Essays on Financial Institutions, Inflation and Inequality

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To my parents,

Kirsten and Mogens Hørder

To my parents,

Kirsten and Mogens Hørder

Abstract

The four essays in this thesis focus on two areas where financial institutions can affect equilibrium: the importance of the design of monetary institutions for the equilibrium inflation rate, and the link between financial intermediation and the real economy.

The first essay takes a political economy perspective to explain differences in inflationary performance in the post communist economies. It is argued that these differences largely result from political choices rather than structural differences. Based on empirical evidence we describe some institutional mechanisms that can prevent reversal of stabilisation policies after a change of government.

The second essay uses an overlapping generations model of money to analyse what the consequences are, for the distribution of real assets and inflation, of having more than one agent extracting seigniorage. As described in the first essay un-coordinated monetary policy caused continued high inflation in some transitional economies. Here it is shown how Russia's inflationary performance after liberalisation can be explained by our model.

The third essay uses a moral hazard framework to derive a testable hypothesis linking the degree of inequality and the volume of financial intermediation. This link is part of the transmission mechanism running from inequality via the financial sector to real growth in some recent models of economic development. We test the hypothesis using a new World Bank data set on inequality and find only partial support for the moral hazard model in the data.

The fourth essay uses a random matching framework to model a financial market without intermediation. The economic consequences of this are analysed and it is shown that in the search economy the dispersion of project returns can affect the growth rate. This is not the case in the intermediated economy where only the mean of the project return distribution matters for growth.

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Chapter 1

Introduction

This thesis deals with issues in monetary economics and financial development. While the essays contained cover different aspects in these fields, the general message across all chapters is that institutions matter for economic outcomes.

Economists have long been criticised by political scientists for focusing on outcomes rather than the processes leading to the outcomes. This, it has been argued, makes the policy advice of the economist removed from the real world where decisions are made in a political setting rather than by a benevolent social planner (Persson and Tabellini(1994)). On the other hand economic theorists argue that policy advice should be based on models with a clear metric for what constitutes welfare of the agents in society (Townsend (1995)).

There is a huge output of policy advice concerning areas undergoing change. The transition process in Eastern Europe and the Former Soviet Union following the breakdown of the socialist one party system and the plan economic model is a pertinent example, the entire development literature another.

The fight against inflation in the transition economies has been high on the recent policy agenda. In the first two essays in this thesis we focus on this aspect of transition and try to highlight both the political and economic aspects of the phenomenon. In *The Politics of Inflation in the Former Socialist Economies* (written jointly with Peter Boone) we take a broad political economy perspective to explain the differences in inflationary performance in the transition economies. The essay surveys the inflationary experience of all the former socialist economies[1]. While all countries experienced a huge price jump at the outset of liberalisation the subsequent inflationary performance has varied greatly across countries. Some countries like Estonia, Poland and the Czech Republic stabilised quickly and have maintained low inflation since then. Others like Russia attempted stabilisation but

[1] We define this to include the countries of Eastern Europe and the Former Soviet Union. Thus the analysis excludes China and other Asian economies that are also undergoing changes in these years.

have since then followed a zigzag course between high and low inflation. Others again experienced continued high inflation and some had episodes of hyperinflation over several years before finally moving on to a stabilisation course. We argue that these differences in inflationary performance resulted largely from political choices rather than from structural differences. By recounting the history of the stabilisation policies in some of these countries we show how political leadership was a key determinant for whether a country initially chose to stabilise or not. A key problem facing a pro-stabilisation political leader is the reversal of his reforms after a change of government. Another problem is that the institutional breakdown in these economies has resulted in un-coordinated implementation of policies, notably monetary policy. Again we use a survey of the evidence from the transition economies to illustrate some of the economic mechanisms that have been used by a reformer acting in what the former Polish Minister of Finance Balcerowitz has called "the period of extra-ordinary politics" at the outset of the reforms to try to prevent this policy reversal and induce policy co-ordination. Examples include "poison pills" which are policies that induce huge losses if there is deviation from the stabilisation course; conditional foreign aid and constitutional reform of budgetary processes.

After this survey of the issues concerning stabilisation in the transition economies we go on to study in greater detail one of the aspects highlighted above. In *Institutions and Inflation* we focus on the implications of the design of monetary policy institutions for the inflationary performance and economic welfare in the economy. The paper was inspired by Russian monetary policy implementation in 1992-93. We document how directed credits were a key factor driving the Russian money supply during this period and how these directed credits until early 1993 were granted in an un-coordinated fashion by several spending ministries, the central bank and the president. This led to near hyperinflation in late 1992. From 1993 a credit commission co-ordinated all credit issues and the inflationary pressures in Russia eased. We use an overlapping generations model of money with heterogeneous agents to analyse the consequences for economic welfare and inflation of the co-ordinated and un-coordinated situation respectively. In this way

our analysis captures both the importance of institutions for economic outcomes, that is stressed by political scientists, and the metric for economic welfare, stressed by economic theorists.

