

TWO ESSAYS ON INFORMALITY

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TWO ESSAYS ON INFORMALITY

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Two Essays on Informality

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## ABSTRACT

### Two Essays on Informality

The first part of this study intends to give a detailed account on the recent literature of economics of informality. In particular, we focus on effects and determinants of informality as well as measurement of informal activity. We present both theoretical and empirical papers that employ a variety of methods to study informality.

In the second part of the paper we ask whether informal economy acts as a barrier to growth of GDP per-capita. This has been a contentious subject in the literature. Cross-country panel regressions for the period between 1960 and 2012 including 160 countries provide evidence for a robust negative relationship between size of informal economy and relative per capita income. Building on this evidence we simulate a simple two-sector (formal and informal) dynamic general equilibrium model and show that under the presence of an informal sector a larger fraction of the observed per capita income differences across countries can be accounted for.

## ÖZET

### Kayıt Dışı Ekonomi Üzerine İki Makale

Bu çalışmanın ilk kısmında kayıt dışı ekonomi üzerine son yıllarda yapılan çalışmalar üzerine bir inceleme yapılmıştır. Bu incelemede, kayıt dışı ekonominin nedenleri, etkileri ve ölçümü üzerine yoğunlaşmıştır. Değişik metotların kullanıldığı ampirik ve teorik makaleler üzerinde durulmuştur.

Çalışmanın ikinci kısmıysa, kayıt dışı ekonominin ülkelerin kişi başına düşen milli gelir açısından yakınsamasında etkili olup olmadığı sorusu cevaplanmaya çalışılmıştır. Bu soru iktisat literatüründe sıkça karşımıza çıkması bakımından önem teşkil etmektedir. 160 ülke için 1960-2012 yıllarını kapsayan veri setini kullanarak yapılan panel regresyonların sonucunda kayıt dışı ekonomi ve kişi başına düşen gelir arasında güçlü bir negatif ilişki olduğu sonucuna varılmıştır. Bu sonuçların beraberinde, iki sektörlü bir dinamik büyüme modelinin çeşitli simülasyonları, kayıt dışı sektörü de göz önünde bulunduran bir modelin, ülkeler arası kişi başına düşen gelir farklılıklarının açıklanmasında önemli bir katkı sunduğunu göstermektedir.

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## CHAPTER 1

### SURVEY ON INFORMAL ECONOMY

#### 1.1 Introduction

In the New Palgrave Dictionary of Economics, Hart defines informal economy or as the term is often coined, shadow, hidden, black, parallel economy, as a set of economic activities that takes place outside the framework of bureaucratic public and private sector establishments. Though this is one way to define informal economy, as Schneider and Enste (2000) argue, disagreement persists over how researchers choose to study various aspects of informality and most importantly, how these researchers define informality.

To give a few examples of how different researchers define informality in various ways, Ihrig and Moe (2004) define it as a sector, which produces legal goods, but does not comply with most of the government regulations, if not all. According to Schneider and Enste (2000), one of the most commonly used definitions for informality is all economic activities that contribute to the officially calculated (or observed) gross national product but are currently unregistered. Edgar L. Feige (2007), Schneider (1994) and Frey and Pommerehne (1984) can be listed as studies that prefer to follow this definition. Philip Smith (1994) defines it as market based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of gross domestic product.

The definition provided by Schneider and Enste (2000) on the other hand, puts emphasis on legal value-added creating activities which are not taxed or registered and

where the largest part can be classified as “black” or clandestine labor. It is of crucial importance, here to note that the way in which informal economy is defined depends largely on how informality is measured.

Leaving the discussion of how to define informal economy aside, we will focus on the recent literature on informality and try to present a comprehensive survey. We will classify the studies in the literature mainly into three categories. The first subsection will deal with the strand of literature that tries to identify the factors behind the presence and prevalence of informal economic activities. We will first look at the theoretical studies that intend to explore the circumstances in which informality arises. Then, we will focus on a selection of articles that adopt empirical methods to deal with the same subject.

The subsequent section will present a collection of articles where the effects of informality is studied. These articles explore the effects of informality on many aspects of economics, politics and society. We will again deal with theoretical studies and empirical studies separately. This strand of literature is especially intriguing in that there are many controversies over the how informality affects certain aspects of the economy such as long-run growth, business cycles etc.

The last section will focus on different studies that aim to measure the size of informal sector. Different approaches on how to measure informal economic activity will be presented. In this section we will have three subcategories of methods to measure informality; direct approach, indirect approach and model based approach. We will provide examples of studies that adopt these methods in order to estimate the size of the shadow economy.

We will also provide summary tables that include the collection of articles mentioned in this survey with brief explanations about which particular theoretical approach or empirical methodology is adopted in each article and notes about the main findings. These supplementary tables are provided in Appendix A, Appendix B and Appendix C.

## 1.2 Determinants of informality

The circumstances in which informal economic activity arise has been one of the most popular questions that have been asked by researchers who study it. Understanding the determinants of informality is of crucial importance since the answers matter especially because of the policy implications they entail. The efforts in identifying the determinants of informality mainly center around topics such as contract enforcement, taxes and tax enforcement, regulation, trade liberalization, institutional quality indicators, labor market conditions (e.g. minimum wage), public trust, political stability, business flexibility, foreign transfers, financial development, banking crises, ethnic fractionalization and so on. For convenience, we will be dealing with theoretical and empirical studies separately.

### 1.2.1 Determinants of informality – theoretical studies

Most of the theoretical studies prefer to employ workhorse models that are frequently referred to in the economics literature. To give a few examples, we encounter two sector small open economy models, search and matching models, two sector dynamic general

equilibrium models, heterogeneous agent models with incomplete markets and some extensions of these models that try to incorporate different modelling objectives.

The literature review that we undertook revealed that taxation, regulation and enforcement stands out as one of the most frequently studied determinant of informal economic activity. Araujo and de Souza (2010), Prado (2011), Ulyssea (2010), Ihrig and Moe (2001), Dessy and Pallage (2003) can be listed as studies that focus on government policy as an important factor that plays an important role in the formation of informality. Araujo and Souza (2010) address the issue by employing an evolutionary game theory approach. In their setting, the agents in the economy choose to operate in formal or the informal sector by maximizing their expected pay-offs. They find the optimal level of enforcement and regulatory action that would prevent the agents to be attracted to the informal sector while taking the evolution of labor market conditions into account. Prado (2011) employs a two sector monopolistic competition model and quantitatively assesses how the size of the shadow economy depends on the level of enforcement and taxation for a given level of regulation. Ulyssea (2010), chooses to employ a continuous investment model with moral hazard where the main finding is that different instruments of government policy may have different effects on the level of informality and other economic indicators in a country. More specifically, the reduction of formal sector entry costs and yet, higher levels of enforcement lead to smaller informal activity whereas higher levels of enforcement might lead to welfare losses and unemployment. Ihrig and Moe (2001) in a two sector dynamic general equilibrium framework, argue that rather than exercising stricter enforcement as a policy tool to reduce informality, it is favorable to decrease tax rates in order to prevent potential welfare losses. In contrast, Dessy and Pallage (2003), using a heterogeneous agents

model with incomplete markets, argue that focusing only on taxation in order to reduce informality might not always be effective. In their model, the tax revenue collected by the government is used to provide public infrastructure which raises the productivity of the formal firms whereas informal firms are modelled to be less productive. In this setting, their main result is that taxation has an ambiguous effect on the size of the informal sector in the economy and also a fully formalized equilibrium is not affordable for low income countries.

Trade liberalization as a driving force behind informal economic activity is another widely studied topic in the literature. With the help of a dynamic extension of the efficiency wage model, Koujianou, Goldberg and Pavcnik (2003) show that in response to removal of trade barriers, there can be an expansion in the size of the informal sector as one might expect. But the authors argue that relying on this model might be misleading since they do not find substantial supporting empirical evidence with Latin American data. Paz (2014) analyzes the change in the formal-informal mix in the labor market following an episode of trade liberalization. With the help of a small open economy model with heterogeneous firms, the study predicts that the abolition of home import tariffs has an ambiguous effect on the informality. In contrast, a decrease in the foreign import taxes results in a reduction of informal employment in the home country.

Chong and Gradstein (2007) and Elgin and Oztunali (2014a) study how various aspects of institutional quality in a country affects the prevalence of informal economic activity. In Chong and Gradstein (2007), the authors develop a two sector model with imperfect credit markets and show that the interplay between low institutional quality and high income inequality results in larger informal economies. On the other hand,

Elgin and Oztunali (2014a) employ a two sector dynamic general equilibrium model and argue that a higher GDP per capita is associated with a larger informal sector when institutional quality is low and a smaller informal economy when institutional quality is high.

Labor market policies are also identified as one of the determinants of informal economy. Bosch and Esteban-Pretel (2012) employ a two sector search and matching model and focus on five different labor market policies associated with hiring, firing, payroll taxes, monitoring of the informal sector and fines to informal firms. In light of the results, they argue that labor market policies that attempt to reduce the costs associated with formality result in a reduction in the share of informality in the economy as well as a reduction in unemployment. Florez (2014) on the other hand prefers to study the how unemployment benefits, a formal lump sum tax, and a job creation subsidy change the formal-informal mix of the economy. Similarly, using a two sector search and matching model, the author suggests that, while unemployment benefits and job creation subsidies encourage formal employment, payroll taxes have a negative effect on formal employment.

There are also studies that explore how business flexibility, product market policies, entry costs etc. affect informality choice. Charlot, Malherbet and Terra (2015) bring labor and product market imperfections together to study how these conditions influence informality. Again, by setting up a two sector search and matching model, the authors infer that product market deregulations can effectively reduce informal employment as well as unemployment. Loayza and Rigolini (2010) employ a two sector small open economy model to show that in the long-run, larger informality is associated with less flexible business procedures.

Level financial development, although can very well be viewed as an outcome of informality, is also nonetheless studied as a determinant of informality. Capasso and Jappelli (2013) argue that financial development that leads to a reduction in the costs of external funding, can lead to a reduction in the size of the informal sector. In a model where firms make investment decisions either with internal funds that pay lower interest as opposed to higher return external funds, financial development reduces tax evasion and thereby reduces informality. Blackburn, Bose and Capasso (2012), again making use of a model with financial intermediation and tax evasion, were able to support arguments similar to Capasso et al. (2013).

#### 1.2.2 Determinants of informality – empirical studies

Empirical studies that try to reveal the factors behind informality incorporate quite a large number of variables in their analysis. To name a few of the most frequently used variables, we can list, various aspects of institutional quality such as corruption, legal system indicators bureaucratic and regulatory quality; political risk rating, credit market regulations, labor market conditions indicators, urbanization, migration, trade liberalization, fiscal policy indicators, per capita income and a large number of control variables.

