On Governments, Markets and Public Finance

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I dedicate this thesis to Emma-Jil and Sebastian.

Washington, October 2011 *Christina Elisabeth Kolerus*

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Chapter 1

Introduction

This dissertation analyzes the interaction between governments and markets when governments have the intention to either spend or raise public funds. It is an elaboration on the role of the State albeit not in a political but economic dimension using analytical tools of economic theory. The dissertation covers two aspects of public finance: the effect of government spending and the design of revenue generation mechanisms. First, in a joint study with António Afonso and Hans Peter Grüner we inquire whether the impact of government spending on GDP differs during financial crises and normal times. Second, we ask what is the optimal way for governments to raise revenue from returns to capital: controlling investments or providing incentives. And third, we consider how revenue generation is affected by skill heterogeneity across entrepreneurs.

From a practical perspective, the objective of these three chapters is to contribute to a better understanding of government intervention into the economy for instance when drafting fiscal stimulus packages or when considering how to collect revenues from resource extracting companies. From a theoretical perspective, the studies examine situations in which self-regulation of markets can fail and what the government's potential is to improve upon via budgetary operations.

The economics discipline departs from the strong belief in the power of markets with the two famous welfare theorems being valid working hypotheses. It is also well known that the underlying assumptions fail to hold in many aspects of economic activity. Most prominently, this is the case when information is imperfect, i.e. when there is private information on some variables or uncertainty over future outcomes. Although information asymmetries became a popular field of study much later, Keynes challenging the view on the self-regulation power of markets formulated an interesting idea on information imperfection. He made a key distinction between risk and uncertainty: risk is when probabilities can be measured and uncertainty exists when they cannot be measured i.e. when the future is unknowable (see Skidelsky (2011)) calling for governmental support for the economy. This dissertation tests Keynesian uncertainty when looking at government spending and picks up his notion of risk when looking at revenue generation. In particular, it inquires the role of the state and government action - spending and raising revenue - in such environment.

The dissertation was written during the great recession triggered by the 2008 financial crisis and the ensuing debt crisis. With governments contemplating on the size of their stimuli an essential research question for the economics discipline was to know to what extent government spending can indeed contribute to mitigate an economic downturn in the short run. The literature on fiscal multipliers is very extensive - as tentatively summarized in Section 2.2 - and our contribution to this field is threefold. First, we explicitly challenge the Keynesian theory and test whether government spending has a larger impact during times of financial turmoil, when crowding out of private consumption is less likely and uncertainty is larger, than during normal times. Second we use panel analysis for a set of OECD and non-OECD countries for the period 1981-2007 while most of the previous studies have referred to single country analyses or advanced countries only. And third, we instrument spending growth by a combination of variables covering the political budget cycle and budgetary room for manoeuvre.

Our results point towards relatively low multipliers and no strengthening of a Keynesian effect from government spending during financial crises. The fiscal multiplier for the full sample for instrumented regular and crisis spending is about 0.6 considering the sample average government spending share of GDP of about one third. Altogether, we cannot reject the hypothesis that crisis spending and regular spending have the same impact using a variation of controls, sub-samples and specifications.

While Chapter 2 examines the effect of spending State money, Chapters 3 and 4 analyze the impact of government policies when raising money, in other words when taxing individual returns. As learned in particular from the recent crisis, spending money is less controversial than raising it. Why the government needs to raise money at all is already subject to ideological views. But even when considering a night watchman state à la Nozick (see, for instance Nozick (1974)), which might be the smallest common denominator across most schools of thought, there is a basic financing need of the government, for instance for the military, police, and legislatures. Taken this as given, revenue collection for these basic needs should still be done in a most efficient way. This is the objective of the second and third chapters of the dissertation in which a revenue generation mechanism is designed for different sizes of basic or not so basic needs.

In Chapter 3, we study the optimal taxation of entrepreneurial returns when capital investment is private information. Facing an external revenue requirement, the government can decide between two options: incentive provision and control of capital investments. On the one hand, the government can design a tax schedule which provides appropriate incentives for entrepreneurs to invest the socially optimal level of their endowments. This implies a welfare loss that stems from the costs of incentive provision. On the other hand, the government has the possibility to control capital input and pay monitoring costs. Comparing the nature of these two cost structures, we find that the government's decision whether to interfere into the control rights of firms depends on three parameters: the external revenue requirement, the entrepreneurs' preferences for insurance and the monitoring costs of capital.

Chapter 4 extends our previous study on revenue generation and takes an additional source of private information into account: the skill level of entrepreneurs. We are thus able to study revenue generation in a more diverse economy. In particular, we are interested to see which group of entrepreneurs is more likely to me controlled.

Chapter 2

Fiscal Policy and Growth: Do Financial Crises make a Difference?[1]

2.1 Introduction

In 2008-2009 the world was hit by what many people now believe is one of the deepest financial crises in modern history. This view relates both to the aggregate volume of non-performing loans (mainly in the housing sector) and to the fact that international financial linkages almost immediately lead to contagion effects around the globe. In the response to these developments, governments around the world initiated huge fiscal stimulus packages. According to the IMF (2009), the US announced the implementation of discretionary fiscal measures of 3.8 percent of GDP in 2009-2010, and the European Union unveiled a European Economic Recovery Plan encompassing a planned two hundred billion Euro fiscal stimulus package. For the OECD, the accumulated budget impact of the stimulus package over 2008-2010 reaches 2.5 percent of GDP[2] (OECD (2009)).

Many economists support these measures, including well known scholars such as Paul Krugman or Joseph Stiglitz. But also economists who were previously opposed to

[1]This chapter is joint work with António Afonso and Hans Peter Grüner

[2]In addition, the headline support for the financial sector is estimated (IMF (2009)), for instance, at 3.7% of GDP in Germany, 6.3% in the US, and 19.8% in the UK.

active stabilization policies seem to be in support of such policies under the current - exceptional - circumstances[3].

These new policy measures contrast with the results of recent empirical research on the potential impact of debt-financed fiscal policy measures (such as spending programs and tax reductions) on economic growth. There is a wide body of literature which carefully studies the size of fiscal multipliers. The common conclusion of this literature is that there are significant effects of fiscal policy on output[4]. Nevertheless, many papers also conclude that the size of these effects is rather small and the estimated multipliers of government spending or tax reduction are below one. Moreover, in many countries the multipliers declined over the 1980s and 1990s. Taking into account that any debt-financed fiscal stimulus package has to be repaid later on (with interest payments) one may have serious doubts in the usefulness of such policy measures.

However, one may argue that times of financial crises are different from normal times. Indeed, there are some good reasons to believe that the economy reacts differently to discretionary fiscal policy in a financial crisis than during normal times. First, there are some theoretical contributions which distinguish between more classical and more Keynesian regimes on output and labor markets (e.g. Malinvaud (1979), Benassy (1986)). A classical situation would be one, where unemployment is generated by excessive real wages while output markets are in equilibrium. A more Keynesian regime is one where unemployment and excess capacities coexist. There are disequilibria both on labor and on output markets. One can argue that in such a situation a fiscal stimulus may become more effective, replacing declining private demand for goods and so stimulating private demand for labor. One could view the public provision of private goods as a replacement for the private provision of these goods. In this case the state would take consumers' decisions in their place and run a higher deficit that later on would have to be repaid in form of taxes by these consumers. Such a policy might have strong crowding-out effects in a situation where capacities are already exhausted, but

[3] In 2008, the German council of economic advisors recently proposed to raise government spending by 1 percent of GDP in order to stimulate the economy, a measure that hardly would have found its support in recent years.

[4] See, for instance, Fatás and Mihov (2001), Blanchard and Perotti (2002), Perotti (2004), de Arcangelis and Lamartina (2003), Galí et al. (2007), Afonso and Claeys (2008), Afonso and Furceri (2010), Afonso and Alegre (2011), and Afonso and Sousa (2009).

this need not be the case when there are excess capacities in the economy.

A second argument in favor of discretionary fiscal policy is that a liquidity trap is associated with financial crises and that "the only policy that still works is fiscal policy" (both Krugman and Stiglitz advocate that). Most importantly, one can argue that financial crisis cut off many consumers and producers from bank lending. During the current crises, the growth rate of lending to the private sector has fallen significantly. This may have two effects on the effectiveness of fiscal policy measures. First, government transfers or tax reductions may result directly in increased consumption of relatively poor, credit constrained consumers. Along these lines Galí et al. (2007) recently calculated larger fiscal policy multipliers when more consumers spend their current income. Second, government purchases directly affect the survival of some firms.

Therefore, it is an interesting question whether the emergence of a systemic financial crisis changes the way in which fiscal policy measures affect the economy. This is the question that we want to address in this empirical research. We assess to what extent in the existence of financial crises, government spending can contribute to reduce observed output losses and to foster economic growth. We employ a panel analysis for a set of OECD and non-OECD countries for the period 1981-2007.

Since causality may run in both directions, from government spending to GDP and from GDP to government spending, we instrument government spending by using a variable that is based on the distance to the next or, respectively, to the last democratic election as an instrument in our analysis. Moreover, we also use the past government budget balance-to-GDP ratio as an additional instrument. We perform each specification and sub-sample with a 1-year and with a 2-year definition of financial crisis, with and without time fixed effects.

Overall, our main result is that we cannot reject the hypothesis that crisis spending and spending in the absence of a financial crisis have the same impact throughout our study using a variation of controls, sub-samples and specifications. The remainder of the chapter is organized as follows. Section two reviews the related literature. Section three briefly presents our empirical methodology. Section four reports and discusses the results of the empirical analysis. Section five concludes the chapter.

2.2 Related Literature

A theoretical model that establishes a relationship between credit constraints and the effects of fiscal policy is Galí et al. (2007). They develop a sticky price model, in which a certain fraction of households always consume their current income. These "rule-of-thumb consumers" coexist with Ricardian consumers. The larger the share of rule-of-thumb (non-Ricardian) consumers the larger is the effect of fiscal policy on output and consumption. One may think of these consumers as credit constrained individuals - or as individuals with no access to financial markets at all[5]. Therefore, one can view that study as supporting a link between credit market conditions and fiscal policy effectiveness. In addition, a calibration of such a model produces relatively large deficit spending multipliers.

The idea that credit frictions have an impact on the way in which policy shocks affect the economy is also well known in monetary economics. An important earlier contribution that links credit market imperfections with the impact of policy shocks is Bernanke et al. (1999). They consider moral hazard in the lending relationships between financial intermediaries and firms and between households and intermediaries. These imperfections strengthen the impact of macroeconomic shocks on output but also the impact of policy responses. Therefore, the study supports the view that policy interventions work better when credit markets are not working well.

The present chapter is related to the empirical literature that studies the effects of fiscal policy on output growth in "normal times". For instance, Blanchard and Perotti (2002) initially applied structured VAR techniques to the measurement of fiscal policy effects on output and private consumption in the U.S., and Perotti (2004) extended their analysis to other OECD countries. Blanchard and Perotti find a fiscal stimulus in the US with multipliers ranging from 0.66 to 0.9. However, they also found that the effects of fiscal policies declined in the 1980s. Some multipliers have become insignificant, others even negative. Benassy-Quere and Cimadomo (2006) argue that

[5]The separation between Ricardian and non-Ricardian households, which have a higher propensity to consume, is quite paramount in the policy discussion, being notably one of the arguments used in support of recent fiscal stimuli packages implemented by the authorities in Europe. For the euro area the share of non-Ricardian households has been estimated around 25-35% by Ratto et al. (2009) and Forni et al. (2009).

domestic fiscal policy multipliers have been declining in the U.S. (since the 1970s) and in Germany (since the 1980s), and that "cross-border" multipliers (from Germany to seven EU economies) have been diminishing[6].

There is also an ongoing debate in the empirical literature about the role of exogenous expansion in government spending on consumption and real wages. Ramey and Shapiro (1998) find that, following an expansionary fiscal policy shock, output rises while private consumption falls (crowding out). Blanchard and Perotti (2002) instead find that output and consumption both increase. The main methodological difference is that Ramey and Shapiro use war build-ups as exogenous dates to identify fiscal expansions while Blanchard and Perotti use identifying restrictions which they derive from delays in the response of fiscal policy decisions to the economic development.

Case studies such as Johnson et al. (2006) also provide valuable insights into the effect of particular spending programs on individual consumption.

For the EU, and using panel data for the 15 "old" EU countries for the period 1971-2006, Afonso and Alegre (2011) identify a negative impact of public consumption and social security contributions on economic growth, and a positive impact of public investment. They also uncover the existence of a crowding-in effect of public investment into private investment that provokes an overall positive effect of public investment on economic growth. More recently, using a Bayesian Structural Vector Autoregression approach for the U.S., the U.K., Germany, and Italy, Afonso and Sousa (2009) show that government spending shocks, in general, have a small but positive effect on GDP, have a varied effect on private consumption and private investment, reflecting the existence of important "crowding-out" effects, and in general, impact positively on the price level and on the average cost of refinancing the debt.

For the case of the U.S., Cogan et al. (2009), find that the government spending multipliers from permanent increases in federal government purchases are lower in new Keynesian models than in old Keynesian models. The differences are quite large regarding estimates of the impact on the future development of U.S. government spending in a fiscal package such as the one of February 2009. On the other hand

[6]Brusselen (2010) provides a broad overview of the effectiveness of fiscal policy, and an evaluation of fiscal multipliers in VAR, macroeconometric models and dynamic stochastic general equilibrium models.

Blanchard et al. (2009) argue that the content of the fiscal packages put in place in 2008-2009 by the major developed economies, with targeted tax cuts and transfers are likely to have the highest multipliers.

Related to the 2008 financial crisis Team (2008) argued that fiscal expansion must "now play a central role in sustaining domestic demand." A similar argument was previously put forward by Krugman (2005) who argued that fiscal expansion is quite possible when economic downturns last for several years and low interest rates reduce monetary policy effectiveness. Nevertheless, Cerra and Saxena (2008) report that a financial crisis tends to depress long-run growth, which may cast some doubts on the short-term effectiveness of fiscal policies under such circumstances.

For a panel of 19 OECD countries, Tagkalakis (2008) finds that in the presence of liquidity constrained households, fiscal policy is more effective in increasing private consumption in recessions than in expansions. Such effect squares with the fact that usually constrained consumers contemplate short-term horizons in their consumption and saving decisions. This issue of credit constrained households is also related to the possibility of expansionary fiscal consolidations, and the eventuality of ensuing non-Keynesian effects of fiscal policies[7].

Finally, Mulas-Granados et al. (2009) analyze the impact of fiscal policy taken during systemic banking crises, and they show that, if countries are not funding constrained, fiscal measures contribute to shortening the length of crisis episodes by stimulating aggregate demand. Their results can not directly be used to compare the impact of fiscal policies in crisis and non-crisis times. In a related study, Röger et al. (2010) found that fiscal policy seems to play a role in the impact of banking crises on headline growth, an insight further rationalized with simulation results. Their econometric analysis consists of a set of OLS regressions distinguishing between crisis and non-crisis multipliers.

[7] The possibility of expansionary fiscal consolidations, notably when triggered by a crisis, was initially discussed by Giavazzi and Pagano (1990), although the empirical evidence is diverse (see, for instance, Afonso (2010).

2.3 Empirical Methodology

The focus of the present chapter is on the role of fiscal policies in phases of financial turmoil. Such phases are associated with tighter credit constraints both for firms and for households, leading to pronounced economic downturns.

However, frequent financial crises in single countries are very rare. Hence, if one only looks at GDP in individual countries, there may not be enough data points to run a time series analysis for several countries, and provide meaningful information about the role of fiscal policies during a crisis. In order to overcome this problem we construct an unbalanced panel containing data from the available set of OECD and non-OECD countries.

We test the impact of government spending on economic growth during crises and normal times by interacting the fiscal stimulus variable with a (dummy) variable that indicates the state of the economy, "crisis" or "normal". In addition, we also perform Wald tests with the null-hypothesis that the coefficients of crisis government spending and government spending in the absence of crisis are equal. The following linear panel model for output growth is then specified:

$$Y_{it} = \beta + \delta Y_{it-1} + \phi X_{it} + \gamma FC_{it} + \theta_1 Sp_{it} \cdot FC_{it} + \theta_2 Sp_{it} \cdot (1 - FC_{it}) + u_{it} \qquad (2.1)$$

In equation (2.1) the index i, $(i = 1, \ldots, N)$ denotes the country, the index t, $(t = 1, \ldots, T)$ indicates the period and β_i stands for the individual effects to be estimated for each country i. Y_{it} is real output growth for country i in period t, Y_{it-1} is the observation on the same series for the same country i in the previous period, X_{it} is a vector of additional explanatory variables, in period t for country i. $FC_{it}(FC_{it-1})$ is a dummy variable that captures the existence of a financial crisis (in the preceding year), either banking, currency or sovereign debt crisis, and Sp_{it} is real government spending growth for country i in period t. Additionally, it is assumed that the disturbances u_{it} are independent across countries. The interaction term $Sp_{it} \cdot FC_{it}$ denotes government spending in the presence of a financial crisis and $Sp_{it} \cdot (1 - FC_{it})$ picks up government spending during normal times. Both interactions terms are also tested using lags.

Obviously, the specification above is not immune to reverse causality. Current economic growth may affect the government's spending behavior. The influence of GDP growth on contemporaneous spending holds true, in particular, for welfare benefits and subsidies, notably via the functioning of automatic stabilizers. For instance, higher economic growth reduces expenses for unemployment benefits since more people are likely to find a job during an economic upswing. Lower growth can lead to higher government transfers as well as to discretionary, countercyclical spending such as infrastructure programs. This negative causal effect from growth on fiscal spending would imply an underestimation of the fiscal stimulus' impact. Due to the large number of countries, data on government spending net of transfers were not available and we need to refer to different methods to address endogeneity.

Also, real economic growth can influence government spending in a positive way if governments follow pro-cyclically economic developments[8]. Under this assumption, politicians do not save (discretionarily) in good times and do not (discretionarily) provide fiscal stimuli in crisis times. Without accounting for endogeneity, this effect would lead to an overestimation of the fiscal multiplier. In our sample, which includes OECD and non-OECD countries, we find some evidence of the first assumption, that growth contemporaneously affects spending in a negative way as fiscal multipliers are larger when endogeneity is accounted for.

A possible way to address endogeneity would be to use time lags of the relevant explanatory variables. Due to data availability we can only use yearly change in spending. As shown by single country time series studies with quarterly data (for instance, Perotti (2004)) the positive impact of a government spending shock vanishes approximately after four to five quarters. That is, with one year lagged spending growth as ordinary control variable, instead of current spending growth, we could address the endogeneity problem but we cannot measure the fiscal multiplier properly. Using lagged government spending as an instrument captures spending habits potentially linked to the institutional path of the economy, rather than discretionary changes in spending[9].

[8] Jaeger and Schuknecht (2004) mention that boom-bust phases tend to exacerbate already existing pro-cyclical policy biases, toward higher spending and public debt ratios.

[9] Actually, using lagged spending as an instrument in a basic panel set up would imply the lack of statistically significance for the effect of spending on growth in our dataset.

We therefore use the following two instruments explained in detail in section 2.4.2: the distance to elections (related to the political budget cycle, Brender and Drazen (2005); and the lagged budget balance-to-GDP ratio.

2.4 Empirical Analysis

2.4.1 Data

Our panel covers 127 countries out of which 98 countries experienced financial crises during the years 1981-2007. The crisis dummy was taken from the IMF dataset on financial crisis. The maximum number of observations used, due to data availability across the panel, is 2867 (3271 observations were initially gathered), and the number of crises years is 218 (encompassing banking, currency and sovereign debt crises). To avoid the influence of outliers, we restrict the dependent variable, GDP growth, as well as the spending variables by excluding the first and last percentile of the sample. Data descriptions and sources are reported in the Appendix.

In our panel, government spending increases on average at 0.76 percent of GDP per year. Spending decreases on a yearly basis by 0.05 percent of last period's GDP on average in the starting year of the crisis and by 0.1 percent of GDP in the next year. Hence, during financial crises governments tend to spend less money, eventually because revenues decline as well. Only during 90 crisis episodes we observe a positive change in government spending relative to GDP the year after the beginning of the crisis.

Real GDP growth is adversely affected by a financial crisis as will be confirmed in our regression results reported in the next sections. While the average real growth rate in our panel is 3.4%, it goes down to 0.1% during a crisis. We also collected data on claims to the private sector. There exists some evidence that links credit contractions to financial markets distress (see Claessens et al. (2008)), and we test the hypothesis that increases in credit concession to the private sector can attenuate economic slowdowns.

2.4.2 Instrumenting Spending Growth

Altogether, to address the endogeneity problem we use two instruments, the *distance to elections* referring to the political budget cycle according to Brender and Drazen (2005) and the *lagged budget balance-to-GDP ratio*. *Distance to elections* is a linear distance measure between the current year and the year of the next election. In other words, the indicator counts the years until the next election takes place. The election years are taken from Pippa Norris' Democracy Time series Dataset (2009). For non-OECD countries, we use the year of legislative elections. For OECD countries, we use legislative elections if the country has a parliamentary system and executive elections if the country is characterized by a presidential system[10]. Note that, by the nature of the instrument, we only capture states with regular elections as reported in the dataset. The distance-to-elections indicator takes on values from 1 to 5.

By using a distance-to-elections indicator, which runs throughout the political budget cycle, we are benefiting from two effects: increase in spending before elections, and decrease in spending after elections[11]. Also, by imposing a parameterized linear relationship we obtain a more robust instrument than using pre-election dummies only. Moreover, as can be seen in Table 2.1, in columns (1)-(4), when there are more than two pre-election dummies, the explanatory power decreases strongly: four years before elections can simultaneously be one year before other, out-of-cycle, elections. This fact, for instance, is taken into account by the indicator.

The parameterized relation between distance to elections and spending is not always monotonous: empirically, the year of elections (”zero distance”) does not display the largest spending increase. Changes in government spending in the year of elections depend very much on when elections take place. Elections in spring can trigger spending cuts for the rest of the year while elections in autumn can lead to spending increases. Since our data do not provide information on the month of elections, we use evidence from regressions of spending growth on different sets of pre-election dummies and construct three different indicators: first, we assign the value three to the election year

[10]Due to data accuracy we use information on the political system only for OECD countries.

[11]The relations between electoral cycles and government behavior be traced back to Nordhaus (1975) and Hibbs (1977), respectively regarding opportunistic and partisan cycles.