The model consists of private agents who use fiat money to smooth consumption across two periods and pairs of state and fiat agents. The state agents have no endowment of the consumption good but instead receive the seigniorage revenues created by their fiat partner. The fiat agents have the right to issue money and do so in a way that maximises the welfare of their state agent partner. The economy consists of an infinite sequence of generations of private agents and state-fiat pairs. We use a sub-game perfect equilibrium set up to model the interaction of money issuing agents across generations and show how both private agent and state agent welfare is maximised when there is only one money issuing agent. Thus the model is an example where a general equilibrium set up with clear welfare criteria can be used to discuss the importance of institutions for economic welfare.

While the analysis described above mainly deals with the importance of the design of the institutions in charge of implementation of monetary policy, the next two essays focus on how financial institutions in general are linked with the real economy. There has long been an ongoing debate in economic development between proponents of the Schumpeterian view that financial institutions matter for the real economy and proponents of the view that the real sector leads the financial sector (Lucas(1988)). In *Inequality and Financial Development* we analyse part of the transmission channel from income distribution via the financial sector to economic growth that is implied in recent models of economic development. One example of such a model is Piketty(1997) who uses a moral hazard argument to determine who has access to borrowing from an intermediary and thus can undertake efficient investment projects, and who is credit constrained and thus must invest sub-optimally. We do not attempt to test Piketty's model in its entirety but we show how the moral hazard mechanism underlying his analysis implies that the degree of inequality in the economy affects the size of the formal financial sector. More specifically we derive a hypothesis stating that there is a non-linear

relationship between the degree of inequality and the level of financial development which is conditional on the level of average national income in the economy. In a poor economy increased inequality increases the amount of financial intermediation by lifting more agents over the cut-off level of wealth implied by the moral hazard set up, in a rich economy increased inequality reduces intermediation since it makes entrepreneurs richer and thus less reliant on outside financing.

The World Bank has recently published a cross-country data set on inequality and we use this data set to test the above model. We find that while there is a non-linear relationship between inequality and intermediation in our sample, the sign switches in the data do not match the sign switches implied by the theoretical analysis. The empirics show that while there appear to be a positive relationship between inequality and intermediation in economies with national income between US$ 500 and US$ 4000 and a negative relationship for richer countries, which is in accordance with the model, there also is a negative relationship for countries with national income below US$ 500. This is against the predictions of the theoretical model. The analysis in this chapter thus suggests to us that while there is some evidence supporting the relevance of the models of economic development based on a moral hazard mechanism of intermediation, caution is urged when using these models as a basis for providing policy advice since it appears that they do not capture the all aspects of the link between inequality and finance. While the welfare metrics are prominent in these models it is not clear whether the models capture the institutional arrangements of the real world.

The link between the financial sector and the real economy is also the topic of the final essay *Search in Financial Markets*. Here we try to capture the effects of the absence of financial intermediaries for growth in a simple set up based on the Romer(1986) endogenous growth model. We compare the outcomes for consumption and savings in two economies: one is a random matching economy where investors search for entrepreneurs with viable investment projects, the other is an economy where an intermediary places the savings of all investors with the entrepreneurs. We show how there are several extra channels through which the

growth rate can be affected in the search economy compared with the intermediated economy. Of course variables directly linked to the search environment only matter in the search economy, but in addition we show how the dispersion of the distribution of project returns matter for growth in the search economy while only the mean matters in the intermediated economy where all projects are pooled together. While the institutional analysis in this chapter is rather simplistic since all conclusions are based on a comparative static analysis, the model represents a first attempt to use the search framework to model the financial market. This is important since autarchy until now has been the benchmark against which financial institutions have been compared, while the alternative in the real world might be closer to the set up of the search economy. There are after all very few Robinson Crusoes in the modern world.

While the essays in this thesis all deal with institutions and economic outcomes they are presented as separate chapters and can be read independently of each other.

Chapter 2

The Politics of Inflation in the Former Socialist Economies[1]

This paper takes a broad political economy perspective to explain the differences in inflationary performances in the former socialist economies of Eastern Europe and the former Soviet Union. It is argued that these differences to a large extent result from political choices in the individual countries rather than from structural differences or policy mistakes. Based on evidence from these economies a description is given of some economic mechanisms a pro-stabilisation political leader can introduce in his stabilisation program to help maintain the low inflation equilibrium even in the case where he is ousted from government.

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[1] This chapter was written jointly with Dr. Peter Boone of the LSE. It is to appear as a book chapter in a forthcoming CEP publication on the transitional economies.

