12-2014

# Corruption and Productivity

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# CORRUPTION AND PRODUCTIVITY

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A Thesis
Presented to
the Graduate School of
Clemson University

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In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
Economics

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by
Christopher Moor Kelly
December 2014

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Accepted by:
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**ABSTRACT**

Corruption is suggested to have a negative impact on productivity and thus growth. Several studies have studied the relationship closely, including Hall and Jones (1999) and Lambsdorff (2003). This paper seeks to build on their foundation and specify a new and robust model by looking at the effect of corruption controls on total factor productivity through a two-stage least squares regression. Since it is through public institutions that corruption manifests, also examined are differences between 'inclusive' and 'extractive' institutions. Also important is the degree to which a state is centralized. Extraction by way of corrupt institutions differs in highly centralized states and highly disordered states. It is through this framework that the relationship between productivity and corruption is analyzed.

# DEDICATION

This paper is dedicated to my four loving grandparents, to whom I owe everything.

Thank you for your unconditional love and support.  I would not be here without it.

## ACKNOWLEDGEMENTS

A special thank you to my family for all their support, understanding, and patience. I would also like to personally thank my committee members, Drs. Scott Baier, Robert Tamura, and Scott Templeton for their time and instruction. Drs. Thomas Mroz, Jacqueline Oliveira, and Michal Jerzmanowski have also been invaluable advisors. I owe much to their council.

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"I do not pretend to understand the moral universe; the arc is a long one, my eye reaches but little ways; I cannot calculate the curve and complete the figure by the experience of sight; I can divine it by conscience. And from what I see I am sure it bends towards justice."

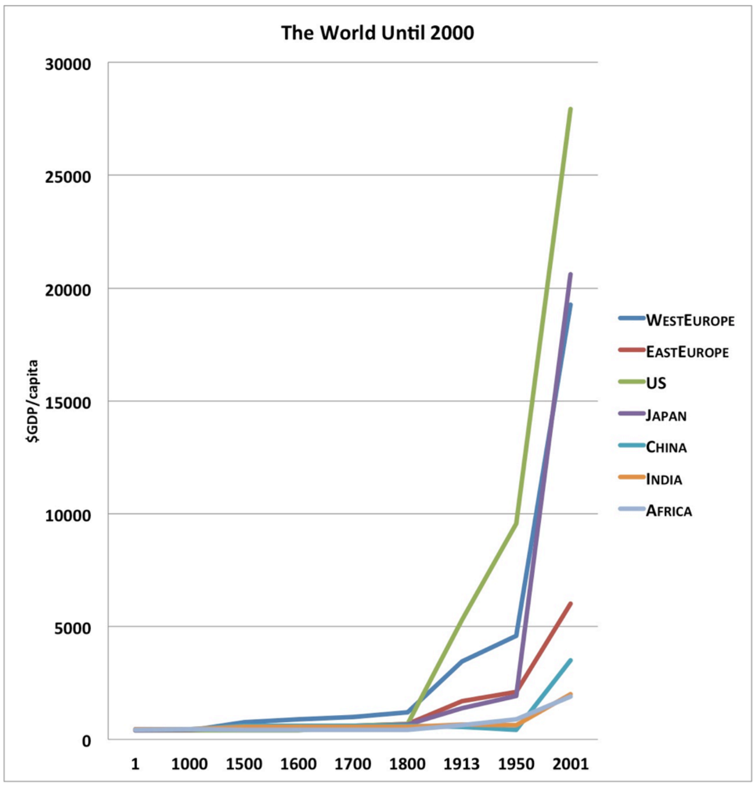
– Theodore Parker

# I. INTRODUCTION

The objective of this paper is to describe the significance, strength, and direction of the relationship between effective corruption controls and aggregate productivity. Previous research has found evidence that economies able to effectively control corruption are more productive (Lambsdorff 2003, Hall and Jones 1999). This paper seeks to build on their foundation and introduce a new model to examine current data over a longer period with a considerably larger sample in the hopes of establishing a more robust relationship.

Productivity is the measure of how much output an economy can produce with a given set of labor and capital inputs. It is a measure of efficiency. Levels of productivity and wealth vary greatly between nations and have been on divergent paths since the late 18th century, as in Graph 1. This paper looks at how the *control* of corruption might play a significant role in such divergence. If corruption is controlled, market access is unrestricted, property rights are secure, and transaction costs are predictable. Workers and firms in nations with weak corruption controls are less willing to take risks, as corruption limits market access, weakens property rights, and increases uncertainty, thus eroding work incentives. It follows that workers produce less with the inputs at their disposal if working harder has no rewards. Weak property rights, a telltale sign of corrupt governments, discourage investment in new ideas. Firms face higher business costs. Bribes increase the cost of new projects. If permits can only be purchased with an expensive bribe, it's difficult for firms to enter new markets. Poor or low-quality infrastructure raises transportation costs. The idea that corruption levels affect productivity and output is called the institutions hypothesis.

**Graph 1: The Great Divergence**[1]

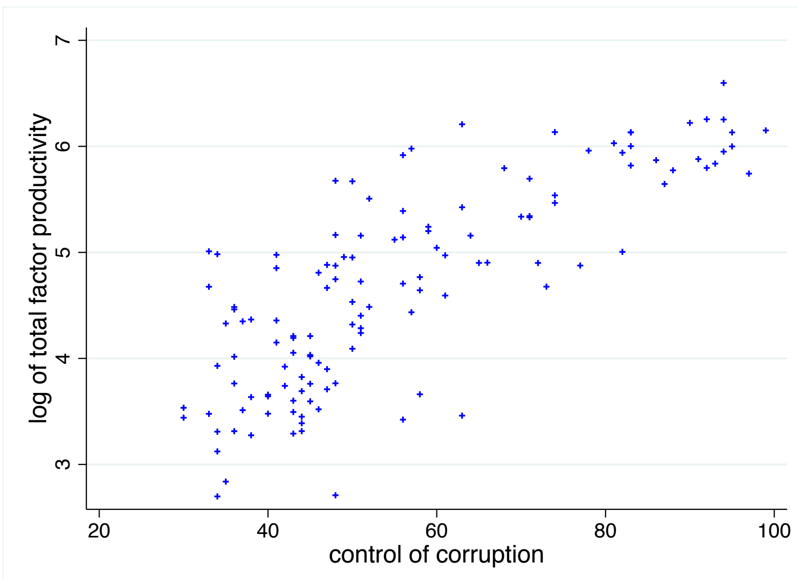



The institutions hypothesis is the focus of the research presented. It states that governing institutions, and any endemic corruption, are significant determinants of aggregate productivity and output. It is these institutions, themselves agents of the government, that have the authority to decide terms of trade, pass laws, issue permits, extract tax revenue, and provide a means of legal recourse. They siphon resources from

[1] Courtesy of *The Atlantic*

the market and enact entry barriers, increasing the cost of doing business and reducing competition. Corrupt officials in institutions like the judiciary, constabulary, or regulatory agencies use their position to extract bribe money, enforce monopolies, expropriate land, or otherwise divert the flow of resources once destined for the marketplace. They ration permits and market access, increasing costs for firms. Supply falls and prices rise (see Graph 4). There is little motivation to produce, create, or pursue education if there are no rewards for doing so. Institutions in less productive nations are more corrupt, as visible in Graph 2.

**Graph 2: National economies by productivity and corruption controls, 2011.**




Conversely, institutions in highly productive nations are more inclusive and assure a level playing field for economic actors. Inclusive institutions act as facilitators by establishing a competitive marketplace through the enforcement of property rights. People and firms are incentivized to take risks and explore new markets. Strong public services, like comprehensive education and an unbiased legal system, empower would-be entrepreneurs, inventors, and academics.

There is another hypothesis that offers additional insight on the productivity gap between nations. The geography hypothesis predicts that productivity and growth are largely determined by geographic variables like rainfall, latitude, and temperature. Nations that are 'lucky' enough to have good natural resource endowments, enough water and land to grow crops, seasonal weather patterns, and access to coastal waters are expected to be wealthier and more productive. The geographic hypothesis has been advocated by Diamond (1997); Gallup, Sachs, and Mellinger (1999); and Sachs (2001, 2003). The model proposed in this paper uses a multiple regression analysis to parse out the effect different variables have on productivity, so it is an easy matter to control for geographic variables.

The following sections provide the framework for the new model presented in this paper. Section II defines productivity in the context of the new model and elaborates on the theoretical determinants. Section III is a detailed look at how institutions evolved, so to more fully understand their impact on aggregate wealth differences and thus inform the new model. Section IV looks at natural experiments and case studies. Sections V and VI describe the models of previous papers and the one presented here, respectively. The paper ends with an analysis of the regression results. Regression tables, variable summaries, and other additional data are included in the Appendix.

## II. PRODUCTIVITY

Productivity is a measure of how efficient an economy is with its current capital stock and labor force. This includes, but is not limited to, technology levels, governance, and weather (Syverson 2011). Productive economies can produce more output without necessarily increasing the number of inputs. Workers are more efficient with the resources they already possess. The measure of productivity used in the new model captures aggregate productivity, allowing for comparison between national economies. This is accomplished with a simple Cobb-Douglas production function that interacts productivity (A) with capital (K), labor (L), and human capital (H) to produce output (Y) in the following form[2]:

$$Y = A(K^{\alpha} HL^{(1-\alpha)})$$

All variables can be sampled, except for the unobservable measure of aggregate productivity, or total factor productivity (tfp).

$$GDP_i = (tfp)[(Capital\ Stock_i)^{\alpha}(Human\ Capital_i)(Labor\ Force_i)^{(1-\alpha)}]$$

Now it is possible back out a measure of productivity consistent across all observations.

$$tfp_i = \frac{GDP_i}{(Capital\ Stock_i)^{\alpha}(Labor\ Force_i)(Human\ Capital_i)^{(1-\alpha)}}$$

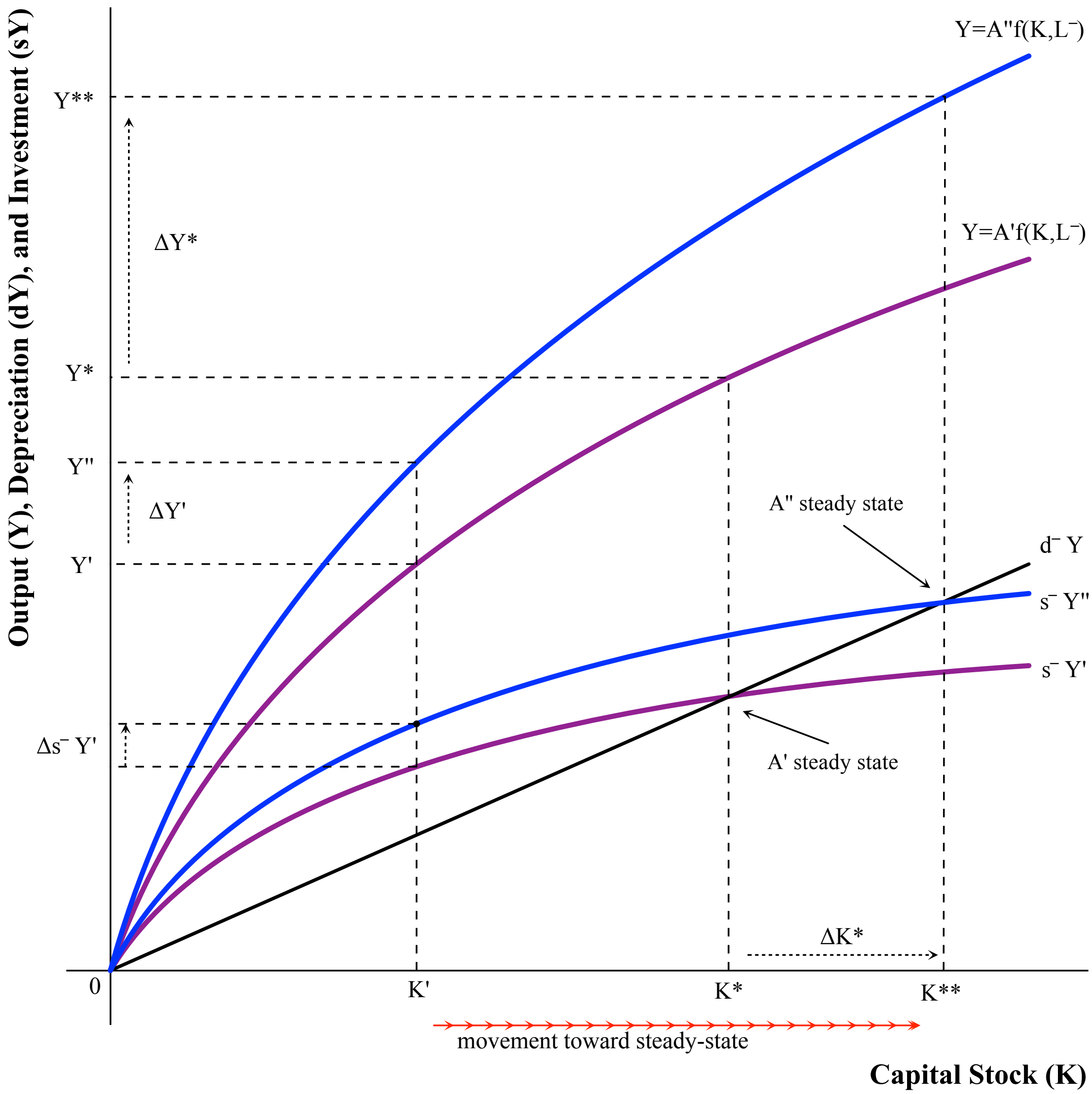
[2] Measures of GDP and labor come from the World Bank, capital stock and human capital come from the Penn World Table.

The function says that no matter how much capital and labor an economy can deploy, it is still dependent on other factors that influence the effectiveness of either input. This paper operates under the assumption that $\alpha = .35$. An alternative calculation of tfp (*tfpalt*) where $\alpha = .3$, is also suggested to accurately capture capital share of output, and will be analyzed in Section VII.

Graph 3 establishes a baseline for looking at how changes in productivity affect economic potential through the Solow model. Output is given by the aforementioned production function, where human capital is included as part of labor (L). An increase in productivity from A' to A'' shifts the output curve upward from the purple to the blue line. In an economy with a set capital stock K' and a fixed labor supply, the productivity boost increases aggregate output by ΔY'. The economic potential (Y*) at the steady-state increases proportionally more, by ΔY*, since the increased investment ($\Delta\bar{s}$ Y') allows for more accumulation of capital, given the constant rate of depreciation ($\bar{d}$Y). At any level of capital stock, labor, depreciation, and savings, any increase in productivity will increase output. The less productive economy (purple function) will reach a steady state (K*) at a lower level of output. Increases in productivity change the maximum amount of deployable capital, indefinitely postponing a steady-state equilibrium.

So what caused productivity to increase so rapidly in those specific 18th century economies? Many variables that are theorized to affect productivity like natural resource endowment and climate are exogenous, given, and cannot be changed by policy or government intervention. To account for changes in productivity, it is necessary to identify other components that are more flexible.[3]

**Graph 3: Solow model**




3 Please note that in the model presented in this paper human capital is used in the productivity (tfp) calculation as a weighting for the labor force. Changes in human capital do affect productivity, but only in calculating the tfp value. For this paper productivity is a measurement of how effectively the available labor force, as weighted by their human capital, utilizes the capital stock.

## TECHNOLOGY

First let us discuss technology as one of these determinants. Technology certainly increases productivity, but a nation is not endowed with a specific number of technologies. Technology disseminates. Humans are industrious creatures and if provided with technology that begets additional utility or profit, like a new innovation, adoption soon follows.

Technology flows downhill between countries. Given the right incentives any technology widely utilized in one country will have little difficulty hopping borders. This diffusion has certainly accelerated because of the Internet. The delay in technology diffusion has certainly diminished. Just Google it! But while access to advanced technology can certainly increase efficiency, there is no guarantee of widespread adoption in countries where private property rights are weak. If corrupt authorities appropriate much profit and income, returns on investments are uncertain and work is de-incentivized. New technology becomes less appealing. Why buy expensive new machines when the risk of appropriation is high? Concurrently, the ruling elites have strong incentives to make procurement of new technologies difficult where it could threaten their political or business interests. The printing press, for example, was outlawed in the Ottoman Empire for its first 250 years because literacy was seen as a potential threat to the sultan.

## GEOGRAPHY HYPOTHESIS

An alternative, or perhaps additional, explanation for the productivity disparity is that geographic variables have had a profound effect on productivity and output. Diamond (1997) traces the effect of resource endowment through early human development in the hope of explaining the great disparity between wealthy and poor states. His thesis begins deep in prehistory, around the Neolithic Revolution circa 10,000 BCE. Hunters and gatherers in certain parts of the world were better able to make the transition to sedentary life due to abundance of domesticable flora and fauna. This led to some regions like Europe, China, and the Middle East to begin accumulating capital at an earlier moment while populations in other regions like the Americas and Polynesia were still itinerant. Denizens of early settlements could now collect and store things that previously would have been impossible. With stores and surpluses came trade.

