

Board of Governors of the Federal Reserve System
International Finance Discussion Papers
Number 664
April 2000

THE DYNAMICS OF INFORMAL EMPLOYMENT

Jane Ihrig and Karine Moe

NOTE: International Finance Discussion Papers are preliminary materials circulated to stimulate discussion and critical comments. Reference to International Discussion Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors. Recent IFDPs are available on the Web at www.bog.frb.fed.us.

The Dynamics of Informal Employment

Jane Ihrig and Karine S. Moe*

Abstract: This paper develops a dynamic model that includes an informal sector. It illustrates the natural dynamics of this sector, shows how tax policy affects the size of this sector, and quantifies the costs of having an informal sector. Simulations yield movements in informal employment and output consistent with empirical observations. Calibrating the model to United States data, we find approximately 5 percent of time is devoted to the informal sector and it produces 3 percent of GDP in steady state. For those who want to reduce the size of this sector, we find the best policy is to reduce tax rates. This policy not only reduces informal employment, but increases the standard of living. If we hold tax revenues constant, then governments should increase efforts in tax collection in conjunction with lowering tax rates. However, the distortion from this sector, in terms of the lifetime loss in an economy's capital stock, is minimal - supporting those who want to keep the informal sector as a functioning part of society.

Keywords: economic development, enforcement, informal employment, taxation

*Ihrig: Division of International Finance, Board of Governors, ihrig@frb.gov. Moe: Department of Economics, Macalester College, moe@macalester.edu. We would like to thank Ron Gecan, Gerhard Glomm, Ed Green, Jinill Kim, Marcelo Veracierto, and Kei-Mu Yi for comments. Moe thanks a 1999 Wallace Research Grant. The views in this paper are solely the responsibilities of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of other members of its staff.

1 Introduction

The informal sector, which produces legal goods but does not comply with government regulations, is a functioning part of all economies. It is estimated that in developing countries the informal sector employs up to 60 percent of the workforce and produces nearly 40 percent of GDP, while in the OECD countries the informal sector employs approximately 17 percent of the workforce and produces 14 percent of GDP.¹ These numbers provide anecdotal evidence that the informal sector makes a sizeable contribution to national income, even as the economy becomes developed.

Throughout time, governments and international organizations have taken actions that affect the size of this sector. Burkina Faso recently created a tax bracket geared towards those who have never paid taxes before, hoping to collect a minimal 2 percent of income from these individuals and shift them from the informal to formal sector. The World Bank supports the goal of taxing laborers and sends mobile tax units to countries for the collection of tax revenue. These actions lead us to the question of whether we should try to control the size of this sector.² Those who want to reduce informal employment point out that agents in the informal sector undermine tax collection and drive a wedge between the returns to factors across sectors. This affects the government's ability to provide public goods and creates an inefficiency or welfare cost. Those supporting informal employment say the informal sector provides a relatively easy way to create and expand employment, and provides a source of subsistence income during recessions.

To shed light on some of the issues in this debate, one must understand the dynamics of the informal sector and how government tax policy affects the size of this sector. We develop a simple dynamic model where an agent has the option to work in the informal sector. In

¹See Chickering and Salahdine (1991), *The Economist* (August 28, 1999), International Labour Organization Yearbooks and Schneider and Enste (1998)

²The view of the informal sector typically changes with the economic environment. The predominant view over the past 40 years is summarized in *World Employment*, 1995.

the informal sector, an agent avoids taxes unless caught, but works with less capital intense production methods.³ In the formal sector, an agent pays taxes and has access to the capital market. The tradeoff for the agent is between higher productivity per unit of labor input in the formal than informal sector, and paying taxes in the formal sector versus possible avoidance in the informal sector.

Focusing on dynamics of the informal sector is important for a variety of reasons. First dynamics generate the two-way causality between informal employment and GDP per worker we suspect from the data (i.e., decreases in informal employment cause a rise in GDP per worker, while a rise in GDP per worker causes further declines in informal employment). Second, dynamics are of interest since most countries are in transition.⁴ Even in the United States, a country with a relatively small informal sector, informal employment has dropped 5 percentage points over the past two decades. Furthermore, transitional dynamics allow us to conduct realistic policy experiments. While we can use comparative statics to evaluate the effects of various policies in steady state, dynamics show how an economy evolves toward steady state under differing policies. Our tests of various tax policies allow for changes in not only the steady state, but also in the convergence rate and, therefore, the length of time to steady state.

Recent theoretical work by Loayza (1996) and Sarte (1997) has modeled the connections between the informal sector and macroeconomy. These studies use AK growth models to theoretically link changes in the size of the informal sector to economic growth.⁵ The AK framework, however, does not generate the transitional dynamics of the informal sector observed in actual economies. Specifically, the proportional change in the size of the informal sector and output as restricted by an AK model is not borne out in the data. Instead, our

³The informal sector should not be confused with the criminal sector, which produces illegal goods and services such as drugs and prostitution. The informal sector produces the same goods as the formal sector, but tries to avoid government regulations.

⁴Jones (1998) argues, for example, that contrary to conventional wisdom, even the U.S. economy is far from its steady-state balanced growth path.

⁵An AK model is a constant saving rate version of the simplest endogenous growth model.

model captures the empirical observation that as an economy grows from a low level of real GDP per capita, changes in informal employment are large. As economies near steady state, changes in informal employment are small.

Simulations yield movement in informal employment, output (both total and informal), and capital consistent with data from the U.S. and other countries around the world. The informal sector naturally declines as the economy grows (even with no change in tax policies) and the informal sector is a functioning part of an economy's steady state. Calibrating to the United States, we find a steady state where approximately 5 percent of time is devoted to informal production and where the informal sector produces 3 percent of total output.⁶

Once we establish that the model replicates the stylized facts of informal data, we analyze the effect of alternative tax policies on this sector and the economy. Empirical work by Johnson et al. (1998) and Schneider and Enste (1998) find, for both transitional and developed economies, that higher burdens of tax policy are correlated with larger informal sectors. Their measures of tax burden, however, combines the administration of the tax policies and the tax rates themselves, and the analysis focuses on cross-sectional data. Here we consider the effects of these policies, either individually or jointly, on the transition of an economy.

We find a reduction in the tax rate or an increase in enforcement (1) increases the level of output and decreases the size of the informal sector in the steady state and (2) increases the rate of convergence to the steady state. While small changes in the tax rate cause measurable changes in both the level of and convergence to the steady state, modest changes in the enforcement variable (i.e., increases in the probability of detection without substantial penalties) have negligible effects on the size of the informal sector. In order for enforcement to have a measurable effect, the government must impose penalties rather than just increase policing. This suggests that governments interested in reducing the size of

⁶This parameterization fits data from the US between 1960 and 1990, and matches observations for a cross-section of developing and industrialized countries in various years. See more details in Section 5.

the informal sector should reduce the tax rate and/or increase the tax penalty of informal agents who are caught. If the economy wants to maintain tax revenues as a percent of GDP (for public good provisions), the model suggests lowering the tax rate and increasing enforcement simultaneously. Therefore, when the World Bank sends mobile tax units to countries for tax collection, this increase in enforcement has minimal effects on the standard of living. Alternatively, if their objective is to increase the country's standard of living, the World Bank should encourage governments to lower tax rates along with increasing tax collection efforts .

To quantify the distortion introduced to an economy by their informal sector, we calculate the difference in the present discounted value of the capital stock between an economy with no taxation or informal sector and (a) our model and (b) an economy with a tax on formal output but no informal sector. We find the majority of the welfare loss comes from a tax rate on formal output rather than the distortions introduced by the informal sector: the informal sector only contributes 2 percent to the total welfare loss of the economy. This finding provides support for those who believe the informal sector should remain a functioning part of the economy. Of course, we should keep in mind that tax policies can alter the size of this sector and, therefore, the standard of living.

We now turn to Section 2 where we describe some stylized facts associated with informal employment. The theoretical economy is presented in Section 3. In Section 4 we discuss the selection of parameter values. The model simulations are presented in Section 5, and we demonstrate how the model matches time-series and cross-sectional data. We conduct policy experiments in Section 6. We examine transitional dynamics and quantify the effect of tax policies in an economy with an informal sector. Concluding remarks are found in Section 7.

2 Stylized Facts

In this section, we describe three stylized facts associated with the informal sector. These statistics are the ones most frequently noted in other empirical work on informal employment.

1. There is a negative and convex relationship between real GDP per worker and the percent of the labor force employed in the informal sector in an economy, where informal workers produce a legal product but avoid taxation and other government regulations.
2. Informal output as a fraction of total output declines with economic development.
3. Higher tax burdens (combining the tax rate with enforcement) significantly increase the size of the informal sector.

Before discussing these stylized facts in more detail, we define a measure of informal employment. We use the International Labour Organization's Yearbook of Labour Statistics (ILO, various years) and consider the percent of the labor force working in the informal sector to be the sum of employers, own-workers, and unpaid family workers divided by the total economically active population. The ILO is the main source quoted for empirical measures of informal employment. Although this measure may pick up formal entrepreneurs, it is one of the best available measure of informal employment and is consistent with other studies in this area. Alternative measures of informal employment, as surveyed by Schneider and Enste (1998), include energy demand and currency demand. While the nominal value of the size of the informal sector varies slightly across measures, regardless of the definition used the three stylized facts highlighted in this section remain unchanged.