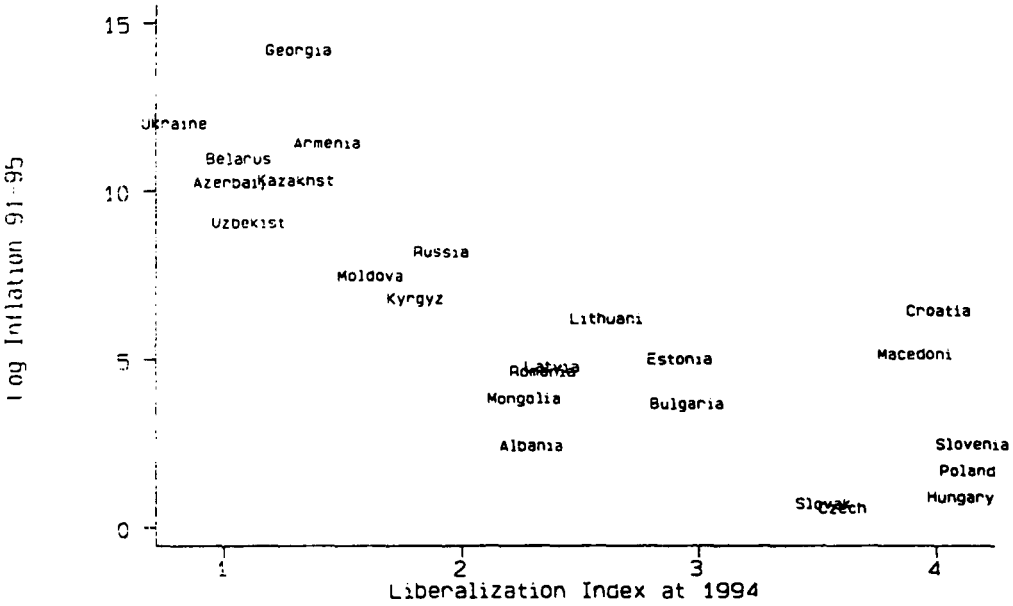
2.1 Introduction

The economic reform process in Eastern Europe and the former Soviet Union was preceded by the collapse of the entire political system in the socialist countries. After decades of socialism the one party system broke down, and new political leaders emerged. This breakdown in the political process meant that many of the checks and balances on political decision making were lost. In this paper we argue that this is a key fact which is needed to understand the subsequent pattern of inflation and liberalisation across these countries.

One of the first economic implication of the breakdown of the political system was a loss of confidence in domestic money. Under the socialist system the main instrument for savings was domestic money. When the USSR broke apart there were fifteen central banks suddenly able to create rouble money. In most of Eastern Europe, political turmoil led to rapid increases in the money supply as governments issued credits to their supporters. The result was initially creeping inflation, which soon spiralled into outright price explosions as people realised continued inflation would erode the value of their savings. As a consequence they sold money balances for goods and foreign exchange. Thus the initial prices jumps, which were very often much larger than economists and policy makers had anticipated, reflected not the past "monetary overhang" but rather sudden losses in confidence due to political turmoil.

After these initial large price jumps some countries were able to contain inflation through orthodox stabilisation programs. But many countries embarked on policies which for several years kept inflation high. As shown in figure 2.1, these same countries tended not to liberalise their economies (as measured by the World Bank index of liberalisation). This begs the question: why did some countries choose not to implement

Figure 2.1 Inflationary Performance and Liberalisation.



full liberalisation and stabilisation while others implemented both very quickly? One possible answer is that gradual reforms would lead to better economic outcomes. But in fact, empirical evidence suggests that at best the slow reformers were no worse off in terms of their total output decline. Furthermore their policies have prevented needed structural adjustment so that these economies have taken much longer to recover from the recession.

In this paper we argue that the real reason underlying the lack of reform in some countries again was the breakdown in the political process. What happened was that in the vacuum following the political breakdown the old elites and rent-seekers captured the political initiative in these countries. In order to sustain their powers, and sequester incomes, they issued credits and maintained distortionary policies. This brought these groups enormous resources. In Russia in 1992 revenues from net credit issue alone equalled 32.7% of GDP. Other countries in the CIS earned similar incomes from credit issuance. When such large amounts of funds are available, it is no surprise that politicians that wanted stabilisation faced enormous and sometimes violent opposition from those fighting to gain access to these resources. Whenever the pro-reform lobby lost the battle, high inflation was maintained and distortionary policies continued for several years.

This explanation, relying on political factors, also helps explain the illusionary "fiscal crisis" in many of these countries. While total revenues (including seigniorage) to many governments in the CIS and Eastern Europe have remained high, these countries have not maintained social programs such as pensions and health care at adequate levels. In this paper we argue that this is yet another consequence of the underlying political crisis in these countries. When the government is controlled by old elites and rent seekers that are grabbing for resources, it is no surprise that the politically weak, and particularly those that benefit from social programs, do not gain from the implemented

policies. The end result of this has been much greater poverty than would otherwise have occurred.

If our arguments are correct and factors related to the breakdown of the political system affected the size of the initial price jump, whether the country stabilised or experienced continued high inflation and what the distributional consequences of the pursued policies were, then we can draw several lessons from the break up of the communist system and the diverse performance of the different economies. It seems that some countries tackled the breakdown differently than others and that the way chosen had severe impact on the subsequent economic performance. Thus we argue that the economic performance of any former socialist economy was heavily influenced by political choices in that economy and not entirely determined by structural factors. The lessons learnt from the different choices made and the reasons for these choices can be useful when designing policies in future situations where there is political breakdown and near anarchy. First, it is clear that stabilisation programs must focus on measures that help reinstate political checks and balances, and promote co-ordination of decision making. We argue that democratic reform is an essential part of this. But in addition we discuss several economic mechanisms that can be implemented to promote stabilisation. These include a macroeconomic version of a "poison pill," i.e. a policy initiative which tends to reduce inflation, and once introduced is difficult to reverse. Currency boards are one example of such policies. Other examples of policies that can help enforce long term stabilisation are: conditional foreign assistance targeting political co-ordination, pre-emptive policy strikes, and the design of detailed budgetary processes.