Diamond suggests that another key ingredient of the geographic hypothesis is continental alignment. Continents with a latitudinal axis (Eurasia) had broad climate zones that encouraged dissemination of agriculture, writing, and other technologies. Continents along a longitudinal axis (Africa, the Americas) had many more geographic and climate hurdles. Gallup et al. (1999) find that economic growth is likely related to location and climate through disease burdens, agricultural productivity, and transportation costs. Tropical climates are full of disease and difficult soil. Bloom and Sachs (1998) suggest that landlocked countries are also at a disadvantage. Populations isolated from water trade are handicapped, as they must pay higher transportation costs in getting goods from or to international markets.

Natural resource endowments factor into this conversation, as they too are completely exogenous. Resource abundance, in theory, should increase the wealth of any nation. But other studies have found that is not necessarily the case (Sachs and Warner 2001). Both Sala-i-Martin and Subramanian (2013) and Leite and Weidmann (1999) found that natural resources are eminently exploitable by rent-seeking officials, especially in highly centralized bureaucracies. Corrupt officials gobble up the wealth otherwise destined for the greater market. Both studies found that open governance and strong, inclusive, and adaptable institutions are key to reaping the full economic benefits of resource exploitation.

**INSTITUTIONS**

Institutions are a different beast altogether. Effective, inclusive institutions offer secure property rights that protect against predation by public or private agents. They provide the underlying framework upon which people base their decisions. The body of literature uses a number of different terms to identify the channel through which corruption manifests itself in real terms. North (1991) identifies corruption as manifesting through institutions, which are defined as "…the humanly devised constraints that structure political, economic, and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, and property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange." Acemoglu et al. (2001, 2002, 2012) distinguish between inclusive institutions, where property rights are secure, and extractive institutions, where investment and development is obstructed by the threat of expropriation at the hands of a small ruling elite. Hall and Jones (1999) identify corruption as a diversion of resources through social infrastructure. In their words,

> "A social infrastructure favorable to high levels of output per worker provides an environment that supports productive activities and encourages capital accumulation, skill acquisition, invention and technology transfer. Such a social infrastructure gets the prices right so that, in the language of North and Thomas (1973), individuals capture the social returns to their actions as private returns. Social institutions to protect the output of individual productive units from diversion are an essential component of a social infrastructure favorable to high levels of output per worker."

Corruption doesn't, however, manifest uniformly. Populations under weak central governments suffer extraction independent of any central authority. Local authorities are unconstrained in corrupt practices. At the other extreme, highly centralized autocracies closely manage institutions so to extract the maximum total wealth (Shleifer and Vishny 1993). Cheung (1998) identified the same pattern of centralized and decentralized corruption as 'top-down' and 'bottom-up,' respectively.

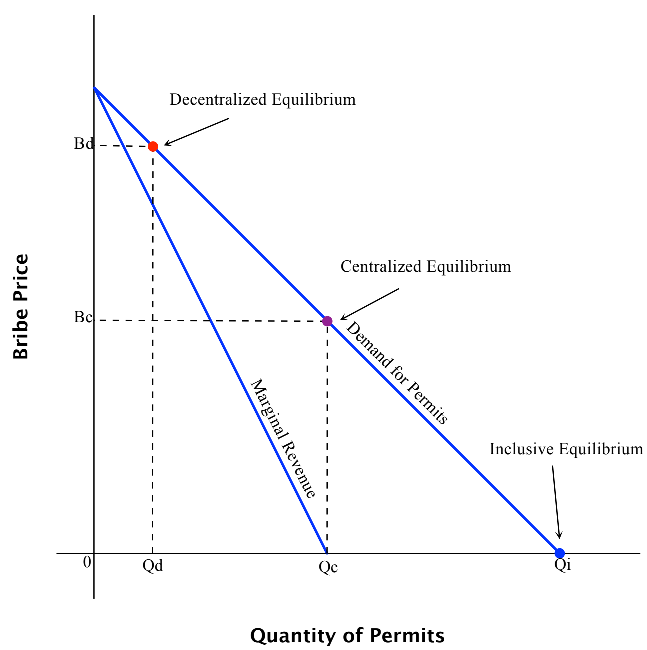
The ruling elite, strongmen, or dons, who use the bureaucracy to extract rents in a controlled way, as in an autocracy or in organized crime, mandate top-down corruption. Here, public servants often act as middle men with bribe money going directly to the central authority. In return they receive kickbacks. Extraction that is constrained this way does not inhibit the economy as strongly, since it is much more predictable (Bardhan 1997). When workers and firms know with certainty what bribes need to be paid, how much, and to whom, they face less risk and are better able to plan ahead. The extra risk and high permit prices faced by new firms still leads to fewer in the marketplace, but there is also the (relative) certainty that unexpected bribes will not be 'levied,' threatening the supply of future income. In this way an economy can still grow and maintain a level of productivity relatively higher than could otherwise be reached in a disordered state.

Where top-down corruption ensures a steady flow of income to the rulers, bottom-up corruption is a free-for-all with each agent extracting as much as possible. When there is an absence of centralized government, officials are free to demand bribes as often as they like. Bottom-up corruption begins with low level bribes, portions of which are used to pay off higher-level officials, all acting in their own self-interests. Bribes must now be paid to most officials. The amount is inconstant without a central authority able to control extraction. Workers and firms face massive uncertainty when regional administrators are independent.

Disordered corruption has a much stronger effect on growth and productivity, as property rights are unenforceable and the risk of unexpected extraction skyrockets. With so many potential bribes to pay and without secure property rights to offer legal recompense, transaction costs skyrocket and output plummets. If the payoff is more uncertain, people are less likely to risk what they have on the hope of higher future returns. A corruption burden de-incentivizes the labor force from engaging in risky behavior. In such a hostile business environment there is little room for growth and expansion. Wei (1997) found that an increase in corruption-induced uncertainty from the level of Singapore to that of Mexico is the equivalent of a 32% tax hike on multinational firms. Other forms of corruption manifest in government contracts, such as over-charging for inferior products.

In both forms of extraction the economic effects are similar: every time an official must be paid to continue business operations, the marginal cost of doing business increases. There is less revenue, and thus less profit. In some ways corruption resembles a tax. Unlike a tax, however, the bribe revenue is not put towards the purchase of infrastructure, capital, welfare programs, or defense (Wei 1997) and is instead spent by elites on private goods.

**Graph 4: bribe price-permit quantity tradeoff**

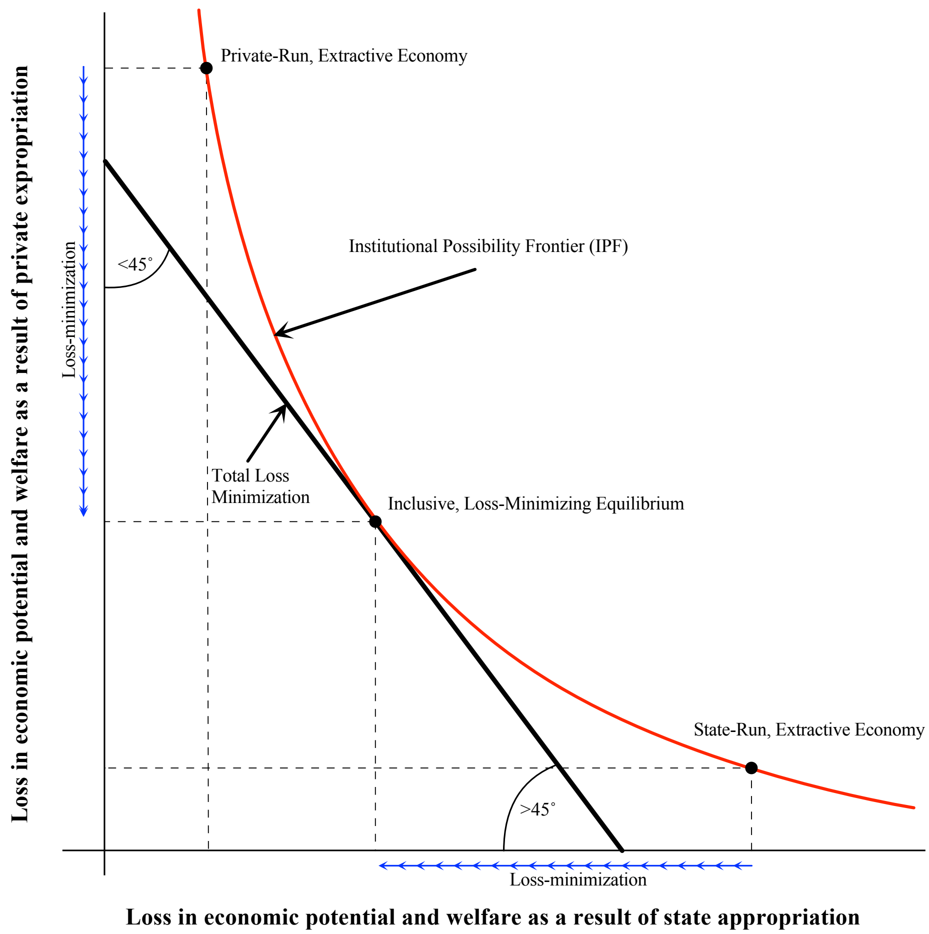



Waller et al. (2002) document the trade off between the level of bribes and the quantity of permits available, as shown in Graph 4. As bribe prices increase, the quantity of permits falls. Under coordinated extraction, as with an authoritarian regime, the autocrat sets bribe levels ($B_c$) to maximize revenues. In a decentralized economy, bribes are set very high ($B_d$) so to maximize revenue for each corrupt official. Because these officials are not acting in unison, bribe demand jumps and the number of permits demanded plummets ($Q_d$). The most permits are available at the inclusive equilibrium ($Q_i$) where no bribes are necessary to access markets. Movement away from disorder and towards inclusion increases the number of permits available in the economy, spurring innovation and entrepreneurship.

Djankov el al (2003) created a theoretical framework that establishes the relationship between institutions of different quality and social welfare loss. The model identifies a trade-off between disorder and dictatorship. As a government decentralizes, disorder must increase. Weak states need stronger central governments to control corrupt agents. Djankov defines disorder as “the risk to individuals and their property of private expropriation in such forms as banditry, murder, theft, violation of agreements, torts, or monopoly pricing…[Disorder] is also reflected in the private subversion of public institutions, such as courts, through bribes and threats, which allows private violators to escape penalties.” Alternatively, dictatorship is the use of the central state to restrict entry into industries, extract resources, and otherwise violate property rights. Corruption, then, is highest in regimes where there is no central government or where the central government is all-powerful.

Graph 5 is based on the one published by Djankov et al. (2003). It has been modified to allow for the important distinction that social loss under a dictatorship are less than in a disordered state. The authors used these two extremes and their associated

**Graph 5: Institutional Possibility Frontier**




social losses to define the tradeoff between disorder (a privately-run nation) and dictatorship (a state-run nation), with an equilibrium where loss, the appropriation of resources by authorities, is minimized. Since a government must levy taxes to fund the institutions that ensure honest exchange, there is no way to reach any equilibrium without social losses.

The institutional possibility frontier (IPF) represents all possible institutional outcomes of any given economy. As disorder increases, so does extraction from officials no longer constrained by central authorities. This situation is endemic in many sub-

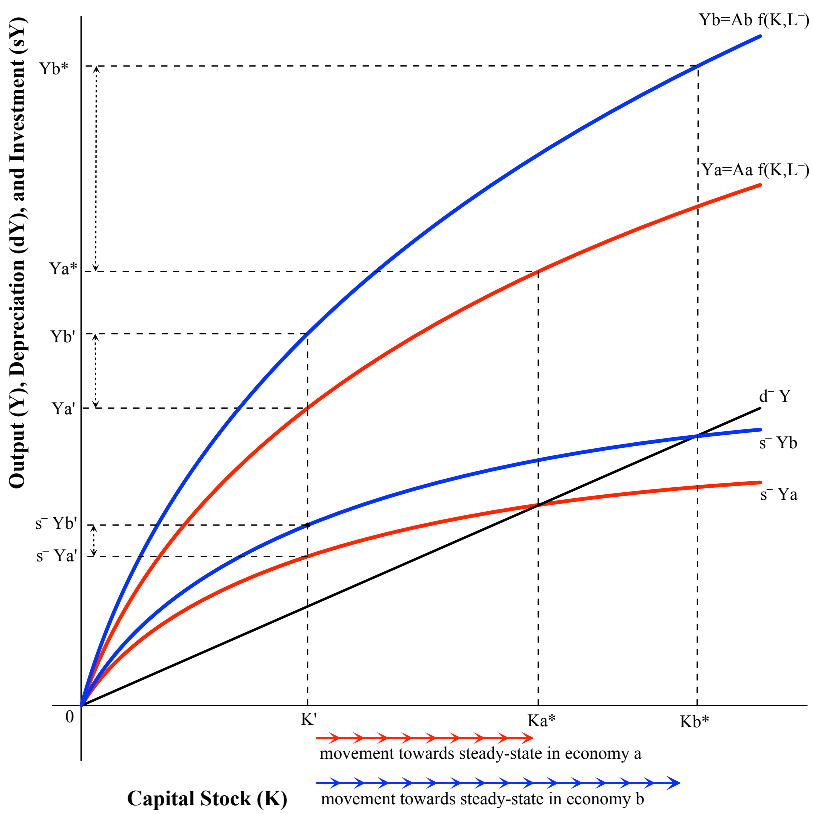
Saharan African nations.  Conversely, states that are highly centralized also experience loss as authoritative governments tightly control economic activity.  Communist nations, present and past, are associated with of this type of extraction.  The point of tangency, where social losses are minimized, falls somewhere in between.

It is important to note that the point of tangency, while the optimal loss-minimizing equilibrium, is not the only equilibrium available to institutions since the countervailing forces of corruption can drive institutions toward the extremes of dictatorship or disorder.  Corrupt officials lose income when corruption is controlled.  It is in their best interests to maintain the status quo.  Equilibrium under extractive regimes is reached when powerful elites resist institutional change that might undermine their influence or income (North 1990, Acemoglu and Robinson 2000, Acemoglu et al. 2001).

What mechanism, then, allows economies to reach an inclusive equilibrium?  In a democracy citizens have the ability to remove officials acting in their self-interests. Institutions move away from extremes.  The democratic process distributes power away from a central authority, checking the personal ambitions of elites, politicians, strongmen, and corrupt bureaucrats.  Inclusive economies are by and large more productive, as observable in Graph 6.  But in countries where this mechanism is absent, ruling elites have no checks on their power and will structure institutions to serve their political and economic self-interests.  Movement along the IPF, and from one equilibrium to another, is highly dependent on the control of corruption, itself a result of the democratic process.

It is then expected that economies suffering from high levels of corruption are less productive.  Also important is that the corruption control indexes used in this paper's model do not distinguish between top-down and bottom-up extraction. To fit the IPF model to the data, corruption must be thought of as levels of social loss. The greater the corruption, the greater the amount of social loss. Thus movement along the IPF represents changes in institutions. To examine how the economic potential of countries with extractive regimes differs from those with inclusive institutions, let us return to the Solow model presented earlier.

**Graph 6: Solow with economies of different corruption levels**




Graph 6 juxtaposes economic potential (both current, Y’, and future, Y*) in extractive nations (red, economy a) and inclusive institutions (blue, economy b). If both nations are otherwise identical in capital stock, labor, depreciation, and savings rate, the inclusive economy will always be wealthier. Greater levels of investment in the blue economy permit a greater accumulation of capital (Kb*-Ka*), and therefore a greater steady-state output. Ya* is the maximum future output in economy a, whereas Yb* represents the economic potential in economy b. The blue steady-state economy will produce Yb*-Ya* more than the red steady-state economy.

There is a great variety of institutional quality in juxtaposition to earlier eras where inclusive institutions were rare or non-existent. Institutions can change and evolve. Such movement, toward or away from the optimal institution set, is known as institutional drift. So where many economies are rife with corrupt institutions, a large number have shown an ability and willingness control corruption. Early attempts at inclusion, however, weren't always successful. Movement away from extraction didn't begin in earnest until the Late Middle Ages and Early Renaissance. It is of interest to point out the mechanisms that cause this shift as it can help shed light on the determinants of corruption and productivity. To explore how this might happen, we examine how institutions first developed in the Natufian and Neolithic cultures. The next section documents the events leading to the eventual control of corruption in many states.

## III. INSTITUTIONAL EVOLUTION

In his seminal paper on how institutions affect economic stability and change, North (1991) points out that the fundamental purpose of institutions is to create order and reduce uncertainty, as they "define the set choice, determine transaction and production cost, and the profitability and feasibility of engaging in economic activity." They establish the rules of the game. Constraints (rules) on economic activity depend not only the laws passed by governments, but on customs, traditions, and moral imperatives.

In early human prehistory, it was solely these customs, traditions, and moral imperatives that governed economic interaction. When humans still hunted and foraged in wandering bands, economic interaction was constrained to a tight social circle. Everyone knew everyone else. The consequences of harming another member of your group (economically or physically) were severe. Interactions were policed by social considerations (Sahlins 1965), the de facto institutions.