Although a wide range of econometric techniques have been employed in these studies, we most commonly encounter simple OLS regressions, panel regressions as well as system estimations. In most cases, the dependent variable is the size of the informal sector to formal GDP, share of informal employment and sometimes probability that a firm operates informally.



Lassen (2007) state that for a cross section of more than 50 countries, larger informal sectors are found to be associated with greater ethnic fractionalization as well as prevalence of corruption at a greater extent. In order to support this argument, the author provides a review of experimental studies on how people are reluctant to contribute towards the public good that will be enjoyed by other ethnic groups. Also there is lower chances of tax evasion when public trust is eroded by prevalence of corruption.

Almeida and Carneiro (2011) investigate the determinants of informal employment in Brazilian context and focus especially on labor market conditions in doing so. Their findings suggest that stricter regulations and enforcement on the labor market, by virtue of reducing self-employment, leads to a reduction in the share of informal employment.

Friedman (2014), employing pooled regressions with a data set comprising of 149 countries, shows that, factors like greater political stability, control of corruption, regulatory quality are associated with smaller informal sector sizes, which is a result that is in line with expectations. On the other hand, the author does not find any robust relationship concerning the size of the informal sector and voice and accountability and rule of law in a country.

Dreher and Schneider (2010), in an attempt to reveal the two way relationship between size of informal sector and corruption, use data for 98 countries. Their expectation is to be able to show that corruption and informal economy are substitutes in high income countries whereas they are complements in low income countries. Their results obtained from different specifications with OLS and TSLS estimations, are not robust to the data for corruption used. With perception based data on corruption, they

fail to provide supporting evidence for their hypothesis. However, with corruption data based on structural model, they can provide evidence for complementarity of corruption and informal economic activity in low income countries. Hence, they argue that the relationship between corruption and informality might not be as straightforward as it seems.

Torgler and Schneider (2007) is another study where political environment in a country is shown to have an important influence on the size of the informal sector. Making use of a large panel data set that is collected from several different resources, authors categorize the explanatory variables they use in the following main headings: economic freedom (business regulations, property rights protection, military intervention etc.), institutional quality (political risk rating, corruption, law and order, democratic accountability, government stability etc.), aggregate governance indicators (indexes of governance, voice and accountability, regulatory quality etc.), willingness to pay taxes and control variables (income per capita, population, trade volume, linguistic fractionalization etc.). In light of the fixed effect estimations, their main finding is that improving various aspects of institutional quality, governance and tax morale help to limit the size of the informal sector. They especially emphasize moral dimension of the issue as one of main determinant of informality.

Elgin and Oyvat (2013), using three different proxies for the size of the informal sector for over 100 countries, argue that, urbanization and share of urban informality have an inverted-U shaped relationship. That is, in the beginning informality grows as urbanization occurs but at later stages of urbanization, a decline in the size of the informal sector is observed. This conclusion bears strong resemblance to the Kuznets' hypothesis.

Trade liberalization is also another potential determinant of informality that was both theoretically and empirically elaborated. Bosch, Maloney and Goni-Pacchioni (2012), using general method of moments and ordinary least squares estimation, show that in Brazil although import penetration has a significant impact on the share of informal employment, the effect of tariffs is rather ambiguous. In contrast, their estimation results suggest that, it is the constitutional changes concerning the labor market conditions such as unionization and hiring/firing costs that have a sizeable effect on the allocation of labor across formal and informal sectors as opposed to the trade liberalization indicators.

Lastly, as it was discussed in the first half of this section, fiscal policy is a crucial determinant of informality. Johnson, Kaufmann and Zoido-Lobaton (1998) is one of the many studies that focus on fiscal policy in relation with corruption empirically. In particular, they challenge the observation that higher taxes lead to large informal sectors and on the other hand corruption is also associated with larger informality. The main result of their estimations is that higher levels of corruption and less strict regulation seem to account for large informal sector size across a small subgroup countries used in the study, however this relationship becomes less apparent for a larger sample of countries.

Along with the studies mentioned above, we also report additional empirical studies that try to reveal various determinants of informal economic activity such as foreign direct investment and availability of technology (internet use, cellular technologies etc.) in tables provided in Appendix A.

### 1.3 Effects of informality

In this section we will try to present an account on how the recent research in economics identifies the effects of informal economy. Here we choose to focus on empirical and theoretical studies separately.

Most theoretical debates on how informality affects the rest of the economy revolve mostly around fiscal policy, business cycles and macroeconomic volatility, long-run growth, poverty and inequality, welfare and redistribution, financial development and employment. Typically the economy is modelled so as to include two productive sectors, formal and informal sectors. A wide range of classes of models are employed, ranging from two sector open economy models, overlapping generations models, endogenous growth models to search and matching models.

Theoretical studies that focus on the effects of informality on fiscal policy often try to solve for the optimal taxation and tax enforcement policies for a government in presence of informality. Turnovsky and Basher (2009), Cuff, Marceau, Mongrain and Roberts (2011), Cerda and Saravia (2013), Markandya, Gonzalez-Eguino and Escapa (2013) can be counted as examples of studies that study the fiscal policy implications of the prevalence of informality. Turnovsky et al. (2009), in a developing country context, set up a two sector model where the government has the ability to choose a tax enforcement level and it can audit firms. They maintain that in such a setting where the government faces the phenomenon known as the recursive fiscal dilemma, auditing firms might seem as a solution yet they show that the government faces a trade-off between taxation and auditing. The trade-off arises since higher tax rates translate into higher tax revenue and it enhances the ability of the government to audit firms. But in

turn, higher levels of auditing disables the government to affect the size of the informal sector through taxation policy. Yet there is an optimal combination of taxation and auditing whereby the government can avoid the fiscal dilemma. Cerda and Saravia (2013) employs a two sector model with heterogeneous firms (in terms of their productivity). They choose to model an informal sector that cannot be taxed to study optimal (Ramsey) taxation. In this setting, they show that, in order to make the informal firms taxable, the government must subsidize the informal firms and give them incentive to operate in the formal sector. They show that, the sign of the optimal capital income tax is negative while sign of the corporate tax rate should be positive. The sign of the labor income tax, on the other hand, is ambiguous. Cuff et al. (2013) uses a two sector (formal and informal) model that features illegal immigration. They suggest that implementing optimal taxation and enforcement policies will lead to a wage equalization across formal and informal sectors. Also contrary to literature, they show that enforcement is not necessarily decreasing in its cost.

On the other hand, theoretical studies on how informal sector affects business cycles and macroeconomic volatility use models so as to reveal the cyclical behavior of macroeconomic indicators. Fernandez and Meza (2014), Restrepo-Echavarria (2014), Mitra (2013), Granda-Carvajal (2012), Busato and Chiarini (2002) can be given as examples of studies on this topic. Restrepo-Echavarria (2014) employs a two sector small open economy model. In this context, she shows that mismeasurement of informal sector can result in a mistakenly high consumption volatility, higher than output volatility, although in reality consumption is not that volatile. This result is valid for most of the developing countries and even some developed countries. Busato and Chiarini (2012), using a two sector dynamic general equilibrium model, show that the

presence of informal economy explains internal propagation of shocks better, helps to resolve the employment and productivity volatility puzzles implied by the standard RBC model, also reveals how informal sector helps to mitigate effects of recessions.

When it comes to the effect of the shadow economy on the long-run economic growth, we see that researchers do not seem to meet on a common ground about whether informality acts as an impediment to long-run growth performance or it contributes to growth. Focusing on different ways in which informality interacts with economic performance, these authors were able to find supporting evidence on these two opposing positions. We pay special attention to this line of literature in Chapter 2 where we go in to a detailed discussion of how informality affects long-run economic growth performance. In addition, Appendix B contains a selection of reviewed articles that study this issue.

How informal sector influences poverty and inequality is often studied in conjunction with urban-rural migration and trade liberalization. Bhattacharya (2011), Kar and Marjit (2009) can be given as examples of this line of research. Kar and Marjit (2009), with a two sector small open economy model, argue that urban income equality and poverty can be mitigated with the help of an increase in the informal sector wages due to trade liberalization. Bhattacharya (2011), on the other hand, sets up a three sector dynamic general equilibrium model where the urban rural migration in presence of informality causes improvements in the Gini coefficient.

When it comes to the potential effects of informality on financial development, we can give Elgin and Uras (2012) as an example. The authors argue that there are two forces that work in opposite directions; on the one hand, due to tax evasion financial

development is hindered, on the other hand, bigger informal sector facilitates financial development through easing the capacity constraint on the financial sector.

Bosch and Esteban-Pretel (2012) and Meghir, Narita and Robin (2012), both employing two sector search and matching models aim to understand the effect of informal sector on unemployment. Both of these studies argue that policies that aim to increase the cost of informality and thereby reduce the size of the informal sector size, can result in reductions in unemployment.

We also review other papers that deal with potential losses and gains associated with the presence of informality and also redistributive aspect of informality, such as, Bennett (2008) and Leal Ordonez (2014). Another interesting topic that we choose to include in this survey is, the effect of the informal economic activities on environmental pollution. Elgin and Oztunali (2014b) employ a two sector dynamic general equilibrium model and they show that the model exhibits an inverse U-shaped relationship between informality and level of environmental pollution.

The empirical studies that try to establish links between informality and its potential effects also concentrate mainly on business cycles, poverty, inequality, financial development, public debt, sovereign default and social policy. Some of these studies use macro data in their empirical analysis, while some others use survey based micro data.

Xue, Gao and Guo (2014) prefer to use a Mincerian regression model and find that a reduction in the share of informal employment translates into a decline in the income inequality in urban China. To do this, they regress hourly earnings on employment status (formal and informal), work experience, years of schooling, marital status, gender etc. Kar and Marjit (2008) on the other hand, relying on General Method

of Moments estimation with Indian data during trade liberalization period, argue that the rise in informal sector wages translated into a reduction in percentage of population below poverty line.

The effect of informality on business cycles and macroeconomic volatility has been a question that has also been both empirically and theoretically formulated in the literature. Mapp, Moore and Winston (2014), Ferreira-Tiryaki (2008), Elgin (2012) are some examples of empirical studies in that field. Bivariate panel regression analysis by Mapp et al. (2014) suggest that larger informal economies are associated with smaller consumption and output volatility in the Caribbean economies context. In contrast, Ferreira-Tiryaki (2008), relying on GMM estimations, argue that countries with larger informal sectors are subject to higher consumption, output and investment volatility. Using panel regressions for 152 countries, Elgin (2012) maintains that the informal economy is counter-cyclical and moreover the presence of informality amplifies business cycle fluctuations.

Another interesting question to be asked when exploring the effects of informality is its potential impacts on social policy. Tuesta (2014) uses probit estimations to show that, for Latin American countries, larger informal economies are associated with lower probability of an individual making contributions to the pension system.

We also report various other empirical studies that attempt to reveal effects of informal economic activity on pollution, fiscal policy, public debt and sovereign default risk in the summary tables provided in Appendix B.