This chapter is organised as follows. Section 2.2 discusses what factors caused the initial price jumps and the eroding confidence in the stability of domestic money Section 2.3 examines the rationale for continued high inflation in many countries, and presents evidence that rent-seeking and support for the old elite were the prime causes of this. Section 2.4 discusses why countries, after several years of high inflation, have

subsequently returned to low inflation. Section 2.5 uses the analysis of the experience of the former socialist economies to draw lessons for future stabilisation policies. Section 2.6 concludes.

2.2 The First Price Jump

The inflation experience of every country we consider can be divided into two components. In all the former socialist economies reform began with an increase in the rate of inflation. The rise in official prices that took place after price liberalisation in part reflected a general monetary overhang. But once the overhang was cleared subsequent inflation was driven by other underlying factors.

The initial price jump episodes in the former socialist economies had surprising features. Table 2.1 shows the pattern of inflation after reforms began in 26 countries. The highest price rise generally took place at the start of reform programs as price liberalisation occurred. These price rises were generally far greater than policy makers initially forecast, and they caused immediate social hardships as the value of past savings was greatly eroded overnight. For example at the start of the Polish stabilisation program it was estimated that prices would rise by 35% in January 1991, this compares with an actual increase of 70%.[2] In Russia the IMF estimated prices would rise by 50% after the January 1992 price liberalisation.[3] But instead prices rose by a startling 250%. The large rise in prices can be explained by a severe loss of confidence in money as a savings vehicle near the time of the reforms. This can be understood by examining the pattern of money demand, money supply and parallel market prices. Under the planning system the government maintained strict control over money circulation so that the demand and supply of domestic money, measured at official prices, were more or less equal. With stable prices households were willing to hold money for both savings and

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[2] See Gomulka(1994).
[3] See IMF(1992).

Table 2.1 Inflation in the Former Socialist Economies.

Inflation at Peak and Recently in Former Socialist Countries				
	Year of Peak	Highest Level	Level in 1994	Level in 1995
Albania	1992	226	28	9
Armenia	1994	5458	5458	179
Azerbaijan	1994	1500	1500	536
Belarus	1994	2200	2200	73
Bulgaria	1991	335	89	70
Croatia	1993	1516	98	3
Czech Republic	1991	57	10	10
Estonia	1992	1069	48	30
Georgia	1994	18000	18000	164
Hungary	1991	34	19	29
Kazakhstan	1994	1980	1980	177
Kyrgyz Republic	1993	1209	280	49
Latvia	1992	951	36	27
Lithuania	1992	1020	72	25
Macedonia	1992	1925	654	18
Moldova	1992	1276	327	25
Mongolia	1992	321	145	65
Poland	1990	586	32	32
Romania	1993	256	131	33
Russia	1992	1353	220	184
Slovakia	1991	61	14	11
Slovenia	1992	201	20	10
Tajikistan	1993	2195	2195	240
Turkmenistan	1993	3102	2400	2500
Ukraine	1993	2735	842	342
Uzbekistan	1994	746	746	254

Source: As reported in Aslund, Boone and Johnston(1996). Original data from de Melo, Denizer and Gelb (1995) and World Bank Country Economic Memorandums, various issues.

transaction purposes. Money market equilibrium in this simple setting is thus:

$$\frac{M_t}{P_t} = m(y_t, \pi_t, E_t\pi_s \forall s > t)$$

The important point here is that the demand for domestic money contains both a transactions component which is affected by output (y_t) and the short term cost of holding money (π_t)[4], and a savings component which is affected by the expected future rate of inflation $(E_t\pi_s \ \forall s > t)$[5]. If we invert this equation we can find the price level that is consistent with individuals being willing to hold the outstanding domestic money. If official prices are set too low then money demand would be less than money supply and parallel market prices would rise to reflect the excess money supply. As official prices are liberalised they jump to the level of parallel prices. This is one interpretation of how a monetary overhang might cause an initial price jump.

However there seems to be more to the price jump than a just the realignment of official and parallel prices. In all countries liberalisation was preceded by an explosion of parallel market prices[6]. There are several factors that affected parallel market prices at the time. The gradual opening of parallel markets and reduced legal restrictions on transactions should have lowered parallel prices. This would occur because greater supply on the parallel market should reduce the relative price differential with official markets. Thus the sharp rise in parallel prices must be attributed to an alternative source. We believe the main source was a fairly sudden loss in confidence in domestic money as a means of savings (i.e. an increase in $E_t\pi_s \ \forall s > t$). In every country the money supply grew relatively slowly during this period, but the threat of high inflation coming from

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[4] These two components are the standard components in the transactions demand for money literature. See Goldfeld and Sichel(1990).