Over several thousand years these groups eventually became sedentary, first forming permanent and complex settlements in the Fertile Crescent region of the Middle East. The climate and abundance of domesticable plant and animal species in the region drove the transition to agrarian life. The earliest groups that left the nomadic lifestyle were of the Natufian culture, spanned the Levant in the 3,000 years leading up to the Neolithic Revolution in 10,000 BCE. The Natufians were the forbearers of agrarian civilization; they were the first hunters-gatherers become sedentary. Another defining feature of the Natufian period was the variety of stone tools. Among the microliths, or chipped-stone tools and weapons, are agricultural tools like sickle blades and grinding stones. This is the first evidence anywhere that cereals were gathered in quantities large enough to offset the need to follow migrating herds (Simmons 2007). But farming was not yet a way of life. It wasn't until the following epoch, the Neolithic Revolution, that the transition to agrarian life truly began.

The primary differences between wanderers and settlers are less in how they acquired food and more in how each subsequent generation was able to build on the labor and innovations of previous generations. A growing capital stock increased potential output. There was no accumulation of goods in wandering bands; a person needed to carry all belongings. Hunters and gatherers may have eaten better diets and had more leisure time, but they were unable to create an economy of any real scale (Sahlins 1972). In settlements each generation was able to build on what previous generations left behind, giving them momentum. Nascent economies were encouraged by the simple drive to improve life, as is evident from improving dental health and cultivation techniques.

Technology advancement in early settlements allowed for more efficient use of available resources. Early inhabitants heated clay balls upon which food could be cooked (Hodder 2006). As pottery became available, cooking techniques evolve. A clay pot was a much more practical way of preparing food. Sickles appear in the archeological record, improving the efficiency with which food can be harvested. With this investment came constant production to reap the financial rewards of the initial investment. Labor markets began to specialize. Increased output permitted population growth.

Turning to agriculture as a food base radically altered the economic condition of early peoples. Settlements increased the size of social groups. The larger the settlement, the less intertwined were its inhabitants. As regional density grew so did interaction between settlements. This expanded the trade possibilities horizon and decreasing the personal nature of economic interactions (Sabloff and Lamberg-Karlovsky 1975).

As the Neolithic Revolution gained momentum, trade between disparate groups becomes apparent. A clear example of this is the early obsidian trade. Obsidian, a strong volcanic glass with diverse uses, has a site-specific geological marker. Each piece can be traced to its origin. Through examining archeological data it was found that obsidian mined in the early settlement of Çatalhöyük in southeast Turkey, circa 7,400 BCE, made its way throughout Anatolia, the Levant, and even Cyprus. At least fifty distinct types of obsidian tools were identified at Çatalhöyük, signifying the importance and value to early laborers. In exchange, residents received shells from the Mediterranean and flint from the Levant (Lamberg-Karlovsky and Sabloff 1979). A regional trade network was apparent early in prehistory.

As trade expanded, so did the risk of conflict. The social networks that enforced codes of conduct were no longer sufficient. A different means of regulating exchange was needed. Shipments had to be protected. Standardized weights were needed, as were legal systems to enforce trade law (North 1991). Institutions stepped in to fill the gap.

Institutions also make construction of public works possible. They are able to divert resources to large-scale infrastructure projects. The earliest known example of a public works comes from Jericho, today considered the oldest inhabited city in the world. Jericho began as a collection of mud-brick structures. By 7,350 BCE an estimated 2,000 people inhabited the village. One of Jericho's most fascinating features is a wall enclosing the community and a tower. The tower appears to have been a ceremonial structure, while the walls were more likely used for flood control than defense (Kenyon and Holland 1981). This provides evidence of an organized, hierarchical society capable of devoting time to public works instead of food production.

The evolution of trade from early Natufian villages to the modern integrated economy was facilitated by the simultaneous evolution of institutions. With the growth of population density and trade came the rise of the first city-states and early civilizations, eventually developing into economies capable of supporting massive works like the Hanging Gardens, extensive irrigation systems, the Pyramids, and countless religious edifices.

As markets grew more complex and diverse, so too did institutions. Early institutions all share one trait: they served the elite ruling class through resource appropriation. Remarkable is that GDP per capita would, for thousands of years, remained at or near a subsistence level largely because extractive institutions remained the norm until political and social movements in Europe began to undermine the absolute authority of monarchal and dictatorial regimes.

## INSTITUTIONAL DRIFT

Eventually a few states began to curtail the power of monarchical regimes. Acemoglu and Robinson (2012) found that small changes to existing governance structures can completely alter the economic and political landscape, for better or worse. One such 'critical juncture' was the signing of the Magna Carta in England 1215 CE. This was an eminently important moment when a monarch's power was peacefully curtailed. Over the ensuing centuries, English parliament, nobility, and gentry slowly pried more and more power away from the monarchy.

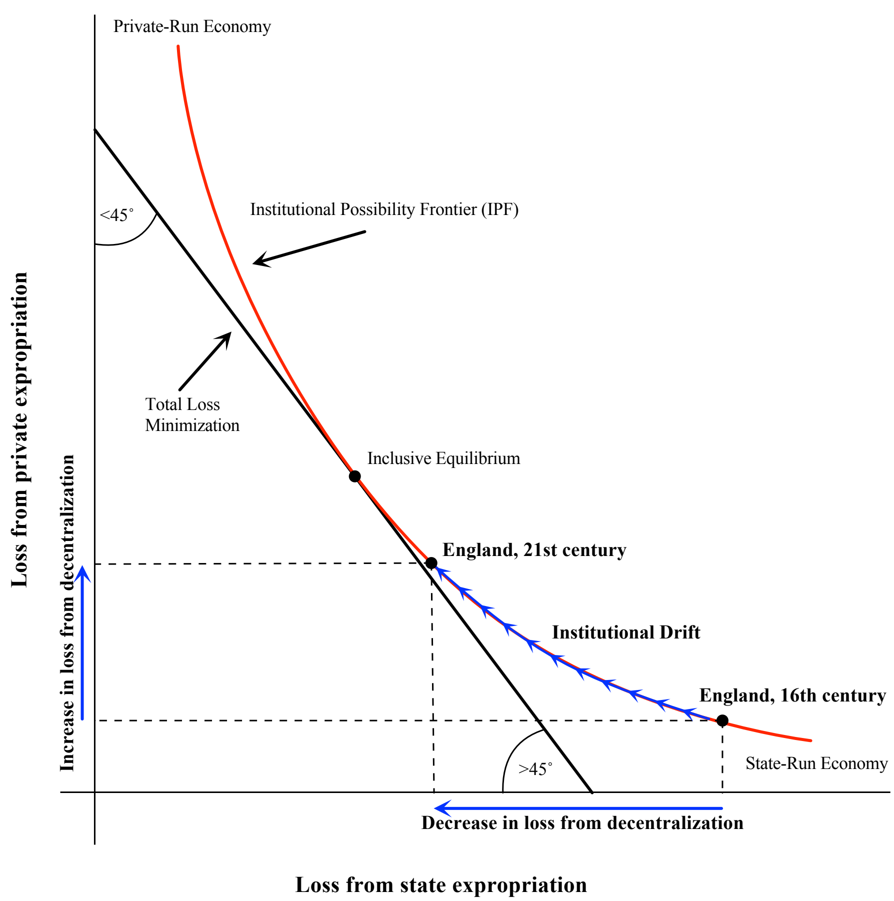
Another event that drastically altered the political and economic landscape during the late Middle Ages was the Black Death that swept Europe in the 14th century, wiping out a massive fraction of the population. With half of the labor supply gone, demand for workers skyrocketed. This economic imperative put much unanticipated power in the hands of a broader section of the population. Political entities scrambled to enforce pre-1347 C.E. labor policies that kept peasantry bound to the land. The effects of such reactionary policies differed significantly between Eastern and Western Europe. Eastern Europe was sufficiently decentralized that rulers were able to *strengthen* their control over the population, known as the Second Serfdom.

In Western Europe it was different. Workers were more urban and organized thanks to the more centralized political nature of Western states. Amidst protestations and revolts they won concessions from rulers and found freedom from feudal ties. The Black Death altered the economic landscape of Europe, providing the foundations for later political and economic reforms. This critical juncture provided the economic shock necessary to shift the institutional trajectory of many economies.

These changes led to the sort of institutions that provide incentives for growth. As the merchant class expanded, their power grew, as did their distrust of the crown. Political and economic concessions were won. One example comes from 1588 CE, when Queen Elizabeth I requested additional tax revenue from Parliament (Parliament controlled taxes, a result of earlier concessions) to fund the effort against the Spanish

Armada. In response they demanded further powers be devolved from the monarchy. Parliament won and funded the English Navy that subsequently served as a guard for the merchant fleet. This happened at a time when other European powers monopolized overseas trade by channeling all merchant activity through their navies. English institutions had begun a march toward inclusiveness. Economic and political freedoms put more and more pressure on rulers to open markets further, thus moving institutions along the IPF toward the loss-minimizing equilibrium, as shown in Graph 7.

**Graph 7: Institutional drift in the IPF framework**[4]




[4] Please note that losses from England's institutions bundle in the 21st century are not necessarily accurately represented. The graph is merely intended to highlight how institutional drift decreases loss. England's drift toward inclusive institutions minimizes losses until the decrease in loss from decentralization roughly equaled the increase in loss from private expropriation.

The idea of institutional drift, that small changes and events leading different nations to form different institutions (Redmond 2005), is highlighted by the juxtaposition between England's path from serfdom to freedom, and that of other European contemporaries. England's market openness led to one of the most significant events in human history: the Industrial Revolution. People with talent were educated, incentivized, protected, and connected to diverse markets. Innovation flourished. As per capita GDP rose, so did the power of less noble citizens. The more power divested away from the monarchy, the greater the economic options available to all citizens. Created is a positive feedback loop where greater freedoms lead to demands for a more inclusive economy. In some states this 'virtuous circle' perpetuated economic and political change. Countries where this divestment of power doesn't happen incur the opposite effect, where greater controls by central governments beget weaker individual rights. In states with a very weak government, enforcing the rule of law becomes nearly impossible, creating a vast gap between ruling elites and the rest of the population.

While the Industrial Revolution was sweeping the Western world, Eastern Europe was deeply resistant to change. Sedentary laborers toiling quietly in small towns, villages, or on farms were of little threat to power. Elites feared high concentrations of poor workers in cities, the result of labor demand in new factories. Workers, if left unemployed by the creative destruction and labor churn that comes with economic growth, could become restless and violent. Keeping workers in the countryside limited their interaction with new ideas. Railways, too, were slow to wend their way across Eastern Europe, a result of the fear of a mobile population. Eastern European states like

Russia, Belarus, and Ukraine still suffer from high levels of extraction. Western Europe, however, grew relatively more productive as a result of economic openness.

The legacy of those critical junctures is apparent today. Variation in GDP per capita across economies today is vast. The wealth gap between nations has grown rapidly in recent centuries. The differences in income between states and regions in antiquity were tiny when compared to the drastic disparities of today. This is known as the Great Divergence, as seen in Graph 1. Output exploded and economies began to accumulate vast amounts of capital and wealth. This had a profound effect on the average person. They could plan for their futures, purchase healthcare, go to school, and procure goods otherwise available only to wealthy elites. But in the centuries since other parts of the world have continued to languish in poverty. Though Western powers were at the vanguard of an institutional shift toward inclusiveness, they did not always spread inclusivity to the native populations they encountered or the colonies they established.

## IV. NATURAL EXPERIMENTS AND CASE STUDIES

To better understand how corruption and productivity interact, we first juxtapose inclusive and extractive institutions through available natural experiments and then further discuss how it is that some nations maintain inclusive institutions and why some seem to perpetuate corrupt ones.

The roots of the modern wealth and productivity inequality between North and South America, for example, extend back to colonization (Acemoglu and Robinson 2005). As European powers began to accumulate more capital and wealth, they began to exert control on overseas territories, usually in the hope of extracting wealth, as in South America. Other regions, like North America[5], became genetic offshoots. The disparate experiences of the many European colonies are informed by how the New World was partitioned and exploited by colonial powers.

In Central and South America, Europeans enslaved native populations, extracted vast amounts of wealth, and maintained order through political dominion. Where power is constrained to a small rich minority and political institutions are organized to prohibit any competition, lasting and effective change is difficult to come by. With power transitions only between elites (or those that subsequently became elite), formed were institutions that concentrated all surplus resources in the hands of the wealthy. The legacy endures. Monopolies and extractive policies are still common in the region.

Native economies that were most developed like those of the Andes region and Meso-America had extensive agricultural land capable of supporting their large urban centers. Social hierarchy was well established and institutions already existed by the time contact was made. Europeans were able to simply remove the native leaders thanks to their superior technology, diseases, and long history of warfare. They usurped the extractive institutions already in place, as well as introducing their own, and pressed the population into slavery. The legacy of expropriation continues today.

With the work of subverting native populations in the more densely populated areas complete, the only regions left were those with low population density like the North American seaboard. It was into these areas that large numbers of colonists settled,

[5] North America refers to the territory of modern Canada and the United States. The Caribbean and Central America are considered part of South America in this paper, as they share similar colonial pasts.

often fleeing poverty or persecution. They established more inclusive institutions in contrast to the monarchical systems they had fled. The legacy of the different colonial governing strategies is apparent. Regional economies that were relatively wealthy, as with the Aztecs and Incas, became impoverished while other regions populated by hunter-gatherers (as in most of North America) became much more wealthy. Acemoglu et al. (2002) document how European colonial policies caused an "institutional reversal" in these regions.

Where Central and South America were stripped of mineral wealth, North America had no gold and silver to expropriate. Early settlers were unable to repeat the policies used in other parts of the New World, where colonial powers used the large native populations to strip the land of value. Enslaving the local natives in North America was impractical, given their low population density. Settlers found themselves unexpectedly working for a living. Attempts by colonial authorities to extract wealth from colonists were mostly in vain as it was very easy to disappear into the vast frontier wilderness. Eventually the companies and governments that sponsored settlement came to the conclusion that it would be more profitable to offer production incentives. Since the colonists couldn't be forced into servitude, authorities began to acquiesce to colonists' demands for political rights. Assemblies of landowners were created, giving political influence to a broader section of the early American colonist population.

In some ways this mirrors the machinations of those early English nobles who wrested power away from the Monarchy. In North America newfound work incentives were a productivity boon. Patents were issued and enforced. Anyone could own and seek profit from an idea. The incentivized population drove the economy forward. The representative nature of the political systems that developed in continental North America functioned as a check on corruption. Politicians who sought to consolidate power and enrich themselves unilaterally can be, and often were, voted out of office. Their incentive is to maintain popular support so to stay in power. The rule of law became supreme. But if there is no mechanism to remove leaders from office, there is little consequence for rulers structuring institutions to support their own power and wealth.

A much more recent natural experiment that cleanly supports the institutions hypothesis is the Korean peninsula post 1953. Since the end of the Korean War the North and South have taken divergent paths. The totalitarian North saw a collapse in agriculture and regularly faces food crises and malnourishment. There is little industry. Electricity is a luxury. The government doesn't acknowledge private property or enforce contracts. There is no institutional evolution. The government firmly controls the few markets that do exist. In familiar terms, the political and economic institutions are completely controlled by a very small group of elites who extract every possible resource to enrich themselves and their supporters at the expense of the general population.

Just a few miles across the border, the South Korean economy flourishes. In the years after the war the military elite dominated the political arena. The economy, however, was not constrained and institutions were free to evolve. Rule of law, private property, and a relative absence of monopoly encouraged innovation, investment, and trade. There was a strong push to educate the populace, which provided a superior and more creative workforce.

The Korean case study provides excellent insight into what encourages prosperity and what hinders it. Inclusive institutions allow individuals to make the best use of their talent by choosing occupations where they can excel. Strong public services, like an education and unbiased legal systems, level the playing field and empower would-be entrepreneurs, inventors, and academicians. Conversely, extractive institutions funnel all surpluses away from the public and into the coffers of the ruling class. There is no motivation for workers and entrepreneurs to produce, create, or learn if there are no rewards for doing so. A strong central government, answerable to citizens, capable of providing a well-functioning system of public works, enforcing an unbiased legal system, and incentivizing innovation is key to a high standard of living.

Another experiment is that of Botswana and its impoverished African neighbors. The Sub-Saharan average per capita GDP is around $1,400[6], while Botswana's is almost $5,000 higher. The regional average for control of corruption (on a scale of 0-100, where a score of 100 implies a complete lack of corruption[7]) is 45 with a standard deviation of 11. Botswana's corruption controls score 73, more than two standard deviations higher than the regional average, putting it on par with Portugal, Spain, Estonia, and Taiwan. Zimbabwe, Botswana's next-door neighbor with its infamous runaway inflation and ineffective government, has a GDP per capita of less than $500 and scores 30 out of 100 for corruption control.

How do we account for this remarkable disparity? In 1966 Botswana, with a population of 600,000, gained independence from Great Britain. At the time there were

[6] All data in this section is for 2011, in 2005 USD, courtesy of the World Bank.
[7] Data is from the World Governance Index's Control of Corruption index.

22 college graduates, 100 secondary school graduates, and 12 kilometers of paved road (Acemoglu et al. 2001) all in a nation with territory comparable to Texas. The country is also landlocked, arid, and geographically isolated, which, according to the geography hypothesis, should be inimical to prosperity. Botswana was a colonial backwater, but it did have rudimentary institutions based on the British common-law model. When the Batswana peacefully gained their independence, they built upon these basic institutions, transforming them into a meritocracy. That they eschewed extractive policies is likely a result of strong private property rights courtesy of the common law system, pre-colonial tribal affiliations that encouraged consensus rather than elite rule, and a diamond endowment that covers a portion of government revenue. Rather than extracting wealth and enforcing monopolies, they invested aggressively in infrastructure, opened markets to foreign interests and prospectors, and subsidized industrial ventures. In the ensuing years, Botswana has outpaced its continental counterparts in most measures of growth, as is certainly consistent with the idea of institutional drift.