Figures 1a-1c illustrate the first stylized fact. There exists a negative and convex relationship between real GDP per worker and the percent of the total economically active population employed in the informal sector. This relationship is shown to hold for a time series of the United States (Figure 1a) and a cross-section of countries in total and in the manufacturing sectors of the economy (Figures 1b and 1c), respectively. The direction of

causality in this relationship is unclear. It may be that a decrease in the size of the informal sector increases GDP per worker as workers shift from informal employment to formal employment. Alternatively, as GDP per worker rises, capital rises and this shifts workers from the informal to the formal, more productive, sector. We believe there is two-way causality and capture this in the model below.

The second fact associated with the informal sector and real GDP per worker can be seen by comparing countries in different stages of economic development. Schneider and Enste (1998) estimate LDCs, on average, have 39.2 percent of their output coming from the informal sector. Countries in transition, such as the Soviet countries and Eastern Europe, have 23.2 percent of their output contributed by the informal sector, while 14.2 percent of the OECD's total output comes from the informal sector.

The third stylized fact is the empirical link between tax policy and the size of the informal sector. Many studies suggest an increase in the tax rate is one of the main causes of increases in the size of the informal economy.⁷ We know, however, that the level of the tax rate cannot be a true indicator of the tax burden since many countries have high levels of corruption. As mentioned above, Johnson et al. (1998) provide empirical evidence, from a cross-section of countries in Latin America, the OECD, and the former Soviet bloc, that the informal economy is large when the burden of tax policy is large. Specifically, this burden is measured by both the administration of the tax policies and the tax rates themselves. Ihrig and Moe (1999) quantify the effect of changes in the tax rate and enforcement on the size of the informal sector. They find each policy significantly influences Asian countries' informal sectors.

We now develop a theoretical model that allows us to examine the relationships among informal employment, real GDP per worker, and taxation policies. The model, with appropriate parameter values, matches these three stylized facts.

⁷*The Economist* (May 3, 1997) reports on how taxation can affect the size of the informal sector in developed countries. See Schneider and Enste (1998) for an overview of studies reaching this conclusion.

3 A Simple Model

The dynamic model is of an agent's decision to accumulate capital and to work in the formal and informal sectors. The economy is characterized by a representative agent, who is endowed with an initial capital stock and a fixed amount of productive time per period. The agent chooses to allocate time between the formal and informal sectors. One key difference between these sectors is that formal production is taxed by the government, while informal production is only taxed when caught by the authorities.⁸ We assume the tax revenues are used by the government to produce nonproductive services.

Informal and formal output are modeled as producing a homogenous good.⁹ A distinguishing feature of the two sectors is their production methods. Formal firms employ labor and capital, while informal firms employ solely labor. This implicitly assumes informal production has a fixed stock of capital. Typically, one finds informal agents do not have access to formal capital markets and production methods are much more labor intense than the formal sector (Celestin, 1989 and Thomas, 1992).¹⁰

The timing of the model is such that the agent begins the period with a capital stock, k , the tax rate in the formal sector, τ , and expectations of the tax rate faced in the informal

⁸Rauch (1991) and Loayza (1994) argue that the minimum wage is a key government policy affecting informal employment. Thus, we should see a negative relationship between the real minimum wage and the size of the informal sector. We do not observe this relationship in the data. In many countries the real minimum wage has saw-toothed over time and the size of the informal sector does not adjust accordingly.

⁹This assumption suggests the model may more accurately depict a developing country whose production focuses on low end manufacturing and agricultural output. Nevertheless, we show in section 5 that the model does capture the stylized facts of informal employment for developed economies.

¹⁰Lall (1989) studies the informal sector in seven sub-regions of the National Capital Region of India and finds less than 0.3 percent of informal capital is obtained from commercial banks. There do exist informal capital markets; however, measuring the rate of return is difficult. DeSoto (1989) cites Instituto Libertad y Democracia estimates of monthly interest rates (outside of the formal credit market) for informal businesses close to 22 percent in Lima during June 1985. At the same time, a formal business could obtain a maximum rate of 4.9 percent at a bank.

sector, $p * \tau$ (which depends on the tax rate, the level of enforcement [policing], and the tax penalty). The agent chooses next period's capital stock, k' , consumption, c , and time spent working in the formal, t_f , and informal, t_i , sectors to maximize

$$V(k) = \max(\log(c) + \beta V(k')) \quad (1)$$

subject to

$$c + k' - (1 - \delta)k \leq (1 - \tau)\theta_f k^\alpha t_f^{1-\alpha} + (1 - p * \tau)\theta_i t_i^\gamma \quad (2)$$

$$t_f + t_i \leq T \quad (3)$$

where δ is the depreciation rate of capital, and T is the total amount of time allocated to the agent. Equation 2 is the budget constraint: consumption plus investment in capital must be less than or equal to after-tax formal plus expected after-tax informal output. Equation 3 is the time use constraint: time spent working in the formal and informal sectors must sum to less than or equal to the time endowment, T .

We interpret $p * \tau$ in one of two ways. We can think of the informal agent facing a probability p of being caught, and that when caught, the agent must pay taxes on output at the rate of τ . In this scenario, the value of $p * \tau$ ranges from 0 to τ . Alternatively, the government may impose a penalty on the informal agent, in addition to the tax payment. If this penalty is a percent of output, then the value of $p * \tau$ incorporates both the tax rate faced by the formal sector, τ , and the penalty. In this case, the upper bound on the value of $p * \tau$ is greater than the tax rate in the formal sector.

The focus of this model is on the agent's decisions to accumulate capital and to devote time to working in the formal and informal sectors of the economy. The size of the informal sector is related to the production techniques in each sector and to government taxation policies. The formal sector employs both capital and labor to produce output and then pays

taxes on the output. An informal firm hires labor, but does not have access to capital. In addition, the informal firm avoids paying taxes unless caught. This illustrates two tradeoffs for the agent. First, the agent must allocate time between the formal sector, which has higher productivity but is subject to taxation, and the informal sector, which has lower productivity but can possibly avoid taxes. Second, the agent must decide how to allocate output between consumption and capital accumulation, given that higher capital in future years will increase productivity in the formal sector, and thus generate higher future consumption.

The model also captures the two-way causality between changes in the size of the informal sector and economic growth.¹¹ As a country grows, capital accumulates and makes the agent more productive in the formal sector. Hence, as a country evolves toward steady state, we expect a natural shift of employment from the informal to the formal sector. Additionally, a decline in informal employment means workers move to the formal sector. This shift increases total output in the economy.¹²

Unlike previous dynamic models of informal employment, we simplify the analysis by excluding issues associated with the existence of informal employment such as lack of access to public goods (Loayza, 1996) and bureaucratic behavior (Sarte, 1997). Our results indicate that the key activities of the informal sector are explained without the added complications addressed by these other models. Given that our framework is consistent with the dynamics of the informal sector, this model can be used as a building block to address how these other issues affect the transition of informal employment and output.

Before proceeding to the model simulations and policy experiments, we discuss the parameterization of the model.

¹¹Economic growth is measured as a change in the sum of formal output plus informal output.

¹²The increase in output occurs because results total output is the sum of formal and informal output, and the marginal product of t_f is greater than the marginal product of t_i so long as $p < 1.0$.

4 Data and Parameter Values

We calibrate the model to match the observations on the percent of the workforce employed in the informal sector, t_i/T , the capital stock, k , and real GDP per worker, $y = \theta_f k^\alpha t_f^{1-\alpha} + \theta_i t_i^\gamma$, in the United States for 1975. Real GDP per worker and the capital stock are taken from the Penn World Tables (Summers and Heston, 1991).¹³ As outlined in Section 2, we use the ILO’s measure of employers, own-workers, and unpaid family workers as a percent of the total economically active population as a measure of informal employment.

The capital share parameter, α , the discount rate, β , and the capital depreciation rate, δ , are set to literature standards of 0.33, 0.96, and 0.08, respectively (see, e.g., Prescott and Parente (1992)). We normalize the total amount of time, T , to 100. The time use parameters, therefore, can be interpreted as the percent of total time devoted to production in the formal, t_f , and informal, t_i , sectors.

Tax policy parameters are set such that the tax rate, τ , is set to 0.46 and enforcement is set to zero, $p = 0$. The tax rate of 0.46 is based on Ernst and Whinney’s “Foreign and U.S. Corporate Income and Withholding Tax Rates.” We choose the highest domestic, public, undistributed profit, corporate tax rate reported in 1976 for the United States. Setting a value of enforcement is the most challenging of all parameters since there are no measures of enforcement.¹⁴ Since we will show the results are not sensitive to small changes in the value of enforcement, we set $p = 0$ in the initial simulation and consider sensitivity analysis of this tax policy in Section 6.