## 1.4 Measuring informality

Informal economic activities are, by definition, outside the reach of the authorities. Moreover, as we discussed earlier, there is no consensus in the literature on how to define informal economy which poses further complications. As a consequence, measuring informal economy still stands as a daunting and challenging task in the economists' research agenda. In this section, we will try to give a detailed account on how different studies use different techniques in order to come up with an accurate picture of the size of the informal sector.

We choose to follow Schneider (2004)'s taxonomy here to give a systematic overview of the articles that try to measure informality. According to Schneider and Klinglmair (2004), there are three commonly used approaches to estimate the size of the shadow economy, namely, direct approaches, indirect approaches and model based approaches.

### 1.4.1 Direct approaches

As the name suggests, studies that fall in to the direct approaches category use survey, interview and questionnaire based micro data in order to estimate the size of the informal economic activity. These studies are least likely to give an accurate figures since by construction, they are subject to measurement errors that can culminate in a series of misleading results. One other disadvantage associated with the direct approaches is that the data collection process is costly and time consuming. Moreover, since surveys can be conducted at a given point in time, the estimates obtained through

direct approaches are destined to yield estimates of shadow economy that do not have a time dimension.

To give a few examples, we choose to report studies that report household survey based estimates of informal activity. Henley, Arabsheibani and Carneiro (2009) use Brazilian household survey data and use three different strategies in order to infer the size of the informal sector. They based their estimates on employment contract status, social security protection and nature of employment and the characteristics of the employer. These three strategies yield results that range between 40% and 63%. Apart from this huge difference they also note that the trend of the size of informality differs across different strategies which casts more doubts on the reliability of the household survey based estimations. Hence the authors conclude by stating that one has to be careful when defining informality since different definitions would lead the researcher to adopt different strategies to measure informality.

#### 1.4.2 Indirect approaches

Indirect approaches usually involve using data on some economic indicators and making an inference on informality implied by this data. This means that indirect approaches to estimate the size of informality is based on interpretation often led by a series of assumptions. According to Schneider and Klinglmair (2004), examples of studies that use the indirect approaches frequently use currency demand approach, discrepancies between actual and registered labor force, discrepancies between national income and expenditure statistics, transactions approach and electricity consumption approach. We

briefly discuss some of these methods here and present selected articles that adopt these techniques.

The classic example of how the currency demand approach is used would be Tanzi (1983). The assumption made here is that informal economic activities should involve cash transactions so that a part of an increase in the money demand should be attributable to an increase in informality. To isolate the portion of the increase in the money demand that is associated with informality, the author uses an econometric specification. The equation specified contains fiscal policy variables, interest rates, payment habits. Using this method, the study finds estimates for the size of USA informal sector for 1930-1980.

Macias and Cazzavillan (2009) also adopts the currency demand method. In an attempt to estimate the size of the shadow economy, the authors set up a vector auto-correction model. They emphasize the importance of taking the remittances into account in doing so. They estimate the size of the informal economy in Mexico for the period covering 1970-2006.

One example of the income-expenditure discrepancy approach would be Dimova, Gang and Landon-Lane (2005). The authors use household income and expenditure surveys to come up with the size of the informal sector in the Bulgarian context. The information gathered from these surveys are used to find the discrepancy between income and expenditures of a given household which are then interpreted as sources obtained through informal economic activity.

### 1.4.3 Model based approach

The model based approach has been developed by borrowing largely from Frey, Weck and Pommerehne (1984)'s "soft modelling" technique for estimating the size of the shadow economy. This method involves using structural equations so as to include various determinants and effects of informality. Once the variables that represent causes and determinants of informality have been identified, the structural equations are used to come up with their respective coefficients. With this method, with the help of the observable determinants and effects of informality, one can come up with the unobservable size of the shadow economy. Frey et al. (1984) later evolved into what is now called in the literature as MIMIC (multiple indicators multiple causes) DYMIMIC (dynamic version) models.

According to Schneider and Klinglmaier (2004), the most commonly used indicators for shadow economy in this line of literature fall in to the following three categories: the burden of direct and indirect taxation, both actual and perceived, the burden of regulation and tax morality. On the other hand frequently encountered variables as potential causes of informality are: development of the monetary indicators, development of the labor market and development of the production market. It should be noted that different studies incorporate different variables as causes and indicators. A typical example of MIMIC application would be Schneider, Buehn and Montenegro (2010). The authors estimate the size of the informal sector as per cent of GDP for 162 countries.

We also present some other studies that try to estimate the size of the informal sector in Appendix C.

## CHAPTER 2

### IS INFORMALITY A BARRIER TO CONVERGENCE?

#### 2.1 Literature review

The main determinants of long-run economic growth still remain as a central item in the macroeconomic agenda. In this study, our intention is to contribute to this strand of literature by questioning whether the prevalence of informal sector acts as a barrier to growth, more specifically a barrier to per capita income convergence.

The presence of informality and its connection with economic growth has been a contentious issue on which the current literature has failed to arrive at an agreement. On one hand, there are studies that claim a positive relationship between informality and growth such as Nabi and Drine (2009), Eliat and Zinnes (2000). On the other hand others like Loayza (1997), Massenot and Straub (2011), De Soto (1989) Benjamin and Mbaye(2010) assert that the relationship is negative on the grounds that efficiency is hindered by informality.

The barriers to growth literature investigates what accounts for the observed income disparities across countries. In a vast number of studies, barriers are introduced in various forms such as barriers to trade, technological adoption, capital accumulation etc.

Parente and Prescott (1994) argue that the standard neoclassical growth model falls short of explaining the actual income differences as opposed to a model that takes barriers to technological adoption into account. They provide quantitative evidence to

this idea by showing that under plausible parametrization of the model, the development theory that they propose is able to explain the growth miracles of East Asia.

Ngai (2004) argues that the differences in income across countries are mostly transitory. The paper sets up a two sector model where the individual countries need to be able to accumulate capital so as to gradually replace the stagnant traditional Malthus technology with the modern Solow technology. The barriers are introduced as exogenous parameters that reduce the capital-output ratio therefore affect the endogenously determined date of the turning point and steady state levels of model variables.

Similarly, Restuccia (2004) employs a two sector model, traditional and modern sectors, and incorporates barriers in the form of a technology parameter that lowers the rate at which output is transformed into capital or equivalently increases the relative price of investment. In this setting, the presence of barriers works at expense of a technological choice that employs modern technology more intensely compared to the traditional sector. This in turn leads to a lower economy wide aggregate total factor productivity.

This study employs a two sector dynamic general equilibrium model where production either occurs in formal or the informal sector. While the formal sector is subject to taxation, for the informal sector there is only partial tax enforcement. In this setting, household chooses how much time to allocate in leisure, formal sector and informal sector. The tax rate and tax enforcement parameter will affect the labor allocation and the size of the informal sector, therefore the formal output. In such an environment, we will show that informality poses a threat to per capita income convergence.

The rest of the paper is organized as follows. In section 2, we introduce our data set and some facts about the relationship between informal sector size and economic growth that motivates this study. In section 3, the results of further empirical analysis are presented. One set of panel regressions will show that relative (to US) GDP per capita and informal sector size as percent of GDP are negatively related. Further, by using the income accounting method, we will decompose relative GDP per capita into three accounts; relative capital-output ratio, relative employment per capita and relative total factor productivity. The panel regressions using these three accounts will show that informal sector size and relative capital-output ratio are significantly and negatively correlated. Section 4 describes the two sector (formal and informal) dynamic general equilibrium model that we employ. The quantitative results obtained through various simulations of the model with different informal sector size determinants are examined in section 5 and 6.

## 2.2 Data and facts:

Throughout our empirical analysis, we make use of the data set provided by Elgin and Oztunali (2012). This dataset comprises of model-based estimates of informal sector size for 160 countries covering the period 1950-2012. The authors employ a two sector (formal and informal) dynamic general equilibrium model where they calibrate the key parameters of the model that yield the observables in the data, which in turn are used to calculate the size of the shadow economy as % of formal GDP.

The empirical counterparts of the model variables such as growth, GDP per capita, population, employment, investment are obtained through World Development Indicators (WDI) of the World Bank and PWT 8.0. Using these, the capital stock series for the countries are constructed by using the conventional perpetual inventory method.<sup>1</sup>

As an initial attempt to motivate our study, the following three figures illustrate the evolution of GDP per capita over time for countries ranked according to their respective informal sector size for each year. We then regroup countries into quartiles, quintiles and deciles (Figure 1 for quartiles, Figure 2 for quintiles and Figure 3 for deciles). The average GDP per capita for each group is plotted against time. We then repeat the same exercise, this time by plotting population weighted GDP per capita against time for each group.<sup>2</sup> The corresponding three graphs can be found in Appendix D.

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<sup>1</sup> Perpetual inventory method: Initial capital stock  $K_{1960}$  is calculated using the following formula:

$$\frac{K_{1960}}{Y_{1960}} = \frac{I/Y}{g_y + \delta}$$

where  $g_y$  is the average growth rate of GDP in the period 1960-2012.  $\delta$  is the depreciation rate and  $I/Y$  is the average investment-to-GDP ratio in the period of interest. The capital stock series  $\{K_t\}_{t=1960}^{2012}$  is then calculated using:

$$K_{t+1} = K_t(1 - \delta) + I_t$$

<sup>2</sup> For robustness, we re-classify countries, this time using weights that take the populations into account, in order to avoid country sizes blur our results. Calculating the weighted GDP per capita for each group and each year then plotting them against time again yields the similar results to the unweighted case.



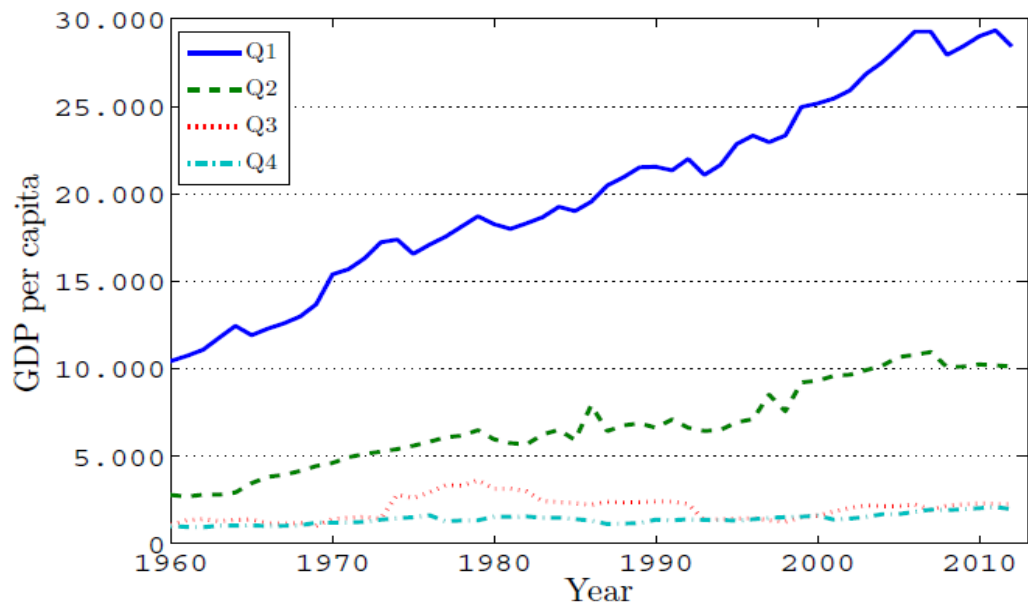


Figure 1. Evolution of unweighted GDP per capita for countries ranked and classified in quartiles according to their informal sector size.