The final case study presented comes from *Why Nations Fail* (2012), which describes education in poor African countries to illustrate how the loss of economic incentives causes growth to stagnate. Without any chance of making profit and improving one's living conditions there is no incentive for parents to send their children to school. This is especially true if the government doesn't provide an education infrastructure. The authors use the Congo region to showcase their thesis. Soon after contact with European powers, Congolese rulers devised institutions that took extraction to an extreme: selling slaves on the international market. This was so profitable that there was no incentive to encourage any sort of political or economic reform. There would be no benefit to them. The country was kept very decentralized as a deterrent to organized opposition. Aside from the slavery markets, little changed for the Congolese in the ensuing centuries. The Congo region currently scores a 30 out of 100 in the control of corruption index.

## V. OTHER MODELS

Let us now look at empirical evidence that corruption dampens output by limiting the usefulness of other inputs. Hall and Jones (1999) examined the differences in productivity between nations and why some invest in more inputs than others. They identify "social infrastructure" as motivating the differences in output per worker. In their paper social infrastructure is defined as "the institutions and government policies that determine the economic environment within which individuals accumulate skills, and firms accumulate capital and produce output." This is the same underlying relationship studied in this paper. Their definition firmly places social infrastructure as a determinant of the production function's productivity multiplier, A, commensurate with corruption. The only difference is that they are studying corruption as it relates to output through its effect on inputs and productivity, as suggested by their infographic:

Hall and Jones (1999):

**Institutions ➔ (Inputs, Productivity) ➔ Output per worker**

This paper, where italics are excluded from analysis:

**Institutions ➔ Productivity ➔ *Inputs* ➔ *Output per worker***

The model presented in this paper seeks to specify only the institutions-productivity relationship. Hall's dependent variable is output while mine is productivity. The basic difference is that Hall identifies corruption (social infrastructure) separately from productivity so to study its effects on output *through* its effects on productivity and inputs. This is important as it means that their study still specifies the relationship between productivity and corruption, which informs the new model proposed in the next section. The sample size for their analysis is 127 observations (countries) over one year, with a measure of corruption coming from a combination of two sources. The new model proposed in this paper greatly expands the sample size to 1,691, covers 16 years, and uses measures of institutional inclusiveness compiled from at least four different sources for each year.

They encountered potential endogeneity when controlling for corruption. High output might lead to corruption controls or low output might encourage extractive policies. To remove any feedback, Hall instruments for corruption through trade and linguistic variables on the premise that the Western world first adopted inclusive institutions and subsequently spread them to colonies. My approach will use very different instruments. Their regression, however, provides some likely determinants that will be included in the new model, including a measure of ethnolinguistic fractionalization as a reflection of national heterogeneity, distance from equator as a geographic indicator, and population as a "simple" way of scaling the economies.

Lambsdorff (2003) performs a similar study: the effect of corruption as measured by the Corruption Perceptions Index, on productivity. For a measure of productivity they use the ratio of GDP to capital stock. The results are crossed checked with a number of alternative corruption variables, where the effect is robust. The paper also notes that there is a tradeoff between government power and disorder, where extremes discourage productivity. He finds that a decrease in corruption by one unit on a scale of 10 increases productivity by 2%.

## VI. NEW MODEL

We already have a measure of productivity, as calculated from a basic production function. A corruption variable, however, cannot be so neatly calculated. Since observable data for corruption is so characteristically rare, it is difficult to accurately account for corruption's economic effects. Since we are looking only for a general, aggregate connection between corruption and productivity, we can use several corruption indexes as data substitutes. Compiled from both hard data and expert surveys, these indexes provide insight into the *perceived* level of corruption in an economy. That they are not strictly based on hard data is not an obstacle. First, we have a large observation size that should mitigate irregularities in the data. Second, perception or expectation of corruption informs the decisions of economically active people. Firms are less likely to invest in a country where corruption is perceived to be high (Wei 2000, Jensen 2003, 2008). Perceptions matter in determining the risks of investing. Third, included are four different indexes to crosscheck the regression results.

The first index, control of corruption, is published as part of the World Governance Index[8]. The WGI is an aggregate measure of governance taken from existing data sources and surveys. According to the creators, Kaufmann, Kraay, and Mastruzzi (2010), the index reflects "the views on governance of survey respondents and public, private, and NGO sector experts worldwide." The control of corruption index captures the "perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests." The data comes from 31 different sources. An alternative index is the Corruption Perception Index[9], published by Transparency International.

As noted earlier, the relationship between corruption controls and productivity might be endogenous: it is possible that productivity levels have an effect on institutional quality. Productivity increases and the resulting surge of wealth may encourage a move toward the more inclusive, loss-minimizing equilibrium. Additionally, poor nations may not have the necessary resources to build effective institutions (Hall and Jones 1999). We will account for the potential feedback by instrumenting for corruption in the regression. A measure of press freedom will be used, as it has been shown to be a powerful control on corruption by Brunetti and Weder (2003):

> "An independent press is probably one of the most effective institutions to uncover trespassing by government officials. The reason is that any independent journalist has a strong incentive to investigate and uncover stories on wrongdoing.

[8] From the World Bank: "Governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them."

[9] From Transparency International: "The Corruption Perceptions Index (CPI) ranks countries and territories based on how corrupt their public sector is perceived to be. It is a composite index – a combination of polls – drawing on corruption-related data collected by a variety of reputable institutions. The CPI reflects the views of observers from around the world, including experts living and working in the countries and territories evaluated."

> Countries with a free press should, therefore, ceteris paribus, have less corruption than countries where the press is controlled and censored."

For the press instrument, two different indexes will be used to corroborate the results. The first is compiled by Reports Without Borders, the second by Freedom House. As the press freedom instruments are surveys and not hard data, also included will be a measure of luxury resource endowments. Luxury resources are unlikely to have much of an effect on productivity. They are not used as production inputs. Any expropriation that occurs in these mining industries will not affect productivity, except through the predicted welfare loss. Thus, rent-seeking in mining industries like gold and diamonds is not expected to affect productivity, except through corruption. Luxury resources will also be effective instruments for corruption.

To parse out the effect of corruption controls on productivity we need to identify the other determinants of productivity. First we control for macro shocks by adding dummy variables for each year of data. We also control for the scale of the economy by including a population variable. Many studies have specified the natural resource relationship with productivity (Jorgenson 1984, 1984) and corruption (Leite and Weidmann 1999). As such we need to include appropriate variables to account for any effect. Since there is a notable difference between energy resources and luxury resources, we can separately explore resources' effect on corruption and productivity. Ayres et al. (2013) and Murillo-Zamorano (2005) documents the positive relationship between energy and economic and productivity growth, respectively. We specify an energy variable that controls for production of all energy, including oil, coal, natural gas, and alternative sources.

In Section III, we noted that secure property rights incentivized English inventors and entrepreneurs. Early advancements in industrial machinery, especially textiles, created demand for factory labor in cities. New markets grew to support the burgeoning populations. The growing population densities increased the frequency of money exchange, the dissemination of ideas and technologies, and the concentration of human capital (Rauch 1993). Most economic activity happens in cities (about 90% in the US), and there is a strong relationship between productivity and city size (Abel et al. 2011, Ciccone and Hall 1996). The new model captures this effect through a measure of the proportion of the population living in urban environments. We can expect nations with low levels of urban population to be less productive than more urban economies.

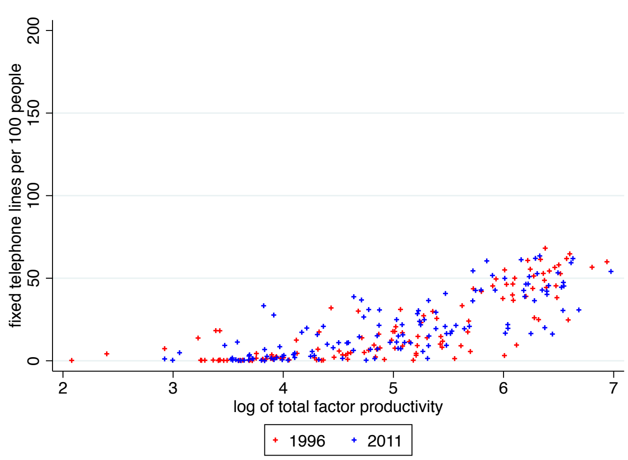
Given the large body of literature documenting the geographic hypothesis, and that geography was a likely determinant of early human development, we include variables that control for average temperature, precipitation, and a dummy variable indicating whether or not a country has a coast. Additionally, regional dummies are included to control for regional culture, weather patterns, economic shocks, stability, shared history, and internal trade patterns.

Another necessary specification is the level of technology available to firms and consumers. The proportion of the population with a phone line (landline or cellular) is a good indicator. Phones require infrastructure, be it cell towers or hard lines. Infrastructure needs to be secured, so we can expect few lines in disordered states. Should the ruling regime instead have authoritarian tendencies, monopolies can be enforced in the telecom industry, causing prices to rise, and thus limiting access.

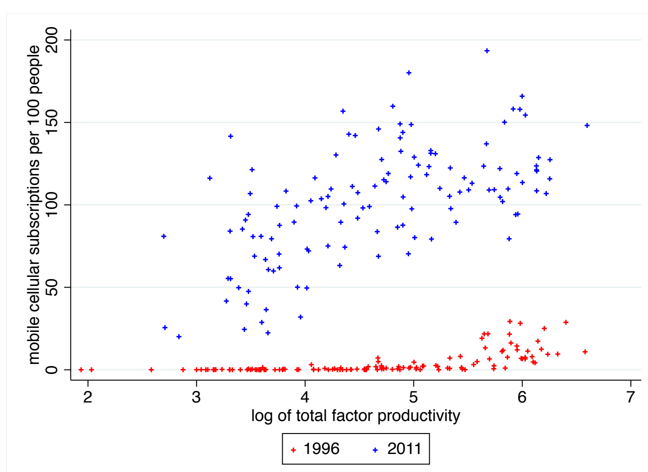
Additionally, phones are the oldest widely adopted long-distance communications technology. Invented in 1876, phones have had a long time to be put into use. Any population able to acquire phones does. Since technology tends to flow downhill between countries and, for the most part, ignore national boundaries, the only impediment to adoption is the institutional framework that either makes infrastructure investment too risky or telephone access too expensive. While autocrats can outlaw technologies, they also have corrupt tendencies, so the effect is still the same. In advanced economies telephones are ubiquitous and inextricably linked to many aspects of life: talking to clients, friends, family, and emergency services.

Cell phones are a newer technology, being adopted over the course of the sample, 1996-2011 (Graph 8 and 9). There are six times as many subscriptions in the United States in the last year of the sample, 2011, as there were in the first year, 1996. Controlling separately for cell phones captures how readily a new technology is adopted into an economy where as fixed lines are more a measure of technology level.

**Graph 8: Fixed lines and tfp**




**Graph 9: Cell subscriptions and tfp**



Graph 8 shows a strong positive correlation with comparatively little dispersion. Cell adoption happened very quickly in highly productive nations. Fixed lines have had more than a 130 years to find their way into homes and offices. That they haven't been widely adopted in all nations strongly suggests that, as technology itself is spreads easily, other factors must be discouraging investment in the requisite infrastructure. Cell phones are quickly adopted in the same productive nations that had already made extensive use of communication networks.

## VII. REGRESSION ANALYSIS

The primary regression will use the control of corruption (*ctrlcorr*) variable from the World Governance Index and the freedom of the press (*fppress*), as published by Freedom House, as the instrumental variable. Both variables will be crosschecked with Transparency International's corruption perception's index (*cpi*) and Reporters Without Borders' press freedom index (*rsfpress*). They are not combined, as some of their components overlap, potentially giving undue weight to some sources. The first regression, and the one referenced throughout this paper, uses the control of corruption and freedom of the press as they give the largest sample size, 1,691, across the most years, 1996-2011. Chart 1 gives the results of this primary regression. Year and regional dummies are included, though not reported in the chart. The full regression results can be found under Regression I in the Appendix.

In the first iteration, where the control of corruption is the sole independent variable (still instrumented), we see that a unit increase in the control of corruption (on a scale of 100, where 100 is an economy with no corruption) increases expected total factor productivity by 4.43%. The second iteration includes year and region dummies. The additional variables decrease the control of corruption effect to 3.64%. The third regression adds the three geography variables, but *no explanatory power is removed from corruption*. Technology variables are added in the fourth, where they capture a healthy portion of the variation in productivity and lower the corruption control effect to 1.33%.

The 5th iteration gives the final effect of corruption control. A country that increases its perceived control of corruption enough to move up by one, on a scale of 100, also increases aggregate productivity in the economy by 1.96%, all other factors constant. This represents the lower bound of the effect. The other limit comes from Regression II, using the press freedom index to instrument for control of corruption, where the effect is a 2.61% increase in productivity. This is remarkably higher than was found by Lambsdorff (2003), where a unit increase in the control of corruption, on the same scale of 100, increased productivity by .2%. Where the models differ is in the way productivity is measured. Whereas this paper uses total factor productivity as the dependent, Lambsdorff uses the ratio of GDP to capital as the measure of productivity. The sample size in Lamsdorff's regressions is also less than 100.

In the 5th iteration all geographic variables are significant once corruption, technology, energy, population, and urbanization have been controlled. This suggests that geographic variables are still strong determinants of productivity, all else constant. Nations with access to coastal waters are expected to be 9.54% more productive than landlocked countries. An additional centimeter of annual rainfall is expected to increase

## Chart 1: Regression results

**2SLS regressions, where freedom of the press (*fppress*) instruments control of corruption**

| *log(tfp)* *α=0.35* | Iterations 1st | ♮2nd | 3rd | 4th | 5th | *α=0.3* | Variable name |
|---|---|---|---|---|---|---|---|
| control of corruption | 0.0443 (0.001) | 0.036 (0.0014) | 0.0364 (0.0014) | 0.0133 (0.0024) | 0.0196 (0.0022) | 0.0208 (0.0022) | *ctrlcorr* |
| mean temperature | | | 0.0115 (0.0024) | 0.0115 (0.002) | 0.0136 (0.002) | 0.0143 (0.002) | *tmean* |
| precipitation | | | 0.0059 (0.0022) | **0.0033 (0.0019) | 0.0082 (0.002) | 0.0071 (0.002) | *precip* |
| coastal border | | | 0.2657 (0.0299) | 0.1811 (0.0264) | 0.0954 (0.0289) | 0.1005 (0.0297) | *coast* |
| telephone landlines | | | | 0.0162 (0.0021) | 0.015 (0.0017) | 0.0151 (0.0017) | *phone* |
| cell subscriptions | | | | 0.0063 (0.0005) | 0.0047 (0.005) | 0.005 (0.0005) | *cell* |
| log(energy) | | | | | 0.0944 (0.0057) | 0.0983 (0.0059) | *lnenergy* |
| log(population) | | | | | -0.1095 (0.0094) | -0.1156 (0.0096) | *lnpop* |
| urbanization | | | | | 0.0045 (0.0007) | 0.0054 (0.0007) | *urban* |
| linguistic diversity | | | | | ***-.0009 (0.0006) | **-.0011 (0.0006) | *lfrac* |
| ethnic diversity | | | | | ***.0007 (0.0007) | ***.0009 (0.0007) | *efrac* |
| constant | 2.1639 (0.0569) | 2.8258 (0.1199) | 2.4294 (0.1258) | 2.7114 (0.1245) | 3.6096 (0.1931) | 3.3909 (0.1982) | *_cons* |
| observations | 2031 | 2031 | 2025 | 2012 | 1691 | 1691 | |
| R-squared | 0.6235 | 0.7541 | 0.773 | 0.8281 | 0.8661 | 0.8726 | |

* insignificant at the 1% level ** insignificant at the 5% level *** insignificant at the 10% level

♮ adds year and region dummies

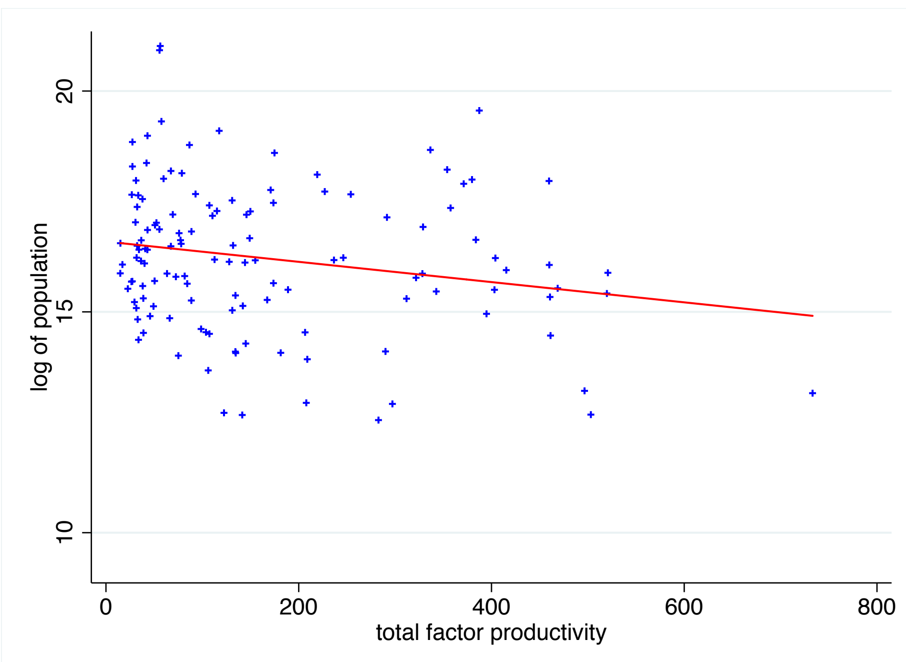
tfp by .82%. Where mean temperature increases by one degree Celsius, productivity also increases by 1.36%. Warmer and wetter climates tend to be more productive once the other variables have been controlled. While disease burdens and other problems suggested to plague tropical areas may have some negative effect on productivity, the effects are not strong enough to upset a biological imperative. Life seems to flourish where the water is plentiful and the weather is warm. Cross-checking these variables with the other measures of corruption control and press freedom, coastal access is insignificant at the 5% level in Regression III, precipitation is insignificant at the 1% level in Regression IV. Temperature is significant across all regressions.