We use the first order conditions of the model and the definition of output to match factor productivities, θ_f and θ_i , and the labor share of output in the informal sector, γ , to the observed values of capital, output and the size of the informal sector. The parameter values

¹³Real GDP per worker as reported in the Penn World Tables includes the output of the economically active population, thus it includes estimates of informal output.

¹⁴Some proxies for enforcement include seignorage and the amount of resources devoted to tax collection, but the values of these variables do not indicate a value for p .

Table 1: Parameter Values

Parameter	Value
α	0.33
T	100.00
θ_f	3.39
θ_i	49.99
γ	0.58
τ	0.46
δ	0.08
β	0.96

are listed in Table 1.¹⁵ First notice that the calibrated value of $\gamma = .58$ is close to the value of 0.6 that Lucas (1990) uses for labor share. Second, notice that θ_2 is significantly larger than θ_1 . We interpret this large value of θ_2 to incorporate total factor productivity and sector specific capital used in informal production. Assuming the same total factor productivity in the formal and informal sectors, this parameterization implies the fixed stock of capital in the informal sector is only 2.3 percent of the formal capital stock for the U.S. in 1975.

5 Simulations

The simulations demonstrate how the economy evolves over time from an initially low level of capital to its steady state value, with a focus on the evolution of total output and informal employment as the capital stock in the country rises. We also present the model's predictions

¹⁵In the calibration and simulations we annualize labor hours since capital and output are annual numbers ($T=100*52$). However, we always report t_i and t_f in units so that $T=100$ and we can easily interpret t_i and t_f as percentages.

for total output versus informal employment and total output versus informal output (the first two stylized facts highlighted in Section 2). Results show the model matches the trend movement in cross-sectional and time series informal employment and informal output data.

Figure 2a shows how total output grows as capital increases towards steady state. This movement in total output is attributed to capital accumulation. As capital accumulates, time spent in the formal sector becomes more productive, thus encouraging workers to move from the informal to the formal sector. For low levels of capital, the growth rate of output is large. As the economy moves towards steady state, the growth rate declines. This transition depicts conditional convergence, i.e., the economy grows faster the further it is from its steady state. The steady state, of course, depends on the specific tax policies set by the government.

Figure 2b illustrates how informal employment evolves towards steady state. Since formal hours is the difference between total hours and informal hours, $T - t_i$, we implicitly know the level of formal employment over the transition. Figure 2b shows the percent of hours worked in the informal sector falls (and therefore hours worked in the formal sector rise) as the economy moves towards steady state. Initially the informal and formal sectors are nearly the same size. As the economy nears steady state, however, informal employment becomes a small fraction of total hours. Along the transition the growth rate in the formal and informal sectors steadily slows as the economy comes closer to steady state: 5.01 percent of working hours are spent in the informal sector in steady state. The transition highlights two key findings: (1) the size of the informal sector naturally declines as the economy grows (even with no changes in government policies), and (2) the informal sector is a functioning part of steady state.

In Section 2 we discussed two ways of measuring the presence of the informal sector in an economy, by determining either the percent of the workforce employed in the informal sector or the percent of total output produced in the informal sector. Figures 2c and 2d relate the model to the stylized facts presented in Section 2. Figure 2c, which generates the

negative and convex relationship we saw in Figure 1, illustrates that when real GDP per worker is relatively low, informal employment is high, and vice versa. So for countries like Korea, where the standard of living is relatively low, the percent of hours devoted to the informal sector is above 30 percent. For countries like Canada, where the standard of living is quite high, the percent of hours devoted to informal employment is less than 10 percent.

Figure 2d accounts for the relationship between country size (measured in terms of real GDP per worker) and the ratio of informal output to total output. Relatively higher levels of informal output as a fraction of total output are linked with relatively small levels of real GDP per worker. As the economy grows, informal output as a fraction of total output falls. For countries like Korea where real GDP per worker is relatively low, our model suggests informal output is a large fraction of total output, over 30 percent. In countries with high levels of real GDP per worker, like Canada, informal output represents less than 5 percent of total output.

Comparing the calibrated model's prediction of real GDP per worker and percent informal with time-series and cross-sectional data we find the model generates results that are consistent with the trends. Figure 3a illustrates that the model does a reasonable job at matching the time-series data for the United States that we saw in Figure 1a. The individual points are the actual data for the United States while the line is the model's simulation. The calibrated line and actual data match for 1975 since this is the year of calibration. Other years lie slightly above or below the calibration line.

Figures 3b and 3c plot cross-sectional data for a variety of countries for 1985 and 1990, respectively. The countries chosen are based on availability of informal employment data. We see the model matches the cross-sectional data reasonably well. As with the time series, we do not find an exact match between the data and model. This is easily explained since the actual tax rates and enforcement policies vary both across time and across countries. The point to take from these figures is that the model's predicted transitions are consistent with the data.

We can use these results to evaluate competing views of policy makers regarding the benefits of an informal sector. Several decades ago, the prevalent view was to rid an economy of the informal sector. Now the predominant view is that the informal sector plays a positive role in the provision of jobs. Those who believe the informal sector should be abolished must consider the impact on the entire economy. Our results highlight that the informal sector can represent a significant portion of employment and total output in an economy. Those who say we should abolish the informal sector, therefore, must not only consider what happens to the economy's employment but also output.

6 Policy Experiments

Section 6 analyzes the dynamics and steady state effects of tax policy. We begin in Section 6.1 by illustrating how changes in tax rates and in enforcement separately alter the convergence rate, length of time to steady state and the steady state levels of output, employment and capital. Section 6.2 captures the cost of having an informal sector. We analyze the effect on steady state informal employment and output of various tax rates and enforcement policies. We also measure the distortion arising from having an informal sector in terms of the lifetime loss in an economy's capital stock. These results provide intuition regarding the extent to which governments and international organizations can influence the size of the informal sector, and hence capital and output, when setting tax and enforcement policies.

6.1 Transitional Dynamics

Empirical evidence suggests both tax rates and the administration of the tax laws are critical factors in the determination of the size of the informal sector.¹⁶ These studies, however, do not address the effect of these tax policies on the transitional dynamics of the economy. Here

¹⁶As mentioned above, both Ihrig and Moe (1999) and Johnson et al. (1998) find empirical evidence that both the tax rate and enforcement affect the size of the informal sector.

we start with the effect of the tax rate.¹⁷ Figures 4a-4d depict the transition of the economy from an initial level of capital, at period 1, to its steady state for various tax rates. The solid line depicts the calibrated model ($\tau = 0.46$) and the other two lines are for a tax rate higher and lower than our calibrated level. Specifically, the low tax rate is 95 percent of 0.46; and the high tax rate is 105 percent of 0.46.

Figures 4a-4c plot the transition of the capital stock, total output and informal employment for each of our three experiments, respectively. The figures can be interpreted as follows. Assume each economy starts with the same initial stock of capital, k_1 , but different tax rates. Figures 4a-4c depict the movement in our model's variables over time. At k_1 , the convergence rate of capital (and hence output and informal employment) is higher the lower the tax rate. The tax rate, however, also affects the steady state levels of capital, total output and informal employment. Hence the length of time until the economy reaches steady state depends on both the rate of growth and the steady state level. For our experiment, the length of time to steady state is the shortest for the high tax rate. The high tax rate hits steady state before the calibrated model since its steady state level of capital is much lower than in the calibrated model, even though at k_1 the speed of convergence is slower.

As seen in 4a-4b, lowering the tax rate increases both the steady state level and the speed of convergence to steady state for the capital and total output, respectively. Figure 4c shows that lowering the tax rate decreases the steady state level and increases the speed of convergence to the size of the informal sector's steady state. These results suggest that a country considering a decrease in its tax rate must realize that the decline to the informal sector's steady state may take time.

Figure 4d depicts the relationship between the percent of time spent in the informal sector and the total output in the economy. Again, we see that lower taxes are associated

¹⁷We do not investigate optimal taxation in this context. Since the tax revenues are used to produce non-productive services, our model implies the social planner set $\tau = 0$. Loayza (1996) develops a rule for optimal taxation in a general equilibrium model with public services financed by tax revenue.

with smaller informal sectors and higher output. For each tax rate, we get the negative and convex relationship we saw in Figure 1. Hence for cross-country data (with different tax rates) or for a given country over time (with different tax policies), we expect to see actual data to fall in the range of these curves but not lie on one specific curve.

Since lower taxes encourage less time in the informal sector, it is not surprising that in Figure 4e lower taxes are associated with a lower percent of output produced in the informal sector. In steady state, the higher tax rate increases the fraction of informal output by 12.3 percent; whereas, the lower tax rate decreases the fraction of informal output by 10.4 percent. Of course, this is only a minor change in terms of percentage points. As stated above, the length of time until the economy hits the steady state, however, depends on the explicit tax rate.

this

Until this point we have assumed time devoted to the informal sector is never detected by the authorities. Now consider how the economy is affected by enforcement of the tax policy. Enforcement can be thought of in one of two ways. First the authorities can change the level of policing of this sector, which changes the chances of an agent being caught. Second, the authorities can change the penalty associated with being caught in the informal sector, by imposing a tax (as a percent of output), in addition to the formal tax of τ , on agents that are caught. Both of these types of enforcement are captured in the value of p . We let p vary between 0.0 (our calibrated value), 0.01, and 0.1. If we think of the tax policy as being one where the agent only pays taxes at the rate faced by formal agents when caught, then $p = 0.01$ implies 1 out of 100 agents working in the informal sector is caught. If we believe a percent of output is taxed away when caught, then $p = 0.01$ should be interpreted to mean that the odds that an informal agent is detected by the government are less than 1 in 100, but when the agents are caught, the government imposes a penalty tax.