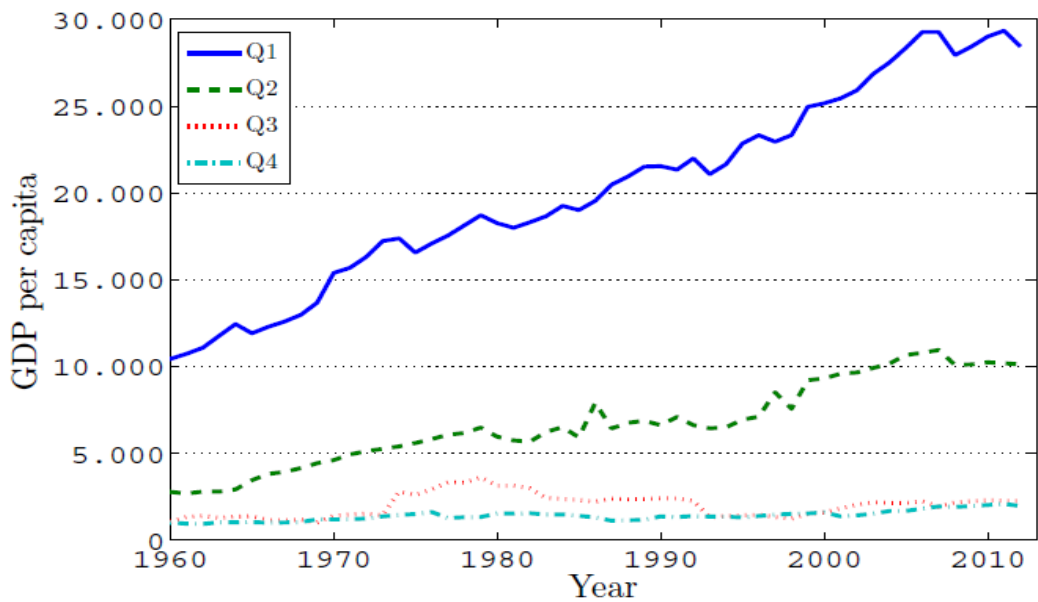


Figure 2. Evolution of unweighted GDP per capita for countries ranked and classified in quintiles according to their informal sector size.

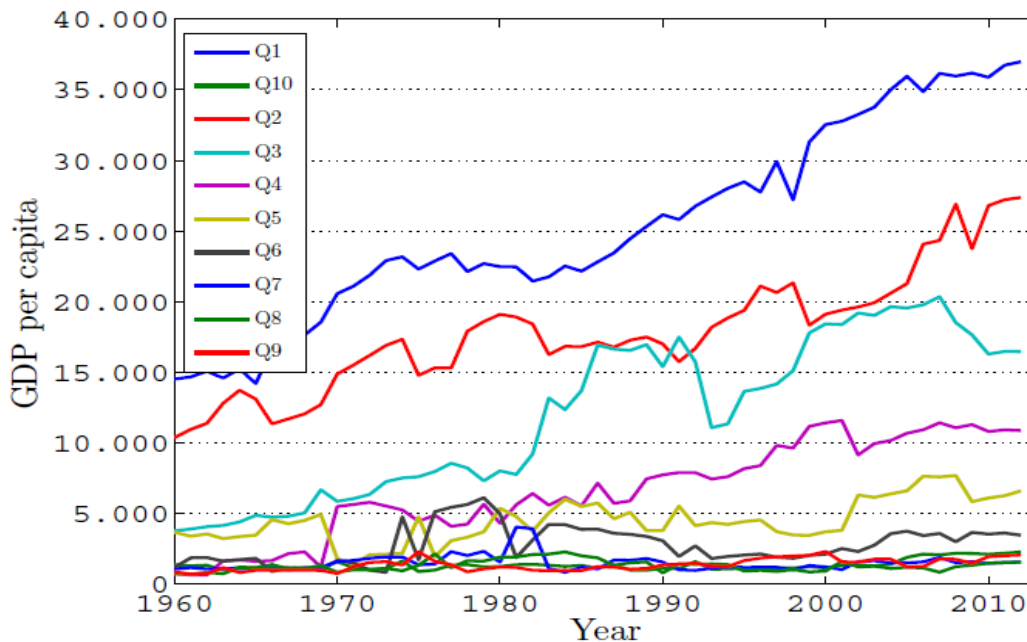


Figure 3. Evolution of unweighted GDP per capita for countries ranked and classified in deciles according to their informal sector size

It can be seen from Figure 1, 2 and 3 that countries with relatively smaller informal sectors perform better in terms of their relative GDP per capita whereas for the countries with relatively larger informal sector size, relative GDP per capita tends to be almost stagnant over the course of time. The take-off of relative income in higher income countries as opposed to the stagnation in lower income countries points out that informality can very well be a barrier to convergence of per capita income.

### 2.3 Empirical analysis

In this subsection we provide empirical evidence illustrating that informality acts as a barrier to growth and per capita income convergence. To do this, we will present results

of regression of relative GDP per-capita (relative to US GDP per-capita) on informal sector size in a panel data setting. Moreover, in the next subsection we will also decompose relative GDP per-capita on three different factors (relative TFP, relative employment per capita and relative capital-output ratio) and investigate how each of these factors is associated with informal sector size. Table 1 summarizes the dataset which will be used throughout this section.

Table 1. Descriptive Statistics of the Data Set Used in the Empirical Analysis.

	Mean	Std. Deviation	Minimum	Maximum
Informal Sector Size (in % GDP)	34.65	14.75	7.97	113.00
(Real) GDP per-capita (thousand USD)	8.42	12.35	0.05	87.72
Relative GDP per-capita (to US)	0.26	0.38	0.001	3.30
Relative TFP	0.37	0.33	0.01	2.15
Relative $H/N$	0.86	0.25	0.32	5.44
Relative $K/Y$	0.95	0.51	0.002	11.06

As can be seen there is a huge divergence between countries in terms of their sizes of informal sector as % of their GDP's. In some countries informal economic activity may be as low as 8 % of the formal economic activity whereas in others, it may very well exceed the size of the formal economic activity. It is also striking to see that real GDP per capita ranges within \$500 to approximately \$88000 which demonstrates the income inequalities across different countries.

### 2.3.1 Relative GDP per capita and informal sector

The first part of the empirical analysis will revolve around the discussion of how relative GDP per capita and size of the informal economy are related. To do this we will rely on a series of panel and cross section regressions using the data set described above.

We report results for 8 different specifications where dependent variable is the relative GDP per capita and independent variables are size of the informal economy and occasionally the first lag of the relative GDP per capita. The benchmark specification is given below:

$$rel\_gdp\_cap_{i,t} = \beta_0 + \beta_1 is_{i,t} + \gamma_i + \theta_t + \epsilon_{i,t}$$

In this specification  $\gamma_i$  and  $\theta_t$  refer to country and year fixed-effects for country  $i$  and year  $t$  respectively. The results are reported in Table 2.<sup>3</sup>

Table 2. Relative GDP per capita and Size of the Informal Sector.

Dep. var. Rel. GDP per-capita	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IS	-0.24*	-0.06*	-0.11*	-0.26*	-1.62*	-0.17*	-0.09*	-0.58*
	(0.07)	(0.02)	(0.02)	(0.05*)	(0.07)	(0.03)	(0.01)	(0.23)
Rel GDP-cap (-1)		0.74*	0.90*					
		(0.01)	(0.01)					
Constant	0.34*	0.08*	0.06*	0.34*	0.8*	0.31*	0.08*	0.63*
	(0.03)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)	(0.09)
<i>R</i> -squared	0.35	0.98	0.99	0.36	0.32	0.35	0.02	0.36
Observations	1405	1266	1107	1347	161	6175	700	705
F-Test	3.66	310.16	1998	20353	51.67	369.47	12.78	2.96

<sup>3</sup> All panel regressions include country fixed effect and year dummies. Robust standard errors are reported in parentheses. \* denote 5% confidence levels. For specifications 3,4 and 6 we report Wald test results instead of F-test statistics.

The first panel regression below is a fixed-effect estimation using 5-year averaged data to rule out possible business cycle effects in the relative GDP per-capita. The second column stands for a fixed effect panel regression with 5-year averaged data but this time includes the lag of dependent variable. The third column is a GMM estimation with 5-year averaged data and lagged dependent variable. The fourth column is an IV estimation with 5-year averaged data and lagged value of the independent variable (IS) is used as an instrument for its level. The fifth column is an OLS estimation with country averaged informal sector size and relative GDP per capita data. The sixth column is a fixed effect estimation with the whole data set under the presence AR(1) disturbances. The seventh column is a fixed effect estimation with 5 year averaged data using data for countries below the median level of GDP per-capita whereas column 8 gives the results of the same estimation using above median countries.

The main observation one can make regarding Table 2 is that the coefficient of the size of the informal sector is consistently negative and significant for all of the different specifications. The fact that the coefficient on first lag of the dependent variable is also negative and significant also adds to the robustness of this relationship.

### 2.3.2 Relative income accounts and informal economy

In this section we decompose relative (to US) income per capita for 160 countries into 3 income accounts: relative TFP, relative capital-output ratio, and relative employment per capita. To make this decomposition, we make use of the capital series created with perpetual inventory method. We assume a Cobb-Douglas production function of the form  $Y_t = A_t K_t^\alpha H_t^{1-\alpha}$  and using the employment and income data from PWT 8.0 we

obtain total factor productivity (TFP) series for 160 countries. Transforming the production function in per capita terms and then taking the natural logarithm yields:

$$\ln(y_t) = \ln(A_t) + \alpha \ln(k_t) + (1 - \alpha) \ln(h_t)$$

Rearranging, we get:

$$\ln(y_t) = \ln(h_t) + \frac{\alpha}{1 - \alpha} \ln\left(\frac{k_t}{y_t}\right) + \frac{1}{1 - \alpha} \ln(A_t)$$

For the country pair i-j, j being USA, the above equation becomes:

$$\ln\left(\frac{y_i}{y_j}\right) = \frac{1}{1 - \alpha} \{ \ln(A_i) - \ln(A_j) \} + \frac{\alpha}{1 - \alpha} \left\{ \ln\left(\frac{k_i}{y_i}\right) - \ln\left(\frac{k_j}{y_j}\right) \right\} + \ln(h_i) - \ln(h_j)$$

Table 3 summarizes different specifications with each of the three income account series created. The first column for each account represents a panel regression with fixed effect estimation using the whole data set under the assumption of AR(1) disturbances. The second column for each account is a fixed effect estimation with the lagged value of the corresponding account included as dependent variable. The third columns are IV estimations using the lagged values independent variable.