[5] See Cagan(1956)

[6] See IMF country staff reports and for Russia see Russian Economic Trends for data on parallel market exchange rate data.

price liberalisation, and a rational belief that the authorities would lose control of monetary policy, would certainly have been enough to cause a flight from monetary savings. With a legacy of high savings in domestic money any loss of confidence could lead to a many fold increase in prices. The result in many countries was a price explosion that appeared in parallel prices sometime before liberalisation. Thus it seems that the initial price jump partly reflected a realignment of official and parallel prices, but partly also reflected a reduction in people's confidence in domestic money.

Some people have argued that this price jump was avoidable. For example Goldman(1994) argues that monetary reform, such as dividing all bank accounts and cash by three, could have prevented the initial inflation. If the authorities had reduced enterprise and business deposits by a greater factor than household savings, then the losses of the pensioners and households could have been reduced. But this measure could have exacerbated problems for other reasons. Such monetary confiscation might reduce people's confidence in money even further, causing prices to rise in any case or necessitating even greater monetary reform. In addition monetary reform would not have changed the basic incentives to cause higher inflation in the future. As discussed below, money confiscation would not change the incentives for issuing money in the future. And in fact, enterprises would have had even greater reason to demand new credits for "working capital" that could have precipitated higher inflation.

The loss of confidence in domestic money that appear to have exacerbated the size of the initial price jump could have been caused by the populations anxieties over what economic policies were to be pursued subsequently. The subsequent experience of most of the former socialist economies has warranted these concerns.

2.3 Subsequent Inflation

In most countries the inflationary performance after the initial price jump was dismal. As shown in table 2.1, even as of 1994 inflation continued at well over 50% per annum in eighteen out of twenty-six countries. There was no technical reason that these countries could not have maintained lower inflation - after an initial price jump it was fully possible that inflation could be reduced and fall to 1 or 2% per month within weeks of the start of reforms. Even when there are substantial official price increases after the initial price liberalisation, it is possible for relative prices to adjust so that monthly inflation remains low. This means that the subsequent high inflation was a choice of the responsible authorities rather than a required outcome.

2.3.1 Economic Rationale for High Inflation

There are two basic categories of explanations as to why the authorities chose to permit high inflation. The first reason is that policy makers may rightly or wrongly perceive this to be to the benefit of the economy. The initial economic collapse, the changed economic system, and subsequent political turmoil meant that government revenues fell sharply at the start of reforms. In the short run, with few alternative means to raise tax revenues, seigniorage became one of the easiest sources of financing. An optimising policy maker would want to equate the marginal benefits of higher government expenditures with the marginal cost of financing those expenditures. If benefits are high, or inflation is perceived not to be costly (or even not caused by money issue !) then increasing money issue and inflation would be a justifiable response.

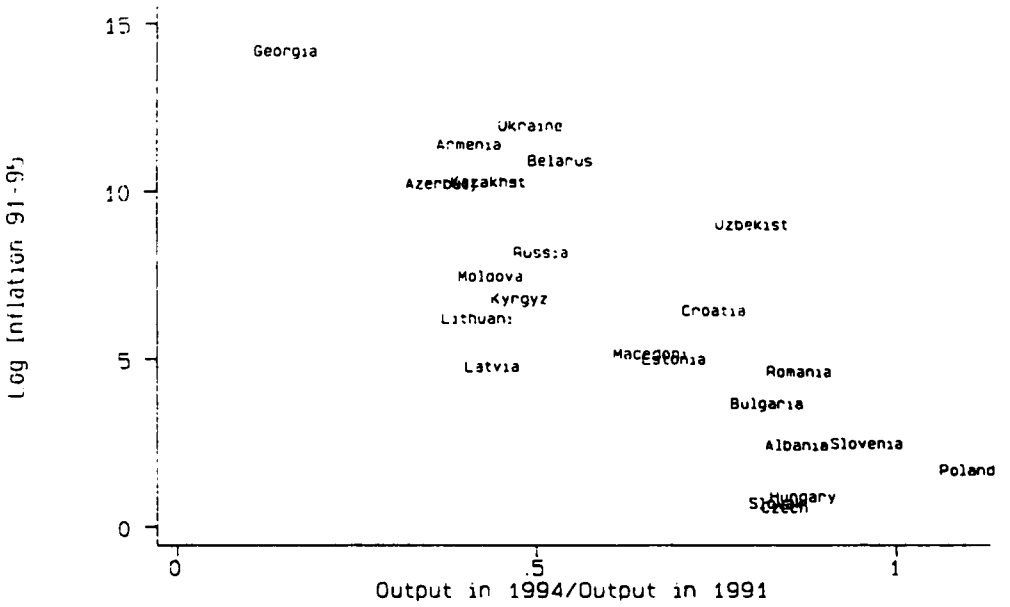
According to this explanation the countries with the greatest economic problems, and hence the worse fiscal constraints, would be the ones that benefited most from seigniorage revenues. We would expect the countries with the largest external and internal shocks, such as those most affected by the CMEA shock, countries with

relatively greater need for restructuring, countries at war, and those with the sharpest fall in fiscal revenues, to have the highest inflation rates. In these cases inflation would be costly, but it would serve a useful purpose in financing productive expenditures.