Figure 5 is similar to Figure 4 but considers different levels of enforcement instead of tax rates. Figures 5a-5e demonstrate that there is hardly any difference between the calibrated

lines and the ones where $p = 0.01$. This suggests that in order for enforcement to have a measurable impact on our economic variables, we need a relatively large increase in the value of p . That is, assuming no tax penalty, a large change in policing, from no policing ($p = 0.0$) to one where 1 in 100 agents is caught ($p = 0.01$), we see infinitesimal effects on the economy. Alternately, we can interpret this as, for a given level of policing, small changes in value of the tax penalty do not induce large changes in the size of the informal sector.

Larger changes in enforcement, such as $p = 0.1$, affect the economy. From Figures 5a-5b we see higher enforcement increases the rate of convergence and steady state level of capital and total output. Figure 5c shows that increasing enforcement decreases the steady state level and increases the speed of convergence to the size of the informal sector's steady state. These results suggest that a country considering raising enforcement should focus on tax penalties and realize that the decline to the informal sector's steady state will take time.

6.2 Costs of Informality

To quantify the effect of tax policies, individually or jointly, on the economy we compare the steady state values of the size of the informal sector and total output under various tax policies. Table 2 presents the percent deviations of the steady state level of these variables from the calibrated model for alternative tax policies. Specifically, we let p range from 0 to 0.5 and τ range from 0.1 to 0.6. Each cell of the table reports how much the steady state level of the size of the informal sector or output deviates from the calibrated model. By looking down a column we hold enforcement fixed and vary the tax rate. By looking across a row we hold the tax rate constant and vary enforcement.

Focusing on the steady state size of the informal sector, we see that, for a given tax rate, as enforcement rises the size of the informal sector falls. For example, given $\tau = 0.46$, going from $p = 0$ to $p = 0.1$ the steady state size of the informal sector falls 10.53 percent. The fall in informal employment is expected since a rise in enforcement increases the expected

tax rate an informal agent faces. Obviously, the effect of changing the value of p , however, is more pronounced the larger the tax rate, since the effect on the informal sector encompasses $p * \tau$. For a given level of enforcement, a decline in the tax rate causes informal employment to decline because a decrease in the tax rate makes working in the formal sector less costly. When there is no enforcement, moving from a tax rate of 0.46 to 0.4, the steady state informal sector shrinks in size by over 31 percent. These results suggest that changing the tax penalty, over the administration of the law, has a larger impact on informal employment.

Next consider the effect of these tax policies on steady state real GDP per worker. An increase in enforcement causes steady state total output to rise. This is as expected, since the rise in enforcement increases the expected tax on informal output. The effect, however, is not very large. On the other hand, a decrease in the tax rate, for a given level of enforcement, has a large effect, causing steady state total output to rise. Even though the tax rate decreases the expected taxes of informal employment, the fall in the tax rate increases output in the formal sector. The effect of the decrease in the tax rate on formal sector output dominates the decrease in informal output. This indicates the tax rate, not enforcement policy, plays a key role on an economy's standard of living.

These results imply a country can increase its standard of living by reducing its tax rate. Governments, however, must balance increasing output with the provision of public goods. Although this issue is not addressed in the paper, we can consider keeping tax revenue as a percent of GDP constant to allow the government to produce a given level of public good. Then, any decrease in the tax rate must be offset by an increase in enforcement. Since the positive effect on real GDP per worker of lowering the tax rate dominates the negative effect of increasing enforcement, the overall effect on output is positive. This analysis suggests a joint policy of decreasing tax rates and increasing enforcement. Therefore, when the World Bank sends mobile tax units to countries for tax collection, it should also encourage governments to lower tax rates to have a significant increase in the standard of living.

World

Finally, we measure the welfare loss associated with an informal sector. While taxes cause a distortion in the formal sector, the informal sector drives a wedge between the returns to labor across sectors and, hence creates an inefficiency. We are interested in how much of the economy's total loss in welfare is attributed to the informal sector. A large proportion would support the view to decrease the size of the informal sector, while a relatively small proportion would give credence to the argument that the informal sector should remain a viable part of an economy.

To measure the welfare loss, we calculate the difference in the capital stock per worker between a model with no taxation and no informal sector and (a) our model and (b) a model with no informal sector but taxes on formal output.¹⁸ The measure of welfare loss between our model and one without taxation and an informal sector (option a) provides a measure of the total loss in the capital stock. To determine the amount of the loss that is attributed to the informal sector, we subtract off the distortion from taxing the formal sector (option b).

For the calibrated model (a tax rate of 46 percent), the tax distortion on the formal sector creates a welfare loss equivalent to 84 percent of the U.S.'s 1992 capital stock per worker; while incorporating the informal sector raises the welfare loss to 86 percent of the U.S.'s 1992 capital stock per worker. So the informal sector raises the welfare loss by 2 percentage points above the welfare loss from taxing the formal sector. This suggests there are relatively small efficiency losses from allowing an informal sector to operate.

As suggested from our steady state analysis, changes in the tax rate have large effects on output and, hence, the capital stock and our welfare numbers. Enforcement, alternatively, plays a minor role in its effect on output and, therefore, the level of the capital stock and the measure of welfare loss. No matter what tax policy we consider, the distortion from the

¹⁸Mathematically, (a) is determined as $\sum_{t=0}^{\infty} \beta [k_p^{\tau}(t) - k^*(t)]$ where $k_p^{\tau}(t)$ is the capital stock of an economy with a tax policy of (τ, p) at date t and $k^*(t)$ is the capital stock of an economy with no taxes or informal sector at date t.

informal sector is much smaller than the distortion from a tax rate on the formal sector.¹⁹ This finding supports those who want to keep the informal sector as a functioning part of an economy.

7 Conclusion

In this paper we examine the dynamics of informal employment by addressing how the informal sector's employment and output transition towards steady state and how government taxation policies affect the transition and steady state. We develop a dynamic model that is consistent with the stylized facts associated with the informal sector and that captures the two-way causality between real GDP per worker and the size of the informal sector.

By calibrating the model to the United States, we show the model predicts movements in informal employment, output (both total and informal), and capital as seen in the data. Informal employment is found to be a large fraction of total employment for countries with relatively low standards of livings. The size of the informal sector falls as countries converge towards the steady state, but at a decreasing rate. In steady state, therefore, we find the United States should have an informal economy that is 5 percent of total employment and produce 3 percent of GDP.

Policy experiments indicate that reductions in the tax rate or increases in enforcement (1) increase the level of total output while decreasing the size of the informal sector (employment and output) in the steady state and (2) change the speed of convergence and length of time to steady state. Although both tax rate and enforcement policy can change the size of the informal sector, we suggest decreasing the tax rate to reduce informal employment since it has a stronger impact on raising real GDP per worker. However, whether one wants to alter the size of the informal sector is questionable. We find a minimal loss in an economy's lifetime capital stock due to the existence of an informal sector.

¹⁹Authors' calculations are available upon request.