Out of the three accounts examined, we observe that relative employment per capita and relative TFP do not seem to have a strong relationship with size of the informal economy. The signs of the coefficients on these variables are not consistent with one another. Moreover, only a few of them are statistically significant. For

specifications with relative capital to output as the dependent variable, on the other hand, we observe a significant and negative relationship. The estimated equations are as follows:<sup>4</sup>

Table 3. Relative Income Accounts and Size of the Informal Sector.

Dep. var.	Income Accounts								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TFP	TFP	TFP	$K/Y$	$K/Y$	$K/Y$	$H/N$	$H/N$	$H/N$
IS	0.13*	0.004	0.004	-2.65*	-0.28*	-0.34*	0.09	-0.003	-0.004
	(0.05)	(0.006)	(0.005)	(0.24)	(0.03)	(0.03)	(0.14)	(0.02)	(0.02)
Rel TFP(-1)		0.95*	1.00*						
		(0.003)	(0.002)						
Rel $K/Y$ (-1)					0.92*	0.83*			
					(0.005)	(0.006)			
Rel $H/N$ (-1)								0.97*	0.97
								(0.004)	(0.005)
Constant	0.78*	0.026*	0.005	1.66	0.17*	0.27*	-0.70*	0.038*	-0.06*
	(0.002)	(0.004)	(0.08)	(23.08)	(0.02)	(0.01)	(0.005)	(0.01)	(0.008)
<i>R</i> -squared	0.0041	0.99	0.80	0.09	0.95	0.94	0.005	0.94	0.94
Observations	6019	6020	5863	6019	6020	5863	6019	6020	5863
F-Test/Wald	9.81	1249.61	571108	6.42	654.71	471182	12.85	887.28	1240000

## 2.4 Model

In this section we describe the two sector dynamic general equilibrium model that we employ, which, to a great extent, is borrowed from Ihrig and Moe (2004).

Infinitely lived representative household is endowed with  $K_0$  units of productive capital and a total of  $T > 0$  units of time each period. The agent chooses how much time to allocate in leisure, formal and informal sector. The formal sector, denoted by  $F$ , has a standard Cobb-Douglas production function and is subject to taxation. On the other

<sup>4</sup> All panel regressions include country fixed effect and year dummies. Robust standard errors are reported in parentheses. \* denote 5% confidence levels.

hand, the informal sector, denoted by I, uses only labor as input. It is plausible to assume that the informal sector is more labor intensive compared to the formal sector. A possible interpretation of this assumption might be that the informal sector has a fixed amount of productive capital as Ihrig and Moe (2004) argue. Moreover, the informal sector is subject to taxation only when it is caught by the authorities. Thus we introduce a tax enforcement parameter  $\rho$  which captures the event of being caught. We assume that the tax revenue collected by the government is spent for unproductive activities.

The model is characterized as follows:

$$\max_{\{C_t, K_{t+1}, l_t, N_{It}, N_{Ft}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(C_t, l_t)$$

$$s. t. C_t + K_{t+1} - (1 - \delta) K_t = (1 - \tau)\theta_{Ft} K_t^\alpha N_{Ft}^{1-\alpha} + (1 - \rho\tau)\theta_{It} N_{It}^\gamma$$

$$N_{It} + N_{Ft} l_t = T$$

Definition: Given the government policy variables  $\{ \tau, \rho \}$ , a competitive equilibrium of this two-sector model is a set of sequences  $\{C_t, l_t, K_{t+1}, N_{It}, N_{Ft}, G_t\}_{t=0}^{\infty}$  such that  $\{C_t, l_t, K_{t+1}, N_{It}, N_{Ft}, G_t\}_{t=0}^{\infty}$  maximizes representative agent's life-time utility.

Assuming logarithmic utility, the maximization problem of the household yields:

$$\frac{C_{t+1}}{C_t} = \beta [(1 - \tau)\alpha \theta_F K_t^{\alpha-1} N_{Ft}^{1-\alpha} + 1 - \delta]$$

Since at the equilibrium marginal products labor for the formal and informal sectors must be equal to each other, we get the following condition:

$$(1 - \tau)(1 - \alpha) \theta_F K_t^\alpha N_{Ft}^{-\alpha} = (1 - \rho\tau) \gamma \theta_I N_{It}^{\gamma-1}$$



By rearranging the Euler equation and combining with the equalization of marginal products of labor across sectors condition, one can obtain the expression for  $K_{t+1}$  in terms of  $N_{ft+1}$ :

$$K_{t+1} = N_{ft+1} \left[ \frac{(1-\tau) \alpha \theta_F}{\frac{(1+g_c)}{\beta} - 1 + \delta} \right]^{\frac{1}{1-\alpha}}$$

Moreover, the time allocated in informal labor can be obtained now using the same equations:

$$N_{It+1} = \left\{ \frac{(1-\rho\tau) \gamma \theta_I}{(1-\tau) (1-\alpha) \theta_F} \left[ \frac{(1-\tau) \alpha \theta_F}{\frac{(1+g_c)}{\beta} - 1 + \delta} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1}{1-\gamma}}$$

Imposing  $g_c = 0$  at the steady state, the expressions for informal and formal labor become:

$$N_I = \left\{ \frac{(1-\rho\tau) \gamma \theta_I}{(1-\tau) (1-\alpha) \theta_F} \left[ \frac{(1-\tau) \alpha \theta_F}{\frac{1}{\beta} - 1 + \delta} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1}{1-\gamma}}$$

$$N_F = \frac{(T - N_I) \gamma (1 - \rho\tau) \theta_I N_I^{\gamma-1} - (1 - \rho\tau) \theta_I N_I^\gamma}{\gamma (1 - \rho\tau) \theta_I N_I^{\gamma-1} + \left[ ((1 - \tau) \theta_F - \delta) \left( \frac{(1 - \tau) \alpha \theta_F}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{\alpha}{1-\alpha}} \right]}$$

## 2.5 Simulating the income difference between Bolivia and Korea

According to the model based estimates of informal sector size as % of GDP, Korea and Bolivia had similar sizes of informal sector in 1960, around 70%. In 2012 while the size of informal economy in Korea has shrank to 25%, Bolivia could only reach 61%. In the meantime the GDP per capita ratio of these countries rose from 1.7 to 25. For the period 1960-2012 this translates into an average of 8.92 GDP per capita ratio.

To be able to simulate the GDP per capita ratio of 9.9, following Restuccia (2004) we allow for total factor productivity differences across countries. In such setting, we want to find the exogenous total factor productivity difference needed to be imposed to the model in order to generate the average income ratio observed through 1960-2012.

Assuming in both Bolivia and Korea there is full tax enforcement, that is,  $\rho_B = \rho_K = 1$ , we need to impose  $\frac{TFP_K}{TFP_B} = 3.13$ . Yet, if we were to take  $\rho_B = 0.4$ , i.e. if we were to raise the barriers, this time we get a ratio of  $\frac{TFP_K}{TFP_B} = 2.84$ , which roughly equals to the  $\frac{TFP_K}{TFP_B}$  ratio that we observe in data (obtained by using perpetual inventory method).

In Table 4, we report the results on how the total factor productivity ratio evolves as we reduce the tax enforcement parameter  $\rho$ .

Table 4. Simulating the Income Ratio between Korea and Bolivia.

$\frac{y_K}{y_B}$	$\rho_B$	$TFP_K/TFP_B$
8.9	1	3.13
8.9	0.9	3.08
8.9	0.8	3.03
8.9	0.7	2.99
8.9	0.6	2.93
8.9	0.5	2.88
8.9	0.4	2.84
8.9	0.3	2.80

For  $\rho_K = 1, \tau_K = 0.25, \tau_B = 0.35$

We should also note that capital-output ratio's for Korea and Bolivia supports our empirical findings from the last section. Capital-output ratio for Bolivia is around 1.76 whereas for Korea the same ratio is 2.04. These results are very similar to those we observe in data, 1.71 and 2.45 respectively. So besides from generating the observed income difference; the model economy is also able produce a capital-output ratio that is close to what we observe in data.

## 2.6 Impulse responses

In this section using a Dynare code written for the model presented above, we try to show how our model brings improvements upon a standard DGE model.

This section will illustrate impulse responses of two economies; one with  $\tau = 1$  and  $\rho = 0$  the other with  $\tau = 0.25$  and  $\rho = 1$ , otherwise identical. The former represents a high tax rate and no tax enforcement environment and the latter case represents a low

tax rate and full tax enforcement environment. We will introduce a 5% total factor productivity shock (to both sectors) in both environments.

The result impulse responses for these two separate environments are given in Figure 4 and Figure 5.