Table 2.1: First Stage Regressions with Instruments Based on Political Budget Cycle, 1y Crisis

	(1) Spending *(1-FC)	(2) Spending *FC	(3) Spending *(1-FC)	(4) Spending *FC	(5) Spending *(1-FC)	(6) Spending *FC	(7) Spending *(1-FC)	(8) Spending *FC	(9) Spending *(1-FC)	(10) Spending *FC
GDP(-1)	0.562***	0.0429***	0.563***	0.0433***	0.547***	0.0423**	0.516***	0,00803	0.550***	0.0461***
	(6.39)	(2.79)	(6.38)	(2.82)	(5.96)	(2.51)	(5.49)	(0.45)	(5.99)	(2.63)
FC	-0.0632***	0.0310***	-0.0644***	0.0307***	-0.0649***	-0,0349	-0.114***	0,00333	-0.0661***	0.0362**
	(-9.41)	(23.10)	(-9.61)	(21.10)	(-4.86)	(-0.89)	(-9.61)	(0.08)	(-8.29)	(2.37)
FC(-1)	-0,0184	-0.00547*	-0,0183	-0.00546*	-0.0207*	-0.00588*	-0,0222	-0,0036	-0.0203*	-0.00538*
	(-1.64)	(-1.75)	(-1.64)	(-1.76)	(-1.81)	(-1.77)	(-1.64)	(-1.43)	(-1.78)	(-1.67)
Spending(-1)	-0.117***	-0,0145	-0.117***	-0,0145	-0.0784**	-0,0092	-0,0299	0,000242	-0.0781**	-0,0113
	(-3.47)	(-1.48)	(-3.47)	(-1.49)	(-2.25)	(-0.85)	(-0.81)	(0.02)	(-2.23)	(-0.97)
Revenue(-1)	0.134***	0,00397	0.134***	0,004	0.149***	0,00733	0.120***	0,01	0.148***	0,00912
	(3.57)	(0.48)	(3.55)	(0.48)	(4.49)	(0.78)	(3.11)	(0.87)	(4.45)	(0.95)
D0y			0,00213	-0,000748						
			(0.31)	(-0.30)						
D1y	0.0104**	-0,00134	0,00989	-0,00273						
	(2.43)	(-1.18)	(1.46)	(-1.36)						
D2y	0.0107**	-0.00258*	0,0102	-0,00398						
	(2.22)	(-1.67)	(1.39)	(-1.53)						
D3y			-0,00456	-0,00338						
			(-0.57)	(-1.29)						
Distance I*(1-FC)					-0.0059***	0,00001				
					(-2.98)	(0.07)				
Distance I*FC					-0,00596	0.0325*				
					(-1.12)	(1.66)				
Distance II*(1-FC)							-0.0066***	0,0000237		
							(-2.97)	(0.44)		
Distance II*FC							-0,00375	0,014		
							(-0.65)	(0.54)		
Distance III*(1-FC)									-0,00267	0,0000517
									(-1.64)	(0.80)
Distance III*FC									-0,000347	-0,00641
									(-0.11)	(-0.42)
Observations	2877	2877	2877	2877	2487	2487	1891	1891	2487	2487
No. Clusters	127	127	127	127	119	119	119	119	119	119

Notes: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$, t-statistics in brackets. Unbalanced panels with country fixed effects. FC - dummy variable for the existence of financial crisis. Constant, fixed effects as well as fixed effects interactions with crises dummy are partialled out. D0y, D1y, D2y, D3y are dummies with value 1 for respectively 0, 1, 2, and 3 years to elections. Distance I: indicator using "3" in election year. Distance II: indicator with missing value in election year. Distance III: indicator with "0" in election year.

(Distance I)[12]; second, we assign a missing value to the election year (Distance II); and third, we keep the value zero in each year in which elections take place (Distance III). The underlying hypothesis for the indicator Distance I to use the value three is that average spending during the election year changes more closely in line with average spending three years before elections (which is, on average, the post-election year in our sample) than with spending one or two years before elections.

Table 2.1 compares the three indicators' performance in the first stage. For regular spending we find that the closer elections (the smaller the indicator) the larger the spending increase, as predicted by the political budget cycle hypothesis. The correlation is significant for Distance I and Distance II. For crisis spending, however, we find that the closer elections the less governments tend to spend. Put differently, governments during financial crises react more strongly via spending when they have more time to stay in office[13]. This correlation is less robust and only Distance I is significant. Note that there are fewer observations for Distance II which is likely to have an impact on crisis spending given the limited number of crisis observations. In the subsequent analysis we use the indicator Distance I as instrument for government spending.

As a second instrument we use the one year lagged budget balance-to-GDP ratio, the difference between total revenue and total expenditure of the central government relative to GDP. The underlying hypothesis is that the larger the buffer provided by last year's budget balance position relative to last year's GDP, the higher is government spending growth during normal times. To avoid that the instrument lagged budget balance-to-GDP ratio is capturing good governance and disciplined political institutions, which is in turn correlated with GDP growth, the budget balance-to-GDP ratio is lagged twice and included in the regression. Furthermore, to ensure that lagged budget balance to GDP is exogenous, we control for lagged spending growth and lagged revenue growth. The Sargan-Hansen test of over-identifying restrictions (not reported) strongly supports the validity of the above described instruments.

These two instruments capture different aspects of government spending. *Distance*

[12] Let the election year be denoted by t. In t, the indicator assumes the value 3. In t-1, t-2, and t-3, the indicator assumes 1, 2, and 3 respectively. For a country with a 4-year cycle over a period of, for instance, 8 years the distance indicator starting with an election year is accordingly: 3-3-2-1-3-3-2-1.

[13] Exogeneity tests rejected the hypothesis that a fall in GDP leads to new elections, hence we reject the hypothesis that the instrument is correlated with the dependent variable.

to elections is a good measure for discretionary fiscal activities if politicians act according to the "political budget cycle". The *budget balance ratio* considers the financial leeway provided by last year's government budget to predict current spending. We perform the instrumental variable estimations with one and two instruments interacted with the crisis dummy. For each specification we report the results of the Kleibergen-Paap test of under identification and the Angrist-Pischke test of weak identification for each individual regressor reflecting the validity of our instruments.

2.4.3 Results and Discussion

Table 2.2 reports the panel estimation results using real GDP growth as the dependent variable as in specification (2.1), using only the distance to elections as an instrument for real government spending growth, and controlling for the existence of a financial crisis, in which case the dummy variable FC assumes the value of one (zero otherwise). We perform each specification with a 1-year definition of financial crisis $-FC$ equals one in the starting year of the crisis - and a 2-year definition of financial crisis (reported in Table2.9) - where $FC2$ equals one in the crisis' starting year as well as in the following year.

Fiscal Multipliers and Instrument Performance From Table 2.2 we can see that increases in real government spending growth have a positive impact on real GDP growth. In addition, the estimated government spending coefficients are higher when a crisis occurs. However, as shown by the Wald test, we cannot reject the null hypothesis that the estimated coefficients for government spending are equal with and without a financial crisis. The existence of a financial crisis also decreases real growth unequivocally. In addition, we also used the variables inflation and claims to the private sector, which indeed had a negative and positive estimated coefficient respectively. Higher inflation reduces economic growth and increases in credit concession to the private sector can positively impinge on economic growth. Limited data availability on claims to the private sector significantly reduces observations and we only report this variable in our 2-year specifications, see Table2.9. In almost all specifications, the positive impact of spending on GDP remains significant.

Table 2.2: Spending Instrumented by Distance to Elections, 1y Crisis

	(1) GDP	(2) GDP	(3) GDP	(4) GDP
Spending*(1-FC)	0.251*	0.195*	0.193	0.260
	(1.87)	(1.74)	(1.51)	(1.46)
Spending*FC	0.502*	0.518*	0.461*	0.697*
	(1.72)	(1.86)	(1.75)	(1.82)
GDP(-1)	0.237**	0.257***	0.230**	0.138
	(2.15)	(3.00)	(2.49)	(1.15)
FC	-0.0875***	-0.0855***	-0.0892***	-0.0760**
	(-3.74)	(-3.62)	(-4.01)	(-2.55)
L.FC	-0,00141	-0,00125	-0,000732	-0,00409
	(-0.27)	(-0.24)	(-0.15)	(-0.70)
Spending(-1)*(1-FC(-1))		0,00535	0,00808	0,0185
		(0.32)	(0.45)	(0.94)
Spending(-1)*FC(-1)		0,0659	0,0643	0,0941
		(1.58)	(1.56)	(1.37)
Revenue(-1)		0,0139	0,0129	0,00376
		(0.60)	(0.53)	(0.13)
Inflation				-0.00316***
				(-3.63)
Time Fixed Effects	No	No	Yes	Yes
Observations	2574	2487	2487	2250
No. Clusters	119	119	119	111
Kleibergen-Paap LM Statistic	7,06	8,7	6,85	4,42
Kleibergen-Paap p-value	0,0079	0,0032	0,0089	0,0356
Angrist-Pischke F Statistic Spending*(1-FC)	7,2144	8,9486	6,739	4,2195
Angrist-Pischke F Statistic Spending*FC	1,8981	2,1231	2,1559	1,6997
Wald Test Statistic	0,5819	1,1622	0,804	0,9796
Wald Test p-value	0,4456	0,281	0,3699	0,3223

Notes: $*p < 0.10$,$**p < 0.05$,$***p < 0.01$, t-statistics in brackets. Unbalanced panel with country fixed effects. GDP, Spending, and Revenue in growth rates. FC - dummy variable for the existence of a financial crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. The Angrist-Pischke F statistic tests weak identification of each individual endogenous variable. Constant as well as fixed effects interactions with crises dummy are partialled out.

In this specification government spending coefficients can not directly be interpreted as fiscal multipliers. We have to multiply them by the inverse average share of government spending in GDP[14]. In our data sample, government spending amounts to around 36% of GDP for the full sample, 33% of GDP for non-OECD countries and 46% of GDP for OECD countries. Overall, the magnitude of the above fiscal multipliers (about 0.6-1.1 for regular and crisis spending) is broadly in line with multipliers observed in the existing literature assuming an average government spending share of GDP of about one third[15]. Similar results can be observed when government spending is instrumented with both the distance to elections and the lagged budget balance (see Table 2.3). In this case, the fiscal multiplier is around 0.6-0.7.

Reverse causality seems to be stronger in crisis times. Intuitively, this is appealing, implying that social transfers and discretionary spending react stronger during an expected and/or experienced economic downturn than in times of an economic upswing. Overall, albeit the qualitative differences, endogeneity does not influence our findings since the marginal impact of spending is not statistically different in crisis and non-crisis times.

Moreover, government spending in the presence of a financial crisis, when compared to normal times, is clearly larger in Table 2.2 compared to Table 2.3. This is likely to be due to a weak instrument bias for crisis spending when using only the distance to elections indicator (see the results for the Angrist-Pischke test). Including the lagged budget balance ratio, the coefficients of crisis spending and regular spending are approximately equal.

In Tables 2.2 and 2.3 we can reject the null hypothesis that the equation is underidentified. In Table 2.3, including the lagged budget ratio balance improves the instrument performance in the first stage for crisis and regular spending. Indeed, the Kleibergen-Paap test statistic also passes the critical value of 10 allowing rejecting the null of under-identification. The Angrist-Pischke F statistic which tests individual endogenous variables separately passes the value 10 for regular spending when using

[14] With Y - GDP, G - government spending, m - fiscal multiplier, $\frac{Y_t - Y_{t-1}}{Y_{t-1}} = m \frac{G_t - G_{t-1}}{G_{t-1}} \leftrightarrow \Delta Y_t = m \cdot \Delta G_t \frac{Y_{t-1}}{G_{t-1}}$ and $\frac{\Delta Y}{\Delta G} \cong m \cdot \frac{Y}{G}$

[15] Our estimates based on different instruments yield output multipliers that are close to the ones derived, for instance, in the papers by Baxter and King (1993), Linnemann and Schabert (2003).

Table 2.3: Spending Instrumented by Distance to Elections and Lagged Budget Balance, 1y Crisis

	(1) GDP	(2) GDP	(3) GDP	(4) GDP	(5) GDP
Spending*(1-FC)	0.133***	0.146***	0.270***	0.252**	0.235*
	(3.47)	(3.04)	(2.58)	(2.41)	(1.80)
Spending*FC	0.106*	0.129**	0.245**	0.258**	0.206*
	(1.92)	(2.01)	(2.30)	(2.42)	(1.69)
GDP(-1)	0.320***	0.310***	0.233***	0.213***	0.186**
	(6.80)	(5.66)	(3.12)	(2.84)	(2.06)
FC	-0.105***	-0.105***	-0.102***	-0.101***	-0.0985***
	(-27.05)	(-21.88)	(-19.35)	(-17.14)	(-13.36)
FC(-1)	-0,00538	-0.00793**	-0,00481	-0,0047	-0.00946**
	(-1.26)	(-1.98)	(-1.04)	(-1.05)	(-2.06)
GDP(-2)		0,0117	0,0173	0,0165	0,0108
		(0.33)	(0.50)	(0.49)	(0.31)
Budget Balance Ratio(-2)		-0,0209	-0,0975	-0,0926	-0.120
		(-0.89)	(-1.39)	(-1.39)	(-1.43)
Spending(-1)*(1-FC(-1))			0,0361	0,0352	0,042
			(1.35)	(1.36)	(1.41)
Spending(-1)*FC(-1)			0,0338	0,0332	0,032
			(0.71)	(0.73)	(0.56)
Revenue(-1)			-0,0149	-0,0127	-0,00976
			(-0.65)	(-0.55)	(-0.37)
Inflation					-0.00229***
					(-5.61)
Time Fixed Effects	No	No	No	Yes	Yes
Observations	2574	2475	2412	2412	2179
No. Clusters	119	119	119	119	111
Kleibergen-Paap LM Statistic	37,58	27,72	14,74	15,29	10,71
Kleibergen-Paap p-value	0	0	0,0021	0,0016	0,0134
Angrist-Pischke F Stat Spending*(1-FC)	22,8453	14,0461	9,6331	11,1354	5,0068
Angrist-Pischke F Stat Spending*FC	5,6381	4,8398	5,4338	5,9152	3,4382
Wald Test Statistic	0,193	0,0687	0,1149	0,0045	0,0521
Wald Test p-value	0,6604	0,7932	0,7347	0,9464	0,8194

Notes: $*p < 0.10$,$**p < 0.05$,$***p < 0.01$, t-statistics in brackets. Unbalanced panel with country fixed effects. GDP, Spending, and Revenue in growth rates. FC - dummy variable for the existence of financial crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. The Angrist-Pischke F statistic tests weak identification of each individual endogenous variable. Constant as well as fixed effects interactions with crises dummy are partialled out. Equation (4) is over-identified.

both instruments suggesting that distance to elections and lagged budget balance ratio are good predictors for regular spending. For crisis spending the Angrist-Pischke statistic assumes values from 3 to 8 in 1-year and 2-year specifications (see Table 2.9) with both instruments and the full sample. This leaves us with a potential bias of our OLS estimates towards an overestimation of the impact of spending during crisis times.

Differentiated Fixed Effects Our sample comprises observations from a diverse set of countries and thus collects information from very heterogeneous financial crises. To allow for a different severity of crisis across countries and a reaction of economic variables to the occurrence of financial crisis (possibly due, for instance, to institutional differences) we interact country dummies with crisis dummies in each specification.

The above results from the IV regression with "differentiated fixed effects" are similar to the results obtained with a sample split into crises and non-crises observations[16]. By keeping the full sample and introducing a country specific interaction term with crises we benefit from gains in efficiency and instrument validity. Moreover, we can directly test the hypothesis of equality between spending in crises and non-crises times[17].

A direct consequence of this approach is that - as in the case of fixed effects observations for countries with only one crisis-year (singleton dummies) are not included in the analysis. Since many countries indeed experienced several financial crises, our FC dummy variable captures 111 crises years for 45 countries with two to four crises. The coefficient of the FC dummy in the tables has to be interpreted by taking into account that country specific crises reactions of GDP have already been partialled out. As a robustness check, we run every specification with a 2-year definition of crises, which also includes observations with only one crisis per country (see Tables 2.8-2.12).

[16]Tables are not reported and can be obtained from the authors upon request.

[17]The coefficients of these interaction terms are not reported since they are partialled out in the regressions, together with the constant.

2.4.4 Robustness Analysis

OECD and Non-OECD Economies Evidence from the related literature points out that (economic) cyclical fiscal behavior in developed economies is somewhat different from the case of developing economies. The conventional wisdom that emerges from such studies is that fiscal policy is counter-cyclical or a-cyclical in most developed countries, while it is pro-cyclical in developing countries[18]. Specifically, reverse causality could be different in developed and developing economies. It is therefore important to analyze the instrument's performance and instrumented fiscal multipliers in OECD and non-OECD sub-samples.

As Table 2.4 shows, the results for non-OECD countries are close to the results obtained for the full sample and fiscal multipliers, for both crisis and regular spending, are on average 0.6. In addition, the instruments behave similarly in the first stage and statistical significance is also comparable to the full sample regressions. For OECD countries, however, distance to elections, i.e. the political budget cycle, does not perform very well as an instrument during regular times (see Table 2.5) while performance is very good during crisis times.

The literature on the political budget cycle mostly confirms our results of different fiscal attitudes in OECD and non-OECD countries (see, for instance, Shi and Svensson (2006)). Interestingly, distance to elections matters for crisis spending as we find a significant negative correlation in the first stage. In other words, during financial crisis, fiscal action is required by the electorate in OECD countries. The lagged budget balance-to-GDP ratio is also significant during crises with a larger coefficient than in the non-OECD countries regressions, while it is not significant in regular times.

Overall, it proved to be difficult to build a significant instrument for regular spending in OECD countries. Therefore, in Table 2.5 (and Table 2.11) the under identification test is not passed. The reported value, however, only captures the average validity of instruments over both endogenous variables. The instruments for crisis spending, crisis distance to elections and crisis lagged budget balance, are still highly significant in the first stage as shown by the Angrist-Pischke test statistic. The fiscal

[18]See, for instance, Galí (1994), Lane (2003), Kaminsky et al. (2004), Talvi and Vegh (2005), and Alesina et al. (2008).

Table 2.4: Spending Instrumented by Distance to Elections and Lagged Budget Balance, Non-OECD Countries, 1y Crisis

	(1) GDP	(2) GDP	(3) GDP	(4) GDP	(5) GDP
Spending*(1-FC)	0.146***	0.148***	0.245***	0.216**	0.208*
	(3.65)	(3.16)	(2.63)	(2.43)	(1.88)
Spending*FC	0.117**	0.138**	0.245**	0.222*	0.170
	(2.11)	(2.05)	(2.17)	(1.82)	(1.27)
GDP(-1)	0.305***	0.297***	0.231***	0.212***	0.175**
	(5.87)	(5.06)	(3.10)	(2.98)	(2.10)
FC	-0.104***	-0.104***	-0.101***	-0.106***	-0.103***
	(-24.15)	(-19.72)	(-18.79)	(-5.57)	(-5.10)
FC(-1)	-0,00404	-0,00712	-0,00371	-0,0035	-0,00846
	(-0.84)	(-1.58)	(-0.74)	(-0.72)	(-1.56)
GDP(-2)		0,0239	0,0312	0,0213	0,0184
		(0.62)	(0.83)	(0.59)	(0.49)
Budget Balance Ratio(-2)		-0,0191	-0,0887	-0,0704	-0.118
		(-0.60)	(-1.13)	(-0.99)	(-1.17)
Spending(-1)*(1-FC(-1))			0,0339	0,0255	0,0392
			(1.23)	(0.99)	(1.26)
Spending(-1)*FC(-1)			0,0366	0,0447	0,0412
			(0.77)	(0.91)	(0.62)
Revenue(-1)			-0,0113	-0,000365	-0,00404
			(-0.50)	(-0.02)	(-0.16)
Inflation					-0.00228***
					(-5.03)
Time Fixed Effects	No	No	No	Yes	Yes
Observations	1869	1794	1732	1732	1518
No. Clusters	91	91	91	91	84
Kleibergen-Paap LM Statistic	35,06	28,36	16,92	18,38	13,82
Kleibergen-Paap p-value	0	0	0,0007	0,0004	0,0032
Angrist-Pischke F Stat Spending*(1-FC)	17,6861	13,325	9,8659	11,7816	10,0344
Angrist-Pischke F Stat Spending*FC	4,8236	4,1282	4,6397	4,5149	3,6008
Wald Test Statistic	0,2034	0,0224	0	0,0051	0,0923
Wald Test p-value	0,652	0,8811	0,9993	0,9429	0,7613

Notes: $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$, t-statistics in brackets. Unbalanced panel with country fixed effects. GDP, Spending, and Revenue in growth rates. FC - dummy variable for the existence of financial crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. The Angrist-Pischke F statistic tests weak identification of each individual endogenous variable. Constant as well as fixed effects interactions with crises dummy are partialled out.

Table 2.5: Spending Instrumented by Distance to Elections and Lagged Budget Balance, OECD Countries, 1y Crisis

	(1) GDP	(2) GDP	(3) GDP	(4) GDP	(5) GDP
Spending*(1-FC)	0,0072	0.486	0.473	0.909	0,0285
	(0.06)	(0.65)	(0.72)	(0.73)	(0.05)
Spending*FC	0.247	0.383***	0.386***	0.354**	0.296**
	(1.07)	(3.33)	(3.39)	(1.98)	(2.03)
GDP(-1)	0.450***	0.272	0.266	0,0303	0.433*
	(8.74)	(0.80)	(0.85)	(0.05)	(1.77)
FC	(dropped)	(dropped)	0.0469***	(dropped)	(dropped)
			(4.02)		
FC(-1)	-0,00667	-0,0213	-0,0196	-0,0394	-0,00453
	(-1.00)	(-0.80)	(-0.74)	(-0.77)	(-0.15)
GDP(-2)		-0.119*	-0.123**	-0,0775	-0.0800*
		(-1.69)	(-2.19)	(-0.93)	(-1.79)
Budget Balance Ratio(-2)		-0,0787	-0.110	-0.202	0,00398
		(-0.62)	(-0.80)	(-0.69)	(0.03)
Spending(-1)*(1-FC(-1))			-0,0112	0,0252	0,0262
			(-0.36)	(0.41)	(0.97)
Spending(-1)*FC(-1)			-0,0557	0.189	-0.130
			(-0.23)	(0.30)	(-0.34)
Revenue(-1)			0,0306	-0,0442	0,000398
			(0.70)	(-0.40)	(0.01)
Inflation					-0,0206
					(-0.90)
Time Fixed Effects	No	No	No	Yes	Yes
Observations	705	681	680	680	661
No. Clusters	28	28	28	28	27
Kleibergen-Paap LM Statistic	8,06	2,23	0,95	0,87	1,04
Kleibergen-Paap p-value	0,0447	0,5256	0,8145	0,8323	0,791
Angrist-Pischke F Stat Spending*(1-FC)	9,828	3,5666	0,2691	0,1536	0,3232
Angrist-Pischke F Stat Spending*FC	3,2168	10,5399	13,1838	10,9541	18,3869
Wald Test Statistic	0,7764	0,0165	0,0192	0,2208	0,3222
Wald Test p-value	0,3782	0,8977	0,8898	0,6384	0,5703

Notes: $*p < 0.10$,$**p < 0.05$,$***p < 0.01$, t-statistics in brackets. Unbalanced panel with country fixed effects. GDP, Spending, and Revenue in growth rates. FC - dummy variable for the existence of financial crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. The Angrist-Pischke F statistic tests weak identification of each individual endogenous variable. Constant as well as fixed effects interactions with crises dummy are partialled out.

multiplier of crisis spending ranges between 0.7 and 0.8 and is therefore slightly larger than in non-OECD countries (the underlying fiscal share is 46% of GDP, as described above).

Banking Crisis The previous analysis showed the impact of government spending on economic growth during up to 141 financial crises, which included banking crises, currency crises, and debt crises. Table 2.6 reports on to what extent government spending and growth are correlated during the identified 60 banking crises.