The technology variables are both significant and positive. There is a potential endogeneity issue where high productivity levels might encourage the adoption of new technologies. But if technology is synonymous with tools, then any decrease in the number or quality of tools available would cause productivity would plummet. A ready example is that of the transition to sedentary life in early prehistory. It wasn't until human populations settled that they were able to accumulate the tools that allowed, for example, more efficient harvesting, cooking, and transporting. The archeological evidence documents all of these innovations: the development of the sickle, the transition from cooking stones to clay pots, and the construction of baskets to transport goods.

Technology drives productivity. Institutions influence how readily new technologies are adopted. It is important to note that cell and phone are proxy variables for different aspects of technology. Cell phones are included as a proxy for how quickly a highly useful technology can be adopted. Hard line phones are a proxy for the overall technology level achievable by a country. These variables are significant in all regressions examined in this paper.

Energy production, as expected, has a positive relationship with productivity: a 1% increase in energy production increases productivity by .094%. Conversely, larger populations have a negative relationship with productivity, where a percentage increase leads to a .11% decrease in tfp. This finding reflects that of Pritchett (1996), who identifies a weak negative correlation between tfp and population growth. The slightly negative relationship can be observed even before controlling for the other variables, as below in Graph 10. The relationship suggests decreasing returns to productivity as economies grow in scale.

**Graph 10: Population and tfp**




The level of urbanization is a significant and positive determinant of productivity, where an additional percentage point of citizens living in urban environs increases productivity by .45%. Ethnic and linguistic fractionalization, however, are not significant determinants of productivity in any of the regressions. Hall and Jones (1999) included a similar variable, ethnolinguistic fractionalization, as a determinant of output. Thought they find it does have an effect on output, any affect it has on tfp is captured by the other variables in the model.

An alternative calculation of productivity is used as the response in the last column. Changing the exponent on the capital share of production from .35 to .3 (and thus labor share from .65 to .7) has minimal effect on the outcomes. The regression is also run with per capita measures of tfp and energy, as in Regression VI, but no significant differences are found.

## VIII. CONCLUSIONS

This paper affirms that aggregate productivity is strongly affected by the perceived level of corruption. The model presented here has isolated a direct and significant relationship between the control of corruption and aggregate productivity. Any national economy willing to tackle corruption can expect productivity to rise rapidly, between 2% and 2.6% for every 'unit' increase in the control of corruption, all other variables constant.

There is an important difference in how corruption manifests. Centralized, top-down patterns of extraction still experience some growth. Successful civilizations throughout history have operated under such extractive institutions. Corruption is coordinated by the central authorities, who set extraction to levels that maximize their wealth. Growth can still happen under extractive regimes. In a country without a strong government able to control its agents, however, lawlessness and disorder abound.

Disordered states require stronger central governments to root out corruption, and can improve their productivity either weakly through a shift toward a dictatorial regime or strongly through the adoption of more powerful and inclusive institutions. For the economies constrained by top-down corruption, productivity can only increase with drift away from monarchical and autocratic governance. This is highlighted by the significant events like the signing of the Magna Carta, the French Revolution, and the end of Apartheid. These events all devolved power away from systems that worked against the best interests of the majority of the population.

The productivity boost from healthy, inclusive institutions provides additional flexibility in how an economy chooses its inputs, as there is an increase in overall economic potential. An example of this flexibility can be seen in how a country deals with negative public externalities like the pollution from energy use and population growth. A country that is more efficient (or more productive with current inputs) has more flexibility in dealing with pollution pressure. Though controlling pollution is, of course, a matter of public will and preference (at least in a full democracy), belief that the economy will grow as a result of increased productivity alters the tradeoff between growth and pollution. Is sacrificing a bit of this newfound economic potential worth the future rewards of staving off pollution? Such a decision is most equitably made in a democracy, where decisions about overall welfare aren't subject to an autocrat's whim.

There are other benefits to good institutions. The increase in productivity can counteract other inherent disadvantages like geographic variables. This is clearly exemplified in the Botswana case study, where a geographically disadvantaged but institutionally strong economy has grown far faster than its neighbors.

While the conclusion of this paper is simple enough—increase productivity by controlling corruption—in practice there are many obstacles to practical implementation. The problem is that good economic policies are often bad politics. An authoritarian ruler requires a base of support to maintain power. The easiest way to maintaining power is to offer monopolies, kickbacks, or other considerations to allies that ultimately undermine the economic potential on the nation. There is a strong incentive for corrupt officials and rulers to maintain that corruption. Though the effects of damaging for the economy as a whole, bureaucrats and the ruling classes have more power and higher income than they would in an inclusive economy. If, however, the rulers and public officials are held accountable and incentivized to not take bribes, social loss is minimized. A highly effective way of rooting out corruption is an unrestricted press, who are strongly incentivized to uncover corrupt practices.

This paper concludes that economies willing to control corruption are much more productive than economies constrained by the high levels of corruption associated with the exclusive institutions of both highly centralized and decentralized states. Institutional change comes in three forms. First, for states that are able to implement effective corruption controls there is a feedback effect that seems to encourage movement toward a loss-minimizing equilibrium. Secondly, rulers that eschew good economics for good politics drive institutions away from the inclusive equilibrium. Finally, states that fall into disorder, as is currently the case in Somalia, Libya, and Syria, can expect lower levels of productivity than either of the other equilibriums. In short, economies that are willing to install even moderate corruption controls are expected to be significantly more productive.

# IX. APPENDIX

**Variable Explanations:**

**Total factor productivity** (*lntfp*): Logarithmic transformation of the productivity multiplier from a production function where $\alpha = .35$, constructed from other production function variables. Measures of output and labor come from the World Bank. Measures of capital stock and human capital come from Penn World Tables.

**Alternative measure of total factor productivity** (*lntfpalt*): Logarithmic transformation of the productivity multiplier from a production function where $\alpha = .30$, constructed from other production function variables. Measures of output and labor come from the World Bank. Measures of capital stock and human capital come from Penn World Tables.

**Control of corruption** (*ctrlcorr*): From the World Governance Index, a measure of how well a country controls corruption. Data in each year is combined from a number of different surveys and studies.

**Corruption Perception Index** (*cpi*): From Transparency International, a measure of how corrupt a nation is perceived to be. Data in each year is combined from a number of different surveys and studies.

**Freedom of the Press** (*fppress*): From Freedom House, an index compiled from surveys by more than 60 analysts that describes the level of press freedom in a country.

**Freedom Press Index** (*rsfpress*): From Reports Without Borders, an index compiled from questionnaires given to journalists and NGO that describes the level of press freedom in a country.

**Mean Temperature** (*tmean*): From the World Bank, the average annual temperature in degrees Celsius for a country.

**Precipitation** (*precip*): From the World Bank, the annual rainfall in centimeters

**Coast** (*coast*): A dummy variable indicating whether a country has a coastal border.

**Telephone Landlines** (*phone*): From the World Bank, fixed telephone lines per hundred people, where a fixed line connects the user to a switchboard network.

**Cellular Subscriptions** (*cell*): From the World Bank, subscriptions per hundred people to public mobile telephone networks as accessed from cellular technology.

**Energy production** (*lnenergy*): From the International Energy Agency, energy and electricity produced from petroleum, natural gas, coal, lignite, combustible renewals, waste- converted into oil equivalents.

**Population** (*lnpop*): From the World Bank, log transformation for national populations.

**Urbanization** (*urban*): From the World Bank, proportion of national population living in urban environments calculated from World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.

**Linguistic Fractionalization** (*lfrac*): From Alesina et al. (2003), the probability that two randomly selected persons will not be from the same linguistic group.

**Ethnic Fractionalization** (*efrac*): From Alesina et al. (2003), the probability that two randomly selected persons will not be from the same ethnic group.

**Regional Dummies**: Dummy variables indicating whether a country is part of the Western world (*west*, the excluded control variable), Eastern Europe and Central Asia (*eeca*), Asia (*asia*), Middle East and North Africa (*mena*), Sub-Saharan Africa (*ssa*), or Central and South America and the Caribbean (*csac*).

**Chart 2: Variable summary**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| *tfp* | 1691 | 187.9323 | 169.7379 | 7.6337 | 877.982 |
| *lntfp* | 1691 | 4.7951 | 0.9924 | 2.0326 | 6.7776 |
| *tfpalt* | 1691 | 169.1556 | 159.3975 | 6.2744 | 841.8193 |
| *lntfpalt* | 1691 | 4.6464 | 1.0443 | 1.8365 | 6.7356 |
| *ctrlcorr* | 1691 | 58.4994 | 19.6559 | 18 | 100 |
| *cpi* | 1338 | 46.9133 | 23.611 | 4 | 100 |
| *fppress* | 1691 | 56.8351 | 23.176 | 0.1 | 95 |
| *rsfpress* | 1027 | 75.5076 | 22.8986 | -36.6 | 110 |
| *tmean* | 1691 | 16.4763 | 8.6962 | -5.4 | 27.9 |
| *precip* | 1691 | 10.5459 | 7.2444 | 0.51 | 29.26 |
| *phone* | 1691 | 23.615 | 20.1361 | 0.0061 | 74.7625 |
| *cell* | 1691 | 49.9861 | 45.1561 | 0 | 215.5038 |
| *lnenergy* | 1691 | 9.4306 | 2.3547 | -0.5997 | 14.7044 |
| *lnpop* | 1691 | 16.3745 | 1.6109 | 12.5022 | 21.019 |
| *urban* | 1691 | 61.9298 | 21.5483 | 9.8642 | 100 |
| *lfrac* | 1691 | 36.4956 | 28.0293 | 0.21 | 89.83 |
| *efrac* | 1691 | 41.1954 | 25.0175 | 0.2 | 87.47 |

## Chart 3: Correlation matrix

| **Variables** | *tfp* | *tfpalt* | *ctrlcorr* | *cpi* | *fppress* | *rsfpress* | *diamond* | *gold* | *tmean* | *precip* | *phone* | *cell* | *energy* | *pop* | *urban* | *lfrac* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *tfp* | 1 | | | | | | | | | | | | | | | |
| *tfpalt* | 0.9994 | 1 | | | | | | | | | | | | | | |
| *ctrlcorr* | 0.8329 | 0.8347 | 1 | | | | | | | | | | | | | |
| *cpi* | 0.8351 | 0.837 | 0.9816 | 1 | | | | | | | | | | | | |
| *fppress* | 0.6045 | 0.6015 | 0.7494 | 0.7084 | 1 | | | | | | | | | | | |
| *rsfpress* | 0.4567 | 0.4548 | 0.5583 | 0.5259 | 0.8076 | 1 | | | | | | | | | | |
| *diamond* | -0.0796 | -0.078 | -0.0746 | -0.0517 | -0.1282 | -0.0301 | 1 | | | | | | | | | |
| *gold* | -0.0118 | -0.0115 | 0.0429 | 0.0534 | 0.0237 | 0.0409 | 0.3483 | 1 | | | | | | | | |
| *tmean* | -0.3957 | -0.3987 | -0.4494 | -0.46 | -0.4378 | -0.3481 | -0.0961 | 0.0707 | 1 | | | | | | | |
| *precip* | -0.1173 | -0.1213 | -0.0826 | -0.0866 | -0.0082 | -0.0038 | -0.088 | -0.0661 | 0.4138 | 1 | | | | | | |
| *phone* | 0.7911 | 0.792 | 0.8143 | 0.8095 | 0.6545 | 0.4603 | -0.0163 | 0.0129 | -0.5968 | -0.1133 | 1 | | | | | |
| *cell* | 0.5135 | 0.5191 | 0.5114 | 0.5178 | 0.3777 | 0.2224 | -0.0422 | -0.0218 | -0.3245 | -0.0599 | 0.5482 | 1 | | | | |
| *energy* | 0.0425 | 0.0456 | 0.0046 | 0.0207 | -0.1229 | -0.2724 | 0.2434 | 0.0613 | -0.2136 | -0.1283 | 0.1324 | -0.0051 | 1 | | | |
| *pop* | -0.1355 | -0.1335 | -0.1176 | -0.1071 | -0.1317 | -0.3068 | 0.0045 | -0.001 | -0.0149 | -0.0028 | -0.0669 | -0.1573 | 0.6713 | 1 | | |
| *urban* | 0.6017 | 0.606 | 0.6207 | 0.6238 | 0.3793 | 0.2741 | 0.0134 | 0.0537 | -0.2995 | -0.109 | 0.6076 | 0.5153 | 0.0744 | -0.1763 | 1 | |
| *lfrac* | -0.3349 | -0.3323 | -0.3376 | -0.3224 | -0.2738 | -0.1548 | 0.0965 | 0.0353 | 0.3029 | -0.019 | -0.459 | -0.3379 | -0.0818 | 0.0407 | -0.4115 | 1 |
| *efrac* | -0.3922 | -0.3938 | -0.4577 | -0.4552 | -0.373 | -0.1983 | 0.0019 | -0.0077 | 0.4101 | 0.0689 | -0.5484 | -0.3806 | -0.0646 | -0.0626 | -0.3125 | 0.7207 |

**Chart 4: Countries in sample**

The 108 economies used in Regression I, by region.

## Western Europe and Offshoots

(*west*)
Albania
Australia
Austria
Belgium
Bulgaria
Canada
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Latvia
Luxembourg
Malta
Netherlands
New Zealand
Norway
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
United Kingdom
United States

## Sub-Sahara Africa

(*ssa*)
Benin
Botswana
Cameroon
Congo, Republic
Congo, Democratic Republic
Côte d´Ivoire
Gabon
Ghana
Kenya
Mozambique
Namibia
Senegal
South Africa
Tanzania
Togo
Zambia
Zimbabwe

## Central, South America, and Caribbean

(*csac*)
Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Dominican Republic
Ecuador
Guatemala
Honduras
Jamaica
Mexico
Panama
Paraguay
Peru
Trinidad and Tobago
Uruguay
Venezuela

## Middle East and North Africa

(*mena*)
Bahrain
Egypt
Iran
Iraq
Jordan
Kuwait
Morocco
Qatar
Saudi Arabia
Sudan
Syria
Tunisia
Turkey

## Eastern Europe and Central Asia

(*eeca*)
Armenia
Kazakhstan
Kyrgyzstan
Moldova
Russia
Tajikistan
Ukraine

## Asia

(*asia*)
Bangladesh
Brunei
Cambodia
China
Hong Kong
India
Indonesia
Japan
Malaysia
Mongolia
Pakistan
Philippines
Singapore
South Korea
Sri Lanka
Thailand
Vietnam

## Regression I
## First Stage

A two-stage least squares regression, with the World Governance Index's control of corruption variable (*ctrlcorr*) and the Freedom House's Freedom of the Press (*fppress*) as the instrument.