References

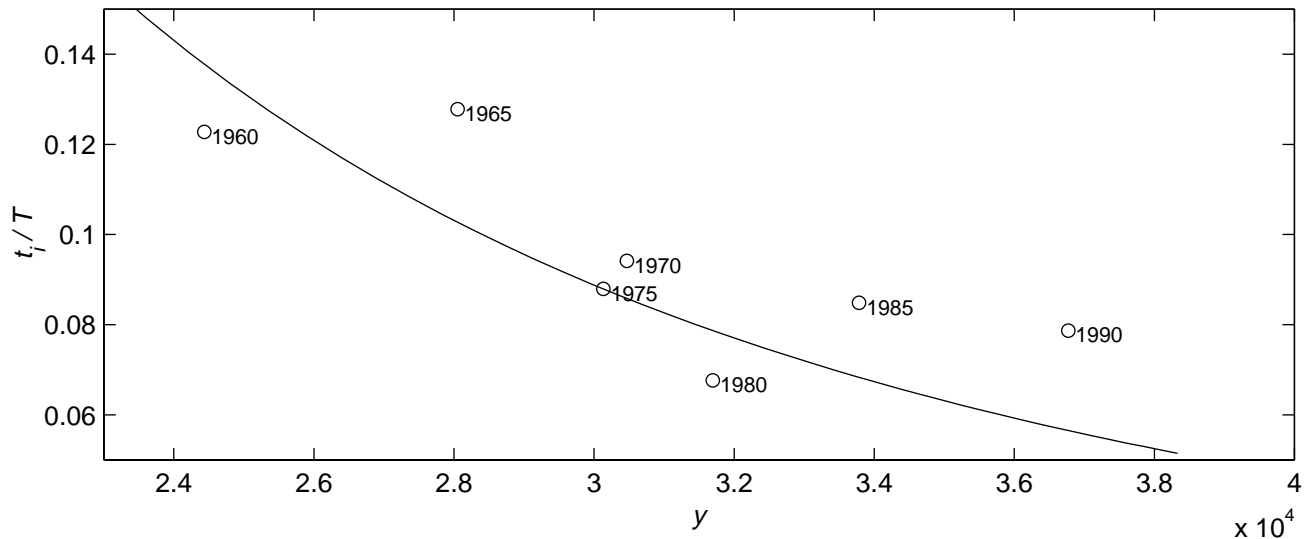
- Celestin, Jean-Bernard *Urban Informal Sector Information: Needs and Methods*. Geneva: International Labour Office, 1989.
- Chickering, A. Lawrence and Salahdine, Mohamed. "Introduction," in A. Lawrence Chickering and Mohamed Saladine, eds., *The Silent Revolution*. San Francisco: International Center for Economic Growth, 1991.
- DeSoto, Hernando. *The Other Path: The Invisible Revolution in the Third World*. New York: Harper & Row, 1989.
- The Economist, "Light on the shadows", May 3, 1997, p.63.
- The Economist, "Black Hole," August 28, 1999, p.99.
- Gollin, Doug. "Nobody's Business but My Own: Self Employment and Small Enterprise in Economic Development." mimeo, October 1997.
- Ihrig, Jane and Moe, Karine. "Government Policies and Informal Employment." mimeo, March, 1999.
- Ihrig, Jane and Moe, Karine. "The influence of Government Policies on Informal Labor: Implications for Long Run Growth." De Economist, forthcoming.
- International Labour Organization. *Yearbook of Labour Statistics*, various years.
- Johnson, Simon, Kaufmann, Daniel, and Zoido-Lobaton. "Regulatory Discretion and the Unofficial Economy." *American Economic Review*, May 1998, 88(2), pp.387-392.
- Jones, Charles I. "Sources of U.S. Economic Growth in a World of Ideas." mimeo, July, 1998.
- Lall, Vinay D. *Informal Sector in the National Capital Region*. B.R. Publishing Corporation: Delhi, 1989.
- Loayza, Norman. "Labor Regulations and the Informal Economy." mimeo, November 1994
- Loayza, Norman. "The Economics of the Informal Sector: A Simple Model and Some Empirical Evidence from Latin America." *Carnegie-Rochester Conference Series on Public Policy*, Dec 1996, 45(0), pp. 129-62.
- Lucas, Robert E., Jr. "Why Doesn't Capital Flow from Rich to Poor Countries?" *American Economic Review*, May 1990, 80(2), pp. 92-96.
- Parente, Stephen L. and Prescott, Edward C. "Technology Adoption and the Mechanics of Economic Development," in Alex Cukierman; Zvi Hercowitz, and Leonardo Leiderman, eds., *Political Economy, Growth, and Business Cycles*. Cambridge: MIT Press, 1992, pp. 197-224.
- Rauch, James E. "Modelling the informal sector formally" *Journal of Development Economics*, 1991, 35, pp. 33-47.
- Sarte, Pierre-Daniel. "Informality and the Nature of Bureaucracies in a Model of Long-Run Growth." mimeo, May 1997.

Schneider, Friedrich and Enste, Dominik. "Increasing Shadow Economies All Over the World - Fiction or Reality? A Survey of the Global Evidence of its Size and of its Impact from 1970 to 1995." mimeo, Oct 1998.

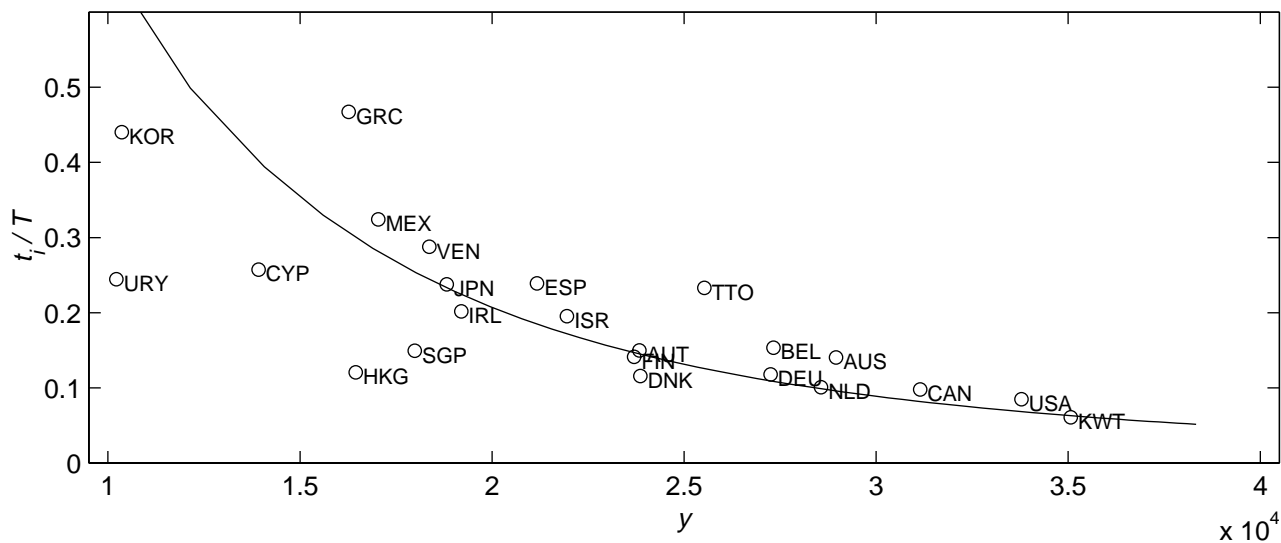
Summers, Robert and Heston, Alan. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988." *Quarterly Journal Of Economics*, May 1991, 106(9), pp.327-68.

Thomas, J.J. *Informal Economic Activity*. Ann Arbor: University of Michigan Press, 1992.