Given the limited number of banking crises recorded in the IMF dataset on financial crisis, between 1981 and 2007 and, in particular, the high proportion of only one banking crises per country, we can only use the 2-year definition of crises, which provides us with two observations per crisis and thus allows us to use the singleton crises. Again, country dummies are interacted with banking crisis dummy in Table 2.6, hence the coefficient of BC2 has to be interpreted taking into account the country specific crises reactions.

Essentially, in the IV estimation spending significantly differs in crises and non-crises times. While there is no impact of a change in spending in the first and second year of a banking crises on GDP growth, the impact of spending in normal times is still positive (and mostly significant) with a multiplier of about 0.5.

Performing the analysis with all remaining financial crises, hence debt and currency crises, supports these results (see Table 2.12), and the coefficient of crisis spending is larger as for the full set of financial crises. The difference between spending in crisis times and normal times is not significant.

2.5 Conclusion

In this chapter we have studied the impact of government spending on output notably during the occurrence of financial crises, covering 127 countries for the period 1981-2007. We have performed each estimation using a 1-year and a 2-year definition of financial crisis, with and without time fixed effects.

To address the endogeneity issue we have used two instruments: the distance to elections - a linear distance measure between the current year and the year of

Table 2.6: Spending Instrumented by Distance to Elections and Lagged Budget Balance, 2y Banking Crisis

Dependent Variable: GDP	(1)	(2)	(3)	(4)	(5)	(6)
Spending*(1-BC2)	0.142***	0.156***	0.185*	0.159	0.117	0.166**
	(3.72)	(2.91)	(1.80)	(1.53)	(1.50)	(2.18)
Spending*BC2	-0.154	-0.162	-0.118	-0.134	0,0337	0,0369
	(-1.15)	(-1.22)	(-1.09)	(-1.18)	(0.35)	(0.36)
GDP(-1)	0.305***	0.289***	0.260***	0.243***	0.271***	0.171***
	(5.69)	(4.70)	(3.41)	(3.17)	(4.18)	(2.86)
BC2	0.0533***	0.0541***	0.0523***	0.0505***	0.0374***	(dropped)
	(7.20)	(6.97)	(7.58)	(7.34)	(5.91)	
GDP(-2)		0,0297	0,0376	0,0358	0,0332	0,0511
		(0.89)	(1.18)	(1.14)	(0.87)	(1.42)
Budget Balance Ratio(-2)		-0,0248	-0,051	-0,0478	-0,0391	-0,0887
		(-1.02)	(-0.76)	(-0.73)	(-0.74)	(-1.57)
Spending(-1)			0,00787	0,00594	0,0115	0,0201
			(0.30)	(0.23)	(0.57)	(0.95)
Revenue(-1)			0,00852	0,0122	0,0126	0,0045
			(0.41)	(0.57)	(0.70)	(0.27)
Inflation					-0.00005***	-0,00004
					(-2.94)	(-1.19)
Claims on Private Sector						0.0132**
						(2.38)
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	2574	2476	2413	2413	2063	1775
No. Clusters	119	119	119	119	105	95
Kleibergen-Paap LM Statistic	25,21	23,89	14,79	14,04	11,77	14,12
Kleibergen-Paap p-value	0	0	0,002	0,0029	0,0082	0,0027
Angrist-Pischke F Statistic Spending*(1-BC2)	25,2773	11,49	7,9165	6,7422	5,5904	5,8056
Angrist-Pischke F Statistic Spending*BC2	3,2259	3,6065	7,7241	7,8484	8,3515	7,7142
Wald Test Statistic	4,5071	5,039	6,4061	5,9735	0,4909	1,2743
Wald Test p-value	0,0338	0,0248	0,0114	0,0145	0,4835	0,259

Notes: $^{*}p < 0.10$,$^{**}p < 0.05$,$^{***}p < 0.01$, t-statistics in brackets. Unbalanced panel with country fixed effects. GDP, Spending, and Revenue in growth rates. BC2 - dummy variable for the existence of a banking crisis in 2 consecutive years.

the next election - and the lagged budget balance-to-GDP ratio. According to the results, the fiscal multiplier for instrumented regular spending ranges between 0.6 and 0.7, considering the average government spending share of GDP of about one third. The multipliers of instrumented government spending are higher than the simple OLS multipliers.The differences between the coefficients of government spending in crises and non-crises periods are insignificant in most of our estimations.

More specifically, the fiscal multiplier for the full sample and for the non-OECD sub-sample, for instrumented regular and crisis government spending, is about 0.6, with an average government spending-to-GDP ratio of one third. For the OECD sub-sample, government spending in the presence of a financial crisis produces a fiscal multiplier of around 0.8 assuming an average fiscal share of GDP of around 46 percent. Moreover, for the sub-sets of OECD and non-OECD countries our results show, that altogether, we also cannot reject the hypothesis that government spending either in the presence or in the absence of a financial crisis has the same impact. Interestingly, for the cases when a banking crisis occurred, our results do not support the idea that expansionary fiscal policies positively impact on economic growth.

Therefore, the main result of our panel analysis is that that government spending has essentially the same impact on economic growth with or without a financial crisis. This result holds throughout our sample, using a variation of controls, sub-samples and specifications. Consequently, taking into account that larger spending programs tend to be less targeted, this indicates that they may actually not be particularly helpful.

The present analysis is a first step and these conclusions are tentative. Additional research is needed to further study the relevance of fiscal policies in the context of financial crisis. One way forward would be to use more detailed data on the composition of government spending and to distinguish between budgetary components that react to changes in output and others that don't.

2.A Appendix Data

Year of banking, currency or sovereign debt crisis: Source: IMF database on financial crises, Laeven and Valencia (2008), and at http://www.luclaeven.com/Data.htm

Government spending: General government spending deflated with the GDP deflator. For some countries only central government data are available. Source: IMF World Economic Outlook database.

Budget balance: General government budget balance as percent of GDP. For some countries only central government data are available. Source: IMF World Economic Outlook database.

Government debt: Government gross debt as percent of GDP. For some countries only central government data are available. Source: IMF World Economic Outlook database.

Real GDP: Source: IMF World Economic Outlook database.

GDP gap: Difference between actual and trend real GDP, as a percentage of trend real GDP. Trend GDP is estimated using an HP-filter on real GDP. The lambda value is chosen as 100.

Inflation rate: Consumer price index. Source: IMF World Economic Outlook database

Long-term nominal interest rate: Data are only available for OECD countries. Source: OECD Economic Outlook database.

Election dates: Legal and Executive Elections taken from Pippa Norris. 2009. Democracy Time Series Dataset. http://www.hks.harvard.edu/fs/pnorris/Data/Data.htm

Claims on private sector: Source: IMF IFS Database.

Table 2.7: List of countries

All countries			**OECD sub-sample**
Albania	Ghana	Oman	Australia
Algeria	Greece	Pakistan	Austria
Antigua and Barbuda	Guinea	Panama	Belgium
Argentina	Guinea-Bissau	Paraguay	Canada
Australia	Guyana	Peru	Czech Republic
Austria	Hungary	Philippines	Denmark
Azerbaijan	Iceland	Poland	Finland
Bahamas, The	India	Portugal	France
Bangladesh	Indonesia	Romania	Germany
Barbados	Iran	Russia	Greece
Belgium	Ireland	São Tomé and Príncipe	Hungary
Belize	Israel	Saudi Arabia	Iceland
Bolivia	Italy	Senegal	Ireland
Bosnia and Herzegovina	Jamaica	Seychelles	Italy
Brazil	Japan	Singapore	Japan
Bulgaria	Jordan	Slovak Republic	Korea
Burkina Faso	Kazakhstan	Slovenia	Luxembourg
Burundi	Kenya	South Africa	Mexico
Cambodia	Korea	Spain	Netherlands
Canada	Kuwait	Sri Lanka	New Zealand
Cape Verde	Kyrgyz Republic	Swaziland	Norway
Chile	Lao	Sweden	Poland
China	Latvia	Switzerland	Portugal
Colombia	Lebanon	Syrian Arab Republic	Slovak Republic
Costa Rica	Lithuania	Taiwan	Spain
Côte d'Ivoire	Luxembourg	Tajikistan	Sweden
Croatia	Madagascar	Thailand	Switzerland
Cyprus	Malaysia	Trinidad and Tobago	United Kingdom
Czech Republic	Mauritania	Turkmenistan	United States
Denmark	Mauritius	Uganda	
Djibouti	Mexico	Ukraine	
Dominican Republic	Moldova	United Arab Emirates	
Ecuador	Mongolia	United Kingdom	
Egypt	Morocco	United States	
El Salvador	Mozambique	Uruguay	
Equatorial Guinea	Namibia	Uzbekistan	
Estonia	Nepal	Venezuela	
Ethiopia	Netherlands	Vietnam	
Fiji	New Zealand	Yemen	
Finland	Nicaragua	Zambia	
France	Niger	Zimbabwe	
Georgia	Nigeria		
Germany	Norway		

2.B Appendix Tables

Table 2.8: Spending Instrumented by Distance to Elections, 2y Crisis

	(1)	(2)	(3)	(4)	(5)
Spending*(1-FC2)	0.266**	0.233**	0.209*	0.271*	0.180*
	(2.28)	(2.23)	(1.85)	(1.93)	(1.66)
Spending*FC2	0.507	0.486	0.429	0.584	0.256
	(1.03)	(1.17)	(1.11)	(1.06)	(1.17)
GDP(-1)	0.168*	0.170**	0.161*	0,0732	0,0681
	(1.78)	(2.01)	(1.92)	(0.75)	(0.87)
FC2	-0.0849***	-0.0855***	-0.0810***	-0.0831***	(dropped)
	(-11.81)	(-12.82)	(-11.16)	(-8.31)	
Spending(-1)		0,0241	0,025	0,0384	0,0124
		(0.97)	(1.04)	(1.26)	(0.78)
Revenue(-1)		0,00322	0,00367	-0,00361	0,0128
		(0.16)	(0.18)	(-0.16)	(0.83)
Inflation				-0.00318***	-0.00228***
				(-3.95)	(-3.22)
Claims on Private Sector					0.0154***
					(2.98)
Time Fixed Effects	No	No	Yes	Yes	Yes
Observations	2574	2487	2487	2250	1926
No. Clusters	119	119	119	111	98
Kleibergen-Paap LM Statistic	7,36	11,59	10,57	8,51	9,08
Kleibergen-Paap p-value	0,0067	0,0007	0,0012	0,0035	0,0026
Angrist-Pischke F Statistic Spending*(1-FC2)	11,5544	12,7874	10,7789	8,3306	9,3518
Angrist-Pischke F Statistic Spending*FC2	1,054	1,4124	1,4639	1,1402	2,912
Wald Test Statistic	0,2275	0,3506	0,287	0,2968	0,0989
Wald Test p-value	0,6334	0,5538	0,5922	0,5859	0,7531

Notes: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$, t-statistics in brackets. Unbalanced panels with country fixed effects. GDP, Spending, Revenue and Claims on Private Sector are used as growth rates. FC2 - dummy variable for the existence of a financial crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. Constant as well as fixed effects interactions with crises dummy are partialled out.

Table 2.9: Spending Instrumented by Distance to Elections and Lagged Budget Balance, 2y Crisis

	(1)	(2)	(3)	(4)	(5)	(6)
Spending*(1-FC2)	0.167***	0.164***	0.231**	0.211**	0.213*	0.201*
	(4.10)	(2.91)	(2.31)	(2.14)	(1.88)	(1.80)
Spending*FC2	0,0297	0,051	0.136	0.147	0,0559	0,0844
	(0.38)	(0.67)	(1.27)	(1.37)	(0.54)	(0.91)
GDP(-1)	0.266***	0.256***	0.206***	0.187***	0.162**	0,0927
	(5.54)	(4.68)	(2.90)	(2.65)	(2.02)	(1.23)
FC2	-0.0796***	-0.0809***	-0.0826***	-0.0779***	-0.0758***	(dropped)
	(-72.35)	(-52.81)	(-40.12)	(-22.75)	(-24.04)	
GDP(-2)		0,0285	0,0377	0,0387	0,0308	0,0277
		(0.89)	(1.22)	(1.31)	(0.97)	(0.89)
Budget Balance Ratio(-2)		-0,016	-0,0658	-0,0624	-0,0962	-0.125
		(-0.57)	(-0.98)	(-0.98)	(-1.31)	(-1.54)
Spending(-1)			0,0223	0,0226	0,0262	0,0242
			(0.86)	(0.88)	(0.92)	(0.80)
Revenue(-1)			0,00036	0,00167	0,00096	0,00098
			(0.02)	(0.09)	(0.05)	(0.05)
Inflation					-0.0025***	-0.0019***
					(-3.46)	(-3.60)
Claims on Private Sector						0.0163***
						(3.34)
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	2574	2475	2412	2412	2179	1874
No. Clusters	119	119	119	119	111	98
Kleibergen-Paap LM Statistic	39,3	27,75	16,11	17,01	12,02	13,11
Kleibergen-Paap p-value	0	0	0,0011	0,0007	0,0073	0,0044
Angrist-Pischke F Statistic Spending*(1-FC2)	22,7259	14,3002	10,3949	10,9581	6,614	7,9881
Angrist-Pischke F Statistic Spending*FC2	4,4027	5,2215	4,5516	4,5918	6,0652	5,7127
Wald Test Statistic	3,062	1,4933	0,836	0,3716	2,1827	1,7505
Wald Test p-value	0,0801	0,2217	0,3605	0,5421	0,1396	0,1858

Notes: See Table 2.8

Table 2.10: Spending Instrumented by Distance to Elections and Lagged Budget Balance, Non-OECD Countries, 2y Crisis

	(1)	(2)	(3)	(4)	(5)	(6)
Spending*(1-FC2)	0.181***	0.168***	0.229***	0.200**	0.200**	0.197**
	(4.28)	(3.14)	(2.58)	(2.33)	(2.10)	(2.19)
Spending*FC2	0,0693	0,0851	0.179*	0.166	0,0931	0.133
	(0.97)	(1.24)	(1.73)	(1.62)	(0.91)	(1.37)
GDP(-1)	0.245***	0.236***	0.185***	0.170**	0.139*	0,057
	(4.63)	(4.08)	(2.59)	(2.45)	(1.82)	(0.81)
FC2	-0.0799***	-0.0817***	-0.0838***	-0.0766***	-0.0748***	(dropped)
	(-77.01)	(-53.73)	(-35.93)	(-17.99)	(-17.30)	
GDP(-2)		0,0412	0,0535	0,0431	0,0382	0,0363
		(1.20)	(1.61)	(1.38)	(1.16)	(1.08)
Budget Balance Ratio(-2)		-0,0122	-0,0676	-0,0531	-0.103	-0.156
		(-0.33)	(-0.88)	(-0.76)	(-1.15)	(-1.54)
Spending(-1)			0,0262	0,0227	0,0303	0,0344
			(0.97)	(0.86)	(1.01)	(1.07)
Revenue(-1)			-0,000547	0,00341	0,00109	-0,00457
			(-0.03)	(0.18)	(0.05)	(-0.22)
Inflation					-0.0026***	-0.0021***
					(-3.49)	(-4.01)
Claims on Private Sector						0.0154**
						(2.46)
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	1869	1794	1732	1732	1518	1256
No. Clusters	91	91	91	91	84	71
Kleibergen-Paap LM Statistic	37,03	29,97	18,94	20,62	15,43	18,58
Kleibergen-Paap p-value	0	0	0,0003	0,0001	0,0015	0,0003
Angrist-Pischke F Statistic Spending*(1-FC2)	20,0087	15,3699	12,4755	12,843	10,0847	17,3551
Angrist-Pischke F Statistic Spending*FC2	4,4218	5,0777	4,504	4,6431	5,7851	6,0733
Wald Test Statistic	2,2791	1,0507	0,3058	0,1334	1,1552	0,5866
Wald Test p-value	0,1311	0,3054	0,5802	0,7149	0,2825	0,4437

Notes: See Table 2.8

Table 2.11: Spending Instrumented by Distance to Elections and Lagged Budget Balance, OECD Countries, 2y Crisis

	(1)	(2)	(3)	(4)	(5)	(6)
Spending*(1-FC2)	0,0862	0.949	1.012*	0.817**	0.559*	0.400*
	(0.73)	(1.62)	(1.95)	(2.40)	(1.84)	(1.79)
Spending*FC2	-0.212	-0,069	-0,0673	-0,0436	-0,0358	-0,0345
	(-0.66)	(-0.31)	(-0.30)	(-0.24)	(-0.18)	(-0.19)
GDP(-1)	0.382***	0,0316	0,0235	0,0769	0.195	0.264**
	(7.52)	(0.10)	(0.09)	(0.40)	(1.26)	(2.38)
FC2	(dropped)	(dropped)	0.0322*	(dropped)	(dropped)	(dropped)
			(1.95)			
GDP(-2)		-0.127	-0.109	-0,0567	-0,0539	-0,0645
		(-1.63)	(-1.33)	(-0.82)	(-0.99)	(-0.89)
Budget Balance Ratio(-2)		-0.159	-0.232*	-0.188*	-0.130	-0.121*
		(-1.45)	(-1.79)	(-1.93)	(-1.48)	(-1.79)
Spending(-1)			-0,0246	0,0226	0,0113	0,0469
			(-0.43)	(0.40)	(0.26)	(1.40)
Revenue(-1)			-0,0144	-0,0554	-0,0216	-0,0186
			(-0.20)	(-0.89)	(-0.52)	(-0.61)
Inflation					0,00272	-0,00196
					(0.21)	(-0.21)
Claims on Private Sector						0,00994
						(1.44)
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	705	681	680	680	661	618
No. Clusters	28	28	28	28	27	27
Kleibergen-Paap LM Statistic	5,74	6,03	5,89	6,19	6,03	5,79
Kleibergen-Paap p-value	0,125	0,1103	0,1171	0,1026	0,11	0,1221
Angrist-Pischke F Statistic Spending*(1-FC2)	8,5894	6,4505	6,4179	5,295	4,7372	6,2707
Angrist-Pischke F Statistic Spending*FC2	2,895	3,6533	4,4542	4,4771	3,8647	4,6369
Wald Test Statistic	0,6817	2,7266	4,3756	6,0171	5,2264	4,6982
Wald Test p-value	0,409	0,0987	0,0365	0,0142	0,0222	0,0302

Notes: See Table 2.8

Table 2.12: Spending Instrumented by Distance to Elections and Lagged Budget Balance, 2y Debt and Currency Crisis

	(1)	(2)	(3)	(4)	(5)	(6)
Spending*(1-DCC2)	0.164***	0.160***	0.274**	0.244**	0.215*	0.207*
	(3.72)	(2.91)	(2.51)	(2.26)	(1.75)	(1.77)
Spending*DCC2	0,0741	0.111	0.232*	0.230*	0.284**	0.345*
	(1.02)	(1.36)	(1.85)	(1.96)	(2.17)	(1.80)
GDP(-1)	0.255***	0.244***	0.182**	0.166**	0.141	0,0856
	(5.29)	(4.40)	(2.33)	(2.14)	(1.58)	(1.04)
DCC2	-0.133***	-0.135***	-0.137***	-0.128***	-0.129***	0,00582
	(-90.58)	(-52.83)	(-37.95)	(-26.41)	(-25.27)	(0.85)
GDP(-2)		0,037	0,0389	0,037	0,0328	0,0238
		(1.20)	(1.26)	(1.27)	(1.06)	(0.71)
Budget Balance Ratio(-2)		-0,0177	-0,0932	-0,0864	-0.104	-0.145*
		(-0.69)	(-1.30)	(-1.28)	(-1.30)	(-1.66)
Spending(-1)			0,0347	0,033	0,0373	0,0344
			(1.24)	(1.21)	(1.19)	(1.02)
Revenue(-1)			-0,013	-0,00956	-0,0075	-0,00541
			(-0.60)	(-0.45)	(-0.34)	(-0.24)
Inflation					-0.0025***	-0.0022***
					(-3.94)	(-3.43)
Claims on Private Sector						0.0148***
						(3.04)
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	2574	2476	2413	2413	2180	1875
No. Clusters	119	119	119	119	111	98
Kleibergen-Paap LM Statistic	39,6	27,68	14,47	14,9	10,4	12,36
Kleibergen-Paap p-value	0	0	0,0023	0,0019	0,0154	0,0062
Angrist-Pischke F Statistic Spending*(1-DCC2)	19,9637	12,1417	10,1513	9,6757	8,1352	11,6752
Angrist-Pischke F Statistic Spending*DCC2	8,1416	6,5528	4,8054	4,877	4,2394	2,5143
Wald Test Statistic	1,1075	0,2691	0,1522	0,0162	0,4113	0,6888
Wald Test p-value	0,2926	0,6039	0,6965	0,8986	0,5213	0,4066

Notes: $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$, t-statistics in brackets. Unbalanced panels with country fixed effects. GDP, Spending, Revenue and Claims on Private Sector are used as growth rates. DCC2 - dummy variable for the existence of a debt or currency crisis. A Wald test is conducted to test whether crisis spending and regular spending are statistically different. The underlying null hypothesis of the test is that the coefficients of the interaction terms between spending and financial crisis are equal. The Kleibergen-Paap statistic tests the null that the equation is underidentified. Constant as well as fixed effects interactions with crises dummy are partialled out.

Chapter 3

Incentive or Control? Taxing Returns to Capital

3.1 Introduction

I expect to see the State, which is in a position to calculate the marginal efficiency of capital goods on long views and on the basis of the general social advantage, taking an ever greater responsibility for directly organising investment.

Keynes (1936) [1]

In this chapter we turn to the revenue side of a government's budget and consider different ways to raise funds. The chapter is indeed a contribution to an old debate on the role of the state: we analyze the decision of governments to interfere into the control rights of firms. The study offers an explanation of why and when governments interfere into a firm's investment choice which builds purely on economic reasoning by combining a governmental revenue motive with informational frictions.

Government control of firms has historically proven to be an inefficient concept of resource allocation as such. In particular after 1989 there has been a broad consensus on the role of the state, that is, to guarantee free markets. Policy changes in Latin America, successful government owned enterprises in Asia, and a wave of nationalizations following the turmoil in European and US American markets in the 2008 financial crisis have revived this ancient debate on government intervention. As of 2009, the value of

[1] *The General Theory of Employment Interest and Money*, Book IV, pg.164

state-owned enterprises (SOEs) across the OECD is estimated at USD 2 trillion and SOEs employ more than 6 million people according to the OECD (2011a).

From an empirical perspective, there is a wide heterogeneity in the scope of the state sector across countries and over time[2]. Political influence and ideology, resource endowments and natural monopolies are important aspects which contribute to explain why and under which conditions governments interfere into investment decisions. In this chapter, we explore a motive based on purely economic forces: government revenue collection combined with informational frictions on capital inputs. Hence, in the following, we look at the generation of public revenue from entrepreneurial returns. In an economy with private information on capital investments and a revenue requirement for a state authority we compare two forms of governmental revenue collection: output taxation designed with appropriate incentives to invest the socially optimal level of capital on the one hand, and, on the other hand, control of capital inputs and collection of dividends. The latter can also be interpreted as a form of property taxation and state ownership of firms.