A related reason in favour of inflation is given by Calvo and Coricelli(1992) who argue that the legacy of imperfect financial markets, which meant that government credit was the only source of financing available to enterprises, made credit policy especially important in former socialist economies. They argue that after the initial price jump enterprises were faced with extremely low real working capital balances. This limited their ability to produce and hence contributed to the output decline. In their model a less restrictive monetary policy would have led to higher output. Thus if they are right we would expect loose monetary policy to be correlated with greater output. Figure 2.2 plots the relation between the cumulative output decline (1989 to 1995) and inflation (1990 to 1995) in 22 former socialist countries. The most striking observation here is the strong negative relation between output growth and inflation. The data does not seem to support Calvo and Coricelli's hypothesis. In fact as was pointed out by Bruno and Easterly(1995) the data, if anything, seems to suggest that stabilisation actually improves rather than worsens output performance.[7] This is perhaps taking the argument a bit too far. As already pointed out, the observed negative correlation might also reflect the reverse situation. That is, countries with severe shocks (low output growth) may have had more to gain from seigniorage financing (high inflation) than countries with smaller output shocks. Closer examination of figure 2.2 seems to support this hypothesis. As can be seen, countries from the CIS, and countries at war, have higher inflation rates than other countries. In order to examine the main country characteristics that correlate

[7] Other authors have drawn similar conclusions from this simple relation. See for example, de Melo, Denizer and Gelb(1995), World Bank(1996), EBRD(1996), Sachs and Warner(1995) and Fischer et. al.(1996).

Figure 2.2 Inflation and Cumulative Output Decline



with high inflation, we report, in table 2.2, some results from cross-country regressions where we regress cumulative output decline on inflation, a dummy reflecting whether the country was in the rouble zone (former USSR), and a dummy for countries at war.

The results show that after controlling for rouble zone and war, there is no longer a significant correlation between growth and inflation. This fact suggests that tight credit policy was not a key factor explaining the output decline in these countries. However these results also suggest that pro-stabilisation policies did not serve to reduce the output decline. A reasonable interpretation of these regressions is that monetary policy had little overall impact on the subsequent economic decline. This conclusion does not mean that monetary policy did not play a role in affecting the timing of the decline and the timing of the return to growth. Figure 2.3 plots the correlation between inflation and growth in 1995 alone, and table 2.2 shows some regression results in which we control for the effects from wars and rouble zone membership. This plot and the regressions show that in 1995, even after conditioning on these variables, there was a strong negative correlation between inflation and growth. The countries that had the highest growth rates were all countries that had stabilised. The countries that had continued high inflation in 1995 had the lowest growth rates. These countries might have avoided large output declines early on but at the cost of large recessions later on.

The main effect of monetary policy in the former socialist economies thus seems to be on the timing of the start of the recession. If one probes a bit deeper one finds that this has been through its effect on restructuring policies. Aslund, Boone and Johnson (1996) show that countries that reduced inflation tended to have more rapid growth of the private sector, greater institutional change as proxied by the EBRD indices, and more rapid growth of services. Lack of stabilisation in part reflected a policy of continued subsidies to the state sector. The countries with high inflation were able to raise extremely large amounts of seigniorage. As shown in table 2.3, these levels of

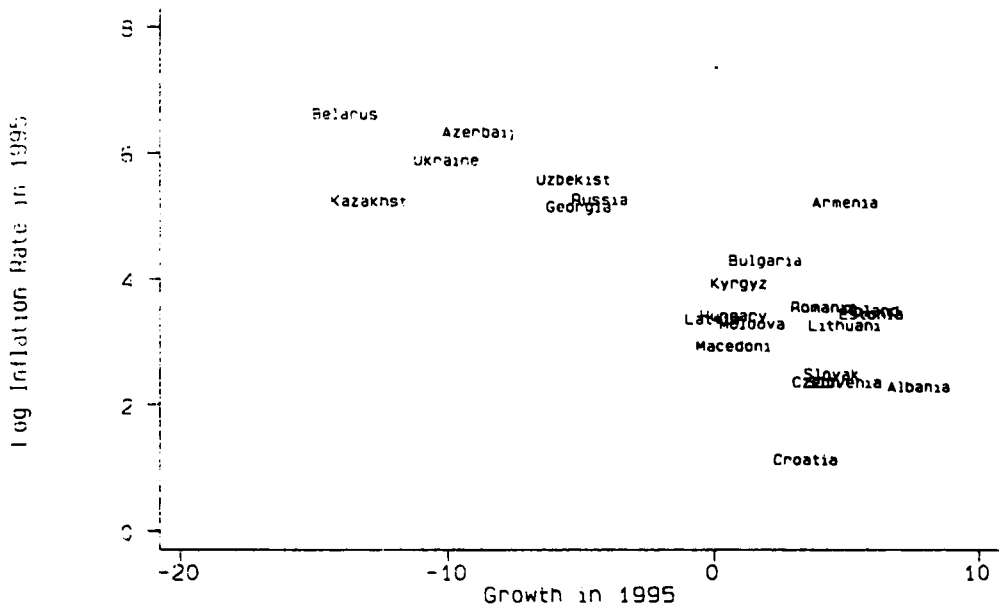
Table 2.2 Output and Inflation

OLS Regressions: Dependent Variables
i) Output 1995/Output 1990
ii) Growth Rate of Output 1995