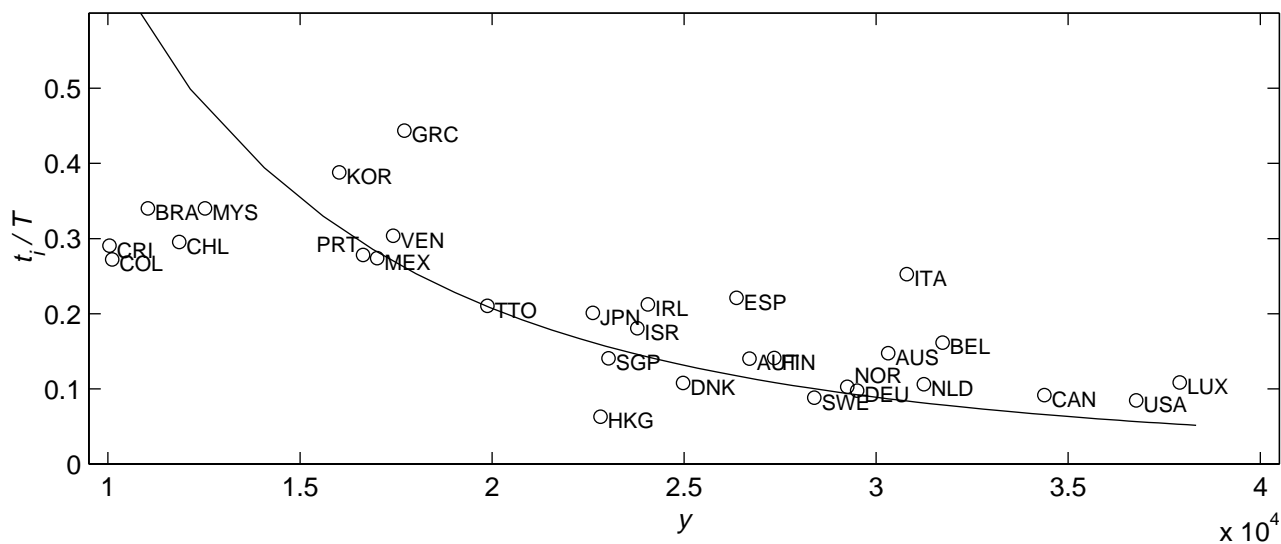
(a) USA timeseries, 1960–90

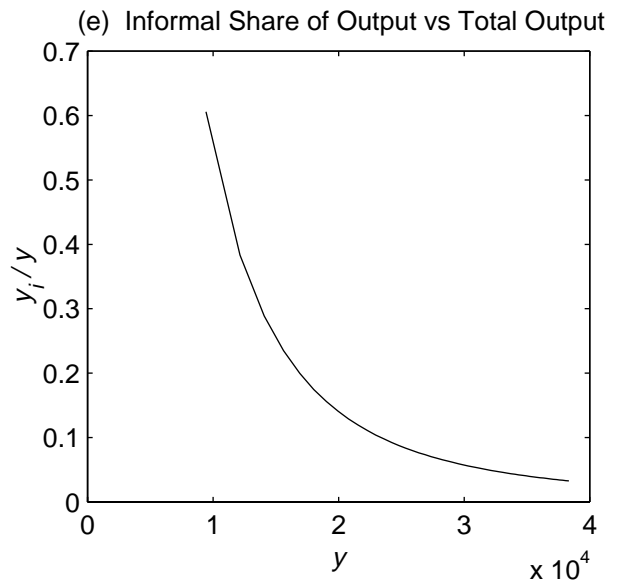
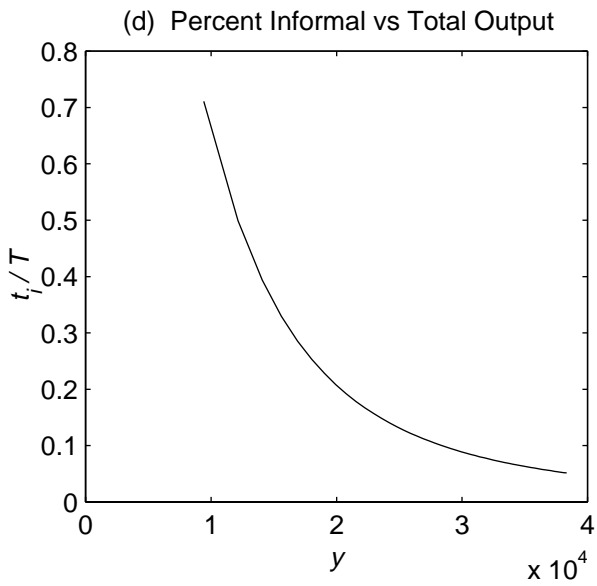
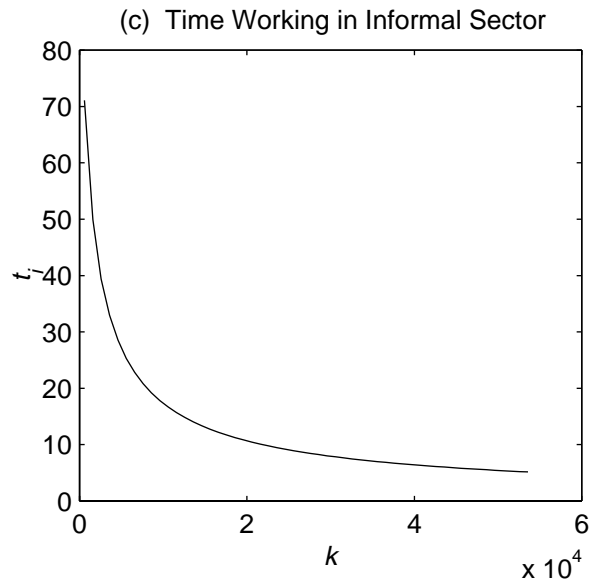
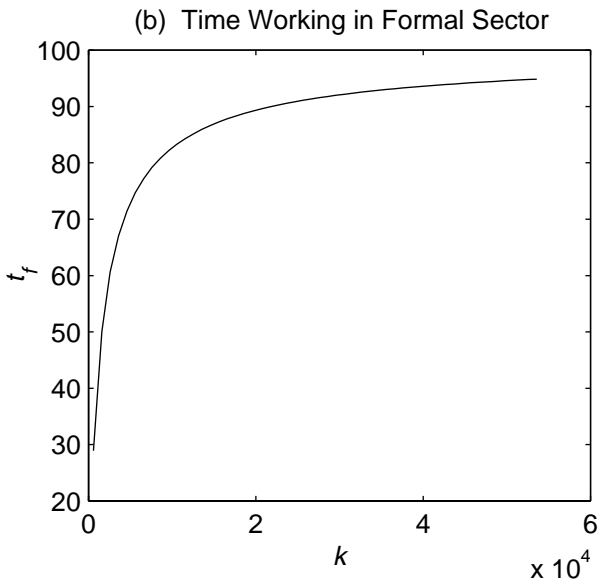
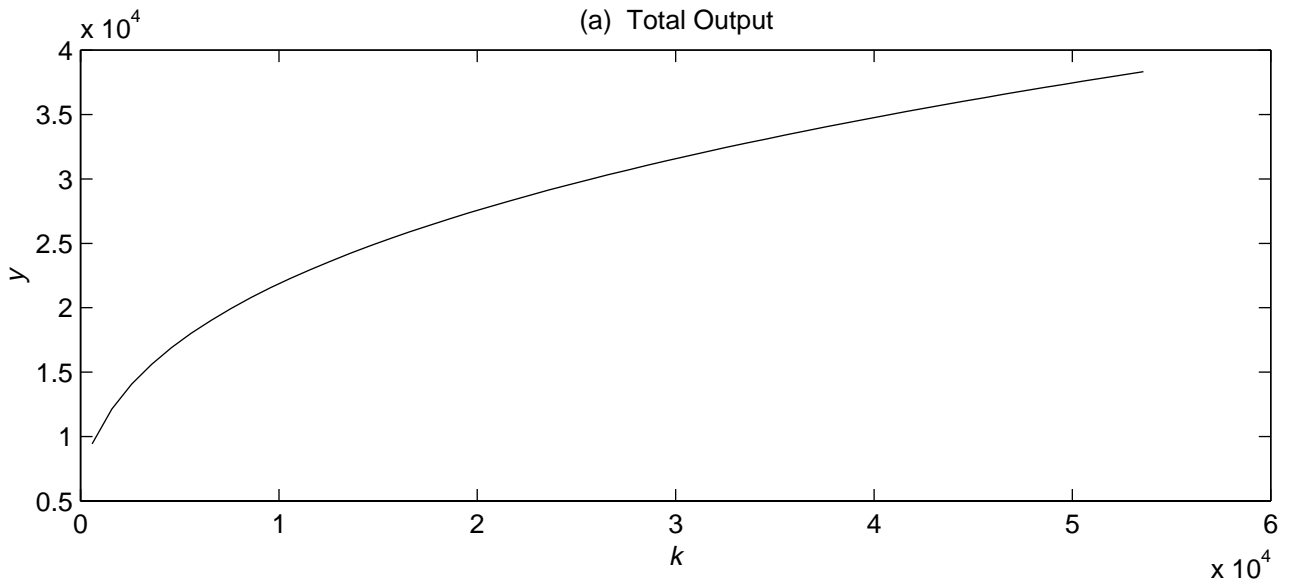