The study builds on a simple trade-off: if entrepreneurial output is taxed in a progressive way, the entrepreneur has an incentive to reduce her investments. Given a positive revenue requirement, there are two ways to tackle this problem: setting the right incentives or controlling inputs. We show that the optimal choice for the government between control or incentive provision depends on three parameters: the government's revenue requirement, the entrepreneurs' preferences for insurance and the monitoring costs of capital.

With intermediate monitoring costs, we can derive the following results. Incentive based taxation is optimal under two parameter combinations: (i) if entrepreneurs have strong preferences for insurance and the revenue requirement is relatively large; and (ii) if entrepreneurs' demand for insurance is low and the revenue requirement is relatively small. In turn, interpreting an entrepreneur's preference for insurance of ex post income as a preference for social security and redistribution we can argue that revenue generation via capital control is optimal under more 'unconventional' parameter combinations: (i) if governments face a low revenue requirement although

[2]See, for instance, OECD (2005) and OECD (2011b)

entrepreneurs have a strong insurance and redistributive motive, and (ii) if a high revenue requirement must be raised from a population with low preferences for redistribution.

The model builds on the literature of optimal capital taxation, cf. Golosov et al. (2003) and Albanesi (2006), and includes risk averse entrepreneurs facing uncertain returns to capital. We relax one crucial assumption: the observability of capital input. Hence, while effort has been the unobserved investment choice of an entrepreneur in Albanesi (2006), for instance, it is capital in our model. We further augment the standard environment by a binary choice of the government whether to monitor and control capital or not. This gives rise to two mechanisms of revenue collection: (i) if capital is not controlled, an incentive compatible tax schedule is designed such that entrepreneurs invest the socially optimal amount of capital; (ii) if the government chooses to monitor capital, the tax schedule conditions on capital inputs and controls the investment decision directly.

Under both systems, revenue collection is costly, but cost structures differ. Under capital control the government pays monitoring costs. The larger the monitoring costs, the higher the entrepreneurs' welfare loss from an increase in government revenue. Under incentive based taxation, the government faces the classical equity-efficiency trade-off and pays incentive costs. These costs increase in government revenue if the economy's ratio of prudence to risk aversion is sufficiently high and decrease if the ratio is sufficiently low implying a high demand for insurance.

Under capital control, an increase in revenue requirement triggers a purely negative income effect which size depends on monitoring costs. Under incentive based taxation, an increase in revenue requirement has an income and substitution effect: income decreases due to transfers to the government; at the same time, lower net income for the entrepreneur makes it possible to substitute incentive provision with insurance against uncertainty in entrepreneurial output. If the increase in insurance is sufficiently strong, incentive costs will be lower than monitoring costs and it is optimal for the government to choose capital control instead of incentive taxation to raise public revenue.

The contribution of this chapter is twofold with both, a theoretical and an applied perspective. The optimal taxation literature is based on relatively restrictive informational assumptions. Starting with the seminal paper by Mirrlees (1971)[3], this type of literature develops constrained efficient allocations via tax schedules that condition on variables such as labor and capital input. Information acquisition of these variables is indeed costly for any government. This study relaxes these assumptions and takes monitoring costs into account. Moreover, we conduct a comparative statics analysis of incentive costs and revenue which has not yet been done analytically for optimal capital taxation.

A related paper which also combines incentives and risk preferences albeit in a different context is Newman (2007)[4]. He considers the role of risk aversion in the context of occupational choice and shows that under decreasing risk aversion but with private insurance markets wealthier agents become workers and poorer agents become entrepreneurs. He uses an incentive effect which is similar to the one described in this chapter: wealthier agents need to bear more risk to act in an incentive compatible way. The author only considers the class of utility functions with decreasing absolute risk aversion while this chapter compares the welfare of entrepreneurs in different preference situations hereby stressing the role of prudence versus risk aversion. We further emphasize the role of the government revenue requirement and the choice between taxation and capital control, the alternative revenue generation mechanism.

On the applied perspective, several policy implications can be derived from the theoretical results. First, an incentive based system achieves higher welfare the stronger the demand for insurance and redistribution, in particular at large revenues. Second, at given monitoring costs, capital control dominates incentive based taxation under empirically unconventional parameter combinations which are likely to happen if the economy is hit by a revenue shock, such as wars or the discovery of natural resources. Third, for sectors or economies with high monitoring costs, incentive based taxation yields a higher welfare than capital control independent of revenue requirement and preference regime. And fourth, the wealthier an economy, the less government interference is optimal and the higher the welfare from incentive based taxation.

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[3]See Kocherlakota (2005) for a survey of the more recent literature.

[4]I thank Nicola Pavoni for pointing this out to me.

The chapter proceeds as follows: in Section 3.2, the model environment is described. Section 3.3 characterizes capital control, and Section 3.4 explores incentive based taxation. Section 3.5 characterizes the optimal choice between the two revenue collection mechanisms and section 3.6 provides an analysis of the results. Policy implications and concluding remarks are presented in the final section. All proofs can be found in the appendix.

3.2 Model Environment

A welfare maximizing government faces a continuum of ex ante identical entrepreneurs who live for two periods. Entrepreneurs invest capital in their company in the first period and earn stochastic returns on investments in the second period. Their lifetime utility depends on consumption in Period 1 and 2 and is given by

$$U(k, \bar{c}, \underline{c}) = u(\omega - k) + \beta(\pi_k u(\bar{c}) + (1 - \pi_k)u(\underline{c})). \tag{3.1}$$

We make the following assumptions on utility: discount factor $\beta \in (0, 1)$, $u'(.) > 0, u''(.) < 0$, $\lim_{c \to 0} u'(c) = \infty$, $\lim_{c \to \infty} u'(c) = 0$. $\bar{c}$ denotes second period consumption in the high state and $\underline{c}$ denotes second period consumption in the low state.

First period consumption, $\omega - k$, is the difference between wealth endowment, ω, and capital investment, k. Assume for the moment that the distribution of initial wealth is degenerate at ω. We will relax this assumption in Paragraph 3.6.1. Entrepreneurs can choose whether to invest a small or large amount of their wealth, $k \in \left\{\underline{k}, \overline{k}\right\}$, with $0 < \underline{k} < \overline{k} \leq \omega$. Higher investments lead to lower consumption in the first period but higher expected return in the second period. Empirically, this assumption can be interpreted as entrepreneurs choosing between two projects with different financing conditions and average returns while the output in monetary terms does not inform about the types of projects.

Denote y the random gross return on capital which is produced with the following technology:

$$y = \begin{cases} \overline{y} \text{ with probability } \pi_k \\ \underline{y} \text{ with probability } 1 - \pi_k \end{cases}$$

with $\overline{y} > \underline{y}$ and $\pi_{\overline{k}} > \pi_{\underline{k}}$. Hence the expected return $E_k[y]$ is increasing in capital. We assume that it is optimal to invest $\overline{k}$ and the economy's efficiency condition $\frac{u'(w-\overline{k})}{\beta u'(E_{\overline{k}}[y]-G)} \leq \pi'_{\overline{k}}(\overline{y} - \underline{y})$ is satisfied for all levels of government revenue G.

The government has to meet the external revenue requirement G and collects its funds from entrepreneurial income in the second period. G can be interpreted as military expenses, public sector costs, or transfers to those who do not own capital. We consider a government deciding on net income or consumption levels $\overline{c}, \underline{c}$ directly instead of choosing tax schedule $T(\cdot,\cdot)$,[5] where $c = y - T(\cdot,\cdot)$ [6]. This approach is described, for instance, in the taxation principle (see Guesnerie (1998)), which implies that the set of allocations obtained by maximizing subject to an anonymous tax schedule is equivalent to the set of allocations obtained from centralized optimization with respect to consumption levels taking into account incentive feasibility.

Initial endowment ω is public information, as well as output levels and the distribution over outputs. Capital input levels are private information of the entrepreneurs and can be observed by government institutions at costs $\delta > 0$. One can claim that observing output levels is as costly as observing input levels. The focus of this chapter is to compare input control with private information on input and w.o.l.g we normalize monitoring costs of y to zero. There is no bond market and entrepreneurs cannot save.

We use a simple moral hazard environment (cf. Albanesi (2006) for capital taxation) with one significant modification to standard models: the underlying source of private information does not refer to effort input but capital input. The ultimate consequence of this change is that capital can be consumed if not invested which is not the case for effort. Hence, with non-linear utility effort costs are additively separable while capital costs are not. Moreover, this allows us to further examine wealth

[5]Note that $T(\cdot,\cdot)$ can be conditioned on input, output or both. In this chapter, we focus on comparing $T(y,\hat{k})$ with $T(y,k)$, that is a tax schedule with unobserved investment to controlled capital investment.

[6]Conditioning on y could be interpreted as output taxation, which is empirically contestable since most capital taxes are deducted from net returns to capital investments. Reducing y by the amount of invested capital gives us net returns, which can be introduced into the model by means of a stronger condition on consumption levels $\overline{c}, \underline{c} \geq \overline{k}$. This condition has an impact on the maximum revenue requirement but does not change the results qualitatively. For simplicity, we condition on consumption levels larger than zero.

effects and investment/savings decisions. Most importantly, by imposing informational frictions on capital we can interpret information acquisition in a broader context and thus provide an answer to our initial research question about government interference in private firms: if capital input is observed, the government is able to condition on its level and thus to control investments. This can be interpreted as interfering into a firm's control rights and, ultimately, as owning the firm's equity.

As δ is a cost borne by the government it enters the government budget directly and can capture various forms of distortions arising from government control next to the above mentioned monitoring costs. First, δ can reflect lower expected output or an exogenous efficiency loss from public management if the firm is controlled by the government: $E_{\overline{k}}[y\,|priv] > E_{\overline{k}}[y\,|gov]$. Here, the agents' wealth ω is taxed in the first period and used for investments in SOEs. Second, δ represents additional financing needs to keep SOEs running and these costs simply add up to the external requirement G. The costs can be higher wages in SOEs or perks and bribes to government officials-entrepreneurs. And third, for an endogenous determination of δ, this distortion can be interpreted as the consequence of a soft budget constraint arising from commitment problems. Then, property tax τ_t raised to finance (controlled) investment $\overline{k}_t$ is (partially) channeled to fill gaps in the current budget and to finance G_t. This happens, for instance, when governments maximize welfare of the current generation (with a share of agents in the investment period, α, and the other share of agents in the return period, $(1-\alpha)$: $\alpha u(w-k)+(1-\alpha)\beta E_k[u(c)]$) thereby neglecting future generations or if the government has a high discount rate while maximizing the welfare of several generations. With lower investments in period t, expected output in t+1, $E_{\underline{k}}[y_{t+1}]$, is smaller and property taxation in period t+1 has to help meeting revenue requirement G_{t+1}.

3.3 Capital Control

We first characterize the allocation of consumption and capital investment, $\{k^*, \overline{c}^*, \underline{c}^*\}$, under a capital control mechanism. The government invests in a monitoring device which allows for perfectly observing inputs at costs δ and maximizes the following

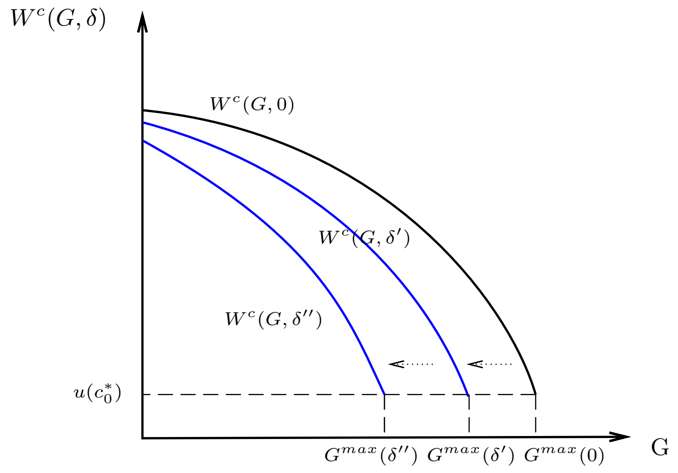


Figure 3.1: Pareto Frontiers with Different Values of δ: $0 < \delta' < \delta''$

problem subject to its budget constraint:

$$\max_{\overline{c},\underline{c}\geq 0} \quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{c}) + (1-\pi_{\overline{k}})u(\underline{c}))$$

subject to

$$BC: \quad \pi_{\overline{k}}\overline{y} + (1-\pi_{\overline{k}})\underline{y} \geq \pi_{\overline{k}}\overline{c} + (1-\pi_{\overline{k}})\underline{c} + G + \delta \tag{3.2}$$

The first order necessary conditions for $k = \overline{k}$ yield $u'(\overline{c}) = u'(\underline{c})$ and it follows that $\overline{c} = \underline{c} = c^*$. The entrepreneurs' consumption is perfectly smoothed across states and the consumption level is determined by both revenue requirement and monitoring costs:

$$BC_\delta^*: \quad c^*(G,\delta) = \pi_{\overline{k}}\overline{y} + (1-\pi_{\overline{k}})\underline{y} - G - \delta \tag{3.3}$$

As a consequence, agents are fully insured against entrepreneurial risks but face lower second period consumption due to monitoring costs.

Welfare and Comparative Statics. The Pareto frontier of the above program given exogenous G and δ is defined as

$$W^C(G,\delta) = u(\omega - \overline{k}) + \beta u(c^*(G,\delta)) \quad \forall G. \tag{3.4}$$

Denote $W^C_G(.)$ the derivative of the welfare function with respect to G. Using Equation (3.2), under capital control, welfare decreases with government revenue G

$$W^C_G(G, \delta) = -\beta u'(c^*(G, \delta)) < 0 \ \ \forall G, \tag{3.5}$$

and the welfare loss is higher the larger δ.

$$W^C_{G\delta}(G, \delta) = \beta u''(c^*(G, \delta)) < 0 \ \ \forall G \tag{3.6}$$

As we can see in Figure 3.3, an increase in δ shifts the Pareto frontier over G to the left.

3.4 Incentive Based Taxation

Under the incentive based taxation scheme, the government chooses not to monitor capital input and to design the tax schedule dependent on output only: $c = y - T(y, \hat{k})$. Entrepreneurs facing a positive average tax rate on high output levels in the second period have an incentive to reduce their capital input in the first period. Therefore, the tax schedule has to be designed such that entrepreneurs choose the socially optimal level of capital investment, $\overline{k}$.

The government faces a trade-off between insurance and efficiency: the government wants to smooth consumption and insure entrepreneurs against output risk to increase aggregate welfare. But if an entrepreneur is insured and receives the same net income in the good and bad state, expected second period consumption is equal for low and high capital investments. The entrepreneur will reduce investment and increase consumption in the first period since there is no additional gain from higher inputs. The government therefore maximizes the following program including both, resource constraint and incentive compatibility, and chooses allocations $\{k^*, \overline{c}^*, \underline{c}^*\}$:

$$\max_{\overline{c}, \underline{c} \geq 0} \ \ u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{c}) + (1 - \pi_{\overline{k}}) u(\underline{c}))$$

subject to

$$BC: \quad \pi_{\overline{k}}\overline{y} + (1-\pi_{\overline{k}})\underline{y} \geq \pi_{\overline{k}}\overline{c} + (1-\pi_{\overline{k}})\underline{c} + G \tag{3.7}$$

$$IC: \quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}}u(\overline{c}) + (1-\pi_{\overline{k}})u(\underline{c})) \geq u(\omega - \underline{k}) + \beta(\pi_{\underline{k}}u(\overline{c}) + (1-\pi_{\underline{k}})u(\underline{c})) \tag{3.8}$$

Denote μ the Kuhn Tucker multiplier of the incentive compatibility and define $\Delta\pi = \overline{\pi} - \underline{\pi}$. The first order necessary conditions with $k = \overline{k}$ are

$$u'(\overline{c})(1 + \mu\frac{\Delta\pi}{\pi_{\overline{k}}}) = u'(\underline{c})(1 - \mu\frac{\Delta\pi}{1-\pi_{\overline{k}}}), \tag{3.9}$$

,

hence $u'(\overline{c}^*) < u'(\underline{c}^*)$ and $\overline{c}^* > \underline{c}^*$. Incentive compatibility requires that consumption be state dependent and there is only imperfect consumption smoothing and partial insurance: the social planner will allocate more consumption in good states and less consumption in bad states. The larger μ, i.e the weight of the incentive compatibility constraint, the higher consumption levels in good states and the lower in bad states.

3.4.1 Tax Design

In this section we analyze how state dependent equilibrium consumption changes with the revenue requirement. We therefore decompose consumption into two components which we label level and spread component. The former is fully determined by the budget constraint, the latter reflects incentive effects. Combining Equations (3.2) and (3.7), we can write:

$$BC^*: \quad \pi_{\overline{k}}\overline{y} + (1-\pi_{\overline{k}})\underline{y} - G = \pi_{\overline{k}}\overline{c}^* + (1-\pi_{\overline{k}})\underline{c}^* = c^*(G, \delta = 0) \tag{3.10}$$

In equilibrium, expected consumption under incentive based taxation equals consumption under full information with no monitoring costs. In the following, we will label $c^*(G, \delta = 0) \equiv c^*(G)$ benchmark consumption and refer to the ensuing equilibrium welfare as benchmark Pareto frontier. Let $\overline{c}^* \equiv c^*(G) + \overline{\epsilon}^*(G)$ and $\underline{c}^* \equiv c^*(G) + \underline{\epsilon}^*(G)$.

Thus,

$$c^*(G) = \pi_{\overline{k}}(c^*(G)+\overline{\epsilon}^*(G))+(1-\pi_{\overline{k}})(c^*(G)+\underline{\epsilon}^*(G)), \text{ with } E[\epsilon^*(G)] = 0 \; \forall G \geq 0. \quad (3.11)$$

At given G, the planner introduces a lottery over consumption and generates uncertainty to meet incentive compatibility, with ϵ_i^* being the spread between consumption in the realized state of nature i and expected consumption c^*.

Lemma 1. *The spread in consumption has the following properties:*

(i) The spread in consumption ϵ_i^* varies with G. The larger G, i.e. the smaller $c^*(G)$, the smaller the spread: $\overline{\epsilon}'^*(G) < 0$ and $\underline{\epsilon}'^*(G) > 0$

(ii) The expected change in spreads due to an increase in G must equal zero: $\pi_{\overline{k}}\overline{\epsilon}'^*(G) + (1 - \pi_{\overline{k}})\underline{\epsilon}'^*(G) = 0$

The central idea of Lemma 1 is that higher government revenue leads to a more 'progressive' tax system. [7] The spreads in consumption capture the variance in ex post net income levels. When this variance is smaller, the tax system offers a larger degree of social insurance and is more redistributive.

The mechanism at work is as follows. The government introduces uncertainty over incomes to incentivize entrepreneurs to invest the socially optimal level of capital. The spreads are chosen such that expected second period utility from high investment compensates lower first period utility. Given concavity of u(.), at high G and low c^* already small deviations from c^* trigger the variance in state utilities necessary to meet incentive compatibility. However, at low G and high c^*, the planner has to introduce a relatively large spread for the same variance in utilities. Thus, the spread decreases in G.

3.4.2 Incentive Costs and Government Revenue

Given that progressivity increases with G we now study how this effect influences welfare. As entrepreneurs are risk averse, the spreads in consumption cause a loss in

[7] In this study, we use a broader definition of progressivity than in the traditional optimal taxation literature where progressivity refers to marginal tax rates which we do not specify explicitly in this chapter. Here, a tax system is progressive if low income is taxed less than high income.

welfare which we label incentive costs. These costs can be increasing, decreasing or constant in G. The size of incentive costs is determined by the difference between benchmark welfare with zero monitoring costs, $W^C(G,0)$, and welfare under the incentive based taxation scheme, $W^{IN}(G)$, $\Delta W(G) = W^C(G,0) - W^{IN}(G)$. In the following we analyze how the costs of maintaining an incentive based taxation evolve with G.

The Pareto frontier under an incentive based taxation scheme can be written as

$$W^{IN}(G) = u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(c^*(G) + \overline{\epsilon}^*(G)) + (1 - \pi_{\overline{k}}) u(c^*(G) + \underline{\epsilon}^*(G))). \qquad (3.12)$$

As incentive compatibility is binding in equilibrium for any G[8], by taking the derivative w.r.t G we know that

$$u'(c^*(G) + \overline{\epsilon}(G))(-1 + \overline{\epsilon}'(G)) = u'(c^*(G) + \underline{\epsilon}(G))(-1 + \underline{\epsilon}'(G)). \qquad (3.13)$$

Using Lemma 1 (i) and Equation (3.13), and taking the derivative of Equation (3.12) w.r.t. G we see that welfare under incentive based taxation is strictly decreasing in G:

$$W^{IN}_G(G) = -\beta u'(c^*(G) + \epsilon(G))(1 - \epsilon'(G)) \ < 0 \ \ \forall G, \epsilon \in \{\overline{\epsilon}, \underline{\epsilon}\}. \qquad (3.14)$$

Two forces are driving the decline in welfare, an income effect and a substitution effect. First, transferring resources to the government lowers the level of consumption for entrepreneurs. Second, by concavity of $u(.)$, at lower consumption levels incentive compatibility becomes less constraining and the government can substitute incentive for insurance provision and spreads adapt.[9]

To see how incentive costs evolve in G, we analyze the difference between marginal benchmark welfare and marginal incentive taxation welfare. By expressing spreads in terms of marginal utility and applying Jensen's inequality, we can infer conditions determining whether the change in incentive costs is positive or negative, as stated in

[8] If incentive compatibility was not binding, the government could reduce consumption in the good state and allocate more in the bad state, which would be Pareto improving.

[9] Note that although income and substitution effects are opposing forces, it is still possible that incentive costs increase due to the impact of uncertainty on utility.

Proposition 2.

Let $a(c) = -\frac{u''(c)}{u'(c)}$ be the coefficient of risk aversion and $p(c) = -\frac{u'''(c)}{u''(c)}$ be the coefficient of prudence [10]. Define $P(c) = \frac{p(c)}{a(c)}$ the ratio between prudence and risk aversion, as in Low and Maldoom (2004). Risk aversion can be understood as the demand for insurance whereas prudence or precautionary motives provide incentives for capital investments in an uncertain environment, which reduces the need for insurance. As summarized in Proposition 2, the welfare loss from incentive based taxation crucially depends on the ratio of entrepreneurial prudence to risk aversion.

Proposition 2. *Incentive costs*

(i) are constant in G if and only if $P(c) = 2$,

(ii) decrease in G if and only if risk aversion dominates and the prudence to risk aversion ratio is sufficiently small, $P(c) < 2$, and

(iii) increase in G if and only if precautionary motives dominate and the prudence to risk aversion ratio is sufficiently large, $P(c) > 2$

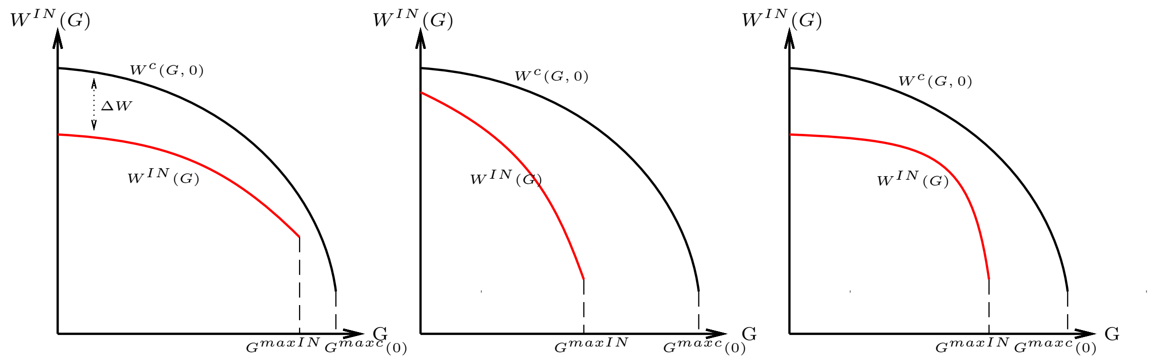
Under incentive based taxation, the slope of the Pareto frontier for the respective cases described in Proposition 2 is (i) equal; (ii) flatter; and (iii) steeper than the slope of the benchmark Pareto frontier. If the ratio of risk aversion to prudence is increasing with G, $P'(c) < 0$,[11] the slope, for instance, can first be flatter and then steeper than the benchmark Pareto frontier. The latter cases are depicted in graphs 3.2, a-c.