| | | |
|---|---|---|
| Number of obs | = | 1691 |
| F( 33, 1657) | = | 230.86 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.8214 |
| Adj R-squared | = | 0.8178 |
| Root MSE | = | 8.3901 |

| ctrlcorr | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.1293056 | .0453632 | -2.85 | 0.004 | -.2182808 | -.0403305 |
| precip | .1457077 | .0460581 | 3.16 | 0.002 | .0553695 | .2360458 |
| coast | -.5147894 | .6693546 | -0.77 | 0.442 | -1.827659 | .7980805 |
| phone | .5031079 | .0236314 | 21.29 | 0.000 | .4567575 | .5494584 |
| cell | .051966 | .0105283 | 4.94 | 0.000 | .0313159 | .0726161 |
| lnenergy | .2972991 | .1341697 | 2.22 | 0.027 | .0341391 | .560459 |
| lnpop | -1.343867 | .2113022 | -6.36 | 0.000 | -1.758315 | -.9294198 |
| urban | .1096815 | .0152906 | 7.17 | 0.000 | .0796906 | .1396723 |
| lfrac | .0406084 | .0138578 | 2.93 | 0.003 | .0134277 | .067789 |
| efrac | -.0526751 | .0150537 | -3.50 | 0.000 | -.0822013 | -.0231489 |
| asia | 7.303675 | .9963307 | 7.33 | 0.000 | 5.349475 | 9.257875 |
| csac | -.121174 | 1.065347 | -0.11 | 0.909 | -2.210743 | 1.968395 |
| eeca | -5.105467 | 1.236508 | -4.13 | 0.000 | -7.53075 | -2.680183 |
| mena | 10.70632 | 1.227848 | 8.72 | 0.000 | 8.298022 | 13.11462 |
| ssa | 7.361554 | 1.188712 | 6.19 | 0.000 | 5.030017 | 9.69309 |
| year | | | | | | |
| 1997 | -.2696248 | 1.163965 | -0.23 | 0.817 | -2.552621 | 2.013372 |
| 1998 | -.5307221 | 1.162352 | -0.46 | 0.648 | -2.810556 | 1.749111 |
| 1999 | -1.248123 | 1.166598 | -1.07 | 0.285 | -3.536284 | 1.040038 |
| 2000 | -2.36897 | 1.170082 | -2.02 | 0.043 | -4.663965 | -.073975 |
| 2001 | -3.211582 | 1.18192 | -2.72 | 0.007 | -5.529796 | -.8933687 |
| 2002 | -3.239593 | 1.193804 | -2.71 | 0.007 | -5.581117 | -.8980696 |
| 2003 | -3.070542 | 1.207047 | -2.54 | 0.011 | -5.43804 | -.7030443 |
| 2004 | -3.976292 | 1.227856 | -3.24 | 0.001 | -6.384605 | -1.567978 |
| 2005 | -4.848387 | 1.262851 | -3.84 | 0.000 | -7.32534 | -2.371435 |
| 2006 | -5.043238 | 1.315106 | -3.83 | 0.000 | -7.622683 | -2.463793 |
| 2007 | -5.256962 | 1.372963 | -3.83 | 0.000 | -7.949887 | -2.564038 |
| 2008 | -5.580282 | 1.43129 | -3.90 | 0.000 | -8.38761 | -2.772954 |
| 2009 | -6.293341 | 1.479864 | -4.25 | 0.000 | -9.195941 | -3.390741 |
| 2010 | -6.519798 | 1.531085 | -4.26 | 0.000 | -9.522863 | -3.516733 |
| 2011 | -6.764964 | 1.581344 | -4.28 | 0.000 | -9.866608 | -3.663321 |
| fppress | .3067728 | .0161763 | 18.96 | 0.000 | .2750446 | .338501 |
| lndiamond | .2479455 | .0492414 | 5.04 | 0.000 | .1513635 | .3445275 |
| lngold | -.1821853 | .0523052 | -3.48 | 0.001 | -.2847765 | -.0795941 |
| _cons | 41.49687 | 3.432169 | 12.09 | 0.000 | 34.76503 | 48.22872 |

## Regression I
## Second Stage

Instrumental variables (2SLS) regression

| | | |
|---|---|---|
| Number of obs | = | **1691** |
| Wald chi2(**31**) | = | **10926.37** |
| Prob > chi2 | = | **0.0000** |
| R-squared | = | **0.8661** |
| Root MSE | = | **.36305** |

| lntfp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ctrlcorr | .0196031 | .0021738 | 9.02 | 0.000 | .0153425 | .0238637 |
| tmean | .013647 | .001993 | 6.85 | 0.000 | .0097408 | .0175531 |
| precip | .0081592 | .0019722 | 4.14 | 0.000 | .0042937 | .0120246 |
| coast | .0954132 | .0289396 | 3.30 | 0.001 | .0386927 | .1521337 |
| phone | .0149557 | .0016909 | 8.84 | 0.000 | .0116415 | .0182698 |
| cell | .0047144 | .000472 | 9.99 | 0.000 | .0037893 | .0056395 |
| lnenergy | .0944116 | .0057066 | 16.54 | 0.000 | .0832268 | .1055964 |
| lnpop | -.109515 | .009395 | -11.66 | 0.000 | -.127929 | -.0911011 |
| urban | .0044942 | .0007025 | 6.40 | 0.000 | .0031172 | .0058711 |
| lfrac | -.0008552 | .0006147 | -1.39 | 0.164 | -.0020601 | .0003496 |
| efrac | .0007223 | .0006699 | 1.08 | 0.281 | -.0005907 | .0020353 |
| asia | -.367182 | .042947 | -8.55 | 0.000 | -.4513566 | -.2830074 |
| csac | -.043934 | .0460783 | -0.95 | 0.340 | -.1342459 | .0463778 |
| eeca | -.6461308 | .0573543 | -11.27 | 0.000 | -.7585431 | -.5337184 |
| mena | .4163284 | .0478052 | 8.71 | 0.000 | .3226319 | .510025 |
| ssa | -.1105426 | .050748 | -2.18 | 0.029 | -.210007 | -.0110783 |
| year | | | | | | |
| 1997 | -.0229611 | .0503677 | -0.46 | 0.648 | -.1216801 | .0757578 |
| 1998 | -.0522296 | .0503264 | -1.04 | 0.299 | -.1508676 | .0464084 |
| 1999 | -.0902313 | .0506084 | -1.78 | 0.075 | -.189422 | .0089594 |
| 2000 | -.1167798 | .0509927 | -2.29 | 0.022 | -.2167237 | -.0168359 |
| 2001 | -.1508126 | .0516905 | -2.92 | 0.004 | -.2521242 | -.049501 |
| 2002 | -.1695333 | .052324 | -3.24 | 0.001 | -.2720865 | -.0669802 |
| 2003 | -.2017424 | .0528319 | -3.82 | 0.000 | -.3052909 | -.0981938 |
| 2004 | -.2204959 | .0541172 | -4.07 | 0.000 | -.3265636 | -.1144282 |
| 2005 | -.2520123 | .0560004 | -4.50 | 0.000 | -.3617711 | -.1422534 |
| 2006 | -.3082083 | .058417 | -5.28 | 0.000 | -.4227035 | -.193713 |
| 2007 | -.3547301 | .0610149 | -5.81 | 0.000 | -.4743172 | -.235143 |
| 2008 | -.4084815 | .0637066 | -6.41 | 0.000 | -.5333441 | -.283619 |
| 2009 | -.4773705 | .0662408 | -7.21 | 0.000 | -.6072 | -.3475409 |
| 2010 | -.489353 | .0685375 | -7.14 | 0.000 | -.623684 | -.3550219 |
| 2011 | -.5049438 | .0707971 | -7.13 | 0.000 | -.6437035 | -.366184 |
| _cons | 3.609641 | .1931256 | 18.69 | 0.000 | 3.231121 | 3.98816 |

**Regression I-A**
**First Stage**

A two-stage least squares regression, with the World Governance Index's control of corruption variable (*ctrlcorr*) and the Freedom House's Freedom of the Press (*fppress*) as the instrument, where insignificant fractionalization measures are excluded.

| | | |
|---|---|---|
| Number of obs | = | 1723 |
| F( 31, 1691) | = | 251.06 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.8215 |
| Adj R-squared | = | 0.8182 |
| Root MSE | = | 8.3546 |

| ctrlcorr | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.1186302 | .0444769 | -2.67 | 0.008 | -.2058658 | -.0313946 |
| precip | .1250969 | .0454462 | 2.75 | 0.006 | .0359602 | .2142336 |
| coast | -.7393816 | .6623108 | -1.12 | 0.264 | -2.038417 | .5596535 |
| phone | .5076366 | .0233451 | 21.74 | 0.000 | .4618482 | .553425 |
| cell | .0537466 | .0103197 | 5.21 | 0.000 | .0335059 | .0739873 |
| lnenergy | .2185311 | .1301376 | 1.68 | 0.093 | -.0367167 | .4737788 |
| lnpop | -1.211339 | .2062358 | -5.87 | 0.000 | -1.615843 | -.8068345 |
| urban | .1073184 | .0149837 | 7.16 | 0.000 | .0779299 | .136707 |
| asia | 7.698915 | .984402 | 7.82 | 0.000 | 5.76814 | 9.629689 |
| csac | -1.326583 | .9997348 | -1.33 | 0.185 | -3.28743 | .6342648 |
| eeca | -5.15121 | 1.210204 | -4.26 | 0.000 | -7.524865 | -2.777554 |
| mena | 10.2772 | 1.20102 | 8.56 | 0.000 | 7.921554 | 12.63284 |
| ssa | 7.122071 | 1.119053 | 6.36 | 0.000 | 4.927197 | 9.316945 |
| year | | | | | | |
| 1997 | -.3159031 | 1.148021 | -0.28 | 0.783 | -2.567595 | 1.935788 |
| 1998 | -.6324707 | 1.146407 | -0.55 | 0.581 | -2.880996 | 1.616055 |
| 1999 | -1.371921 | 1.150382 | -1.19 | 0.233 | -3.628243 | .8844014 |
| 2000 | -2.482303 | 1.153479 | -2.15 | 0.032 | -4.7447 | -.2199065 |
| 2001 | -3.376351 | 1.164577 | -2.90 | 0.004 | -5.660515 | -1.092188 |
| 2002 | -3.417735 | 1.175837 | -2.91 | 0.004 | -5.723984 | -1.111485 |
| 2003 | -3.184572 | 1.188346 | -2.68 | 0.007 | -5.515355 | -.8537895 |
| 2004 | -4.103713 | 1.20844 | -3.40 | 0.001 | -6.473908 | -1.733518 |
| 2005 | -4.938742 | 1.242017 | -3.98 | 0.000 | -7.374794 | -2.50269 |
| 2006 | -5.104253 | 1.292901 | -3.95 | 0.000 | -7.640107 | -2.5684 |
| 2007 | -5.381341 | 1.349995 | -3.99 | 0.000 | -8.029177 | -2.733505 |
| 2008 | -5.707884 | 1.406943 | -4.06 | 0.000 | -8.467417 | -2.948351 |
| 2009 | -6.469272 | 1.454417 | -4.45 | 0.000 | -9.321918 | -3.616626 |
| 2010 | -6.719314 | 1.504398 | -4.47 | 0.000 | -9.669993 | -3.768636 |
| 2011 | -6.979854 | 1.553318 | -4.49 | 0.000 | -10.02648 | -3.933226 |
| fppress | .3116604 | .015988 | 19.49 | 0.000 | .280302 | .3430189 |
| lndiamond | .2568348 | .0488479 | 5.26 | 0.000 | .1610261 | .3526435 |
| lngold | -.1896668 | .0514198 | -3.69 | 0.000 | -.29052 | -.0888137 |
| _cons | 39.63647 | 3.344721 | 11.85 | 0.000 | 33.07624 | 46.19669 |

## Regression I-A
## Second Stage

Instrumental variables (2SLS) regression

| | |
|---|---|
| Number of obs = | 1723 |
| Wald chi2(29) = | 10324.80 |
| Prob > chi2 = | 0.0000 |
| R-squared = | 0.8569 |
| Root MSE = | .37282 |

| lntfp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ctrlcorr | .0200316 | .0021758 | 9.21 | 0.000 | .015767 | .0242961 |
| tmean | .0138319 | .0020084 | 6.89 | 0.000 | .0098954 | .0177684 |
| precip | .0079289 | .0020028 | 3.96 | 0.000 | .0040035 | .0118544 |
| coast | .1141472 | .0295639 | 3.86 | 0.000 | .056203 | .1720914 |
| phone | .0146962 | .001717 | 8.56 | 0.000 | .0113309 | .0180616 |
| cell | .0048445 | .000479 | 10.11 | 0.000 | .0039057 | .0057832 |
| lnenergy | .0941652 | .0056989 | 16.52 | 0.000 | .0829956 | .1053347 |
| lnpop | -.1130261 | .0093333 | -12.11 | 0.000 | -.131319 | -.0947332 |
| urban | .003752 | .0007039 | 5.33 | 0.000 | .0023725 | .0051315 |
| asia | -.3802135 | .0440329 | -8.63 | 0.000 | -.4665164 | -.2939106 |
| csac | .0222611 | .0446475 | 0.50 | 0.618 | -.0652464 | .1097687 |
| eeca | -.6421904 | .0580413 | -11.06 | 0.000 | -.7559493 | -.5284316 |
| mena | .4503752 | .0476883 | 9.44 | 0.000 | .3569079 | .5438426 |
| ssa | -.1353835 | .0494055 | -2.74 | 0.006 | -.2322165 | -.0385505 |
| year | | | | | | |
| 1997 | -.0226512 | .0512345 | -0.44 | 0.658 | -.123069 | .0777666 |
| 1998 | -.0515135 | .051199 | -1.01 | 0.314 | -.1518618 | .0488347 |
| 1999 | -.0910897 | .0514827 | -1.77 | 0.077 | -.1919939 | .0098144 |
| 2000 | -.1201364 | .0518612 | -2.32 | 0.021 | -.2217826 | -.0184903 |
| 2001 | -.1547851 | .0525616 | -2.94 | 0.003 | -.2578039 | -.0517663 |
| 2002 | -.1742929 | .0532006 | -3.28 | 0.001 | -.2785641 | -.0700218 |
| 2003 | -.2103287 | .0536764 | -3.92 | 0.000 | -.3155325 | -.1051248 |
| 2004 | -.2313593 | .0549853 | -4.21 | 0.000 | -.3391285 | -.1235901 |
| 2005 | -.2681592 | .0568562 | -4.72 | 0.000 | -.3795952 | -.1567231 |
| 2006 | -.327201 | .0592749 | -5.52 | 0.000 | -.4433776 | -.2110244 |
| 2007 | -.3761033 | .0619586 | -6.07 | 0.000 | -.49754 | -.2546666 |
| 2008 | -.4311946 | .0646788 | -6.67 | 0.000 | -.5579627 | -.3044265 |
| 2009 | -.4998703 | .0672734 | -7.43 | 0.000 | -.6317238 | -.3680168 |
| 2010 | -.5128507 | .0696055 | -7.37 | 0.000 | -.6492749 | -.3764265 |
| 2011 | -.5311851 | .0718832 | -7.39 | 0.000 | -.6720735 | -.3902967 |
| _cons | 3.684499 | .1903666 | 19.35 | 0.000 | 3.311388 | 4.057611 |

## Regression II
## First Stage

A two-stage least squares regression, using the World Governance Index's control of corruption variable (*ctrlcorr*) and the Freedom Press Index published by Reporters Without Borders (*rsfpress*) as the instrument.

| | | |
|---|---|---|
| Number of obs | = | 1029 |
| F( 27, 1001) | = | 152.56 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.8045 |
| Adj R-squared | = | 0.7992 |
| Root MSE | = | 8.8021 |

| ctrlcorr | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.2285397 | .0604635 | -3.78 | 0.000 | -.3471895 | -.1098899 |
| precip | .0392393 | .0613895 | 0.64 | 0.523 | -.0812277 | .1597062 |
| coast | .6871982 | .9134658 | 0.75 | 0.452 | -1.105329 | 2.479726 |
| phone | .5206648 | .0307979 | 16.91 | 0.000 | .460229 | .5811007 |
| cell | .0284166 | .0131138 | 2.17 | 0.030 | .0026829 | .0541503 |
| lnenergy | .1322645 | .1943622 | 0.68 | 0.496 | -.2491395 | .5136685 |
| lnpop | -1.320102 | .297876 | -4.43 | 0.000 | -1.904635 | -.7355692 |
| urban | .1872803 | .0206491 | 9.07 | 0.000 | .1467598 | .2278008 |
| lfrac | .0635042 | .0185765 | 3.42 | 0.001 | .0270508 | .0999576 |
| efrac | -.0649188 | .0200586 | -3.24 | 0.001 | -.1042805 | -.025557 |
| asia | 5.455754 | 1.371547 | 3.98 | 0.000 | 2.764317 | 8.147191 |
| csac | -2.424823 | 1.432408 | -1.69 | 0.091 | -5.235689 | .3860438 |
| eeca | -15.09271 | 1.520736 | -9.92 | 0.000 | -18.07691 | -12.10851 |
| mena | 3.377544 | 1.62332 | 2.08 | 0.038 | .1920441 | 6.563044 |
| ssa | 3.064629 | 1.605915 | 1.91 | 0.057 | -.0867175 | 6.215976 |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | 0 | (empty) | | | | |
| 1999 | 0 | (empty) | | | | |
| 2000 | 0 | (empty) | | | | |
| 2001 | 0 | (empty) | | | | |
| 2002 | .4242271 | 1.612864 | 0.26 | 0.793 | -2.740756 | 3.58921 |
| 2003 | .6575075 | 1.540944 | 0.43 | 0.670 | -2.366344 | 3.681359 |
| 2004 | .1746038 | 1.481308 | 0.12 | 0.906 | -2.732221 | 3.081429 |
| 2005 | -.7406935 | 1.426408 | -0.52 | 0.604 | -3.539786 | 2.058399 |
| 2006 | -.9000276 | 1.365474 | -0.66 | 0.510 | -3.579547 | 1.779491 |
| 2007 | -.3354203 | 1.296141 | -0.26 | 0.796 | -2.878885 | 2.208044 |
| 2008 | -1.380016 | 1.27363 | -1.08 | 0.279 | -3.879307 | 1.119276 |
| 2009 | -1.527149 | 1.242413 | -1.23 | 0.219 | -3.965181 | .9108839 |
| 2010 | -1.317704 | 1.221154 | -1.08 | 0.281 | -3.71402 | 1.078611 |
| 2011 | 0 | (omitted) | | | | |
| rsfpress | .1809921 | .0187179 | 9.67 | 0.000 | .1442611 | .217723 |
| lndiamond | .1831368 | .0654285 | 2.80 | 0.005 | .0547441 | .3115296 |
| lngold | -.2773598 | .066078 | -4.20 | 0.000 | -.407027 | -.1476926 |
| _cons | 42.96004 | 5.117286 | 8.40 | 0.000 | 32.91821 | 53.00188 |