(b) Cross country comparison, 1985

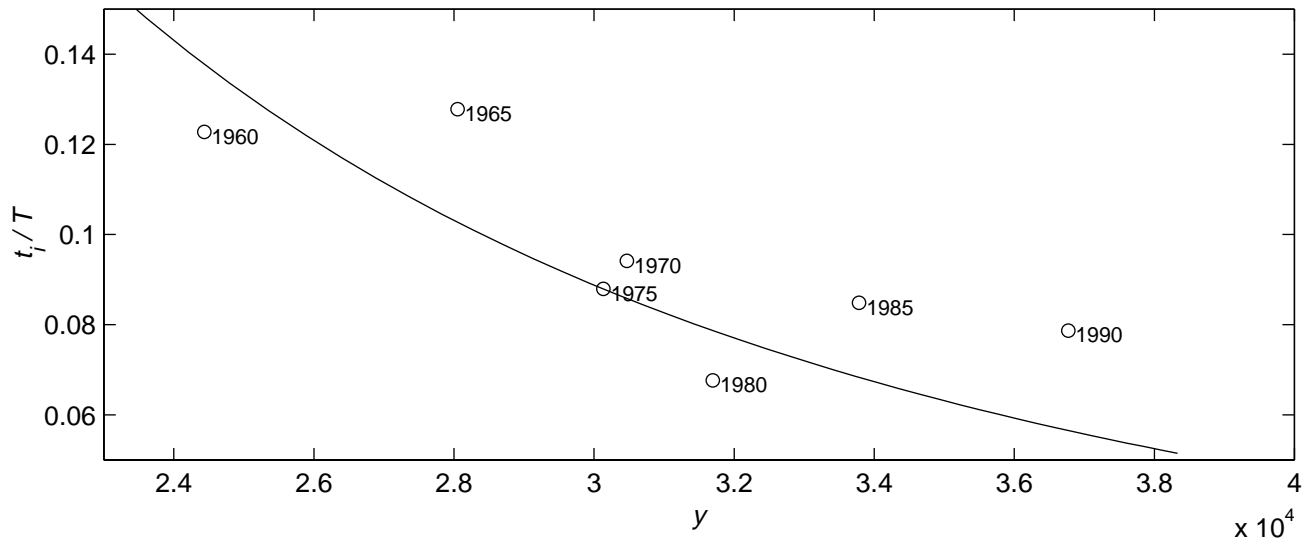


(c) Cross country comparison, 1990

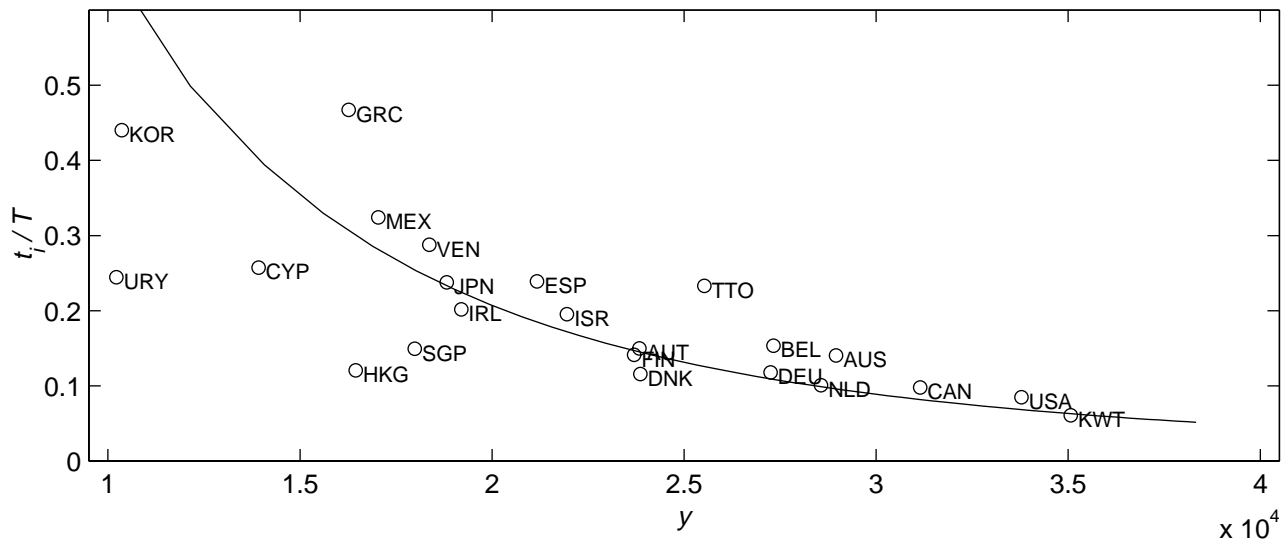




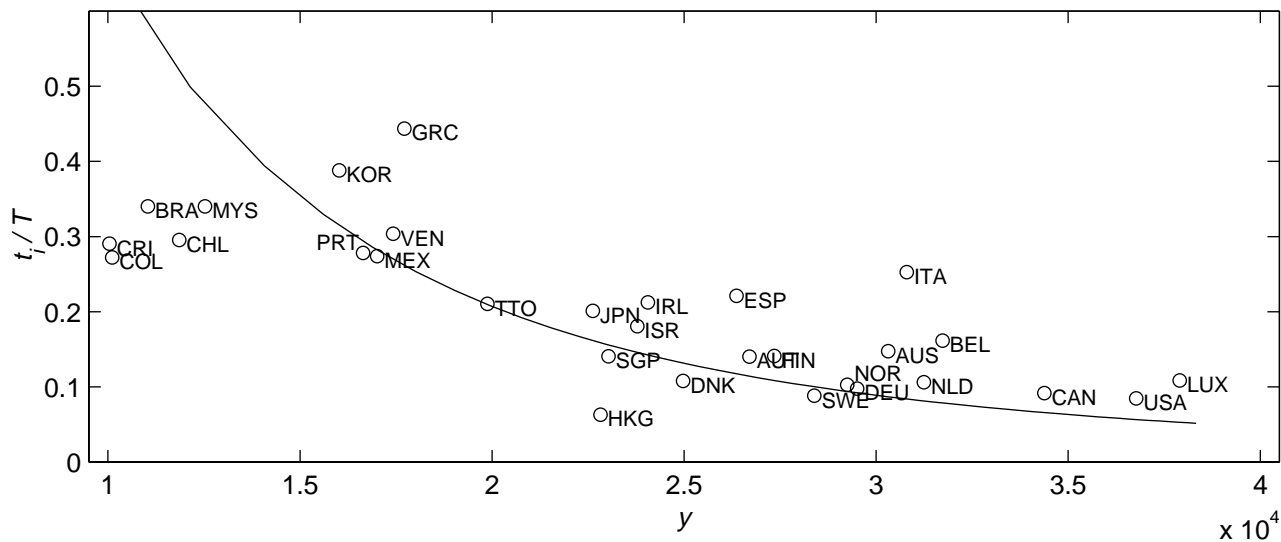
(a) USA timeseries, 1960–90

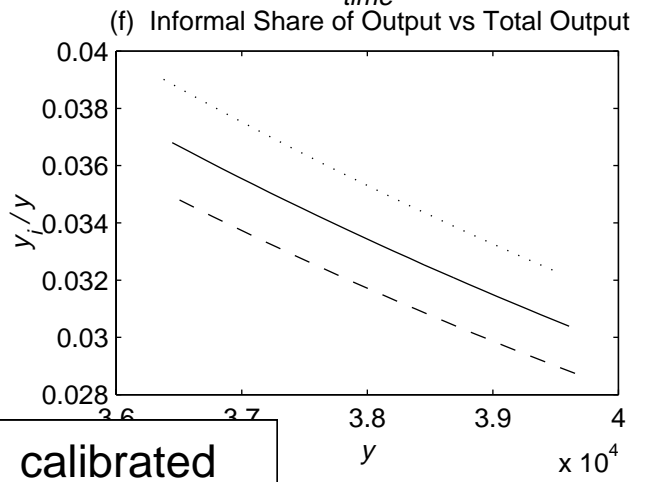
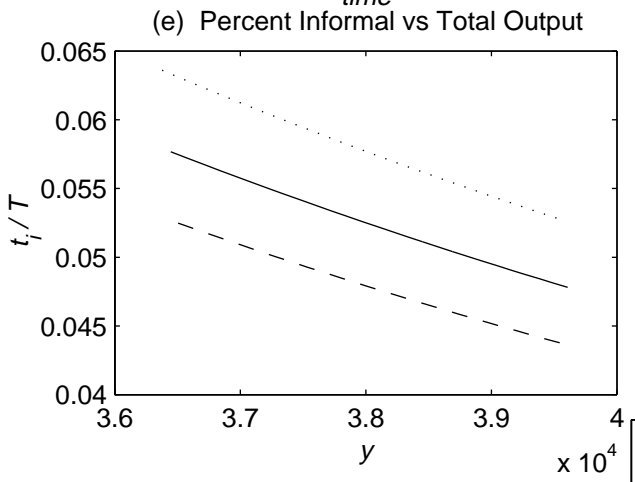
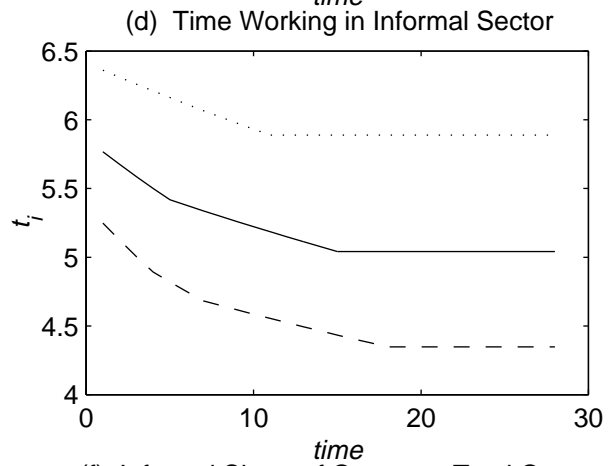
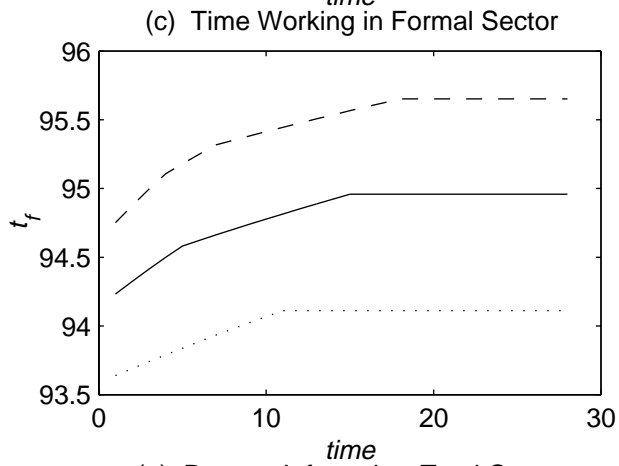
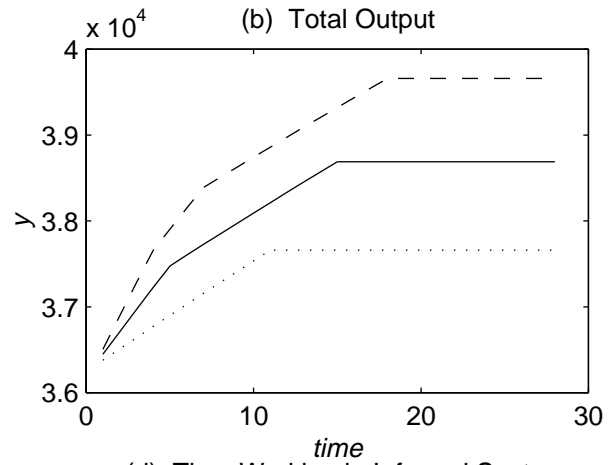
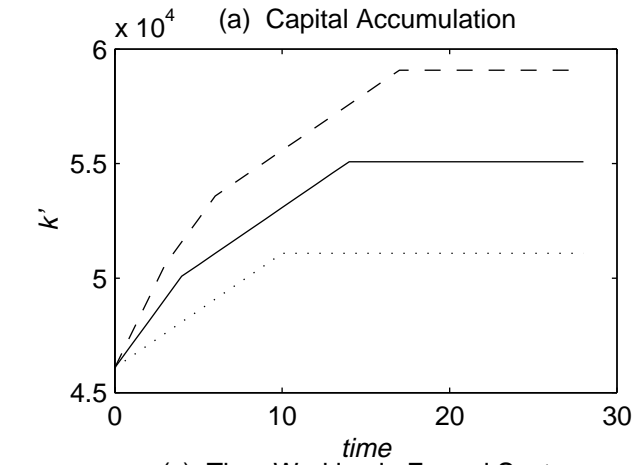