The trade-off between demand for insurance and motivation to invest determines the evolution of incentive costs. If entrepreneurs are sufficiently risk averse, the spread necessary to provide appropriate investment incentives is small at lower levels of consumption due to the curvature of u(.) and the increase in progressivity due to an increase in G is strong.[12] Moreover, a more progressive tax system is

[10] These coefficients are, in particular, analyzed in the context of precautionary saving behavior, see Kimball (1990).

[11] Entrepreneurs with low consumption levels will be more inclined to invest while those with high consumption levels are rather risk averse.

[12] A positive effect of risk aversion on progressivity has also been observed by Low and Maldoom (2004) who consider a principle agent model with continuous effort choice but no revenue requirement. The authors parametrize their model and find that risk aversion increases progressivity while precautionary motives decrease progressivity.



a: Incentive costs are decreasing. b: Incentive costs are increasing. c: Incentive costs decreasing and increasing

Figure 3.2: Incentive Costs According to Preference Regime

particularly beneficial for aggregate welfare in case of dominating risk aversion and small consumption levels. Therefore, if risk aversion is relatively large and dominates precautionary incentives, a larger G reduces incentive costs.

In turn, more prudent entrepreneurs derive their investment incentives from the possibility of achieving a high income. Reducing the high state income level by smoothing consumption over states and transferring resources to the government deters incentives more strongly as under dominance of risk aversion. Thus, the spread albeit decreasing with G will decrease less quickly. An alternative explanation establishes a link to the literature of precautionary savings. Here, agents behave prudently and save more in one period when they face uncertain outcomes in the next period. The larger the uncertainty the more agents are likely to save. For entrepreneurs, savings corresponds to the capital investment that they don't consume in the first period. A prudent entrepreneur is thus less likely to invest if the consumption spread is small.

The above conditions can be expressed by all standard utility functions. Consider, for instance, isoelastic utility functions within the HARA class. In their case, the prudence to risk ratio is constant with $P(c) = \frac{1+\nu}{\nu}$, where ν is the coefficient of relative risk aversion. Incentive costs decrease if CRRA risk aversion is sufficiently large, i.e. $\nu > 1$. Incentive costs also decrease under quadratic utility or CARA. Incentive costs are constant, i.e. the decline in welfare with increasing G under incentive based taxation and the benchmark case is equal, in case of log utility, where $\nu = 1$. A sufficiently small coefficient of risk aversion $\nu < 1$ leads to an increase in incentive costs. Considering non-HARA functions, the ratio P(c) will depend on the level of consumption and a combination of both regimes is possible. At low levels of consumption, prudence dominates while risk aversion is more important at higher levels of consumption.

Several empirical studies attempt to measure the actual coefficient of relative risk aversion of an economy. As summarized by Browning et al. (1999), the estimation results from these studies vary from 0.64 to 4 with an average around 2.5. This would suggest a prevalence of the insurance economy in our research. However, these studies mainly rely on consumption data from the US. Entrepreneurial risk aversion is very likely to be lower. Also, studies from emerging economies in Asia and Latin America point towards relatively low levels of relative risk aversion for some countries[13].

3.5 Optimal Revenue Collecting Mechanism

We have shown that under capital control higher monitoring costs amplify the decline in welfare due to an increase in revenue requirement. Under incentive based taxation costs can either exacerbate or dampen welfare losses depending on the ratio of prudence to risk aversion, i.e. on the desire for insurance relative to the motivation to invest from income uncertainty. As, by definition, the incentive tax Pareto frontier is independent of monitoring costs, incentive taxation will be preferred more strongly the larger monitoring costs.

The crucial question remains at which level of revenue requirement should the government choose which system for a given δ. We answer the question by first considering the benchmark welfare with zero monitoring cost. Subsequently, we define an interval for positive monitoring costs such that both welfare functions intersect and finally we analyze which system dominates before and after the intersection.

Comparing Incentive Taxation Welfare to Benchmark Welfare. If monitoring costs of capital inputs δ equal zero, the government chooses capital control taxation instead of incentive based taxation for any non-negative revenue requirement G which

[13]See, for instance, Panopoulou (2008).

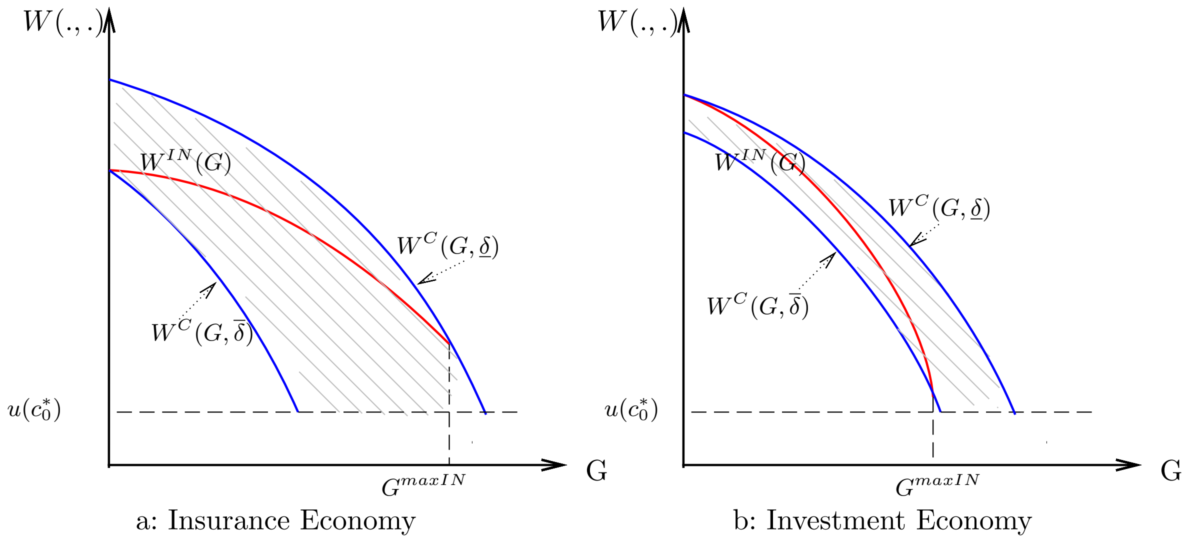


Figure 3.3: Intervals for Monitoring Costs

do not exceed the economy's total surplus, $\pi_{\overline{k}}\overline{y} + (1 - \pi_{\overline{k}})\underline{y}$.

$$\begin{aligned} W^C(G, \delta = 0) =& u(\omega - \overline{k}) + \beta u(c^*(G)) \\ =& u(\omega - \overline{k}) + \beta u(\pi_{\overline{k}} u(\overline{c}^*(G)) + (1 - \pi_{\overline{k}}) u(\underline{c}^*(G))) \\ >& u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{c}^*(G)) + (1 - \pi_{\overline{k}}) u(\underline{c}^*(G))) = W^{IN}(G) \quad \forall G \end{aligned}$$

Using Jensen's inequality and concavity of u(.) we see that welfare with no monitoring costs and perfect information on inputs is larger than welfare under the incentive based taxation scheme.

Positive Monitoring Costs. To compare the entrepreneurs' welfare under the two taxation systems we will define a range for δ within which an intersection of the welfare curves takes place. Let G^{maxIN} be the maximal government revenue which can be raised under incentive based taxation and $\Delta W(0)$ the incentive costs at $G = 0$.

Lemma 3. *There exists an interval* $[\underline{\delta}, \overline{\delta}]$ *such that the two welfare curves intersect. The cut-off value is denoted* $G^o(\delta) \in [0, G^{maxIN}]$.

As can be also seen in Figure 3.3, if $\delta < \underline{\delta}$, capital control is optimal for all G. If $\delta > \overline{\delta}$, the incentive based mechanism is optimal for all G. The interesting case arises when monitoring costs are moderate and lie within the defined interval. If P(c) is decreasing in c, the two welfare curves intersect up to two times within the interval $[\underline{\delta}, \overline{\delta}]$, with cut-off values $G_1^o(\delta), G_2^o(\delta) \in [0, G^{maxIN}]$.

In the following we describe the choice path of the optimal revenue generating mechanism dependent on the preference regime of the economy. We restrict attention to $\Delta W(0)$ sufficiently small[14] and moderate levels of monitoring costs $\delta \in [\underline{\delta}, \overline{\delta}]$. The proofs follow from the definition of the interval of monitoring costs, Lemma 3, and the characterization of incentive costs, Proposition 2.

Insurance Economy. Entrepreneurs in this regime have a stronger preference for insurance and ex post redistribution of outcomes and their risk aversion dominates precautionary effects from investment. The government chooses interference into control rights of capital for sufficiently small values of revenue requirement:

Proposition 4. *When entrepreneurs are relatively more risk averse than prudent,* $P(c) < 2$ *and (i) if* $G \in [0, G^o(\delta)]$*, capital control dominates incentive based taxation; and (ii) if* $G \in (G^o(\delta), G^{maxIN}]$*, incentive based taxation dominates capital control.*

Under capital control, an increase in G translates into a pure income effect which is amplified by the level of δ. Under incentive based taxation, an increase in G triggers both an income and substitution effect, as described in Section 3.4.2 on the nature of incentive costs. Entrepreneurial income decreases due to transfers to the government. As entrepreneurs are risk averse, a lower income relaxes incentive compatibility and the tax system can insure entrepreneurs more. Put differently, the government can substitute incentive provision with insurance. In an insurance economy with a large revenue requirement G, the curvature of the entrepreneurs' utility function is then bended enough to grant such a high level of insurance while meeting incentive compatibility that the incentive tax triggers smaller welfare losses than capital control.

Investment Economy. Under this preference set, entrepreneurs face stronger motivation to choose high capital investment and act in a precautionary matter when facing risky future income. As a consequence, redistribution is less desirables than

[14] I.e. $\Delta W(0) < \overline{W} = WC(0,0) - \overline{W}^{IN}(0)$, with $\overline{W}^{IN}(0) : \overline{W}_G^{IN}(G)|_{G=0} = W_G^C(G)|_{G=\delta}$

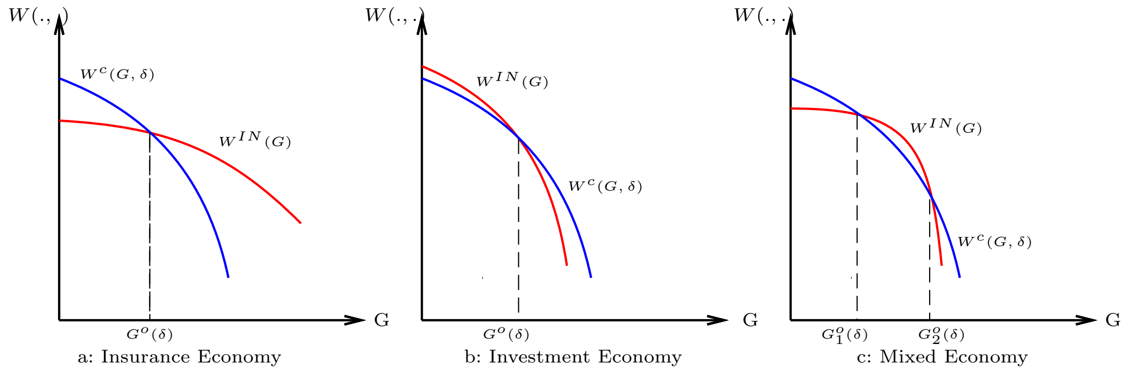


Figure 3.4: Optimal Revenue Generating Mechanism

under a social insurance economy. In this case, the government will choose capital control taxation if the revenue requirement is sufficiently large:

Proposition 5. *When entrepreneurs are relatively more prudent than risk averse, $P(c) > 2$, and (i) if $G \in [0, G^o(\delta)]$, incentive based taxation dominates capital control; and (ii) if $G \in (G^o(\delta), G^{maxIN}]$, capital control dominates incentive based taxation.*

Entrepreneurial motivation to invest is derived from the potential of achieving a high output. By increasing G, the entrepreneurs' intrinsic source of motivation is eroding which slows down the reduction in spreads. Hence the substitution of incentive provision by insurance can not be large enough to offset the losses in income from additional transfers and uncertainty. Incentive costs increase, welfare losses become more pronounced and, at a large enough revenue requirement, capital control offers a higher level of welfare.

Finally, if the population's demand for insurance is decreasing in income, the government will choose capital control for low and high values of G, and implement incentive based taxation for intermediate values of G. The optimal choice path of tax systems for the respective regimes is depicted in Figure 3.4, a-c.

On the Role of Concavity With risk neutral entrepreneurs and linear utility, $u = \omega - k + \beta(\pi\bar{c} + (1-\pi)\underline{c})$, there is no need for the government to insure agents across states and incentive costs are zero. Incentive taxation strictly dominates capital control for all $\delta > 0$ and $G \in [0, G^{max}]$, see Figure 3.5.

The only case for the government to interfere into the investment decision is for small enough values of δ and high revenue requirements $G > G^{max}$. In this case

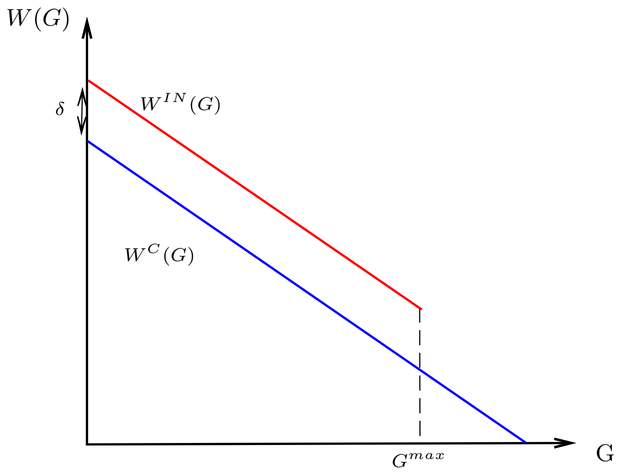
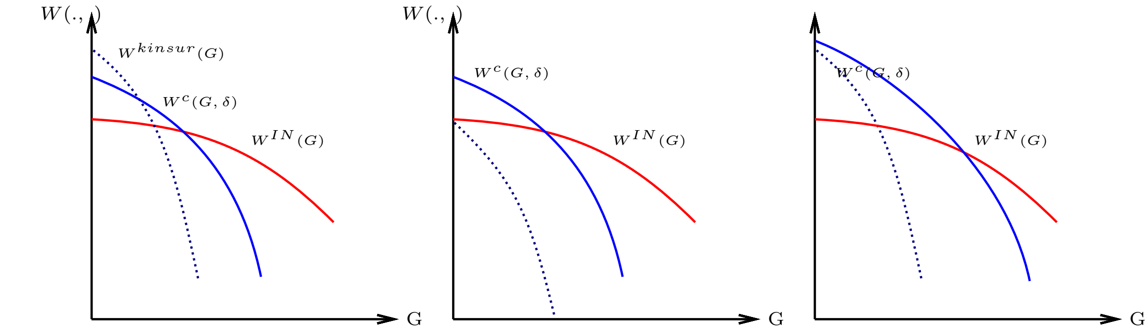


Figure 3.5: Optimal Mechanism with Risk Neutral Entrepreneurs

incentive compatibility requires more resources for $\bar{c}$ ($\underline{c} = 0$) than the budget is able to allocate. Hence, a mechanism based on incentive taxation is no longer feasible while capital control is.

The third option: investing $\underline{k}$ and providing full insurance For some parameter values of G and δ, it can be optimal for the government to smooth the agents' second period consumption perfectly and to allow for a higher first period consumption due to lower investments ($\underline{k}$-insurance). The existence of this option has no impact on the properties of incentive costs as described above. Whether $\underline{k}$-insurance is chosen depends, in particular, on the output differential of the two technologies, $E_{\bar{k}}y - E_{\underline{k}}y$, and monitoring costs δ.

If $P(c) \leq 2$, the slope of $\underline{k}$-insurance is always steeper than the slope of incentive taxation: $W_G^{IN} > W_G^{\underline{k}ins}$ $\forall$ G. This can be derived from two inequalities: (i) welfare under $\underline{k}$-insurance is strictly lower than under first best and declines faster with G: $W_G^{FB} > W_G^{\underline{k}ins}$ due to a lower second period utility under $\underline{k}$-insurance, $E_{\bar{k}}y > E_{\underline{k}}y$; (ii) from section 3.4.2, we know that $W_G^{IN} > W_G^{FB}$. Hence, if there exists an intersection between the Pareto frontier of the incentive mechanism and the one of $\underline{k}$-insurance, then $\underline{k}$-insurance will intersect from above. Whether there is an intersection depends on the level of welfare at $G = 0$. The lower $E_{\underline{k}}y$, the lower the second period utility of $\underline{k}$-insurance (and the higher second period utility of incentive taxation) - this relation



$\underline{k}$-insurance for lower values of G — Output difference large enough — δ small enough

Figure 3.6: Insurance with Low Capital Investment

holds independent of the properties of the second and third derivative of the utility function. Incentive taxation yields a higher welfare $\forall G$ if, at $G = 0$ [15]

$$E_{\bar{k}}u(c) \geq \frac{\Delta u_0}{\beta} + u(E_{\underline{k}}y) \tag{3.15}$$

Intuitively, the lower G, the more the agent can consume in the second period. With concavity, the more the agent can consume in the second period, the less she is inclined to invest in the first period. In addition, the value of consumption smoothing (full insurance) in the second period decreases relatively to incentive provision with larger G as incentive provision becomes cheaper. Put differently, if insurance is better than incentives, then only for lower values of G.

Alternatively, even if condition 3.15 is not met, $\underline{k}$-insurance is not necessarily optimal as capital control could still yield higher welfare: If $\delta < E_{\bar{k}}y - E_{\underline{k}}y$, the slope of the Pareto frontier is flatter for the capital control mechanism than for $\underline{k}$-insurance and we can state the following inequality: $W_G^{IN} > W_G^C > W_G^{\underline{k}ins}$. For capital control to dominate $\underline{k}$-insurance for all values of G, we need to assume that

$$\delta \leq E_{\bar{k}}y - u^{-1}(\Delta u_0 + \beta u(E_{\underline{k}}y)). \tag{3.16}$$

Figure 3.6 depicts the above derived results.

[15] With log utility, the condition for incentive taxation always being better than $\underline{k}$-insurance is: $\frac{E_{\bar{k}}y}{E_{\underline{k}}y} \geq \pi_{\bar{k}}(\frac{\omega-\underline{k}}{\omega-\bar{k}})^{\frac{1-\pi_{\underline{k}}}{\Delta\pi\beta}} + (1-\pi_{\bar{k}})(\frac{\omega-\underline{k}}{\omega-\bar{k}})^{\frac{-\pi_{\underline{k}}}{\Delta\pi\beta}}$. Log utility implies that P(c)=2, hence incentive costs are constant. Then, there exists a $\delta > 0$ such that for lower G control is optimal and for higher G incentive taxation is optimal.

If $P(c) > 2$, assumption 3.16 is still applicable for $\underline{k}$-insurance not being optimal. When analyzing the relation between $\underline{k}$-insurance and incentive taxation we need to consider an additional aspect: the slope of incentive taxation relative to $\underline{k}$-insurance can be larger, equal or lower (see also the comparison to the control mechanism, see footnote 14). The intuition is that, although with lower G, the agent consumes more and is less inclined to invest, the value of consumption smoothing becomes more important at high values of G. There are hence two countervailing forces which determine the relative position of the slopes. Assume that delta is not too small. Then, the optimal revenue generating mechanism can not be, for instance, with increasing G: incentive taxation, control, $\underline{k}$-insurance. The following option, however is possible: $\underline{k}$-insurance, incentives, control. If delta is small enough or the output differential high enough, we are back to the original sequence for increasing G: incentives, control.

In the following analysis we focus on the two main mechanisms, incentive provision and control, and thus assume that $\underline{k}$-insurance yields lower welfare than any of the two mechanisms for all levels of G.

3.6 Analysis

3.6.1 Revenue Generation Under Wealth Heterogeneity

In this paragraph we consider the impact of an economy's wealth distribution on the above derived results about the government's choice of its revenue collection mechanism. We now assume that the distribution of wealth is no longer degenerate but that the endowment ω is distributed over the interval $[\underline{\omega}, \overline{\omega}]$, where $\underline{\omega} \geq \overline{k}$ and the distribution is exogenous.

When rearranging incentive compatibility we have the following inequality:

$$\Delta\pi\beta(u(\overline{c}) - u(\underline{c})) \geq u(\omega - \underline{k}) - u(\omega - \overline{k}) \tag{3.17}$$

The right hand side is the difference in first period utilities, $\Delta u(\omega)$, which is due to different capital needs of entrepreneurial projects. As $\frac{\partial(\Delta u(\omega))}{\partial \omega} < 0$, a higher level of initial wealth ω leads to a smaller difference in first period utilities. The latter, in turn, allows for a smaller spread in second period state dependent utility and thus lower incentive costs, ceteris paribus. As shown in in Paragraph 3.4.2 incentive compatibility is binding in equilibrium. Hence - maintaining the assumption of no property taxes - wealth heterogeneity has an impact on the contract the government designs under incentive taxation while it has no influence on monitoring costs. We can thus derive directly Proposition 6.

Proposition 6. *For a given level of revenue requirement G and monitoring costs δ*

(i) Incentive costs decrease with initial wealth ω.

(ii) There exists a wealth level $\hat{\omega}(G, \delta)$, such that all entrepreneurs with higher initial wealth, i.e. $\omega \geq \hat{\omega}(G, \delta)$, are incentive-taxed and all entrepreneurs with lower initial wealth, i.e. $\omega < \hat{\omega}(G, \delta)$, are controlled.

In a simplifying manner, Proposition 6 says that if the government faces a population of agents who own capital and were to choose how to collect revenues from their returns to capital, at given levels of monitoring costs the government would provide incentives for the rich and control the poor.

This result can be taken to a different level of aggregation. Next to the heterogeneity of wealth across entrepreneurs, we can also consider wealth inequality across countries. A testable hypothesis with this regard would be that we should observe more government interference in poorer countries and less control in richer economies.

Note that a similar result is obtained if a larger variance in the level of capital investment k is considered.

