**

Variable Description	Variable Name	Descriptive Statistics				Correlation Coefficients				
		Mean	S.D.	Min	Max	CPI	research	lnGDP	voiceacct	rulelaw
Natural log of patent applications of residents of that country	lnpatentres	6.44	2.55	0	12.94					
Corruption Perceptions Index score	CPI	5.23	2.37	1.5	10					
Research and development expenditure as a percentage of GDP	research	1.16	1.01	0.02	4.84	0.73*				
Natural log of GDP per capita (current US\$)	lnGDP	9.07	1.39	5.07	11.63	0.83*	0.67*			
World Governance Indicator – Voice and Accountability	voiceacct	0.45	0.93	-1.87	1.83	0.76*	0.55*	0.74*		
World Governance Indicator – Rule of Law	rulelaw	0.50	0.98	-1.37	2.0	0.94*	0.70*	0.84*	0.84*	
Membership to the OGP	OGPmember	0.60	0.49	0	1	0.03	0.03	0.10*	0.27*	0.04

* Denotes pair-wise correlation coefficients are significant at 5%.

Model specification

The Wald test of country fixed effects tests the null hypothesis that the coefficients on country indicators are jointly equal to zero. The results of this test indicate that countries should be controlled since the null hypothesis is rejected ($p < 0.001$) (Table B.3). The Wald test of year fixed effects tests the null hypothesis that the coefficients on year are jointly equal to zero. The results of this test indicate time should also be controlled since the null hypothesis is rejected ($p < 0.001$) (Table B.3).

The Hausman test determines whether the fixed effects model or random effects model is appropriate (Table B.3). A random coefficients model was also estimated to allow the coefficients to change between countries, whereas the fixed effect model controls for all country characteristics that do not change over time. Since the coefficients are not the same, we use the fixed effects model as the unbiased estimator. Despite these tests, the analysis is conducted with these limitations in mind.

Table B.3: Determining model specification with Wald and Hausman Tests

Test			Interpretation
Wald Test of country fixed effects	F-statistic	Prob>F	Reject the null hypothesis that fixed effects are zero; therefore include country fixed effects
	50071.96	<0.001	
Wald Test of year fixed effects	F-statistic	Prob>F	Reject the null hypothesis that fixed effects are zero; therefore include year fixed effects
	4.12	0.02	
Hausman Test	Chi2	P>Chi2	Reject the null hypothesis that the coefficients for fixed effects and random effects are the same. Since the coefficients are not the same, we use the fixed effects model as the unbiased estimator.
	36.32	<0.001	

The Ramsey test for omitted variables indicates that there might be problems with omitted variable bias (OVB) or functional form (Table B.4). This study will accept OVB because of the limitations of the data. As discussed in the body of the paper, additional control variables – trade, level of labor force education, and the government indicator “Rule of Law” – were considered for this study, but were not pursued because these controls either did not pass diagnostic tests or did not substantially change the outcome of the study. In addition, future research might consider testing new measures for transparency or innovation, such as Hollyer et al.’s (2013) “HRV Index” and the INSEAD and the World Intellectual Property Organization’s Global Innovation Index (GII), respectively.

The Link Test for model specification indicates that an alternate model might be considered (Table B.4). Despite possible problems, the analysis is conducted with these limitations in mind.

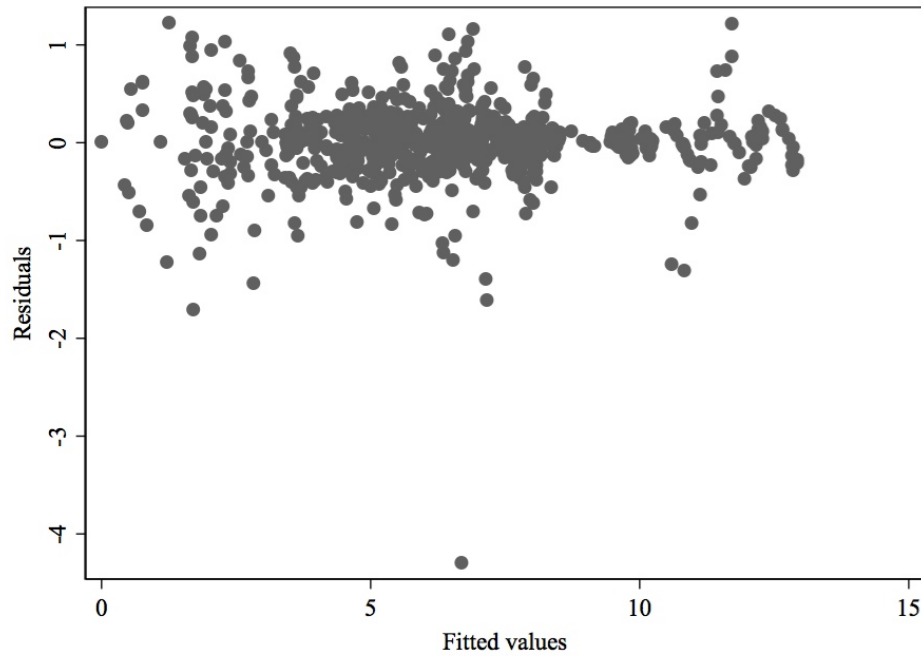
Table B.4: Ramsey and Link Tests

Test			Interpretation
Ramsey Test of regression specification-error test for omitted variables	F-statistic	Prob>F	Reject the null hypothesis
	73.14	<0.001	
Link Test	P-value of:		Reject the null hypothesis
	Hat	Hat_sq	
	<0.001	<0.001	

Homoscedasticity

Multiple post-estimation tests indicate that the data are not homoscedastic, based on post-estimation tests of the OLS multiple regression test. This can also be seen visually in a plot of residuals against the fitted values (Exhibit B.1). The distribution of residuals varies with the predicted value of natural log of annual resident patents suggesting a violation of the assumption that the variance of the error term is constant, conditional on the independent variables.

Exhibit B.1: Model specification test – residuals against the fitted values



The Breusch-Pagan / Cook-Weisberg test for homoscedasticity and the White's test indicates that the regression model should include robust standard errors (Table B.5). The tests confirm the hypothesis drawn from the graph, therefore robust standard errors have been included in the analysis.

Table B.5: Results of post-estimation tests to test for homoscedasticity

Test			Interpretation
Heteroscedasticity Test (Breusch-Pagan / Cook-Weisberg test for heteroscedasticity)	F-statistic	Prob>F	Reject the null hypothesis that the data is homoscedastic
	140.18	<0.001	
White's Test	Chi2	P-value	Reject the null hypothesis that the data is homoscedastic
	410.99	<0.001	

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