(b) Cross country comparison, 1985

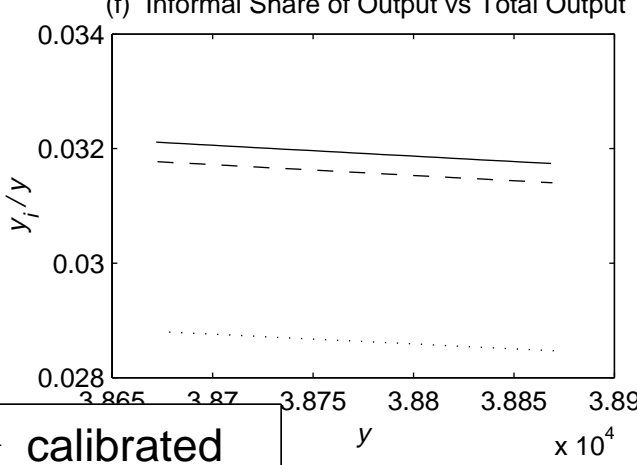
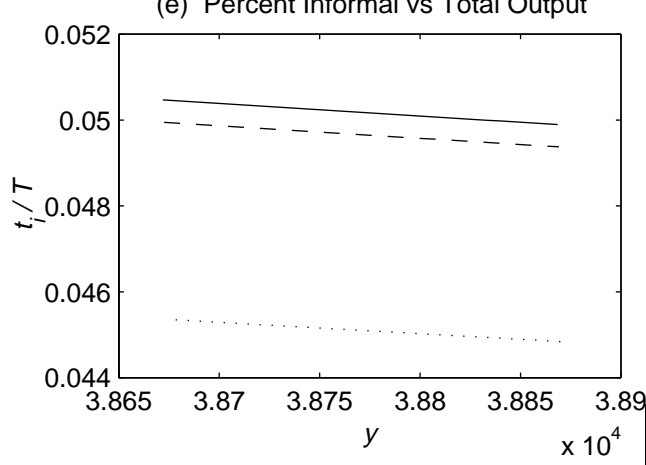
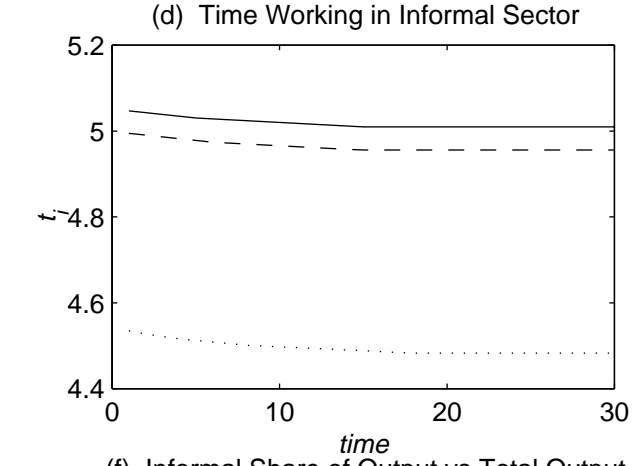
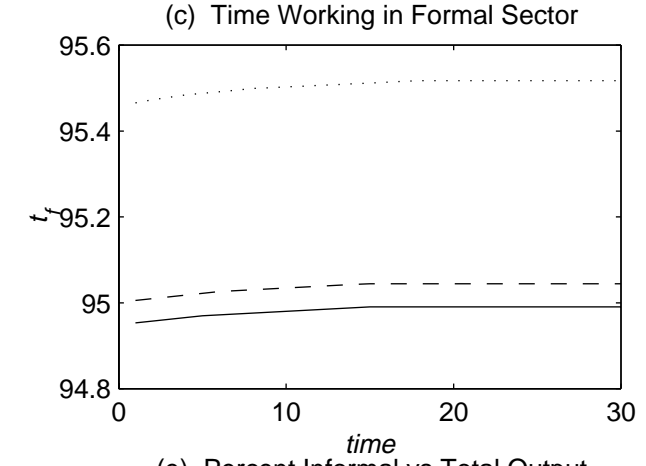
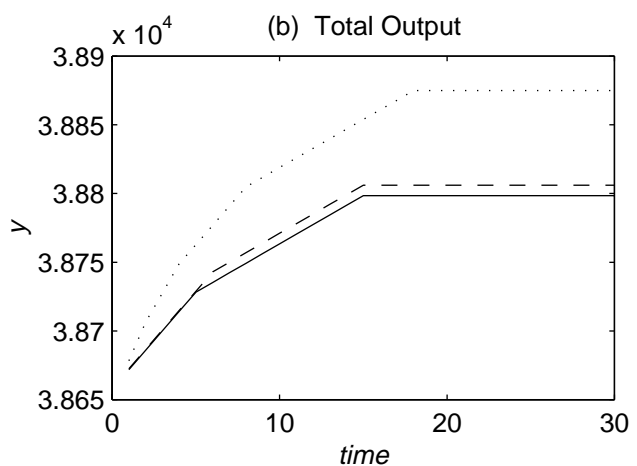
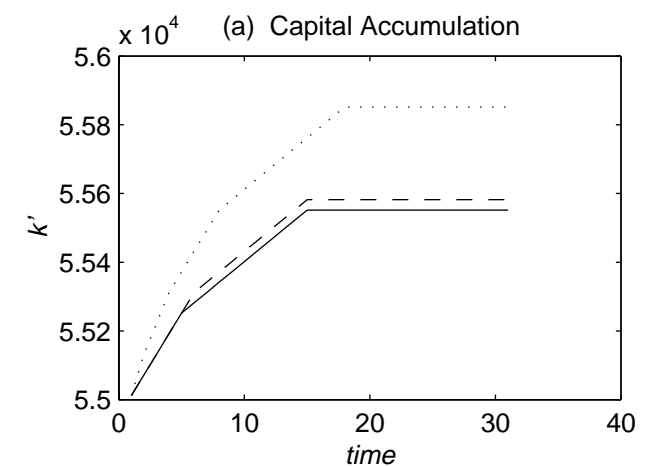


(c) Cross country comparison, 1990





— calibrated
 - - - tau=low
 ···· tau=high



— calibrated
 - - p=0.01
 ··· p=0.1

Table 2

**PERCENT DEVIATION
FROM CALIBRATED STEADY STATE**

% Informal

$\tau \backslash p$	0	0.1	0.2	0.3	0.4	0.5
0.1	-83.64%	-84.02%	-84.40%	-84.77%	-85.14%	-85.51%
0.2	-75.16%	-76.32%	-77.45%	-78.54%	-79.60%	-80.64%
0.3	-60.13%	-62.90%	-65.56%	-68.10%	-70.53%	-72.84%
0.4	-31.16%	-37.49%	-43.47%	-49.10%	-54.40%	-59.37%
0.46	0.00%	-10.53%	-20.39%	-29.59%	-38.15%	-46.07%
0.5	31.35%	16.36%	2.41%	-10.53%	-22.47%	-33.43%
0.6	189.65%	150.26%	114.15%	81.24%	51.46%	24.71%

Real GDP per Worker

$\tau \backslash p$	0	0.1	0.2	0.3	0.4	0.5
0.1	31.62%	31.62%	31.62%	31.62%	31.61%	31.61%
0.2	23.93%	23.94%	23.95%	23.95%	23.96%	23.96%
0.3	15.60%	15.63%	15.66%	15.68%	15.71%	15.74%
0.4	6.30%	6.40%	6.50%	6.59%	6.68%	6.76%
0.46	0.00%	0.20%	0.39%	0.57%	0.73%	0.88%
0.5	-4.65%	-4.34%	-4.05%	-3.78%	-3.54%	-3.31%
0.6	-19.12%	-18.19%	-17.34%	-16.56%	-15.86%	-15.23%

Note: The steady state calibrated values of % informal=5.01% and RGDPW=38805