## Regression II
## Second Stage

| Instrumental variables (2SLS) regression | |
|---|---|
| Number of obs = | 1029 |
| Wald chi2(25) = | 6500.77 |
| Prob > chi2 = | 0.0000 |
| R-squared = | 0.8633 |
| Root MSE = | .35647 |

| lntfp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ctrlcorr | .0261157 | .0036548 | 7.15 | 0.000 | .0189525 | .033279 |
| tmean | .0107338 | .0026166 | 4.10 | 0.000 | .0056054 | .0158622 |
| precip | .0092544 | .0024868 | 3.72 | 0.000 | .0043803 | .0141285 |
| coast | .12653 | .0370131 | 3.42 | 0.001 | .0539857 | .1990743 |
| phone | .0095339 | .0024521 | 3.89 | 0.000 | .004728 | .0143399 |
| cell | .0050883 | .0005394 | 9.43 | 0.000 | .004031 | .0061456 |
| lnenergy | .0913925 | .0077106 | 11.85 | 0.000 | .07628 | .106505 |
| lnpop | -.072939 | .0133812 | -5.45 | 0.000 | -.0991658 | -.0467123 |
| urban | .0018728 | .0010856 | 1.73 | 0.084 | -.0002549 | .0040006 |
| lfrac | -.0010358 | .0007994 | -1.30 | 0.195 | -.0026026 | .000531 |
| efrac | .0005142 | .000857 | 0.60 | 0.548 | -.0011655 | .002194 |
| asia | -.4391132 | .0533283 | -8.23 | 0.000 | -.5436348 | -.3345916 |
| csac | -.0585568 | .0586824 | -1.00 | 0.318 | -.1735721 | .0564585 |
| eeca | -.4435279 | .0899087 | -4.93 | 0.000 | -.6197457 | -.26731 |
| mena | .4114864 | .0605251 | 6.80 | 0.000 | .2928593 | .5301135 |
| ssa | -.1040587 | .0636701 | -1.63 | 0.102 | -.2288498 | .0207324 |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | 0 | (empty) | | | | |
| 1999 | 0 | (empty) | | | | |
| 2000 | 0 | (empty) | | | | |
| 2001 | 0 | (empty) | | | | |
| 2002 | .3146858 | .0650829 | 4.84 | 0.000 | .1871256 | .442246 |
| 2003 | .3018671 | .0624549 | 4.83 | 0.000 | .1794578 | .4242764 |
| 2004 | .2882356 | .0598303 | 4.82 | 0.000 | .1709704 | .4055009 |
| 2005 | .2549822 | .0570614 | 4.47 | 0.000 | .1431438 | .3668205 |
| 2006 | .1984112 | .0545711 | 3.64 | 0.000 | .0914538 | .3053687 |
| 2007 | .1444008 | .0522061 | 2.77 | 0.006 | .0420789 | .2467228 |
| 2008 | .0964636 | .0507028 | 1.90 | 0.057 | -.002912 | .1958393 |
| 2009 | .0365289 | .0497574 | 0.73 | 0.463 | -.0609938 | .1340515 |
| 2010 | .0193993 | .0491161 | 0.39 | 0.693 | -.0768664 | .115665 |
| 2011 | 0 | (omitted) | | | | |
| _cons | 2.434334 | .2961643 | 8.22 | 0.000 | 1.853863 | 3.014805 |

## Regression III
## First Stage

A two-stage least squares regression, with Transparency International's Corruption Perceptions Index (*cpi*) and the Freedom House press index (*fppress*) as the instrument.

| | | |
|---|---|---|
| Number of obs | = | 1338 |
| F( 31, 1306) | = | 166.22 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.7978 |
| Adj R-squared | = | 0.7930 |
| Root MSE | = | 10.7424 |

| cpi | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.2945064 | .0658159 | -4.47 | 0.000 | -.4236229 | -.16539 |
| precip | .2212108 | .06584 | 3.36 | 0.001 | .092047 | .3503745 |
| coast | .7248071 | .9410556 | 0.77 | 0.441 | -1.121339 | 2.570953 |
| phone | .5755788 | .0335829 | 17.14 | 0.000 | .5096965 | .6414612 |
| cell | .0454374 | .0147239 | 3.09 | 0.002 | .0165524 | .0743225 |
| lnenergy | .407447 | .2078321 | 1.96 | 0.050 | -.0002743 | .8151684 |
| lnpop | -2.171958 | .330365 | -6.57 | 0.000 | -2.820062 | -1.523854 |
| urban | .2097648 | .0225743 | 9.29 | 0.000 | .165479 | .2540506 |
| lfrac | .0790646 | .0199985 | 3.95 | 0.000 | .0398319 | .1182973 |
| efrac | -.0884154 | .0214993 | -4.11 | 0.000 | -.1305924 | -.0462385 |
| asia | 8.271328 | 1.462256 | 5.66 | 0.000 | 5.4027 | 11.13996 |
| csac | -.5551192 | 1.523163 | -0.36 | 0.716 | -3.543233 | 2.432995 |
| eeca | -8.442224 | 1.809717 | -4.66 | 0.000 | -11.99249 | -4.891955 |
| mena | 11.98056 | 1.778742 | 6.74 | 0.000 | 8.491055 | 15.47006 |
| ssa | 10.56967 | 1.707008 | 6.19 | 0.000 | 7.220894 | 13.91845 |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | 5.209994 | 2.1757 | 2.39 | 0.017 | .9417456 | 9.478243 |
| 1999 | 4.114206 | 2.083125 | 1.98 | 0.048 | .0275682 | 8.200844 |
| 2000 | 3.144777 | 2.042355 | 1.54 | 0.124 | -.8618783 | 7.151433 |
| 2001 | 2.408915 | 1.963432 | 1.23 | 0.220 | -1.442912 | 6.260741 |
| 2002 | 2.553645 | 1.900458 | 1.34 | 0.179 | -1.174639 | 6.281928 |
| 2003 | 2.010873 | 1.816956 | 1.11 | 0.269 | -1.553598 | 5.575344 |
| 2004 | 1.432406 | 1.744046 | 0.82 | 0.412 | -1.989032 | 4.853844 |
| 2005 | 1.679284 | 1.676266 | 1.00 | 0.317 | -1.609185 | 4.967752 |
| 2006 | 1.297413 | 1.609093 | 0.81 | 0.420 | -1.859278 | 4.454103 |
| 2007 | 1.017493 | 1.548176 | 0.66 | 0.511 | -2.019691 | 4.054676 |
| 2008 | .8235426 | 1.515609 | 0.54 | 0.587 | -2.149752 | 3.796837 |
| 2009 | .1185052 | 1.49198 | 0.08 | 0.937 | -2.808435 | 3.045445 |
| 2010 | .2001182 | 1.479459 | 0.14 | 0.892 | -2.702258 | 3.102494 |
| 2011 | 0 | (omitted) | | | | |
| fppress | .2797067 | .0239117 | 11.70 | 0.000 | .2327972 | .3266162 |
| lndiamond | .3460823 | .0696725 | 4.97 | 0.000 | .2094 | .4827646 |
| lngold | -.3015742 | .0735887 | -4.10 | 0.000 | -.4459392 | -.1572092 |
| _cons | 30.14883 | 5.489352 | 5.49 | 0.000 | 19.37992 | 40.91774 |

**Regression III**
**Second Stage**

Instrumental variables (2SLS) regression

| | |
|---|---|
| Number of obs | = 1338 |
| Wald chi2(29) | = 7981.93 |
| Prob > chi2 | = 0.0000 |
| R-squared | = 0.8549 |
| Root MSE | = .36869 |

| lntfp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| cpi | .0224906 | .0025612 | 8.78 | 0.000 | .0174708 | .0275105 |
| tmean | .0127452 | .0024351 | 5.23 | 0.000 | .0079725 | .0175178 |
| precip | .0060005 | .0022783 | 2.63 | 0.008 | .0015351 | .010466 |
| coast | .0617195 | .0323149 | 1.91 | 0.056 | -.0016165 | .1250554 |
| phone | .0103887 | .0020917 | 4.97 | 0.000 | .0062891 | .0144884 |
| cell | .0057645 | .0005178 | 11.13 | 0.000 | .0047496 | .0067795 |
| lnenergy | .0729815 | .0070429 | 10.36 | 0.000 | .0591778 | .0867853 |
| lnpop | -.0507773 | .0127814 | -3.97 | 0.000 | -.0758283 | -.0257263 |
| urban | .0010348 | .0009506 | 1.09 | 0.276 | -.0008282 | .0028979 |
| lfrac | -.0013237 | .000739 | -1.79 | 0.073 | -.0027721 | .0001246 |
| efrac | .0014501 | .0007979 | 1.82 | 0.069 | -.0001138 | .0030139 |
| asia | -.4348351 | .0502017 | -8.66 | 0.000 | -.5332287 | -.3364415 |
| csac | -.0073485 | .0522285 | -0.14 | 0.888 | -.1097144 | .0950174 |
| eeca | -.5387845 | .0696197 | -7.74 | 0.000 | -.6752366 | -.4023323 |
| mena | .3418085 | .0551634 | 6.20 | 0.000 | .2336903 | .4499267 |
| ssa | -.1703447 | .0608546 | -2.80 | 0.005 | -.2896175 | -.0510719 |
| | | | | | | |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | .5440474 | .0763096 | 7.13 | 0.000 | .3944833 | .6936115 |
| 1999 | .4893016 | .0725371 | 6.75 | 0.000 | .3471316 | .6314717 |
| 2000 | .4317845 | .0708086 | 6.10 | 0.000 | .2930022 | .5705668 |
| 2001 | .4184052 | .0679312 | 6.16 | 0.000 | .2852626 | .5515479 |
| 2002 | .3986028 | .0657725 | 6.06 | 0.000 | .269691 | .5275146 |
| 2003 | .4009283 | .0627353 | 6.39 | 0.000 | .2779694 | .5238872 |
| 2004 | .3677052 | .0600622 | 6.12 | 0.000 | .2499854 | .4854249 |
| 2005 | .3043765 | .0578131 | 5.26 | 0.000 | .1910649 | .4176881 |
| 2006 | .2399651 | .0553845 | 4.33 | 0.000 | .1314135 | .3485167 |
| 2007 | .1827581 | .053246 | 3.43 | 0.001 | .0783978 | .2871184 |
| 2008 | .1169997 | .0520906 | 2.25 | 0.025 | .014904 | .2190954 |
| 2009 | .0485874 | .0512069 | 0.95 | 0.343 | -.0517762 | .148951 |
| 2010 | .0226344 | .0507787 | 0.45 | 0.656 | -.07689 | .1221588 |
| 2011 | 0 | (omitted) | | | | |
| | | | | | | |
| _cons | 2.731972 | .2182809 | 12.52 | 0.000 | 2.304149 | 3.159795 |

## Regression IV
## First Stage

A two-stage least squares regression, using Transparency International's Corruption Perceptions Index (*cpi*) and the Freedom Press Index published by Reporters Without Borders (*rsfpress*) as the instrument.

| | | |
|---|---|---|
| Number of obs | = | 1004 |
| F( 27, 976) | = | 139.03 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.7937 |
| Adj R-squared | = | 0.7879 |
| Root MSE | = | 10.7183 |

| cpi | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.394314 | .0747411 | -5.28 | 0.000 | -.5409858 | -.2476421 |
| precip | .1521769 | .0753198 | 2.02 | 0.044 | .0043695 | .2999844 |
| coast | 1.537147 | 1.117364 | 1.38 | 0.169 | -.6555661 | 3.72986 |
| phone | .6073076 | .0377318 | 16.10 | 0.000 | .5332628 | .6813524 |
| cell | .0261949 | .0160339 | 1.63 | 0.103 | -.0052699 | .0576598 |
| lnenergy | .3007058 | .2388668 | 1.26 | 0.208 | -.1680458 | .7694575 |
| lnpop | -1.842335 | .3680043 | -5.01 | 0.000 | -2.564506 | -1.120164 |
| urban | .2436204 | .0254239 | 9.58 | 0.000 | .1937286 | .2935121 |
| lfrac | .0994881 | .0227996 | 4.36 | 0.000 | .0547463 | .14423 |
| efrac | -.1024122 | .0245755 | -4.17 | 0.000 | -.150639 | -.0541853 |
| asia | 6.645018 | 1.699307 | 3.91 | 0.000 | 3.310301 | 9.979735 |
| csac | -3.181438 | 1.753434 | -1.81 | 0.070 | -6.622372 | .2594958 |
| eeca | -17.11743 | 1.870203 | -9.15 | 0.000 | -20.78751 | -13.44735 |
| mena | 5.258136 | 1.991302 | 2.64 | 0.008 | 1.350409 | 9.165862 |
| ssa | 5.627823 | 1.973048 | 2.85 | 0.004 | 1.755917 | 9.499728 |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | 0 | (empty) | | | | |
| 1999 | 0 | (empty) | | | | |
| 2000 | 0 | (empty) | | | | |
| 2001 | 0 | (empty) | | | | |
| 2002 | -.8717288 | 2.029899 | -0.43 | 0.668 | -4.855198 | 3.111741 |
| 2003 | -.8958837 | 1.894141 | -0.47 | 0.636 | -4.612942 | 2.821174 |
| 2004 | -.9483171 | 1.809642 | -0.52 | 0.600 | -4.499553 | 2.602919 |
| 2005 | -.7993046 | 1.740837 | -0.46 | 0.646 | -4.215519 | 2.61691 |
| 2006 | -1.167399 | 1.663961 | -0.70 | 0.483 | -4.432752 | 2.097954 |
| 2007 | -.6400641 | 1.578998 | -0.41 | 0.685 | -3.738686 | 2.458558 |
| 2008 | -1.484854 | 1.551533 | -0.96 | 0.339 | -4.529578 | 1.55987 |
| 2009 | -1.772595 | 1.513246 | -1.17 | 0.242 | -4.742186 | 1.196995 |
| 2010 | -1.291365 | 1.487188 | -0.87 | 0.385 | -4.20982 | 1.62709 |
| 2011 | 0 | (omitted) | | | | |
| rsfpress | .1743916 | .0229896 | 7.59 | 0.000 | .129277 | .2195063 |
| lndiamond | .2577327 | .0809254 | 3.18 | 0.001 | .0989249 | .4165406 |
| lngold | -.391844 | .0815082 | -4.81 | 0.000 | -.5517954 | -.2318925 |
| _cons | 33.83975 | 6.310085 | 5.36 | 0.000 | 21.45686 | 46.22264 |

## Regression IV
## Second Stage

Instrumental variables (2SLS) regression

| | | | |
|---|---|---|---|
| Number of obs | = | 1004 |
| Wald chi2(25) | = | 5837.66 |
| Prob > chi2 | = | 0.0000 |
| R-squared | = | 0.8518 |
| Root MSE | = | .36786 |

| lntfp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| cpi | .0244519 | .0035475 | 6.89 | 0.000 | .0174989 | .0314049 |
| tmean | .0134944 | .002961 | 4.56 | 0.000 | .0076911 | .0192978 |
| precip | .0062791 | .0026433 | 2.38 | 0.018 | .0010983 | .01146 |
| coast | .1112707 | .0385693 | 2.88 | 0.004 | .0356763 | .186865 |
| phone | .0083301 | .0027132 | 3.07 | 0.002 | .0030124 | .0136478 |
| cell | .0052746 | .0005547 | 9.51 | 0.000 | .0041874 | .0063619 |
| lnenergy | .0844275 | .0080226 | 10.52 | 0.000 | .0687035 | .1001515 |
| lnpop | -.0610657 | .0148025 | -4.13 | 0.000 | -.0900781 | -.0320533 |
| urban | .0005478 | .0012362 | 0.44 | 0.658 | -.0018751 | .0029707 |
| lfrac | -.0016535 | .0008766 | -1.89 | 0.059 | -.0033716 | .0000647 |
| efrac | .001382 | .0009409 | 1.47 | 0.142 | -.0004621 | .0032262 |
| asia | -.4612487 | .0567198 | -8.13 | 0.000 | -.5724174 | -.3500799 |
| csac | -.0347397 | .0610852 | -0.57 | 0.570 | -.1544646 | .0849851 |
| eeca | -.4422784 | .0939647 | -4.71 | 0.000 | -.6264458 | -.2581109 |
| mena | .3505263 | .0626428 | 5.60 | 0.000 | .2277486 | .473304 |
| ssa | -.1587823 | .0691141 | -2.30 | 0.022 | -.2942435 | -.0233211 |
| | | | | | | |
| year | | | | | | |
| 1996 | 0 | (empty) | | | | |
| 1997 | 0 | (empty) | | | | |
| 1998 | 0 | (empty) | | | | |
| 1999 | 0 | (empty) | | | | |
| 2000 | 0 | (empty) | | | | |
| 2001 | 0 | (empty) | | | | |
| 2002 | .3611739 | .0686934 | 5.26 | 0.000 | .2265373 | .4958105 |
| 2003 | .3629041 | .0641345 | 5.66 | 0.000 | .2372028 | .4886055 |
| 2004 | .3308214 | .0614367 | 5.38 | 0.000 | .2104077 | .4512352 |
| 2005 | .2698115 | .0588896 | 4.58 | 0.000 | .1543899 | .385233 |
| 2006 | .2118796 | .0561986 | 3.77 | 0.000 | .1017324 | .3220267 |
| 2007 | .1569853 | .0537495 | 2.92 | 0.003 | .0516383 | .2623323 |
| 2008 | .103173 | .0522654 | 1.97 | 0.048 | .0007346 | .2056114 |
| 2009 | .0448461 | .0513421 | 0.87 | 0.382 | -.0557827 | .1454748 |
| 2010 | .0199441 | .0506862 | 0.39 | 0.694 | -.0793991 | .1192873 |
| 2011 | 0 | (omitted) | | | | |
| | | | | | | |
| _cons | 2.790529 | .2717398 | 10.27 | 0.000 | 2.257928 | 3.323129 |