	Output 1995/Output 1990				Growth Rate 1995			
log(Price Level 1995/Price Level 1991)	-0.048* (0.01)	-0.006 (0.01)			-3.470* (0.57)	-3.400* (0.83)		
Cumulative Liberalisation Index			0.133* (0.03)	0.007 (0.03)			3.517* (0.78)	3.307* (1.43)
Former USSR		-0.340* (0.09)		-0.348* (0.08)		-0.281 (2.38)		-0.600 (3.45)
War		-0.183* (0.07)		-0.191* (0.05)		-0.101 (2.08)		-0.144 (2.26)
R^2	0.65	0.80	0.48	0.79	0.64	0.64	0.47	0.47
N	23	23	25	25	23	23	25	25

Notes:
* significant at 5% level.
t-statistics in parentheses
War, and Former USSR are dummy variables set to one for countries in war or members of the former USSR respectively.
Cumulative Liberalisation Index from De Melo, Denizer and Gelb(1995) measures the degree of liberalisation of the economy as described in the text. The index ranges from 0 to 4.

Figure 2.3 Inflation and Output Growth.



seigniorage generally far exceeded levels in Latin America and were truly enormous. In Russia seigniorage equalled approximately 33% of GNP in 1992. The primary beneficiaries of seigniorage in the CIS countries, Romania and Bulgaria were enterprises. With negative real interest rates this was an important source of finance to enterprises which kept the state sector producing and limited reforms that would be induced by hard budget constraints. Why then did the policy makers in some countries choose to delay restructuring by maintaining lax monetary policies while others went for the immediate stabilisation option and thus plunged directly into recession? The above analysis seems to suggest that it could not have been because continued lax policies provided the economy with better options after a couple of years of delayed stabilisation. The data, if anything, supports the opposite view that the economies that delayed stabilisation suffered more subsequently.

2.3.2 Politics and the Credit Process

We might conclude from these facts that the policy makers who did not stabilise simply made mistakes. They initially thought loose credit would give enterprises time to adjust, and this in turn would limit ultimate output declines and restructuring costs. In retrospect credit policy has had little impact, so the policy measures were at best unhelpful and turned out to be costly due to social costs of continued inflation. But this view completely ignores political explanations of inflation, and these seem far more reasonable than economic arguments or explanations based on ignorance. Under the

Table 2.3 Seigniorage and Natural Resources

Illustrative Potential for Revenues from Money Creation and Natural Resources		
	Real Value of Net Credit Issue[1] (% GNP: 1992)	Major Natural Resource Exports Outside FSU[3] ($ million of cotton, oil and gas)
Estonia	0.2	0
Hungary	0.4	0
Poland	6.4	0
Romania	6.4	0
Latvia	11.9[2]	0
Albania	14.4	0
Lithuania	19.7[2]	0
Kyrgyzstan	29.1[2]	0
Moldova	32.6[2]	0
Russia	32.7[1]	24,200
Ukraine	34.5	small
Kazakhstan	35.7	1,000
Belarus	42.8	0
Turkmenistan	63.2	840
Uzbekistan	na	673

Notes:

[1] Where available (see note 2)The data show the change in net credits to government plus gross credits to the rest of economy by the monetary authority measured as a fraction of GNP. These are calculated on a quarterly basis. To calculate quarterly GNP, we allocated annual nominal GNP according to the quarterly pattern of producer price indexes (or consumer price indexes when producer prices were unavailable). The estimates will tend to overstate the real value of credits if there are long lags in credit allocation, and when quarterly inflation is high. The high measures for Turkmenistan reflect this. The Russian measure is calculated using monthly data so the inflation bias should not be large in this case. Data from IMF: Economic Trends for various countries, IMF: International Financial Statistics for CIS countries, Russian Economic Trends (various), Ukrainian Economic Trends October 1994.

[2] These estimates are based on credits from commercial banks and the monetary authorities. This will therefore be substantially larger than credits from the monetary authority alone. To the extent that governments also directed commercial bank loans, and given negligible nominal interest rates during this period in most countries, this may be a better measure of the resources available to the authorities that control credit issue.

[3] Data from IMF Economic Trends for respective countries.

Soviet system the link between monetary variables and demand was well understood. While policy makers were unfamiliar with free prices, they were well aware for seventy years that economic balance required stringent control on credit and money issue. And while officials such as the Russian Central Bank chairman Viktor Gerashchenko argued that money issuing was not inflationary, he may have done so more to support his policy of liberal credits to the industrial lobby, rather than truly believing a statement which was very clearly incorrect in Russia by the end of 1992. Even in Ukraine, notorious for its lack of professional economists, Oleh Havrylyshyn argues that ignorance and lack of careful consideration of stabilisation policies was not the primary factor explaining the choice of loose credit policies:[8]

> "..progress in reforms is not hampered primarily by a lack of understanding about the objective measures of stabilisation and adjustment that need be taken. What is most lacking is a sufficiently large constituency that is both committed...and able to see through [such measures]...the 30 March Economic Reform Program of the Ukrainian Cabinet of Ministers was no less sensible or orthodox than the Russian Letter of Intent to the International Monetary Fund of February 1992. In practice, the main difference was a reformist Russian cabinet...the Ukrainian government allowed a huge expansion of credits to the economy starting in mid-1992, revealing its lack of commitment to the stabilisation goals set out in March. The Russian government did the exact same thing...because it was unable to convince the public body on the need for monetary constraint."