Figure 4. Impulse responses for high tax - no tax enforcement economy

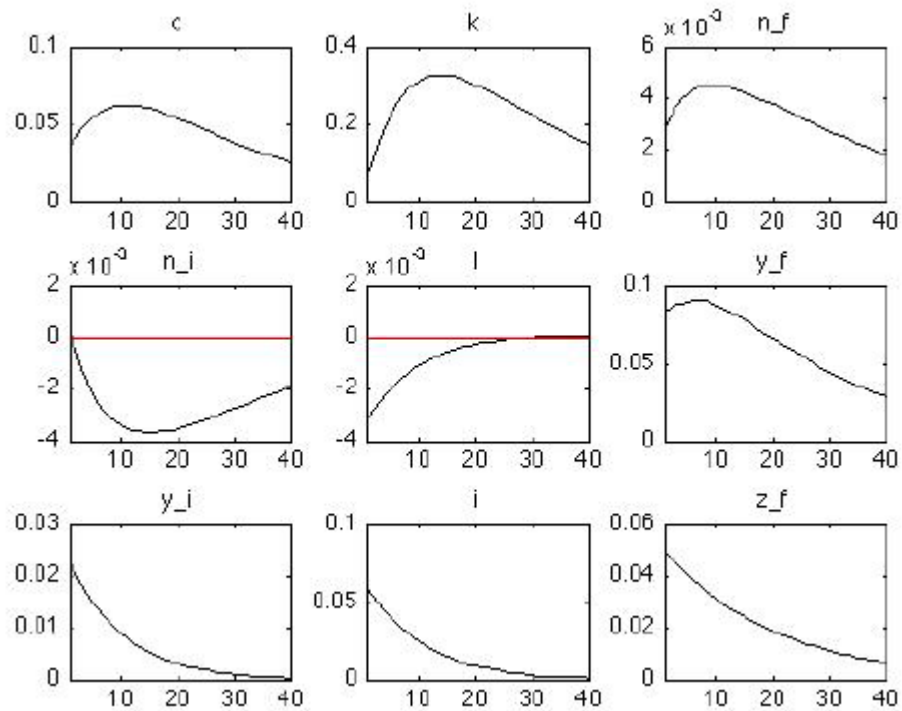
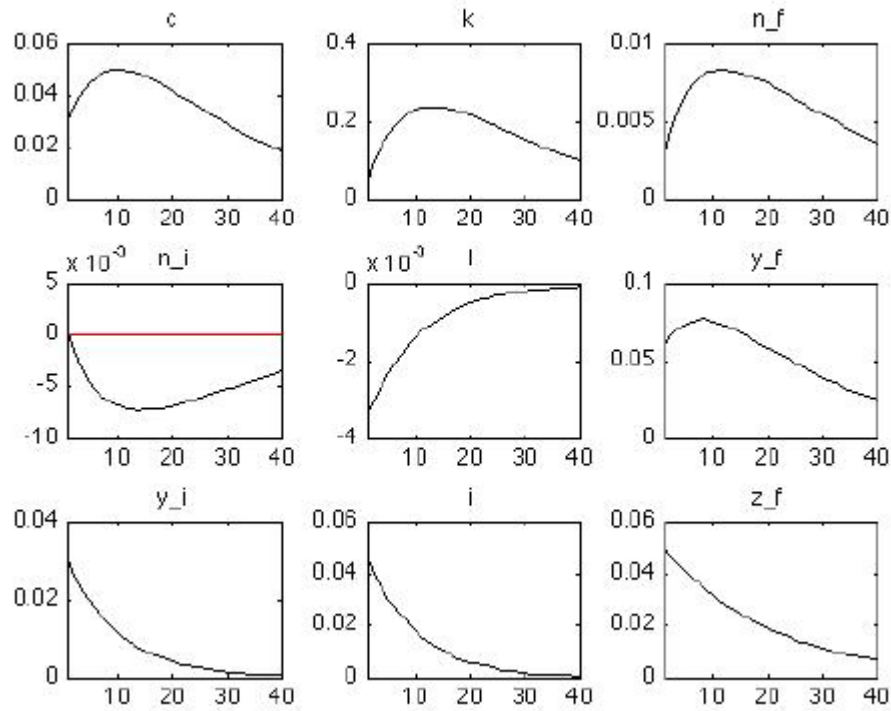


Figure 5. Impulse responses for low tax - full tax enforcement economy



For the economy with high tax-full tax enforcement we observe that formal output starts at a 0.025 higher level compared to low tax-no tax enforcement economy. When the total factor productivity shock kicks in, the former elevates to 0.0909 whereas the latter can only reach 0.0707. The observation to be made is that in face of a total factor productivity shock, the increase in formal output is more significant for the former environment with high tax- full tax enforcement.

The pattern of capital after the shock is introduced is another interesting part of this exercise. We observe that for the high tax-full tax enforcement environment capital elevates to higher levels whereas the movement in capital for the low tax-no tax enforcement is relatively smaller. This fact supports the evidence provided in the empirical analysis section.

## 2.7 Capital utilization extension

In this section we extend our two sector model and include capital utilization. This new model will feature two separate choices regarding the capital level. The first decision will be about how much of the resources today will be transferred to the future in form of capital and second decision concerns how much of the capital in hand will be employed in the production process. Examples of this class of models can be found in Shimer (2009, 2010). Using this model we will try to show that, as we argue in the empirical part of our analysis, informality suppresses the capital-output ratio in a given country and thus poses a threat to per capita income convergence. In order to be able to show this we will again introduce a positive 5% shock to a low informality and a high informality environment and present the impulse responses.

The distinguishing feature of this model from the former model that we employed so far is that the informal sector will now employ capital. The production function for the formal sector will be:

$$Y_{Ft} = e^{zt} A_f (K_{Ft} H_{Ft})^\alpha L_{Ft}^{(1-\alpha)}$$

It should be noted that this production function exhibits constant returns to scale.

The informal sector production function on the other hand is as follows:

$$Y_{It} = e^{zt} A_I (K_{It} H_{It})^{\alpha_i^k} L_{It}^{\alpha_i^l}$$

The capital stocks for the formal and informal sectors evolve according to the following equations respectively:

$$x_{ft} = k_{ft+1} - (1 - \delta(h_{ft})) k_{ft} + \phi(k_{ft}, k_{ft+1})$$

$$x_{it} = k_{it+1} - (1 - \delta(h_{it})) k_{it} + \phi(k_{it}, k_{it+1})$$

Here  $x$  denotes investment,  $\phi$  denotes capital adjustment cost function,  $\delta$  denotes capital depreciation function.

In this setting representative household solves the following problem to maximize expected life-time utility:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left( \ln c_t - m \frac{\xi}{\xi + 1} (n_{it} + n_{ft})^{\frac{\xi+1}{\xi}} \right)$$

$$s. t. \quad c_t + x_{it} + x_{ft} = (1 - \tau) e^{zt} A_f (K_{Ft} H_{Ft})^\alpha L_{Ft}^{(1-\alpha)} + (1 - \rho\tau) e^{zt} A_l (K_{It} H_{It})^{\alpha_k} L_{It}^{\alpha_l}$$

$$x_{ft} = k_{ft+1} - (1 - \delta(h_{ft})) k_{ft} + \phi(k_{ft}, k_{ft+1})$$

$$x_{it} = k_{it+1} - (1 - \delta(h_{it})) k_{it} + \phi(k_{it}, k_{it+1})$$

We use a Dynare code to solve this model. We create two environments; a low informality and a high informality economy. The low informality economy has a relatively lower tax rate and an higher tax enforcement parameter whereas the high informality economy has a high tax rate and a low tax enforcement parameter. We introduce a 5% technology shock to both of these environments. We are particularly interested in the response of the capital-output ratio in this experiment.

We report the results in Figure 6. For the low informality environment, we observe a greater jump in the capital-output ratio whereas the response is almost nonexistent for the high informality environment. This result is crucial since it supports the argument made throughout the empirical analysis section of this study.

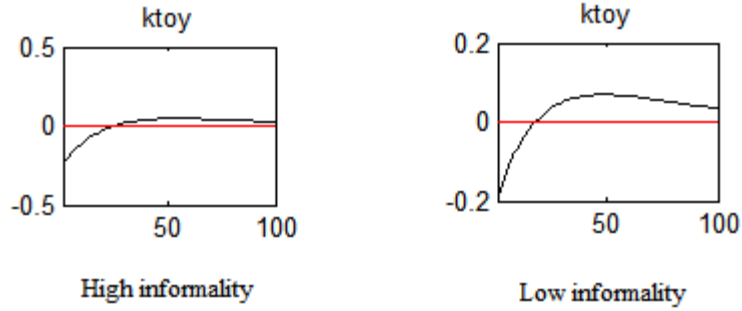


Figure 6. Impulse responses for the high and low informality environments.

## 2.8 Conclusion

In this study we try to establish the negative relationship between informal sector size and relative GDP per capita, hence convergence. The empirical analysis we conducted establishes this analysis, more over we find that informality obstructs growth especially through the channel of capital-output ratio. Our quantitative analysis showed the two sector dynamic general equilibrium model that we employ is capable of producing the observed income differences as well as the capital-output ratio observed in data. Thus this study contributes to the barriers to growth literature by pointing out the prevalence of informality as a major determinant that obstructs growth of relative income per capita.

A future study asking the same questions as this paper might consider different model economies. Employing an endogenous growth model would enable the growth rate to be determined endogenously. Although employing an endogenous growth model will, by construction, compromise transitional dynamics analysis, still it might lead to different results than what has been presented in this paper. Setting up such a model poses challenges, especially in establishing the existence of a balanced growth path; yet



a model that allows for the endogenous determination of the growth rates of the sectors would be a valuable contribution.

APPENDIX A

DETERMINANTS OF INFORMALITY SUMMARY TABLES

Table 5. Summary Table for Determinants of Informality

Determinants	Study	Model	Findings
Contract enforcement	Pedro S. Amaral, Erwan Quintin (2006)	Span-of-control model	Instead of modelling barriers to movement across formal and informal sectors, the authors model costs of informality so as to reflect difficulties in accessing to formal means of contract enforcement. The decision on in which sector to operate depends on the return to outside financing and additional tax costs. In equilibrium, skilled managers remain in the formal sector.
	Amab K. Basu, Nancy H. Chau, Ravi Kanbur (2011)	Search model	The model shows that two common attributions about informal sector - being more competitive and having greater difficulty in contract enforcement- are incompatible with each other.
Trade liberalization	Pnelopi Koujianou Goldberg, Nina Pavcnik (2003)	Dynamic efficiency wage model	Although the authors empirically do not find supporting evidence, they develop a model where trade liberalization leads to an expansion of the informal sector by altering both firm and worker behavior.
	Lourenco S. Paz (2014)	Small open economy with heterogeneous firms	Model predicts that a reduction in the Home import tariffs has ambiguous effects, whereas a decrease in the Foreign import cuts decreases the share of informal employment in Home.

Determinants	Study	Model	Findings
Institutional Quality	Alberto Chong, Mark Gradstein(2007)	2-sector model with imperfect credit market	The model shows that low institutional quality together with high income inequality generate larger informal economies.
	Ceyhun Elgin, Oguz Ozunalı (2014a)	2-sector dynamic general equilibrium model	A higher GDP per capita is associated with a large informal sector when institutional quality is low and a smaller informal economy when institutional quality is high.
Government Policy: Taxes, Regulation, Enforcement	Ricardo Azevedo Araujo, Nathalia Almeida de Souza (2010)	Evolutionary game theory approach	The model investigates optimal enforcement and regulatory action by the government by taking the labor market evolution into account.
	Mauricio Prado (2011)	2 sector monopolistic competition model	The quantitative analysis assesses how the size of the informal economy is related to the level of enforcement for a given level of regulation for 29 countries.
	Gabriel Ulyssea(2010)	Continuous investment model with moral hazard	Reducing the entry costs and increasing enforcement both effective in reducing informality, yet more enforcement can have negative effects on employment and welfare.