3.6.2 Private Insurance Market

In their seminal paper on moral hazard economies, Prescott and Townsend (1984) show that the first welfare theorem holds and competitive equilibrium allocations are Pareto optimal in a decentralized insurance market for contracts with individually effected and private information dependent options. One might argue that, in our environment, private insurance firms can take over the job of insurance provision and taxation becomes less costly for the government relative to capital control.

In the following, we will show that the existence of private insurance markets does not change our results on the choice of the optimal revenue collection mechanism. Even though insurance is provided privately, governments facing a revenue requirement G will still collect taxes from the agents 'insured' state dependent gross income. For optimality, taxes need to respect incentive compatibility and we face the same path of incentive costs as under a purely public social security scheme. Obviously, the government could also tax insurance companies directly instead of taxing entrepreneurs. This, again, would not change the results. We would then compare capital control to taxation of insurance companies which fully pass through their tax burden to entrepreneurs. The resulting pricing schedule is the same as our previous tax schedule.

Consider an economy with free entry into the private insurance market and a government facing a revenue requirement G. As in Prescott and Townsend (1984), agents will choose the insurance contract which is best for them. Alike the State, private firms have no information on the level of capital. They offer a state dependent transfer m and collect the entrepreneurial output y. The government, in turn, taxes state dependent income m and offers state dependent consumption c.

Without loss of generality, we assume that entrepreneurs announce truthfully the level of capital they invested in their projects. Hence the optimal, incentive feasible contract offered by competitive insurance firms smooths entrepreneurial income in the second period[16] and specifies the allocation of capital and state dependent insurance payments $\{k, \overline{m}, \underline{m}\}$.

$$\max_{\overline{m},\underline{m}\geq 0} \quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{m}) + (1-\pi_{\overline{k}})u(\underline{m}))$$

subject to

$$\begin{aligned} PC_{insurance}: &\quad \pi_{\overline{k}}\overline{y} + (1-\pi_{\overline{k}})\underline{y} \geq \pi_{\overline{k}}\overline{m} + (1-\pi_{\overline{k}})\underline{m} + G \\ IC: &\quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{m}) + (1-\pi_{\overline{k}})u(\underline{m})) \geq u(\omega - \underline{k}) + \beta(\pi_{\underline{k}} u(\overline{m}) + (1-\pi_{\underline{k}})u(\underline{m})) \end{aligned}$$

The problem the insurance companies face is exactly the same problem the government faces under section 3.4 with zero revenue requirement. Subsequently, in equilibrium, there is only partial consumption smoothing and consumption spreads are

[16] For simplicity, we abstract from intertemporal insurance. Entrepreneurs could shift their wealth over time which is optimal for them as we face discrete choice of capital. This does not change the nature of our results and would be irrelevant if investment was continuous.

equal to those in section 3.4 when setting $G = 0$. It follows that the participation constraint is binding as well as incentive compatibility.

Consider now the 'new' optimization problem of the government which taxes the second period gross state dependent income of all entrepreneurs, $\overline{m}, \underline{m}$:

$$\max_{\overline{c},\underline{c}\geq 0} \quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{c}) + (1 - \pi_{\overline{k}}) u(\underline{c}))$$

subject to

$$\begin{aligned} BC_{gov}: & \quad \pi_{\overline{k}} \overline{m} + (1 - \pi_{\overline{k}}) \underline{m} \geq \pi_{\overline{k}} \overline{c} + (1 - \pi_{\overline{k}}) \underline{c} + G \\ IC: & \quad u(\omega - \overline{k}) + \beta(\pi_{\overline{k}} u(\overline{c}) + (1 - \pi_{\overline{k}}) u(\underline{c})) \geq u(\omega - \underline{k}) + \beta(\pi_{\underline{k}} u(\overline{c}) + (1 - \pi_{\underline{k}}) u(\underline{c})) \end{aligned}$$

Comparing these two problems with the original environment without private insurance market, it is obvious that the same second period consumption levels are reached. The government simply pools expected insured income, which is equal to expected non-insured income, collects G and allocates incentive compatible consumption levels as before.

To summarize, private insurance firms improve the welfare of entrepreneurs by partially smoothing their incomes. Figure 3.7 depicts starting point A of entrepreneurial welfare without any insurance and point B with (private) insurance. As soon as the government raises funds, expected second period consumption decreases and we see a downward sloping welfare function w.r.t. G. See revenue level G' (G") and welfare at point C' (C") in Figure 3.7. The government can only raise revenues optimally in an incentive compatible way and this implies the same consumption schedule as we have seen in section 3.4. Finally, the actual slope is determined by the ratio of prudence to risk aversion.

Essentially, when considering again the role of the government in an economy with no or imperfect insurance of entrepreneurial income, the government has two roles: revenue collection and insurance provision, which can be interpreted as some form of social security. In our environment, the insurance part can be 'out-sourced' to a competitive insurance markets. If the government taxes entrepreneurs directly, it insures entrepreneurs in addition to the insurance provided by the private insurer, as

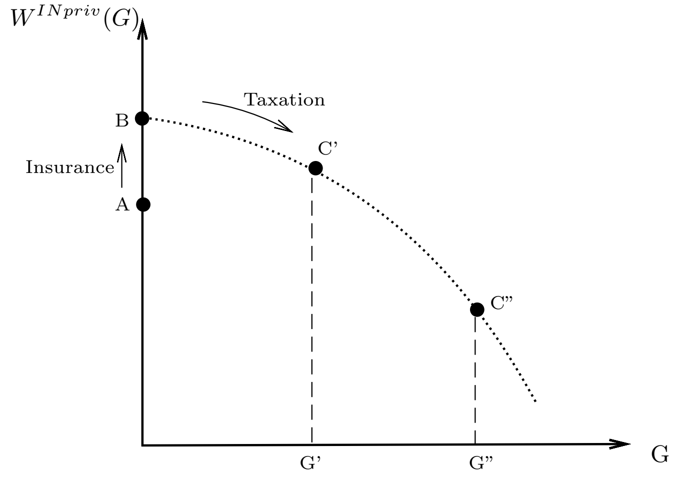


Figure 3.7: Private Insurance Market and Public Revenue Generation

consumption spreads decrease and progressivity increases with G. This does not affect incentive costs and welfare and thus the decision whether to control capital investments or not.

Note that this result, combined with our findings in the previous paragraph (3.6.1) are clearly different to the insights from Newman (2007). He finds that with private insurance markets poorer agents become entrepreneurs as opposed to wealthier ones. The reason is the two period setup and the different role that wealth plays in this model.

3.6.3 Continuous Capital Investment

If capital investment is no longer discrete but continuous and $k \in \left[\underline{k}, \overline{k}\right]$ with $\omega > \overline{k} > \underline{k} > 0$, the above described properties of the two revenue generating mechanisms are still valid. With continuous capital input, the government is able to (partially) smooth the entrepreneurs' consumption not only across states but also over time. Under the incentive based mechanism, the government's objective is to design a tax system, $\{k^*, \overline{c}^*, \underline{c}^*\}$ such that welfare is maximized and the resource constraint as well as the entrepreneurs' incentive compatibility are satisfied, with the latter being:

$$u'(\omega - k) = \beta\pi'(k)(u(\overline{c}) - u(\underline{c})) \tag{3.18}$$

Whenever the government wants to implement a positive capital input $k > 0$ corresponding to the equilibrium contract, it needs to offer a positive spread in state dependent utility, $u(\overline{c})-u(\underline{c})$, and hence consumption for all entrepreneurs in the second period, $\overline{c} > \underline{c}$.

Lemma 7. *For all $k > 0$, second period consumption in the successful state must be larger than consumption in the less successful state, $\overline{c} > \underline{c}$.*

The positive consumption spread has exactly the same properties as in the discrete case since Proposition 2 is valid irrespective of the number of levels of k.

Proposition 8. *If $P(c) < 2$ and G increases, incentive costs decrease. If $P(c) > 2$ and G increases, incentive costs increase.*

This leaves us with the same slope properties of the efficiency frontier for the incentive taxation mechanism as in the previous two level environment. With respect to capital control, by definition, monitoring costs are independent of considerations on incentive provision. With perfect information on continuous capital investment, perfect consumption smoothing is possible, across states and over time. The slope, as before, is determined by the level of revenue requirement and monitoring costs. Consequently, for both mechanisms, the behavior of the efficiency frontiers with respect to the revenue requirement is the same as under the previous discrete problem and the government's choice of the optimal revenue generating mechanism follows from Propositions 4 and 5.

3.7 Policy Implications and Concluding Remarks

In this chapter we augment the traditional optimal taxation problem with a binary choice of the government about the tax system to use for the generation of revenue. We first describe a tax system in which the government relies on controlling capital inputs and pays for observability. Second, we characterize allocations under a tax system which renounces to monitor capital inputs but designs an incentive compatible tax schedule.

Under both systems, costs arise from taxing entrepreneurial rents. But cost structures are different along the feasible revenue requirement measure. When comparing these costs we find that interference into control rights is chosen (i) in an investment economy, where prudence dominates risk aversion, for higher levels of revenue requirement and (ii) in a social insurance economy, where risk aversion dominates prudence, for lower levels of revenue requirement. An income effect and an insurance/incentive substitution effect are the drivers of this result, with the ratio of prudence to risk aversion leading the direction. Finally, these results are dependent on the level of monitoring costs.

Real World Tax Systems. Obviously, both mechanisms, capital control and incentive taxation, are not images of real world tax systems. However, capital control can proxy an institutional set-up in which the government interferes into the control rights of firms. Here, δ can also be interpreted as an output loss capturing inefficiency of government control or ownership. Also, perfect consumption smoothing - as under capital control - corresponds to a constant wage payment independent of the realization of output.

Incentive based taxation can proxy a tax system in which firms report their returns on balance sheets without documenting in detail the specific use of their capital inputs making it intractable for tax authorities to pin down size of input and associated project output. The resulting tax schedule is non-linear and automatic stabilizers smooth consumption but do not fully insure against entrepreneurial risk.

The framework delivers a differentiated picture about the choice of the two tax systems depending on several parameters which can be chosen according to country specifics. Monitoring costs (or efficiency losses), for instance, vary from sector to sector within an economy. They are potentially higher for services than for resource extraction. Revenue requirement and, to some extent, the preference regime apply for the entire economy, but vary significantly across countries.

Five implications of the model deserve emphasis. First, the higher the demand for insurance, the relatively better the incentive based system.[17] Second, at large revenue requirements, capital control dominates incentive based taxation only if the economy

[17]Note that this result is counterintuitive at first glance when interpreting ex post insurance across entrepreneurs as some form of social security. The stronger the preferences for social security, the better performs incentive based taxation and not capital control.

is sufficiently prudent. Third, for sectors or economies with high monitoring costs, incentive based taxation yields a higher welfare than capital control independent of revenue requirement and preference regime. Fourth, the wealthier an economy, the less government interference is optimal and fifth, if there is heterogeneity in wealth across entrepreneurs within the economy, there exists allocations in which it is optimal for the government to incentive-tax rich entrepreneurs and control poor entrepreneurs.

Stylized Facts and Policy. How do these implications square with stylized facts? Most developing economies, for instance, feature low government revenue as share of their output: 15.2% of GDP on average over the past 20 years, according to IMF (2011). Moreover, automatic stabilizers are rarely in place, suggesting a low degree of consumption smoothing. If this correlates with a preference regime with low risk aversion and demand for social insurance corresponding to an 'investment economy', incentive based taxation would be the optimal revenue generation mechanism. However, if the revenue requirement in such an economy increases due to wars or natural desasters, for instance, a shift to capital control taxation for sectors with low enough monitoring costs would be efficient.

In advanced economies, in particular in European welfare states, the share of the public sector to GDP is relatively high, averaging 41.5% of GDP for 30 OECD countries (IMF (2011)). Moreover, tax systems are highly redistributive. If this goes along with the economy's demand for social insurance, incentive based taxation is the welfare maximizing mechanism. This economy would be better off under capital control only if the revenue requirement is reduced, i.e. by discovery of natural resources, for instance.

To summarize, capital control is chosen under more unconventional combinations of preferences and revenue requirement: first, if governments face a low revenue requirement although the population has a high redistributive motive, and second, if a high revenue requirement must be raised from a prudent, incentive driven population. In these cases, interference into the control rights of capital input leads to a higher welfare of exactly those who are taxed.

For the sake of tractability, the underlying theoretical framework abstracts from some factors which potentially influence the decision of controlling capital such as labor input and thus labor taxation. It is also not possible for entrepreneurs to save. These two extensions are subject to future work. Further, government revenue under the current model is purely exogenous. It could be used for the provision of public goods, for instance, which would enter the utility of entrepreneurs. Moreover, it would be interesting to endogenize the revenue requirement by means of a political economy framework. This positive extension to a so far normative environment would allow for determining government revenue by an electorate with a given preference regime and a government offering both, tax schedule and tax system associated with preferences and revenue levels.

3.A Technical Appendix

Proof. (Lemma 1)

Incentive compatibility and can be written as:

$$u(c^*(G)+\overline{\epsilon}(G)) - u(c^*(G)+\underline{\epsilon}(G)) = \frac{u(\omega-\underline{k}) - u(\omega-\overline{k})}{\Delta\pi\beta} \tag{3.19}$$

Assume $\epsilon'(G)=0$, i.e. the spread in consumption ϵ is independent of G. As incentive compatibility is binding for any equilibrium given $G \in [0, G^{max}]$, a change in G must meet

$$-u'(c^*(G)+\overline{\epsilon}(G)) + u'(c^*(G)+\underline{\epsilon}(G)) = 0 \tag{3.20}$$

which is a contradiction, as $u'(\underline{c}^*) < u'(\overline{c}^*)$ in equilibrium. Hence, spreads vary with G.

ad (i) :

$$\begin{aligned}
&\pi\overline{\epsilon}'(G) + (1-\pi)\underline{\epsilon}'(G) \\
&= \pi \cdot \lim_{x\to 0} \frac{\overline{\epsilon}(G+x)-\overline{\epsilon}(G)}{x} + (1-\pi)\lim_{x\to 0}\frac{\underline{\epsilon}(G+x)-\underline{\epsilon}(G)}{x} \quad , \ (x \in R) \\
&= \lim_{x\to 0}\frac{1}{x}\left\{\pi\overline{\epsilon}(G+x) + (1-\pi)\underline{\epsilon}(G+x) - (\pi\overline{\epsilon}(G) + (1-\pi)\underline{\epsilon}(G))\right\} \\
&= 0
\end{aligned}$$

ad (ii): $u'(c^*(G)+\overline{\epsilon}(G))(-1+\overline{\epsilon}'(G)) = u'(c^*(G)+\underline{\epsilon}(G))(-1+\underline{\epsilon}'(G))$ and $u'(c^*(G)+\overline{\epsilon}(G)) < u'(c^*(G)+\underline{\epsilon}(G))$ imply that $\overline{\epsilon}'(G) < \underline{\epsilon}'(G)$. Assume $\overline{\epsilon}'(G) < 0 \wedge \underline{\epsilon}'(G) < 0$, this contradicts (ii). Assume $\overline{\epsilon}'(G) > 0 \wedge \underline{\epsilon}'(G) > 0$, this also contradicts (ii). Therefore, $\overline{\epsilon}'(G) < 0 \wedge \underline{\epsilon}'(G) > 0$. □

Proof. (Proposition 2)

Using Lemma 1 (ii) we can rewrite marginal welfare as

$$W_G^{IN}(G) = -\beta\frac{u'(\overline{c}^*(G))u'(\underline{c}^*(G))}{\pi u'(\underline{c}^*(G)) + (1-\pi)u'(\overline{c}^*(G))} \ < 0 \ \ \forall G. \tag{3.21}$$

Consider the following inequality:

$$
\begin{aligned}
& W_G^{IN}(G) > W_G^{C,\delta=0}(G) \\
& \Leftrightarrow -\beta \frac{u'(\overline{c}^*(G))u'(\underline{c}^*(G))}{\pi u'(\underline{c}^*(G)) + (1-\pi)u'(\overline{c}^*(G))} > -\beta u'(c^*(G)) \\
& \Leftrightarrow \frac{1}{u'(c^*(G))} < \pi \frac{1}{u'(\overline{c}^*(G))} + (1-\pi)\frac{1}{u'(\underline{c}^*(G))} \\
& \Leftrightarrow g(c^*) < \pi g(\overline{c}^*) + (1-\pi) g(\underline{c}^*)
\end{aligned}
$$

with $g(c) \equiv \frac{1}{u'(c)}$. By Jensen's inequality, $W_G^{IN}(G) > W_G^{C,\delta=0}(G)$ if and only if g(c) is strictly convex $\forall$ G. Accordingly, $W_G^{IN}(G) < W_G^{C,\delta=0}(G)$ if and only if g(c) is strictly concave $\forall$ G. And, $W_G^{IN}(G) = W_G^{C,\delta=0}(G)$ if and only if g(c) is linear. The second derivative of g(c) is given by:

$$
g''(c) = -\frac{\frac{u'''(c)}{u''(c)} - 2\frac{u''(c)}{u'(c)}}{\frac{u'(c)^2}{u''(c)}} = -\frac{-p(c) + 2a(c)}{\frac{u'(c)^2}{u''(c)}}
$$

ad(i): g(c) is linear if and only if $p(c) = 2a(c)$
ad(ii): g(c) is strictly convex if and only if $\frac{p(c)}{a(c)} = P(c) < 2$
ad(iii): g(c) is strictly concave if and only if $\frac{p(c)}{a(c)} = P(c) > 2$ □

Proof. (Lemma 3)
Let $j \in \{r, p, rp\}$ denote the preference regime of the economy: $j = r$ if risk aversion dominates, i.e. $P(c) \leq 2$, $j = p$ if prudence dominates, $P(c) \geq 2$, and $j = rp$ if P(c) depends on c and agents are relatively more risk aversion for small G and prudent for large G. The interval limits are chosen such that the curves intersect at the minimum or maximum feasible G under both systems, hence at 0 and G^{maxIN}: For $\Delta W(0) < \overline{W}$, define

$$
\begin{aligned}
& \underline{\delta}^r \text{ and } \overline{\delta}^p : W^C(G^{maxIN}, \delta^j) = W^{IN}(G^{maxIN}) \\
& \overline{\delta}^r \text{ and } \underline{\delta}^p : W^C(0, \delta^j) = W^{IN}(0)
\end{aligned}
$$

Welfare is monotonously decreasing in G under both systems. If $j = r$, $W^C(0,\delta) > W^{IN}(0)\ \forall\ \delta \leq \overline{\delta}^r$. From Proposition 2 we know that $W_G^{IN}(G) > W_G^C(G,0) \geq W_G^C(G,\delta)\ \forall\ \delta$, i.e. the welfare curve of incentive based taxation is flatter than the welfare function of capital control for all levels of monitoring costs. Hence, for any $\delta \in [\underline{\delta}^r, \overline{\delta}^r]$, the two curves intersect.

If $j = p$ and $\Delta W(0) < \overline{W}$, $W^{IN}(0) \geq W^C(0, \delta) \; \forall \; \delta \geq \underline{\delta}^p$. From Proposition 2 and by definition of $\overline{W}$, $W_G^C(G, \delta) > W_G^{IN}(G)$ for $\delta \in [\underline{\delta}^p, \overline{\delta}^p]$ and the two curves intersect. □

Proof. (Proposition 4)
$W^{CC}(0, \delta) > W^{IN}(0) \; \forall \; \delta \leq \overline{\delta}^r$, and marginal welfare monotone and decreasing with $W_G^{IN}(G) > W_G^C(G, 0)$. Thus, $W^C(G, \delta) > W^{IN}(G) \; \forall G \in [0, G^o(\delta)]$ and $W^C(G, \delta) < W^{IN}(G) \; \forall G \in (G^o(\delta), G^{maxIN}]$. □

Proof. (Proposition 5)
$W^C(0, \delta) < W^{IN}(0) \; \forall \; \delta \leq \overline{\delta}^p$, and marginal welfare monotone and decreasing with $W_G^{IN}(G) < W_G^C(G, 0)$. Thus, $W^C(G, \delta) < W^{IN}(G) \; \forall G \in [0, G^o(\delta)]$ and $W^C(G, \delta) > W^{IN}(G) \; \forall G \in (G^o(\delta), G^{maxIN}]$. □

Proof. (Lemma 7)
The government chooses k s.t. entrepreneurs have no incentive to deviate:

$$u'(\omega - k) = \beta \pi'(k)(u(\overline{c}) - u(\underline{c}))$$

Assume $\overline{c} \leq \underline{c}$, then entrepreneurs would choose $k = 0$. □

Proof. (Proposition 8)
Lemma 7 shows that there exists a positive spread in consumption levels whenever $k > 0$. Fix $k > 0$, the utility spread is determined by:

$$u(\overline{c}) - u(\underline{c}) = \frac{u'(\omega - k)}{\beta \pi'(k)}$$

At lower levels of expected second period net income, the incentive compatible utility spread requires a smaller spread in consumption due to concavity of $u(.)$ - as with discrete capital. Here, we can apply the reasoning from Lemma 1 and Proposition 2. If $P(c) < 2$, marginal welfare is larger than first best marginal welfare (incentive costs decrease). If $P(c) > 2$, marginal welfare is smaller than first best marginal welfare (incentive costs increase). □

Chapter 4

Incentive or Control II: Heterogeneous Entrepreneurs

4.1 Introduction

Governments have a bad history in picking the winners.

The Economist, April 28 2011, On government intervention in the private sector.

This chapter analyzes revenue generating mechanisms in an economy with skill heterogeneity of entrepreneurs. Facing private information on capital and entrepreneurial skill, governments can choose between two mechanisms to collect entrepreneurial returns: designing an incentive compatible tax schedule or controlling capital input. The objective of this chapter is twofold. First, we consider how equilibrium allocations change under both mechanisms with respect to our previous findings in Chapter 3 when introducing heterogeneity of skills into the model. Second, we analyze whether "picking the losers", hence controlling the low skilled entrepreneurs, can be an optimal strategy for the government.

The study builds on the model from Chapter 3 and extends the analysis to a framework which includes informational frictions leading to both, moral hazard and adverse selection. This environment is analyzed, for instance, in Jullien et al. (2007). In the previous chapter we have seen that it is optimal for a government, which faces a given revenue requirement, to interfere into the investment decision of entrepreneurs if taxing those entrepreneurs involves too costly distortions. This occurs under two circumstances. First, if the revenue requirement is small and entrepreneurs are more risk averse than prudent; and second, if the revenue requirement is large and entrepreneurs are more prudent than risk averse. The distortions in the tax mechanisms arise due to moral hazard in the investment choice of the entrepreneur which triggers a trade-off between insurance and efficiency: with capital investment being private information, entrepreneurs have an incentive to reduce their investment when they are offered to smooth their consumption.

When skills are heterogeneous, i.e. there exist different levels of productivity among entrepreneurs, the welfare maximizing government offers consumption smoothing across states and entrepreneurial types. With private information on both, capital and productivity, this leads to moral hazard and adverse selection in the tax mechanism and triggers incentive costs which reduce welfare. Controlling capital investments is costly too, as the government pays monitoring costs (or efficiency losses), but the cost structures is different to the one under incentive based taxation. Moreover, we only consider government interference into one privately observed variable, monitoring capital input and not entrepreneurial skill, as the government can control capital but not the ideas and productivity of entrepreneurs.