**Regression V**
**First Stage**

A two-stage least squares regression, where an alternative measure of productivity (*tfpalt*) is used as the dependent variable. The corruption variable is the World Governance Index's control of corruption (*ctrlcorr*) and the Freedom House press index (*fppress*) instruments.

| | | |
|---|---|---|
| Number of obs | = | 1691 |
| F( 33, 1657) | = | 230.86 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.8214 |
| Adj R-squared | = | 0.8178 |
| Root MSE | = | 8.3901 |

| ctrlcorr | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.1293056 | .0453632 | -2.85 | 0.004 | -.2182808 | -.0403305 |
| precip | .1457077 | .0460581 | 3.16 | 0.002 | .0553695 | .2360458 |
| coast | -.5147894 | .6693546 | -0.77 | 0.442 | -1.827659 | .7980805 |
| phone | .5031079 | .0236314 | 21.29 | 0.000 | .4567575 | .5494584 |
| cell | .051966 | .0105283 | 4.94 | 0.000 | .0313159 | .0726161 |
| lnenergy | .2972991 | .1341697 | 2.22 | 0.027 | .0341391 | .560459 |
| lnpop | -1.343867 | .2113022 | -6.36 | 0.000 | -1.758315 | -.9294198 |
| urban | .1096815 | .0152906 | 7.17 | 0.000 | .0796906 | .1396723 |
| lfrac | .0406084 | .0138578 | 2.93 | 0.003 | .0134277 | .067789 |
| efrac | -.0526751 | .0150537 | -3.50 | 0.000 | -.0822013 | -.0231489 |
| asia | 7.303675 | .9963307 | 7.33 | 0.000 | 5.349475 | 9.257875 |
| csac | -.121174 | 1.065347 | -0.11 | 0.909 | -2.210743 | 1.968395 |
| eeca | -5.105467 | 1.236508 | -4.13 | 0.000 | -7.53075 | -2.680183 |
| mena | 10.70632 | 1.227848 | 8.72 | 0.000 | 8.298022 | 13.11462 |
| ssa | 7.361554 | 1.188712 | 6.19 | 0.000 | 5.030017 | 9.69309 |
| year | | | | | | |
| 1997 | -.2696248 | 1.163965 | -0.23 | 0.817 | -2.552621 | 2.013372 |
| 1998 | -.5307221 | 1.162352 | -0.46 | 0.648 | -2.810556 | 1.749111 |
| 1999 | -1.248123 | 1.166598 | -1.07 | 0.285 | -3.536284 | 1.040038 |
| 2000 | -2.36897 | 1.170082 | -2.02 | 0.043 | -4.663965 | -.073975 |
| 2001 | -3.211582 | 1.18192 | -2.72 | 0.007 | -5.529796 | -.8933687 |
| 2002 | -3.239593 | 1.193804 | -2.71 | 0.007 | -5.581117 | -.8980696 |
| 2003 | -3.070542 | 1.207047 | -2.54 | 0.011 | -5.43804 | -.7030443 |
| 2004 | -3.976292 | 1.227856 | -3.24 | 0.001 | -6.384605 | -1.567978 |
| 2005 | -4.848387 | 1.262851 | -3.84 | 0.000 | -7.32534 | -2.371435 |
| 2006 | -5.043238 | 1.315106 | -3.83 | 0.000 | -7.622683 | -2.463793 |
| 2007 | -5.256962 | 1.372963 | -3.83 | 0.000 | -7.949887 | -2.564038 |
| 2008 | -5.580282 | 1.43129 | -3.90 | 0.000 | -8.38761 | -2.772954 |
| 2009 | -6.293341 | 1.479864 | -4.25 | 0.000 | -9.195941 | -3.390741 |
| 2010 | -6.519798 | 1.531085 | -4.26 | 0.000 | -9.522863 | -3.516733 |
| 2011 | -6.764964 | 1.581344 | -4.28 | 0.000 | -9.866608 | -3.663321 |
| fppress | .3067728 | .0161763 | 18.96 | 0.000 | .2750446 | .338501 |
| lndiamond | .2479455 | .0492414 | 5.04 | 0.000 | .1513635 | .3445275 |
| lngold | -.1821853 | .0523052 | -3.48 | 0.001 | -.2847765 | -.0795941 |
| _cons | 41.49687 | 3.432169 | 12.09 | 0.000 | 34.76503 | 48.22872 |

## Regression V
## Second Stage

Instrumental variables (2SLS) regression

| | |
|---|---|
| Number of obs | = 1691 |
| Wald chi2(31) | =11575.07 |
| Prob > chi2 | = 0.0000 |
| R-squared | = 0.8726 |
| Root MSE | = .3726 |

| lntfpalt | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ctrlcorr | .0207678 | .002231 | 9.31 | 0.000 | .016395 | .0251405 |
| tmean | .0143379 | .0020454 | 7.01 | 0.000 | .0103289 | .0183469 |
| precip | .0071413 | .0020241 | 3.53 | 0.000 | .0031741 | .0111085 |
| coast | .1004856 | .0297015 | 3.38 | 0.001 | .0422718 | .1586994 |
| phone | .0150972 | .0017354 | 8.70 | 0.000 | .0116958 | .0184986 |
| cell | .005025 | .0004844 | 10.37 | 0.000 | .0040755 | .0059745 |
| lnenergy | .0983195 | .0058569 | 16.79 | 0.000 | .0868402 | .1097988 |
| lnpop | -.1155911 | .0096424 | -11.99 | 0.000 | -.1344898 | -.0966924 |
| urban | .0054428 | .000721 | 7.55 | 0.000 | .0040296 | .006856 |
| lfrac | -.0011105 | .0006309 | -1.76 | 0.078 | -.0023471 | .000126 |
| efrac | .0009316 | .0006875 | 1.35 | 0.175 | -.0004159 | .0022792 |
| asia | -.3634368 | .0440777 | -8.25 | 0.000 | -.4498276 | -.2770461 |
| csac | -.0644188 | .0472915 | -1.36 | 0.173 | -.1571084 | .0282708 |
| eeca | -.6328035 | .0588643 | -10.75 | 0.000 | -.7481755 | -.5174316 |
| mena | .3971272 | .0490638 | 8.09 | 0.000 | .3009638 | .4932905 |
| ssa | -.1544307 | .0520841 | -2.97 | 0.003 | -.2565138 | -.0523477 |
| year | | | | | | |
| 1997 | -.0240506 | .0516938 | -0.47 | 0.642 | -.1253686 | .0772674 |
| 1998 | -.0544747 | .0516514 | -1.05 | 0.292 | -.1557096 | .0467602 |
| 1999 | -.0941188 | .0519409 | -1.81 | 0.070 | -.195921 | .0076834 |
| 2000 | -.1223998 | .0523353 | -2.34 | 0.019 | -.224975 | -.0198246 |
| 2001 | -.1577612 | .0530515 | -2.97 | 0.003 | -.2617401 | -.0537822 |
| 2002 | -.1775381 | .0537016 | -3.31 | 0.001 | -.2827913 | -.0722849 |
| 2003 | -.210211 | .0542228 | -3.88 | 0.000 | -.3164857 | -.1039362 |
| 2004 | -.2273986 | .055542 | -4.09 | 0.000 | -.3362588 | -.1185384 |
| 2005 | -.2573818 | .0574748 | -4.48 | 0.000 | -.3700303 | -.1447332 |
| 2006 | -.3132911 | .059955 | -5.23 | 0.000 | -.4308008 | -.1957815 |
| 2007 | -.3610241 | .0626213 | -5.77 | 0.000 | -.4837597 | -.2382885 |
| 2008 | -.4156214 | .0653838 | -6.36 | 0.000 | -.5437714 | -.2874715 |
| 2009 | -.4867773 | .0679848 | -7.16 | 0.000 | -.620025 | -.3535296 |
| 2010 | -.5004691 | .070342 | -7.11 | 0.000 | -.6383368 | -.3626014 |
| 2011 | -.5166118 | .072661 | -7.11 | 0.000 | -.6590248 | -.3741988 |
| _cons | 3.390893 | .1982102 | 17.11 | 0.000 | 3.002408 | 3.779378 |

**Regression VI**
**First Stage**

A two-stage least squares regression, with the World Governance Index's control of corruption variable (*ctrlcorr*) and the Freedom House's Freedom of the Press (*fppress*) as the instrument. Measures of *tfp* and *energy* are replaced with per capita measures.

| | | |
|---|---|---|
| Number of obs | = | 1691 |
| F( 33, 1657) | = | 230.86 |
| Prob > F | = | 0.0000 |
| R-squared | = | 0.8214 |
| Adj R-squared | = | 0.8178 |
| Root MSE | = | 8.3901 |

| ctrlcorr | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| tmean | -.1293056 | .0453632 | -2.85 | 0.004 | -.2182808 | -.0403305 |
| precip | .1457077 | .0460581 | 3.16 | 0.002 | .0553695 | .2360458 |
| coast | -.5147894 | .6693546 | -0.77 | 0.442 | -1.827659 | .7980805 |
| phone | .5031079 | .0236314 | 21.29 | 0.000 | .4567575 | .5494584 |
| cell | .051966 | .0105283 | 4.94 | 0.000 | .0313159 | .0726161 |
| lnenergypc | .297299 | .1341697 | 2.22 | 0.027 | .0341391 | .560459 |
| lnpop | -1.046568 | .1638053 | -6.39 | 0.000 | -1.367855 | -.7252811 |
| urban | .1096815 | .0152906 | 7.17 | 0.000 | .0796906 | .1396723 |
| lfrac | .0406084 | .0138578 | 2.93 | 0.003 | .0134277 | .067789 |
| efrac | -.0526751 | .0150537 | -3.50 | 0.000 | -.0822013 | -.0231489 |
| asia | 7.303675 | .9963307 | 7.33 | 0.000 | 5.349475 | 9.257875 |
| csac | -.1211741 | 1.065347 | -0.11 | 0.909 | -2.210743 | 1.968395 |
| eeca | -5.105467 | 1.236508 | -4.13 | 0.000 | -7.53075 | -2.680183 |
| mena | 10.70632 | 1.227848 | 8.72 | 0.000 | 8.298022 | 13.11462 |
| ssa | 7.361554 | 1.188712 | 6.19 | 0.000 | 5.030017 | 9.69309 |
| year | | | | | | |
| 1997 | -.2696248 | 1.163965 | -0.23 | 0.817 | -2.552621 | 2.013372 |
| 1998 | -.5307221 | 1.162352 | -0.46 | 0.648 | -2.810556 | 1.749111 |
| 1999 | -1.248123 | 1.166598 | -1.07 | 0.285 | -3.536284 | 1.040038 |
| 2000 | -2.36897 | 1.170082 | -2.02 | 0.043 | -4.663965 | -.073975 |
| 2001 | -3.211582 | 1.18192 | -2.72 | 0.007 | -5.529796 | -.8933687 |
| 2002 | -3.239593 | 1.193804 | -2.71 | 0.007 | -5.581117 | -.8980696 |
| 2003 | -3.070542 | 1.207047 | -2.54 | 0.011 | -5.43804 | -.7030442 |
| 2004 | -3.976292 | 1.227856 | -3.24 | 0.001 | -6.384605 | -1.567978 |
| 2005 | -4.848387 | 1.262851 | -3.84 | 0.000 | -7.32534 | -2.371435 |
| 2006 | -5.043238 | 1.315106 | -3.83 | 0.000 | -7.622683 | -2.463793 |
| 2007 | -5.256962 | 1.372963 | -3.83 | 0.000 | -7.949887 | -2.564038 |
| 2008 | -5.580282 | 1.43129 | -3.90 | 0.000 | -8.38761 | -2.772954 |
| 2009 | -6.293341 | 1.479864 | -4.25 | 0.000 | -9.195941 | -3.390741 |
| 2010 | -6.519798 | 1.531085 | -4.26 | 0.000 | -9.522863 | -3.516733 |
| 2011 | -6.764964 | 1.581344 | -4.28 | 0.000 | -9.866608 | -3.663321 |
| fppress | .3067728 | .0161763 | 18.96 | 0.000 | .2750446 | .338501 |
| lndiamond | .2479455 | .0492414 | 5.04 | 0.000 | .1513635 | .3445275 |
| lngold | -.1821853 | .0523052 | -3.48 | 0.001 | -.2847765 | -.079594 |
| _cons | 41.49687 | 3.432169 | 12.09 | 0.000 | 34.76503 | 48.22872 |

## Regression VI
## Second Stage

Instrumental variables (2SLS) regression

| | |
|---|---|
| Number of obs | = 1691 |
| Wald chi2(31) | =54459.36 |
| Prob > chi2 | = 0.0000 |
| R-squared | = 0.9699 |
| Root MSE | = .36305 |

| lntfppc | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ctrlcorr | .0196031 | .0021738 | 9.02 | 0.000 | .0153425 | .0238637 |
| tmean | .0136469 | .001993 | 6.85 | 0.000 | .0097408 | .0175531 |
| precip | .0081592 | .0019722 | 4.14 | 0.000 | .0042937 | .0120246 |
| coast | .0954132 | .0289396 | 3.30 | 0.001 | .0386927 | .1521337 |
| phone | .0149557 | .0016909 | 8.84 | 0.000 | .0116415 | .0182698 |
| cell | .0047144 | .000472 | 9.99 | 0.000 | .0037893 | .0056395 |
| lnenergypc | .0944116 | .0057066 | 16.54 | 0.000 | .0832268 | .1055964 |
| lnpop | -1.015103 | .0071034 | -142.90 | 0.000 | -1.029026 | -1.001181 |
| urban | .0044942 | .0007025 | 6.40 | 0.000 | .0031172 | .0058711 |
| lfrac | -.0008552 | .0006147 | -1.39 | 0.164 | -.0020601 | .0003496 |
| efrac | .0007223 | .0006699 | 1.08 | 0.281 | -.0005907 | .0020353 |
| asia | -.3671821 | .042947 | -8.55 | 0.000 | -.4513567 | -.2830075 |
| csac | -.0439339 | .0460783 | -0.95 | 0.340 | -.1342458 | .0463779 |
| eeca | -.6461308 | .0573543 | -11.27 | 0.000 | -.7585431 | -.5337184 |
| mena | .4163285 | .0478052 | 8.71 | 0.000 | .3226319 | .510025 |
| ssa | -.1105427 | .050748 | -2.18 | 0.029 | -.210007 | -.0110783 |
| year | | | | | | |
| 1997 | -.0229613 | .0503677 | -0.46 | 0.648 | -.1216803 | .0757577 |
| 1998 | -.0522298 | .0503264 | -1.04 | 0.299 | -.1508678 | .0464082 |
| 1999 | -.0902315 | .0506084 | -1.78 | 0.075 | -.1894222 | .0089592 |
| 2000 | -.1167801 | .0509927 | -2.29 | 0.022 | -.216724 | -.0168361 |
| 2001 | -.1508128 | .0516905 | -2.92 | 0.004 | -.2521244 | -.0495012 |
| 2002 | -.1695335 | .052324 | -3.24 | 0.001 | -.2720866 | -.0669803 |
| 2003 | -.2017425 | .0528319 | -3.82 | 0.000 | -.3052911 | -.098194 |
| 2004 | -.2204961 | .0541172 | -4.07 | 0.000 | -.3265638 | -.1144284 |
| 2005 | -.2520124 | .0560004 | -4.50 | 0.000 | -.3617713 | -.1422536 |
| 2006 | -.3082084 | .058417 | -5.28 | 0.000 | -.4227037 | -.1937132 |
| 2007 | -.3547302 | .0610149 | -5.81 | 0.000 | -.4743173 | -.2351431 |
| 2008 | -.4084816 | .0637066 | -6.41 | 0.000 | -.5333442 | -.2836191 |
| 2009 | -.4773707 | .0662408 | -7.21 | 0.000 | -.6072003 | -.3475412 |
| 2010 | -.4893532 | .0685375 | -7.14 | 0.000 | -.6236843 | -.3550222 |
| 2011 | -.504944 | .0707971 | -7.13 | 0.000 | -.6437038 | -.3661842 |
| _cons | 3.609641 | .1931256 | 18.69 | 0.000 | 3.231121 | 3.98816 |

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