Determinants	Study	Model	Findings
Government Policy: Taxes, Regulation, Enforcement	Jane Ihrig, Karine S. Moe (2001)	2-sector dynamic general equilibrium model	Rather than increasing the level of enforcement as a policy tool to reduce informality, it is favorable to reduce tax rates in order to prevent welfare losses. Also, at times of recession, informal sector is shown to be an important source of subsistence.
	Sylvain Dessy, Stephane Pallage (2003)	Heterogenous agents model with incomplete markets	An equilibrium with full formalization is affordable only for the high income countries. Moreover, the effects of taxation on the size of the informal economy is ambiguous.
Labor market policies	M. Bosch, J. Esteban-Preterl (2012)	2- sector search and matching model	Labor market policies that aim at reducing costs associated with formality result in a reduction in the share of informality in the economy as well as a reduction in unemployment.
	Luz A. Florez (2014)	2- sector search and matching model	Model shows that while unemployment benefits and job creation subsidies encourage formal employment, while payroll taxes have negative effect.
Business Flexibility Product market policies Entry costs	Olivier Charlot, Franck Malherbet, Cristina Terra (2015)	2- sector search and matching model	Product market deregulation can effectively reduce informality and unemployment while fiscal policies that aim at reducing informality can increase unemployment.

Determinants	Study	Model	Findings
Business Flexibility Product market policies Entry costs	Norman V. Loayza, Jamele Rigolini (2010)	2- sector small open economy model	In the long-run larger informality is associated with limited government services, less flexible business procedures and lower labor productivity. However in the short run informal sector acts as a safety net.
Public Trust	Ceyhan Elgin, Mario-Solis Garcia(2011)	Optimal taxation model	If producers' trust in the government is lower (higher), the government announces a lower (higher) tax rate on the formal sector, but more (less) producers chose to stay in the informal economy.
Foreign Transfers	Chatterjee, Santanu Turnovsky, Stephen (2014)	2-sector small open economy model	While remittances support economic growth in the short-run, in the long run it leads to an increase in the size of the informal sector. The effect of aids on the size of the informal sector depends on whether they
Financial Development	Salvatore Capasso, Tullio Jappelli (2013) Keith Blackburn, Niloy Bose, Salvatore Capasso (2012)	Investment model Model of tax evasion and financial intermediation	Financial development, understood as decreasing costs of external financing leads to a reduction in the size of the informal economy. When financial development is at low levels, tax evasion is more pervasive, thus the informal sector is larger.
Banking crises	Emilio Colombo, Luisanna Omnis, Patrizio Tirelli (2015)	2-sector dynamic stochastic general equilibrium model	At times of banking crises, informal sector expands and acts as a buffer that compensates for the losses in official economy.

Study	Dependent Variable(s)	Explanatory Variable(s)	Method	Findings
David Dreyer Lassen (2007)	Size of the informal sector to GDP	Significant: Corruption, Ethnic fractionalization, urbanization. Insignificant: Level of income, inflation	Simultaneous equations system	For a cross-section of more than 50 countries, more ethnically fractionalization and corruption are associated with significantly larger informal sectors.
Axel Dreher, Friedrich Schneider (2010)	Size of the informal sector to GDP	Significant: Government effectiveness, minimum wage regulation, credit market regulations Insignificant: GDP per capita, corruption	OLS, TSLS	No strong evidence found for the relationship between corruption and size of the informal sector.
Friedman, B. A. (2014)	Size of the informal sector to GDP	Significant: Political stability, regulatory quality, control of corruption, employment rate, manufacturing share, net immigration, GDP, economic growth Insignificant: Rule of law, voice and accountability	Pooled regression	With panel data for 149 countries, higher levels of regulatory quality, political stability, control of corruption are found to be associated with smaller informal economies.
Benno Torgler, Friedrich Schneider (2007)	Size of the informal sector to GDP	Significant: Political risk rating, bureaucratic quality, corruption, democratic accountability, government stability, law and order, internal conflict military interference, tax morale Insignificant: Trade, urbanization	Fixed effect estimation, OLS	Higher levels of institutional quality, governance and tax morale are usually related with smaller shadow economy.
Rita Almeida, Pedro Carneiro (2011)	Share of informal employment	Significant: Various aspects of labor market regulation and enforcement	Least squares	With data for Brazil, the paper shows that stricter regulations and enforcement, by reducing self employment, can lead to a reduction in the size of the informal economy.

Study	Dependent Variable(s)	Explanatory Variable(s)	Method	Findings
Martha Garcia-Murillo, Jorge Andres Velez-Ospina (2014)	Size of the informal sector to GDP	Significant: Mobile cellular access, fixed broadband subscribers, unemployment, corruption index, business start up cost Insignificant: Public spending on education	MIMIC	While mobile cellular access has a positive impact on informal sector size, fixed broadband has a negative impact.
Shanthy Nataraj (2011)	Probability of a firm being informal	Significant: FDI, new firm dummy, access to electricity dummy Insignificant: Final good tariff, input tariff	Logistic regression	Although no significant relationship between the probability of informality in India and tariff cuts is detected, the paper shows that trade liberalization leads to a productivity increase in both sectors.
Mariano Bosch, Edwin Goni-Pacchioni, William Maloney (2012)	Share of informal employment	Significant: Import penetration, Constitutional changes (unions, firing costs) Insignificant: Tariffs	OLS, GMM	Paper argues that trade liberalization had a small impact on the allocation of labor between informal and formal sectors in Brazil yet constitutional changes seem to be contributing to more.
Johanna D'Hermoncourt, Pierre-Guillaume Meon (2012)	Size of the informal sector to GDP	Significant: Per capita GDP, trust, taxation, legal systems, regulation	OLS	Prevalence of trust is associated with smaller informal economies, more so for developing countries.

Study	Dependent Variable(s)	Explanatory Variable(s)	Method	Findings
Simon Johnson, Daniel Kaufmann, Pablo Zoido-Lobaton (1998)	Unofficial economy as % of GDP	Significant: GDP per capita, regulation, regulatory discretion, bureaucratic quality, economic freedom, tax burden, tax rates, legal environment indicators, corruption indicators	OLS	Although high levels of corruption and less strict regulation seems to account for large sizes of unofficial economies for a limited set of countries, the relationship becomes less apparent for a large set of countries.
Ceyhun Elgin (2012)	Size of informal sector to GDP	Significant: Internet, GDP, Internet*GDP, democracy, tax, productivity Insignificant: Censorship, law and order, openness	Fixed effect estimation, System estimation	Panel and cross-section estimation results indicate that the association between internet usage and shadow economy size strongly interacts with GDP per-capita.
Ceyhun Elgin, Cem Oyvatt (2013)	Size of informal sector to GDP	Significant: Urbanization, tax burden, openness Insignificant: Censorship, law and order, openness	Fixed effect estimation, Ols	Results reveal an inverted-U relationship between urbanization and the share of informal sector.
Ceyhun Elgin, Mario-Solis Garcia (2011)	Size of informal sector to GDP	Significant: Lagged informal sector size, public trust, risk premium, GDP per capita Insignificant: Censorship, law and order, openness	Fixed effect estimation, GMM, System estimation	If the public trust variable is not added to the regression, the coefficient of the tax rate has negative impact on size of the informal sector. However, once the public trust index is controlled for, the coefficient of the tax rate becomes positive.



APPENDIX B

EFFECTS OF INFORMALITY SUMMARY TABLES

Table 6. Summary Table for Effects of Informality

Effect(s)	Author(s)	Model	Findings
Fiscal Policy	Stephen J. Turnovsky, Md.A. Basher (2009)	2-sector neoclassical growth model	Optimal fiscal policy in the presence of tradeoff between taxation and auditing, i.e. recursive fiscal dilemma.
	Katherine Cuff, Nicolas Marceau, Steeve Mongrain, Joanne Roberts (2011)	2-sector model of migration	Optimal tax and enforcement policy in the presence of illegal immigration
	Rodrigo A. Cerda, Diego Saravia(2013)	2-sector model with heterogeneous firms	Optimal solution of the Ramsey taxation problem The optimal capital income tax is negative while the corporate tax rate is positive and the sign of labor income tax is ambiguous
	Anil Markandya, Mikel Gonzalez-Eguino, Marta Escapa (2013)	Multisector computable general equilibrium model	Taking the distortions created by the informal economy into account, benefits of a green tax reform that reduces labor taxes are justified in the context of double dividend hypothesis.

Effect(s)	Author(s)	Model	Findings
Long-run growth	Docquier, Frederic and Muller, Tobias and Naval, Joaquin (2014)	2-sector OLG model	In the short run informality contributes to the well-being of workers but in the long run it slows down per capita income convergence.
	Pierre-Daniel G. Sarte (2000)	2-sector endogenous growth model	The 2 sector endogenous growth model employed in the paper shows that informality is not necessarily an impediment to growth. However, if the bureaucratic rent seeking behaviour is so that it encourages operating informally, depending on the costs of property rights protection, lower growth might emerge as a result.
Poverty and Inequality	Prabir C. Bhattacharya (2011)	3-sector general equilibrium model	In the urban-rural migration context, the presence of informal economy reduces income inequality.
	Saibal Kar, Sugata Marjit (2009)	2-sector small open economy model	In response to trade liberalization in a developing country, the increase in the informal wages will reduce urban poverty.
	John Bennett (2008)	2-sector model with heterogeneous entrepreneurial ability	If there is high product demand, informality reduces consumer surplus and profits are redistributed towards more able entrepreneurs.

Effect(s)	Author(s)	Model	Findings
Financial development	Ceyhan Elgin, Burak R. Uras (2012)	2-sector dynamic general equilibrium model	Informal sector harms financial development through increasing financial repression due to tax evasion. On the other hand, larger informal sector size facilitates financial development through easing the capacity constraint on the financial sector.
Environmental pollution	Ceyhan Elgin, Oguz Oztunali (2013)	2-sector dynamic general equilibrium model	There is an inverse-U relationship between the size of the informal economy and environmental pollution.
Employment	Costas Meghir, Renata Narita and Jean-Marc Robin (2012)	2-sector equilibrium search model	Increasing the cost of informality results in improvements in welfare and reduction in unemployment while regulation of labor market does not have a sizeable effect.
	Mariano Bosch, Julien Esteban-Prete(2012)	2-sector search and matching model	Policies that aim to increase the costs associated with informality, raise the share of formal employment while reducing unemployment.

Effect(s)	Author(s)	Dependent & Explanatory Variables	Findings
Poverty and Inequality	Jinjun Xue, Wenshu Gao, Lin Guo(2014)	DV: Hourly earnings EV: Employment status (formal informal)* Work experience*, Gender*, Marital status*, Years of schooling*	Using Mincerian regression model, authors find that a reduction in the share of informal employment translated in a decline in income inequality in urban China.
	Saibal Kar, Sugata Marjit(2008)	DV: Percentage below poverty line EV: Informal sector wage for the previous year	Relying on GMM estimation, the study shows that during trade liberalization, rise in the informal sector wage leads to a reduction in the percentage in below poverty line in India.
Corruption	Axel Dreher, Friedrich Schneider(2010)	DV: Perceived corruption EV: Regulation of prices*, rule of law*, democracy*, size of the shadow economy, fiscal burden, GDP per capita	OLS and 2SLS regressions for a cross-section of 98 countries provide no strong evidence for complementarity of shadow economy and corruption in low income countries and substitutability for the high income countries.
Financial Development	Ceyhan Elgin Burak R. Uras (2013a)	DV: Financial development proxies EV: Informal sector*, GDP per capita*, Current account balance*, Capital-output ratio*, Law, Inflation, Tax Burden	Using panel, IV and GMM regressions, with a sample of 152 countries, the paper argues that on the one hand, informal sector harms financial development through increasing financial repression due to tax evasion; on the other hand, increasing informal sector size facilitates it through easing the capacity constraint on the financial sector.