In this environment, we find that low productivity entrepreneurs are more costly to incentivize than high productivity entrepreneurs. In addition, the presence of low productivity entrepreneurs increases the burden high productivity entrepreneurs have to bear while taxation becomes less progressive implying a lower degree of consumption smoothing. Precisely, the consumption spread due to incentive provision is equal in equilibrium for low and high types with two dimensional private information. As a consequence, the more heterogeneous an economy the more costly incentive provision and the more often the government chooses capital control for revenue generation. Finally, if the government decides to control one type of entrepreneurs only, it will control low productivity entrepreneurs if the share of high productivity entrepreneurs is not too large.

The chapter is organized as follows: Section 4.2 briefly summarizes the model environment which is described in detail in Section 3.2 and emphasizes the inclusion of heterogeneity in entrepreneurial skill. In Section 4.3, the optimization problems for an incentive compatible tax schedule are characterized and Section 4.4 analyzes the control of capital and the government's choice on the optimal revenue generating mechanism. Section 4.5 concludes. All proofs can be found in the appendix.

4.2 Model Environment With Skill Heterogeneity

A welfare maximizing government faces a continuum of ex ante identical entrepreneurs who live for two periods. Entrepreneurs invest their own capital in the first period and earn stochastic returns on these investments in the second period. There are two types of entrepreneurs, high productivity agents (H) earn a larger return on the same amount invested than low productivity agents (L). Their lifetime utility depends on consumption in Period 1 and 2 and is given by

$$U(k, \overline{c}^{\theta}, \underline{c}^{\theta}) = u(\omega - k) + \beta(\pi_k^{\theta} u(\overline{c}^{\theta}) + (1 - \pi_k^{\theta}) u(\underline{c}^{\theta})). \tag{4.1}$$

$\overline{c}^{\theta}$ denotes second period consumption in the successful state for an entrepreneur of type $\theta \in \Theta = \{H, L\}$ and $\underline{c}^{\theta}$ denotes second period consumption in the less successful state. Note that θ can also be interpreted as the quality of the agent's entrepreneurial idea or innovation.

First period consumption is the difference between initial wealth endowment, ω, and capital investment, k. Assume for simplicity that the distribution of initial capital is degenerate at ω. Entrepreneurs can choose whether to realize their idea θ with a low capital technology or a capital intensive technology and thus to transfer a small or large amount of their initial wealth to their firms, $k \in \left\{\underline{k}, \overline{k}\right\}$, with $0 < \underline{k} < \overline{k} \leq \omega$. Higher investments lead to lower consumption in the first period but higher expected return in the second period.

As before, empirically, this assumption can be interpreted as entrepreneurs choosing between two projects with different refinance conditions while the output in monetary terms does not inform about types of projects. Denote y the random gross return on capital which is produced with the following technology:

$$y = \begin{cases} \overline{y} \text{ with probability } \pi_k^{\theta} \\ \underline{y} \text{ with probability } 1 - \pi_k^{\theta} \end{cases}$$

with $\overline{y} > \underline{y}$, $\pi_{\overline{k}}^{H} > \pi_{\underline{k}}^{H}, \pi_{\overline{k}}^{L} > \pi_{\underline{k}}^{L}$ and $\frac{\pi_{\overline{k}}^{H} - \pi_{\underline{k}}^{H}}{\pi_{\overline{k}}^{H}} > \frac{\pi_{\overline{k}}^{L} - \pi_{\underline{k}}^{L}}{\pi_{\overline{k}}^{L}}$. The expected return is thus increasing in capital and type. For single crossing, we need the additional assumption that high productivity entrepreneurs have a higher probability to succeed than low types even if they invest a low level of capital only, i.e. $\pi^H_{\underline{k}} > \pi^L_{\underline{k}}$, similar to Faynzilberg and Kumar (2000). Laffont and Martimort (2002) call this assumption that the ranking among types is strong.

We make the following assumptions on utility: discount factor $\beta \in (0,1)$, $u'(.) > 0, u''(.) < 0$, $\lim_{c\to 0} u'(c) = \infty$, $\lim_{c\to\infty} u'(c) = 0$. As in Chapter 3, the government has to meet an external revenue requirement G and taxes entrepreneurial income in the second period. We consider a government deciding on net income or consumption levels $\overline{c}^H, \underline{c}^H, \overline{c}^L, \underline{c}^L$ directly, which corresponds to the decentralized tax schedule $T(y,k,\theta)$.

Initial endowment ω is public information, as well as output and its distribution. Capital investment k and productivity θ are private information of the entrepreneurs and unknown to the revenue collecting government. In order to understand the underlying dynamics we will start with perfect and partial information on k and θ in Sections 4.3.1, 4.3.2 and 4.3.3 before we look at two-dimensional private information in Section 4.3.4. Further, it is possible for the government to monitor capital investment k at costs δ, which will be introduced in Section 4.4.

For efficiency in the moral hazard problem, we will assume that the following condition holds:

$$\frac{u'(w-\overline{k})}{u'(E_{\overline{k}}[c^\theta(G)])} \leq \beta \pi^{\theta'}_{\overline{k}}(\overline{y}-\underline{y}) \;\forall\; \theta, G \in [0, G^{max}] \tag{4.2}$$

E^θ_k denotes the expectation operator w.r.t. the entrepreneur's productivity θ and capital input k. Equation (4.2) implies that it is efficient for the government to implement a high capital investment for all feasible levels of revenue requirement and both types. It also implies that the marginal rate of transformation is large enough to sustain high investments from low types even at heavy rate of cross-subsidization. Note that this precludes a shut down of low productivity types. We thus neglect the exclusion of low productivity entrepreneurs on purpose as this is a well-studied phenomenon in an adverse selection environment and does not constitute the focus of this chapter. Consequently, Equation (4.2) implies voluntary participation in the tax mechanism of both types of entrepreneurs. Finally, a direct mechanism specifies the contract $\{k, (\overline{c}^H, \underline{c}^H), (\overline{c}^L, \underline{c}^L)\}$.

In the following, we assume that it is optimal for the government to implement $\overline{k}$ for all values of G and for both types. We thus do not consider an additional option, $\underline{k}$-insurance, in which the government would allocate low capital investment in the first period but grant full insurance in the second period. In this sense, our results in this chapter are partial in nature.

4.3 Taxing Entrepreneurial Returns

The government faces the following problem: First, it needs to raise revenue G by taxing its population of entrepreneurs. Second, it wants to maximize the agents' welfare and thus smooth consumption in the second period between a successful state and a less successful state. Thus, the government offers to insure entrepreneurs. This implies that it taxes successful entrepreneurs more than unsuccessful ones (or even subsidizes the latter) and hereby provides social insurance. As investments can not be observed without costs, the government needs to design a tax schedule which is incentive compatible with the socially optimal level of capital investment $\overline{k}$. Moreover, entrepreneurs' skills are heterogeneous and the government cannot observe which agent is more productive than the other. Therefore, the government faces a two-dimensional information problem which gives rise to moral hazard due to unobserved capital input and adverse selection due to heterogeneous productivity.

Before specifying the optimal contract offered by the government it is important to understand which distortions arise from each source of private information. We therefore discuss in the following equilibrium allocations when the government has (i) perfect information on both capital and technology, (ii) perfect information on productivity but not on capital, and (iii) perfect information on capital but not on productivity.

4.3.1 Perfect Information on Capital and Productivity

We first characterize the unconstrained allocation of consumption and capital investment, $\left\{k^*, (\overline{c}^{H*}, \underline{c}^{H*}), (\overline{c}^{L*}, \underline{c}^{L*})\right\}$, assuming the government has access to information on capital and productivity. Let q be the share of high productivity entrepreneurs in the population. The optimization problem for the welfare maximizing government is the following:

$$\max_{\overline{c}^H,\underline{c}^H,\overline{c}^L,\underline{c}^L\geq 0} \quad q(u(\omega-k)+\beta E_k^H[u(c^H)])+(1-q)(u(\omega-k)+\beta E_k^L[u(c^L)])$$

subject to

$$BC: \quad q\cdot E_k^H[y]+(1-q)\cdot E_k^L[y]\geq q\cdot E_k^H[c^H]+(1-q)\cdot E_k^L[c^L]+G \tag{4.3}$$

In equilibrium, the government sets $k=\overline{k}$ for all feasible $G\in[0,G^{max}]$ and $\overline{c}^H=\underline{c}^H=\overline{c}^L=\underline{c}^L=c^*$. The entrepreneurs' consumption is perfectly smoothed across states and across types and the consumption level is determined by the revenue requirement:

$$BC: \quad c^*(G)=q\cdot E_{\overline{k}}^H[y]+(1-q)\cdot E_{\overline{k}}^L[y]-G \tag{4.4}$$

4.3.2 Private Information on Capital

Let us now assume that the government has no information on the capital invested by entrepreneurs but observes their productivity. This is the case, for instance, when educational degrees reflect entrepreneurial innovation and skill. The government can verify the entrepreneurs' educational background while it is unable to track the invested capital and technology used to realize the project. In this pure moral hazard environment, the optimization problem takes into account two incentive compatibility conditions to maintain high capital investments by both types of entrepreneurs:

$$\max_{\overline{c}^H,\underline{c}^H,\overline{c}^L,\underline{c}^L\geq 0} \quad q(u(\omega-k)+\beta E_k^H[u(c^H)])+(1-q)(u(\omega-k)+\beta E_k^L[u(c^L)])$$

subject to

$$BC: \quad q \cdot E_k^H[y] + (1-q) \cdot E_k^L[y] \geq q \cdot E_k^H[c^H] + (1-q) \cdot E_k^L[c^L] + G \tag{4.5}$$

$$IC_1^H: \quad u(\omega - \overline{k}) + \beta E_{\overline{k}}^H[u(c^H)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^H[u(c^H)] \tag{4.6}$$

$$IC_1^L: \quad u(\omega - \overline{k}) + \beta E_{\overline{k}}^L[u(c^L)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^L[u(c^L)] \tag{4.7}$$

The government chooses consumption levels such that the first order conditions are satisfied:

$$\pi_{\overline{k}}^H \frac{1}{u'(\overline{c}^H)} + (1 - \pi_{\overline{k}}^H) \frac{1}{u'(\underline{c}^H)} = \pi_{\overline{k}}^L \frac{1}{u'(\overline{c}^L)} + (1 - \pi_{\overline{k}}^L) \frac{1}{u'(\underline{c}^L)} \tag{4.8}$$

In equilibrium, perfect consumption smoothing is no longer possible and the government needs to provide incentives for entrepreneurs to produce with the socially optimal level of capital. We therefore have $\overline{c}^H > \underline{c}^H$ and $\overline{c}^L > \underline{c}^L$ such that both types' incentive compatibility conditions are met [1]:

$$u(\overline{c}^H) - u(\underline{c}^H) = \frac{\Delta u_0}{\Delta \pi^H \beta} \tag{4.9}$$

$$u(\overline{c}^L) - u(\underline{c}^L) = \frac{\Delta u_0}{\Delta \pi^L \beta} \tag{4.10}$$

where $\Delta u_0 = u(\omega - \underline{k}) - u(\omega - \overline{k})$ and $\Delta \pi^\theta = \pi_{\overline{k}}^\theta - \pi_{\underline{k}}^\theta$. Note that when comparing Equations (4.9) and (4.10) the utility spread for low productivity entrepreneurs is larger than for high productivity entrepreneurs. We will summarize this property in the following Lemma:

Lemma 9. *With a welfare maximizing government and a single resource constraint, taxation of low productivity entrepreneurs implies larger distortions from incentive provision than taxation of high productivity entrepreneurs.*

Entrepreneurs' Welfare Lemma 9 allows us to analyze the welfare of the individual types of entrepreneurs. If the agents are as prudent as risk averse, $P(c) = 2$, low

[1] Incentive compatibility conditions are binding in equilibrium. If they weren't the government could improve the welfare of entrepreneurs by granting a smaller consumption spread.

productivity entrepreneurs are worse off than high productivity entrepreneurs. This is also the case, if the agents are more risk averse than prudent, $P(c) < 2$. Whereas low types are better off for some parameter settings, when $P(c) > 2$. Subsequently, higher costs for incentive provision stemming from the presence of low productivity entrepreneurs are also borne by high productivity entrepreneurs. We will come back to this observation later as the low type externalities generate scope for the government to improve upon the current allocation.

4.3.3 Private Information on Productivity

In the following, we assume that the government can observe technology and capital input but does not know the entrepreneurs' productivity.

$$\max_{\bar{c}^H, \underline{c}^H, \bar{c}^L, \underline{c}^L \geq 0} \quad q(u(\omega - k) + \beta E_k^H[u(c^H)]) + (1-q)(u(\omega - k) + \beta E_k^L[u(c^L)])$$

subject to

$$BC: \; q \cdot E_k^H[y] + (1-q) \cdot E_k^L[y] \geq q \cdot E_k^H[c^H] + (1-q) \cdot E_k^L[c^L] + G \tag{4.11}$$

$$IC_2^H: \; E_{\overline{k}}^H[u(c^H)] \geq E_{\overline{k}}^H[u(c^L)] \tag{4.12}$$

$$IC_2^L: \; E_{\overline{k}}^L[u(c^L)] \geq E_{\overline{k}}^L[u(c^H)] \tag{4.13}$$

In this environment, it is straight forward to see that first best consumption smoothing can be implemented, $\bar{c}^H = \underline{c}^H = \bar{c}^L = \underline{c}^L = c^*(G)$, while incentive compatibility is satisfied. If capital input and thus technology is known, there is no distortion from heterogeneous types of entrepreneurs and adverse selection does not occur. Moral hazard is thus the principle source of distortions in an environment with private information on both, capital and productivity. Subsequently, if the government had to decide which private information problem to resolve by monitoring it would choose capital, not entrepreneurial skill, and obtain full consumption smoothing across state and type. Lemma 10 follows directly from the equilibrium allocation specified above.

Lemma 10. *In an economy with unobserved productivity and capital, and entrepreneurs choosing between two investment levels, the government can allocate full insurance and perfect consumption smoothing by monitoring capital inputs of all entrepreneurs.*

This result is, in part, a consequence of the simplified modeling of first period utility and the restriction to two capital levels. With continuous capital, the planner would like to allocate $k^{H*} > k^{L*}$. This, however, is not incentive compatible. The high productivity agent will mimic the low productivity agent and the planner chooses $\bar{c}^L < \underline{c}^L, k^H = k^{H*}$. Capital investment of the low type is either lower, higher or equal to the optimal level, depending on the properties of the utility function.

To summarize, the continuous case involves more complex equilibrium outcomes with one source of private information only. Hence, restricting our attention to the discrete case is a necessary assumption to keep the model tractable in the following sections. Moreover, it is interesting to look at the simplified version as typical properties of adverse selection will occur once we allow for both information asymmetries. As in Chapter 3, we can understand the underlying production technology as two business operations with different financing conditions which can be launched by all entrepreneurs in the economy.

4.3.4 Private Information on Capital and Productivity

Consider now a government which can neither observe technology nor productivity of entrepreneurs and faces two potential sources of distortions: moral hazard due to unknown technology and adverse selection due to heterogeneous entrepreneurial skills. This situation occurs, for instance, when the government could observe education which is a proxy for the skill level but cannot condition on a diploma in a tax schedule as the legal framework prohibits discrimination with respect to degrees.

$$\max_{\bar{c}^H, \underline{c}^H, \bar{c}^L, \underline{c}^L \geq 0} \quad q(u(\omega - k) + \beta E_k^H[u(c^H)]) + (1-q)(u(\omega - k) + \beta E_k^L[u(c^L)])$$

subject to

$$BC: \; q \cdot E_k^H[y] + (1-q) \cdot E_k^L[y] \geq q \cdot E_k^H[c^H] + (1-q) \cdot E_k^L[c^L] + G \tag{4.14}$$

$$IC_1^H: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^H[u(c^H)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^H[u(c^H)] \tag{4.15}$$

$$IC_1^L: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^L[u(c^L)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^L[u(c^L)] \tag{4.16}$$

$$IC_2^H: \; E_{\overline{k}}^H[u(c^H)] \geq E_{\overline{k}}^H[u(c^L)] \tag{4.17}$$

$$IC_2^L: \; E_{\overline{k}}^L[u(c^L)] \geq E_{\overline{k}}^L[u(c^H)] \tag{4.18}$$

$$IC_3^H: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^H[u(c^H)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^H[u(c^L)] \tag{4.19}$$

$$IC_3^L: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^L[u(c^L)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^L[u(c^H)] \tag{4.20}$$

Equations (4.15) to (4.18) are known from Sections 4.3.2 and 4.3.3. Two informational frictions give rise to the possibility of double deviation captured in equations (4.19) and (4.20). It is easy to verify that both conditions are slack, as IC_1^L and IC_2^H imply IC_3^H, and IC_2^L more restrictive than IC_3^L. We can further derive Lemma 11 when combining the above constraints.

Lemma 11. *If productivity and capital are private information of entrepreneurs, then, in equilibrium, the spread of state dependent consumption levels for high productivity entrepreneurs is larger than or equal to the spread of consumption for low productivity entrepreneurs.*

This information helps us to find the equilibrium to the optimization problem.

Proposition 12. *The government offers a pooling contract with partial consumption smoothing,* $\overline{c}^H = \overline{c}^L > \underline{c}^H = \underline{c}^L$ *while the spread in consumption levels is determined by low type incentive compatibility,* $u(\overline{c}^L) - u(\underline{c}^L) = \frac{\Delta u_0}{\Delta \pi^L \beta}$*. The pooling contract dominates the separating contract for all* $G \in [0, G^{max}]$*.*

The equilibrium tax schedule offered by the government can be characterized accordingly. Since both types of entrepreneurs have the same consumption level when they are in the same state, the tax system is progressive in two regards. First, tax payments to the government are larger in successful states than in unsuccessful ones and second, high productivity agents pay more on average than low productivity agents. As before, there exists a welfare loss from the provision of incentives for using the capital intensive technology. However, instead of offering a utility spread of $\frac{\Delta u_0}{\Delta \pi^H \beta}$ to the high types as under Section 4.3.2, the government has to offer $\frac{\Delta u_0}{\Delta \pi^L \beta}$ for both types. Hence, high types face the same lottery on consumption as low types and incentive costs are larger for high productivity entrepreneurs than under pure moral hazard. While heterogeneous productivity alone has not caused distortions, it increases the incentive costs the government has to take into account when raising the revenue G and neither capital nor productivity is observed. As a consequence, high productivity types bear an important share of the welfare loss caused by variations in entrepreneurial productivity. Comparing this result to an economy with homogeneous entrepreneurial skill supports this conclusion.

Homogeneous versus Heterogeneous Entrepreneur Economy Consider an economy with homogeneous entrepreneurs producing expected output

$$E_{\overline{k}}^{homo}[y] = \pi_{\overline{k}}^{homo} \cdot \overline{y} + (1 - \pi_{\overline{k}}^{homo}) \cdot \underline{y} \tag{4.21}$$

and an economy with heterogeneous entrepreneurs producing the same aggregate output

$$E_{\overline{k}}^{\theta}[y] = q(\pi_{\overline{k}}^{H} \cdot \overline{y} + (1 - \pi_{\overline{k}}^{H}) \cdot \underline{y}) + (1 - q)(\pi_{\overline{k}}^{L} \cdot \overline{y} + (1 - \pi_{\overline{k}}^{L}) \cdot \underline{y}) = E_{\overline{k}}^{homo}[y]. \tag{4.22}$$

Assume further that entrepreneurs in the homogeneous economy have the average skill level of the heterogeneous economy w.r.t both capital investments. Then, according to Proposition 12, utility spreads of the low types determine the tax schedule for all entrepreneurs in the heterogeneous economy while a smaller utility spread is possible in the homogeneous economy. It follows directly:

Proposition 13. *A government designing an incentive compatible tax schedule for entrepreneurs faces larger welfare losses from incentive provision in a heterogeneous economy than in a homogeneous economy.*

This is a familiar result of principle agent problems with two-dimensional private information and when adverse selection happens before moral hazard, as described for instance in Laffont and Martimort (2002). Figure 4.1 depicts this result, with

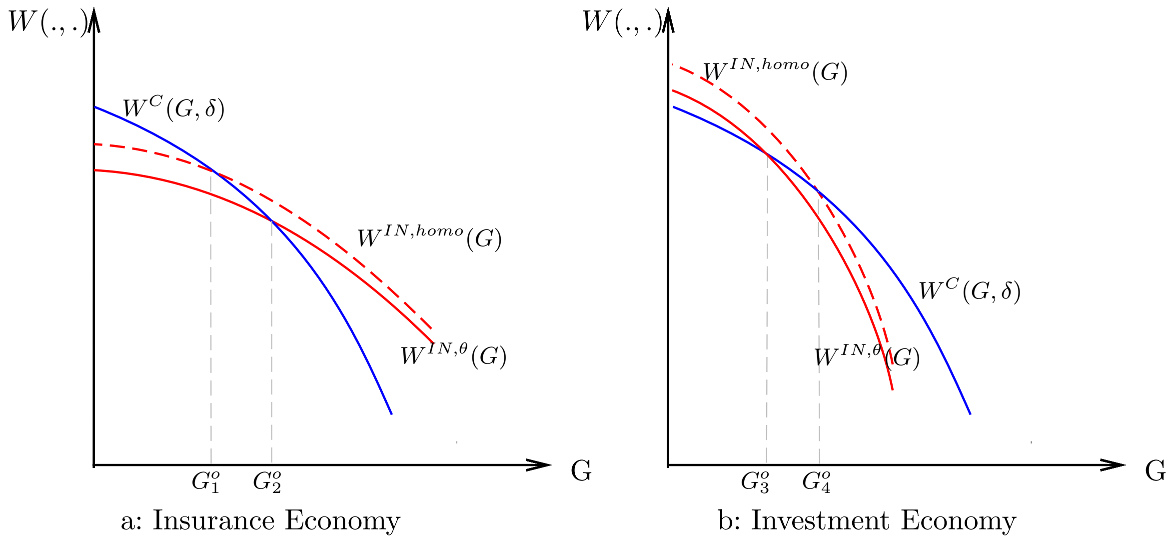


Figure 4.1: Homogenous vs Heterogenous Entrepreneur Economy

$W^{IN,homo}(G)$ being the welfare in the homogeneous economy and $W^{IN,\theta}(G)$ being the aggregate welfare with different productivity types. The graph shows aggregate welfare with respect to government revenue.

The distinction between Insurance and Investment Economy follows from Chapter 3 and refers to preferences on risk aversion and prudence in the economy. In the former, risk aversion dominates prudence, $P(c) < 2$, and in the latter, prudence dominates risk aversion, $P(c) > 2$. The same applies for the shape of the graphs, which reflects the evolution of incentive costs under the two preference sets. Welfare losses from incentive provision decrease in an Insurance Economy and increase in an Investment Economy.

4.4 Controlling Heterogeneous Entrepreneurs

Having characterized equilibrium tax schedules under incentive based taxation, we will discuss a second option for governmental revenue collection in the following: the control of capital inputs. Precisely, we will analyze when it is optimal for the government to control capital investments of high type, low type, or both types of entrepreneurs.

4.4.1 Control With Moral Hazard and Adverse Selection

Controlling High and Low Skilled Entrepreneurs. As under Chapter 3, the government can choose between two mechanisms to raise revenue from entrepreneurial returns when capital input is unobserved. First, providing incentives for entrepreneurs to invest the socially optimal level, and second, controlling capital investment directly at monitoring costs δ. These monitoring costs enter the government budget and the government faces a similar optimization problem as under Section 4.3.1 with the budget constraint as

$$BC^C: \; q \cdot E_k^H[y] + (1-q) \cdot E_k^L[y] \geq q \cdot E_k^H[c^H] + (1-q) \cdot E_k^L[c^L] + G + \delta \qquad (4.23)$$

Consequently, equilibrium allocations are $\overline{c}^H = \underline{c}^H = \overline{c}^L = \underline{c}^L = c^*(G, \delta)$. When increasing the revenue requirement G, welfare under the control mechanism evolves very differently than welfare under the incentive mechanism. The variation in G has an impact on the consumption spread and thus on incentive costs while it has no impact on monitoring costs. In Chapter 3 we draw conclusions on the choice of the optimal revenue generating mechanisms at given preferences for insurance and levels of revenue requirement. By introducing heterogeneity in skill levels, incentive costs are larger for all levels of G as described above and depicted in Figure 4.1. As a consequence, incentive based taxation performs worse relative to capital control (of both entrepreneurial types) than before: (i) the government switches from incentives to control already for smaller values of G in the Investment Economy ($P(c) > 2$); and (ii) keeps on controlling capital investments longer, i.e. for higher values of G, before switching to incentives in the Insurance Economy ($P(c) < 2$), see also G_1^o to G_4^o in Figure 4.1.

Diversification of Skill. We continue to assume that the government controls both types of entrepreneurs if it chooses capital control as revenue generating mechanism. Keeping aggregate output constant but increasing the difference in productivity of entrepreneurs under the capital intensive technology, $\pi_{\overline{k}}^H - \pi_{\overline{k}}^L$, yields a higher utility spread for low types, $\frac{\Delta u_0}{\beta \Delta \pi^L} \uparrow$, and a smaller utility spread for high types, $\frac{\Delta u_0}{\beta \Delta \pi^H} \downarrow$. Since the government offers a pooling equilibrium contract with low type incentive compatibility determining consumption levels for both types, we can derive the following conclusion on the impact of skill heterogeneity:

Proposition 14. *The more heterogeneous an economy the more costly incentive provision and the more often it is optimal for the government to choose capital control for revenue generation.*

Controlling Low Skilled Entrepreneurs. In the following we consider the possibility to monitor only one type of entrepreneur. In this environment, offering control (and consumption smoothing) to low types has an impact on the mimicking behavior of high types. The government therefore reduces the allocated consumption to low types and/or introduces a spread for low type consumption, too. The government faces the following optimization problem:

$$\max_{\overline{c}^H, \underline{c}^H, \overline{c}^L, \underline{c}^L \geq 0} \quad q(u(\omega - k) + \beta E_k^H[u(c^H)]) + (1-q)(u(\omega - k) + \beta E_k^L[u(c^L)])$$

subject to

$$BC: \; qE_k^H[y] + (1-q)E_k^L[y] \geq qE_k^H[c^H] + (1-q)E_k^L[c^L] + G + (1-q)\delta \tag{4.24}$$

$$IC_1^H: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^H[u(c^H)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^H[u(c^H)] \tag{4.25}$$

$$IC_1^L: \; - \tag{4.26}$$

$$IC_2^H: \; E_{\overline{k}}^H[u(c^H)] \geq E_{\overline{k}}^H[u(c^L)] \tag{4.27}$$

$$IC_2^L: \; E_{\overline{k}}^L[u(c^L)] \geq E_{\overline{k}}^L[u(c^H)] \tag{4.28}$$

$$IC_3^H: \; - \tag{4.29}$$

$$IC_3^L: \; u(\omega - \overline{k}) + \beta E_{\overline{k}}^L[u(c^L)] \geq u(\omega - \underline{k}) + \beta E_{\underline{k}}^L[u(c^H)] \tag{4.30}$$

Note that monitoring costs enter the budget constraint on the right hand side multiplied with the share of low skilled entrepreneurs that the government controls. Subsequently, monitoring one type only is less costly in terms of monitoring costs than controlling two types. However, 1-type-control triggers incentive costs in addition to monitoring costs as high types have to be incentivized to invest and prevented from mimicking low types. The equilibrium can be described accordingly.

Proposition 15. *In equilibrium, low types are not offered perfect consumption smoothing for the entire choice set. High types face a spread in consumption according to* $IC_1^H: \ u(\bar{c}^H) - u(\underline{c}^H) = \frac{\Delta u_0}{\Delta\pi^H\beta}$.

A similar result occurs if the government aims at controlling high types only. Low types are offered state dependent consumption at according to $IC_1^L: \ u(\bar{c}^L) - u(\underline{c}^L) = \frac{\Delta u_0}{\Delta\pi^L\beta}$ while high type consumption cannot be fully smoothed for the entire choice set.

Optimal Revenue Generation. Assume, for instance, the economy is relatively more risk averse than prudent, $P(c) < 2$. For δ not too large, the overall welfare under 2-type control is higher than under 1-type-control and higher than under full incentive provision as one constraint is removed and, for L-type-control, the spread is smaller. Welfare under control of both types declines more quickly with δ than welfare with one-type control, as monitoring costs are paid for all entrepreneurs and not only for the share of the respective type. There are thus parameter values such that the optimal revenue generation mechanism is 2-type-control for low values of the revenue requirement, 1-type-control for intermediate values and full incentive provision for large values of G. The decision about which type of entrepreneur to control, however, depends on the share q. We can analyze this choice in more detail when considering pure moral hazard only.

4.4.2 Control With Pure Moral Hazard

If the government has information on productivity, and decides to control one type of entrepreneurs, it could either choose to control low type entrepreneurs, with consumption allocations $\bar{c}^H > \bar{c}^L = \underline{c}^L > \underline{c}^H$ such that IC_1^H and BC are equalized. Or the government could choose to control high type entrepreneurs, with consumption allocations $\bar{c}^L > \bar{c}^H = \underline{c}^H > \underline{c}^L$.

The government pools all resources in its budget constraint and allocates consumption levels such that expected inverse marginal utilities equalize. As incentivizing low types is always more costly in terms of welfare than incentivizing high types, we can write as a consequence of Lemma 9:

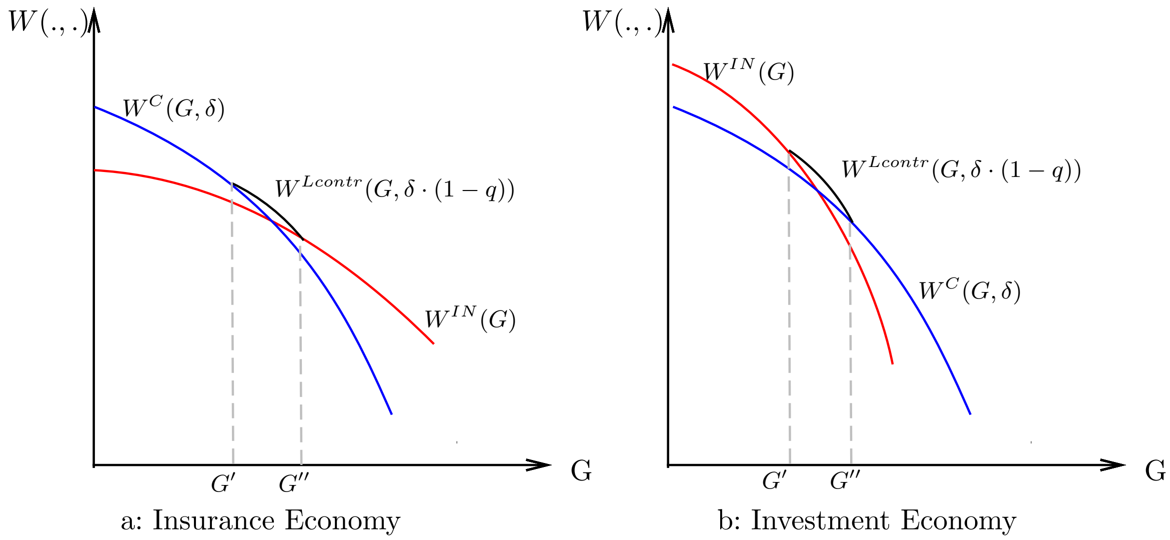


Figure 4.2: Controlling Low Productivity Entrepreneurs Under Pure Moral Hazard

Lemma 16. *For zero monitoring costs, controlling L types dominates controlling H types if the share of H types is not too large.*

We can further derive properties of marginal welfare under the four mechanisms.

Proposition 17. *Marginal Welfare of Control and Incentive Mechanisms:*

(i) If $P(c) < 2$ and $\delta \geq 0$, welfare under 2-type-control decreases faster with G than welfare under 1-type-control which decreases faster than welfare under pure incentive provision: $W_G^{IN} > W_G^{\theta} > W_G^C$, for $\theta = H, L$.

(ii) If $P(c) > 2$ and $\delta \geq 0$, welfare under pure incentive provision decreases faster with G than welfare under 1-type-control which decreases faster than welfare under 2-type-control: $W_G^C > W_G^{\theta} > W_G^{IN}$, for$\theta = H, L$ and δ not too large.

Note that $W_G^{IN} > W_G^{Hcontr} > W_G^{Lcontr} > W_G^C$ for $P(c) < 2$ and $\delta = 0$ as well as $W_G^{IN} < W_G^{Hcontr} < W_G^{Lcontr} < W_G^C$ for $P(c) > 2$ and $\delta = 0$. This holds true for nonzero values of δ if and only if the share of high skilled entrepreneurs is moderate. Hence, with positive monitoring costs, marginal welfare depends on the share of respective types in the economy. If q is low, $(1-q)\delta$ is large and expected consumption under low type control is lower than expected consumption under high type control: $c^{*Lcontr} > c^{*Hcontr}$. For q large enough, this can, e.g. for $P(c) < 2$, lead to steeper marginal welfare under low type control than under high type control.

Proposition 18. *At moderate levels of δ and q,*

(i) *and $P(c) > 2$, it is optimal for a government to control all entrepreneurs for low values of G, control low skilled entrepreneurs at moderate values of G and provide incentives for high values of G.*

(ii) *and $P(c) < 2$, it is optimal for a government to provide incentives for low values of G, control low skilled entrepreneurs at moderated values of G and control all entrepreneurs for high values of G.*

Note that in an insurance economy, there exist parameter constellation such that it is optimal to first control low types, then high types and then to provide incentives for both.

4.5 Conclusion

This chapter examines the role of adverse selection and moral hazard in the context of optimal capital taxation. It elaborates on the results of the study from Chapter 3 and adds the following insights to the analysis. First, we find that low productivity entrepreneurs are more costly to incentivize than high productivity entrepreneurs. In addition, the presence of low productivity entrepreneurs increases the burden high productivity entrepreneurs have to bear while taxation becomes less progressive implying a lower degree of consumption smoothing.

Second, the more heterogeneous an economy the more costly incentive provision and the more often the government chooses capital control for revenue generation. And third, if the government decides to control one type of entrepreneurs only, it will control low productivity entrepreneurs if the share of high productivity entrepreneurs is not too large. Overall, it is not necessarily bad for governments to have a bad history in picking the winners. There are situations in which it is indeed optimal to pick the losers.

4.A Technical Appendix

Proof. (Lemma 9)
IC_1^H and IC_1^L are binding in equilibrium and

$$u(\overline{c}^H) - u(\underline{c}^H) = \frac{\Delta u_0}{\Delta \pi^H \beta} < \frac{\Delta u_0}{\Delta \pi^L \beta} = u(\overline{c}^L) - u(\underline{c}^L) \tag{4.31}$$

as $\pi^H_{\overline{k}} - \pi^H_{\underline{k}} > \pi^L_{\overline{k}} - \pi^L_{\underline{k}}$. Given a single resource constraint and concave utility, the government cross-subsidizes to smooth consumption across entrepreneurs. A larger spread in utility between the two states implies a lower level of aggregate welfare at given expected consumption. □

Proof. (Lemma 10)
The Lemma follows directly from the preceding equilibrium allocations. The equilibrium tax schedule to the problem in Section 4.3.3 offers $\overline{c}^H = \underline{c}^H = \overline{c}^L = \underline{c}^L = c^*(G)$, i.e. full insurance when capital is observed. The tax schedule to the problem in Section 4.3.2 offers partial insurance only. If monitoring is costly and costs are the same for capital and productivity, then welfare is larger when monitoring capital inputs than when monitoring productivity. □

Proof. (Lemma 11)
IC_2^H and IC_2^L are satisfied simultaneously if $\overline{c}^H \geq \overline{c}^L \wedge \underline{c}^L \geq \underline{c}^H$. Combining IC_2^H and IC_2^L, we know that $\frac{1-\pi^L_{\overline{k}}}{\pi^L_{\overline{k}}}(u(\underline{c}^L) - u(\underline{c}^H)) \geq \frac{1-\pi^H_{\overline{k}}}{\pi^H_{\overline{k}}}(u(\underline{c}^L) - u(\underline{c}^H))$. $u(\underline{c}^L) - u(\underline{c}^H) < 0$ yields a contradiction, hence $\underline{c}^L \geq \underline{c}^H$. As $u(\overline{c}^H) - u(\overline{c}^L) \geq \frac{1-\pi^H_{\overline{k}}}{\pi^H_{\overline{k}}}(u(\underline{c}^L) - u(\underline{c}^H))$, it follows that $\overline{c}^H \geq \overline{c}^L$. □

In the following, subscripts $(\overline{k})$ are omitted without loss of generality.

Proof. (Proposition 12)
Lemma 11 states that the consumption spread of high types must be equal to or larger than the spread of low types. Assume the government offers $\underline{c}^H = \underline{c}^L$ and $\overline{c}^H > \overline{c}^L$ while respecting incentive compatibility and budget. Since the resource constraint is binding, the government can allocate

$$c^* = (q\pi^H + (1-q)\pi^L)\overline{c} + (q(1-\pi^H) + (1-q)(1-\pi^L))\underline{c}, \tag{4.32}$$

and $\overline{c}^H > \overline{c}^L$ such that

$$(q\pi^H + (1-q)\pi^L)\overline{c} = q\pi^H\overline{c}^H + (1-q)\pi^L\overline{c}^L. \tag{4.33}$$

Then, by Jensen's inequality,

$$\begin{aligned} u(\overline{c}) \geq \frac{q\pi^H}{q\pi^H + (1-q)\pi^L}u(\overline{c}^H) + \frac{(1-q)\pi^L}{q\pi^H + (1-q)\pi^L}u(\overline{c}^L) \;\Leftrightarrow \\ (q\pi^H + (1-q)\pi^L)u(\overline{c}) \geq q\pi^H u(\overline{c}^H) + (1-q)\pi^L u(\overline{c}^L) \;\Leftrightarrow \\ E[u(\overline{c}, \underline{c})] \geq E[u(\overline{c}^H, \overline{c}^L, \underline{c})] \end{aligned}$$

and the above consumption allocations cannot be optimal. It is always possible to increase welfare by reducing the spread in consumption between types at a given state and the government offers the smallest spread possible across states to both types.

Further, the pooling contract is the unique equilibrium since any contract which aims at separating the two types while being incentive compatible involves a larger spread for the high types. □

The proof for Proposition 13 follows from Proposition 12.

The proof for Proposition 14 follows from the text.

Proof. (Proposition 15)
Incentive compatibility is binding for H types. If it were not the planner would reduce the spread and increase welfare. □

Proof. (Lemma 16)
Assume $q = 0$, then controlling low types yields higher utility. Assume $q = 1$, then controlling high types yields higher utility. For $q \in (0,1)$, the following equation holds if q is not too large:

$$q(\pi^H u(\overline{c}^H) + (1-\pi^H)u(\underline{c}^H)) + (1-q)u(c^L) > qu(c^H) + (1-q)q(\pi^L u(\overline{c}^L) + (1-\pi^L)u(\underline{c}^L)) \tag{4.34}$$

Note that with equal shares, control of high low types yields higher utility as spreads are larger for the control of high types. □

Proof. (Proposition 17)
Assume $\delta = 0$. First order conditions of both, L-type and H-type optimization problems are

$$\pi_{\overline{k}}^{H}\frac{1}{u'(\overline{c}^{H})}+(1-\pi_{\overline{k}}^{H})\frac{1}{u'(\underline{c}^{H})}=\frac{1}{u'(c^{L})} \tag{4.35}$$

$$\pi_{\overline{k}}^{L}\frac{1}{u'(\overline{c}^{L})}+(1-\pi_{\overline{k}}^{L})\frac{1}{u'(\underline{c}^{L})}=\frac{1}{u'(c^{H})} \tag{4.36}$$

Using Proposition 2, Chapter 3, and Equations 4.35 and 4.36, marginal welfare can be written as:

$$\begin{aligned}
\frac{1}{W_G^C} &= -\frac{1}{\beta}\frac{1}{u'(c^*(G))}\\
\frac{1}{W_G^{Lcontr}} &= -\frac{1}{\beta}\frac{1}{\frac{u'(\overline{c}^H(G))u'(\underline{c}^H(G))}{\pi^H u'(\underline{c}^H(G))+(1-\pi^H)u'(\overline{c}^H(G))}+u'(c^L(G))}\\
&= -\frac{1}{\beta}\frac{1}{2}\frac{1}{u'(c^L(G))}\\
&= -\frac{1}{\beta}\frac{1}{2}(q(\pi^H\frac{1}{u'(\overline{c}^H(G))}+(1-\pi^H)\frac{1}{u'(\underline{c}^H(G))})+(1-q)\frac{1}{u'(c^L(G))})\\
\frac{1}{W_G^{Hcontr}} &= -\frac{1}{\beta}\frac{1}{2}\frac{1}{u'(c^H(G))}
\end{aligned}$$

Note that

$$\begin{aligned}
c^*(G) &= q(\pi^H\overline{c}^H(G)+(1-\pi^H)\underline{c}^H(G))+(1-q)c^L(G)\\
&= qc^H(G)+(1-q)(\pi^L\overline{c}^L(G)+(1-\pi^L)\underline{c}^L(G))
\end{aligned}$$

(i) If $P(c) < 2$ and thus $\frac{1}{u'(.)}$ a convex function, combining Equations 4.8, 4.35 and 4.36, and applying Jensen's inequality we know that:

$$\pi^H\frac{1}{u'(\overline{c}^{HIN})}+(1-\pi^H)\frac{1}{u'(\underline{c}^{HIN})}>\frac{1}{u'(c^H)}>\frac{1}{u'(c^L)}>\frac{1}{u'(c^*)} \tag{4.37}$$

This is also shown by graph 4.3, a. We can derive the following inequalities:

$$W_G^{IN} > W_G^{Hcontrol} > W_G^{Lcontrol} > W_G^C \tag{4.38}$$

A positive δ has no impact on W_G^{IN}, but decreases marginal welfare of the control mechanisms further. As it enters the budget constraint with $q < 1$ under 1-type-control, marginal welfare of 2-type-control is smaller than marginal welfare of 1-type-control for all G.

(ii) If $P(c) > 2$ and thus $\frac{1}{u'(.)}$ a concave function, combining Equations 4.8, 4.35 and 4.36, and applying Jensen's inequality we know that:

$$\frac{1}{u'(c^*)} > \frac{1}{u'(c^L)} > \frac{1}{u'(c^H)} > \pi^H \frac{1}{u'(\overline{c}^{HIN})} + (1-\pi^H)\frac{1}{u'(\underline{c}^{HIN})} \tag{4.39}$$

This is also shown by graph 4.3, b. We can derive the following inequalities:

$$W_G^C > W_G^{Lcontrol} > W_G^{Hcontrol} > W_G^{IN} \tag{4.40}$$

A positive δ has no impact on W_G^{IN}, but decreases marginal welfare of the control mechanisms further. As it enters the budget constraint with $q < 1$ under 1-type-control, marginal welfare of 2-type-control decreases more quickly with δ than marginal welfare of 1-type-control for all G.

□

Proof. (Proposition 18)
The Proposition follows from Lemma 16 and Proposition 17.

(i) If $P(c) > 2$, choose q and δ, s.t. $W^C(G=0) > W^{Lcontr}(G=0) > W^{Hcontr}(G=0) > W^{IN}(G=0)$.

(ii) If $P(c) < 2$, choose q and δ, s.t. $W^{IN}(G=0) > W^{Lcontr}(G=0) > W^{Hcontr}(G=0) > W^C(G=0)$.

Given the slope properties and the monotonicity of Welfare w.r.t G and δ, the efficiency frontiers of the four mechanisms will intersect as depicted in Figure 4.2. □

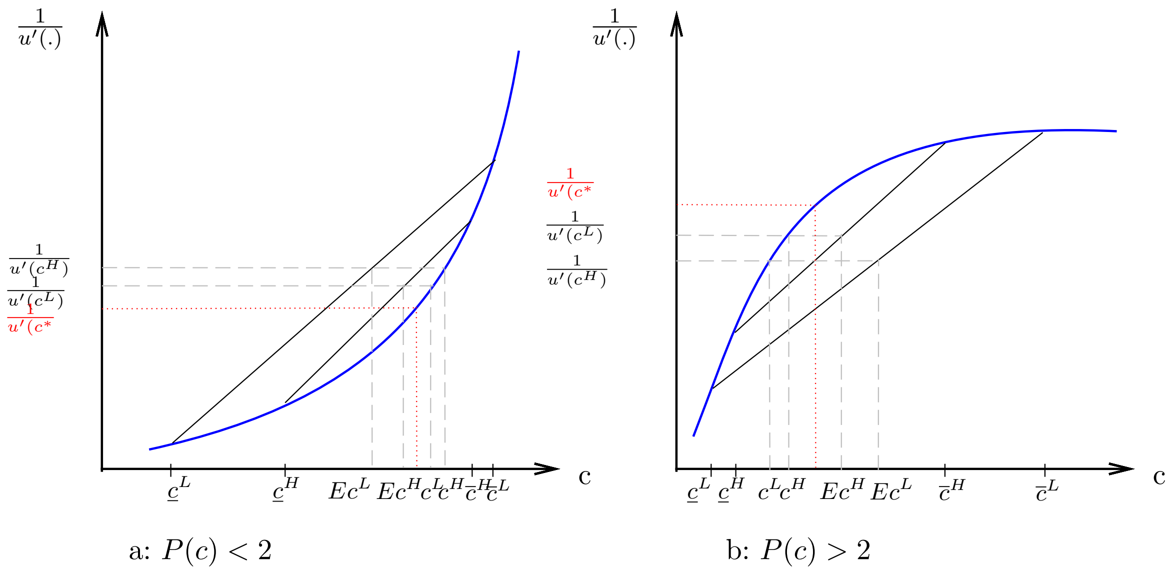


Figure 4.3: Inverse Marginal Utilities and Expected Consumption by Type

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Eidesstattliche Erklärung

Hiermit erkläre ich, die vorliegende Dissertation selbständig angefertigt und mich keiner anderen als der in ihr angegebenen Hilfsmittel bedient zu haben. Insbesondere sind sämtliche Zitate aus anderen Quellen als solche gekennzeichnet und mit Quellenangaben versehen.

Washington, den 25.11.2011.

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