Effect(s)	Author(s)	Dependent & Explanatory Variables	Findings
Business cycles Macroeconomic volatility	Mapp, Terral Moore, Winston(2014)	DV: Consumption and output volatility EV: Size of the informal economy*	Using bivariate panel regressions, the findings suggest that larger informal economies are associated with smaller macroeconomic volatility for Caribbean economies.
	Gisele Ferreira-Tiryaki(2008)	DV: Consumption, output and investment volatility EV: Size of the informal economy*, domestic credit in private sector*, openness, monetary policy	GMM estimations validate that countries with larger informal sectors tend to be subject to higher consumption, output and investment volatility over the business cycle.
Public debt and Sovereign default risk	Ceyhun Elgin(2012)	DV: Cyclical, Growth EV: Size of the informal economy*, openness, fiscal balance*, growth*, interest rate*, corruption, law/order, democracy	Panel regressions for 152 countries show that the presence of informal economy is counter-cyclical and moreover it amplifies business fluctuations.
	Ceyhun Elgin Burak R. Uras (2013b)	DV: Public debt, sovereign default risk EV: Informal sector*, GDP per capita*, corruption control*, bureaucratic quality, democratic accountability., political stability	Various specifications point out that larger informal sector is associated with greater public debt and higher probability of sovereign default.

Effect(s)	Author(s)	Dependent & Explanatory Variables	Findings
Fiscal Policy	Ceyhan Elgin, Deniz Cicek (2010)	DV: Cyclicity of fiscal deficits EV: Informal sector*, corruption*, output volatility*, GDP per capita, political stability	Estimations with cross-section and panel data sets for 78 countries document that procyclicality of fiscal policy is more pronounced in countries with a larger size of the shadow economy.
Pensions	David Tuesta (2014)	DV: Probability of contribution to pension system EV: Employment status*, education*, gender*	Probit estimations employed show that, for Latin American countries, larger informal economies are associated with lower probability of an individual making contributions to the pension system.

APPENDIX C

MEASURING INFORMALITY SUMMARY TABLES

Table 7. Summary Table for Measuring Informality

Author(s)	Method	Explanation
Schneider Friedrich, Andreas Buehn, Claudio E. Montenegro (2010)	MIMIC	The purpose of the study is to estimate size of the shadow economy as % of GDP for 162 countries. The estimation technique adopted is the Multiple Indicators Multiple Causes estimation which is a special type of structural equations model. The authors identify indicators of informality as growth rate of GDP per capita, growth rate of labor force, labor force participation rate, currency and causes of informality as size of government, share of direct taxation, fiscal freedom, business freedom, unemployment rate GDP per capita, government effectiveness. With these variables they present results for different specifications.
Ceyhan Elgin, Oguz Ozunali (2012)	Model based estimates	Relying on a two-sector dynamic general equilibrium model, the paper intends to estimate a new dataset for size of the shadow economy. The model is then calibrated to match various reported macroeconomic variables and then the size of the shadow economy is backed out from the calibrated model. Using these, an unbalanced 161-country panel dataset over the period 1950 and 2009 is constructed.
Pedro Gomis-Porqueras, Adrian Peralta-Alva, Christopher Waller (2014)	Model based estimates	Using a dynamic monetary model with tax evasion, the paper theoretically measures the size of the shadow economy. Then the model is calibrated to match money demand data and the size of the shadow economy is backed out. The estimates obtained are consistent with those obtained from structural models.
Bruno S. Frey Werner W. Pommerehne (1984)	Structural equations	The paper discusses the existing methods for estimating the size of the shadow economy. Then a model in which both indicators and causes of informal economy are used to estimate size of the shadow economy as % of GNP. The authors argue that this combined approach improves upon the existing alternatives.

Author(s)	Method	Explanation
Roberto Dell'Anno Friedrich Schneider(2004)	MIMIC	Using MIMIC approach the paper presents results for the size of the shadow economy for 21 OECD countries. Also Italian case is studied in detail using various different specifications for robustness checks.
Jose Brambila Macias, Guido Cazzavillan (2009)	Currency demand approach	The purpose of the paper is to estimate the size of the shadow economy in Mexico using a vector error correction model. They emphasize the importance of taking remittances into account in the Mexican context in addition to standard currency demand approach. They generate annual estimates covering the period 1970-2006.
Trevor Breusch(2005)	MIMIC	The paper argues that MIMIC models are not appropriate for estimating the size of the shadow economy. Concentrating on three studies that adopt MIMIC approach, the author provides technical arguments to justify this claim.
Dimova, R. D., Gang, I. N., & Landon-Lane, J. S. (2011)	Income-expenditure survey	In Bulgarian context, the authors develop a method whereby informality is detected using income and expenditure discrepancies observed in household surveys.
Henley, Andrew & Arabsheibani, G. Reza & Carneiro, Francisco G. (2009)	Household survey	The purpose of the study is to estimate the size of the informal economy in Brazil. The authors use three different approaches to infer informal activity from household surveys and discuss the reasons why these three approaches yield substantially different results.



APPENDIX D

WEIGHTED GDP PER CAPITA PLOTTED AGAINST TIME

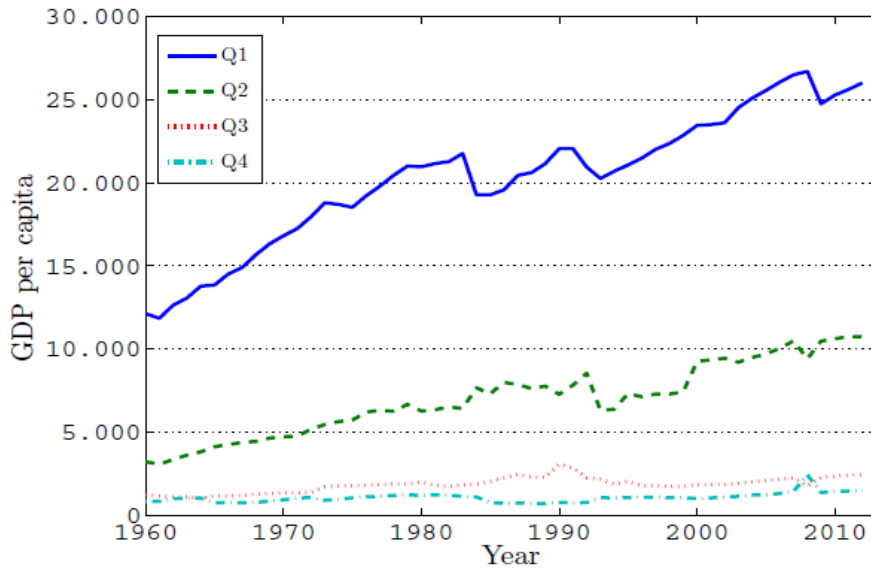


Figure 7. Weighted GDP per capita plotted against time for 4 groups of countries

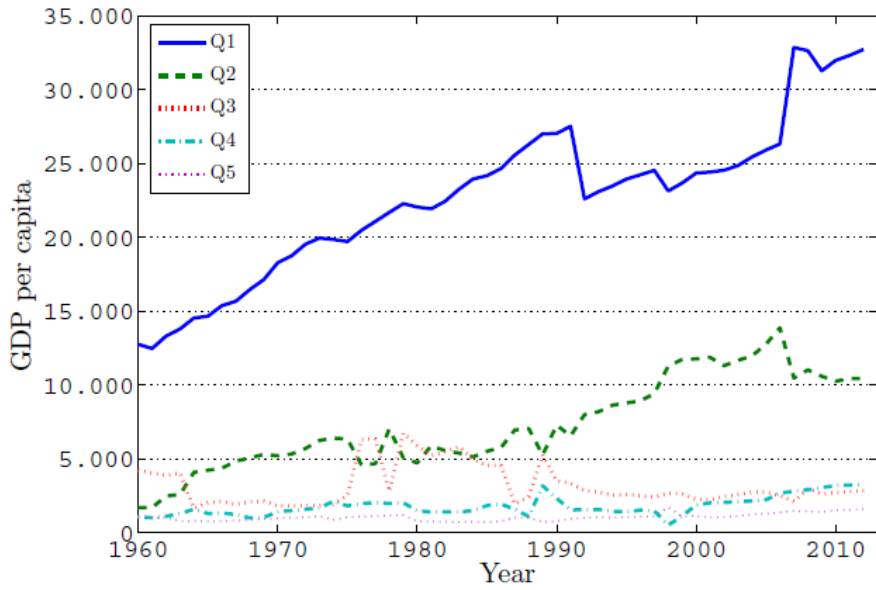


Figure 8. Weighted GDP per capita plotted against time for 5 groups of countries

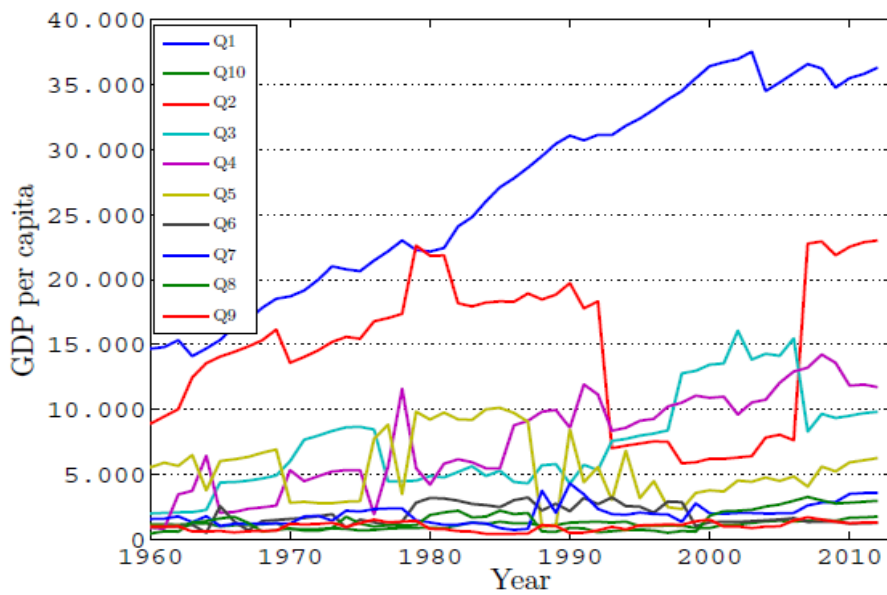


Figure 9. Weighted GDP per capita plotted against time for 10 groups of countries

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