Is it true that the answer to the question again should be found in the breakdown of the political system and that subsequent high inflation was caused by a lack of political consensus rather than by wrong economic judgements or ignorance by the policy makers in the affected economies? There are several reasons to think so. The most basic reason can be gleaned from re-examining table 2.3. The credit issues that occurred in these countries bordered on the obscene. The amounts are truly enormous, and even if we believe that some industries needed subsidies, and that households deserved better social programs, the 32.7% of GNP seigniorage in Russia is far greater than would have been needed to pursue a careful and well-targeted program. In the first year of reforms over 80% of Russian enterprises reported profits and in Poland all of the top 500 enterprises reported profits. This was in part due to accounting methods, but it was also due to the

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[8] Havrylyshyn, Oleg (1994) p. 429.

ability of enterprise directors to suppress wages given their relative power over employees. Most enterprises had substantial scope to sell inventories and to sell foreign exchange to provide financing. But with highly negative real interest rates, and large profits to be made from credits, it is no surprise that they all demanded credits. A program that targeted a few politically sensitive enterprises could have been worked out costing only 3-5% of GNP.[9]

Likewise a well designed social support program would have been very cheap. The IMF estimated that an extensive social safety net, along with increased benefits to pensioners and health care provisions would have cost roughly 3% of GNP in 1992. Thus in combination, an enterprise support program and a social safety net would cost only 8% of GNP, less than one quarter of the 33% of GNP seigniorage raised in 1992. These numbers show that monetary policy was simply out of control in Russia, and likewise in the other high inflation countries during the early stage of reform. A more careful examination of credit policy provides additional evidence that the process was hijacked. While there is little evidence on the pattern of credit issue by country, Russia's experience provides what appears to be a common trend. In 1992 there was no centralised program for monetary policy and orders for new credits frequently came from the parliament, government and president. The benefactors of these huge credits were not those groups that were socially harmed most: for example pensions remained relatively low and access to them was very limited. Subsidised credits were given to the agroindustrial complex, northern territories and major industries. In June 1992 Gaidar, after trying to implement a tight credit policy, caved in to the demands of the industrial lobby in order to protect the privatisation program. He remarks on this directly in his Lionel Robbins Lectures[10]:

> "..So we were ready to begin the process of privatization. Unfortunately, it coincided with a civil crisis during which pressure mounted to weaken monetary policy and increase drastically the

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[9] See IMF et. al. (1991).

[10] Gaidar(1995) pp.42-43.

budget deficit. When we could no longer withstand the pressure, we loosened monetary and financial policy."

This pattern of large credits to the industrial lobbies and agriculture repeats itself throughout the CIS countries, Bulgaria and Romania. In a few cases, such as Estonia, Poland and Czechoslovakia, where reformists managed to maintain a social consensus (at least for some time) with the population, the demands for credits by industry could be fought off. But in those countries where reformists were weak, or where no reformists came to power, the social consensus necessary to fight off large industrial concerns and fight inflation was not strong enough or simply non-existent.

A related reason for the lack of monetary discipline is corruption. There is substantial evidence that corruption and bribery was rife in Ukraine and Russia and particularly in Central Asian countries during the first few years of reforms. Handelman(1994) documents the Chechyna scandals of 1992 where gangs obtained promissory notes authorised by the regional branch of the Russian Central Bank in Chechyna. These were subsequently honoured by commercial banks in other parts of Russia and in one arrest some $200 million dollars worth of cash was collected. Triesman(1995) examines the allocation of preferential credits in the Moscow region. While these credits were ostensibly aimed to improve food supplies in the Moscow region, in his econometric work he finds that an enterprise director's "connections with Moscow city authorities" is the only variable that can significantly explain which enterprises received funds. No variables related to food supplies or other factors reflecting stated purposes of the credits were explanatory. In Ukraine, while there is no recorded evidence of central bank corruption, there are similar incidents. For example, the former prime minister has been charged with embezzling several hundred million dollars. In such an environment it is understandable that officials would come under enormous pressures to issue credits for personal gain.

The sheer size of potential seigniorage is in itself a factor that made inflation almost inevitable. The amounts that were available were so substantial that any one person would have been under enormous pressure to break credit limits. It would have taken a set of determined politicians, a government with a strong political base, and a weak opposition to prevent inflation in a country as large as Russia. In smaller countries where increases in money issuing would lead directly to inflation through exchange rate depreciation which would lead to an increase in import prices, there would have been smaller benefits of inflation. In such a situation a determined reformer would face less opposition. In the Czech Republic there was a strong leader able to build consensus. And in Poland, Balcerowicz ironically was unopposed in the first few months largely because his government represented the major force that would have benefited from industrial credits, i.e. the Solidarity trade union. In all these cases personal leadership undoubtedly played a key role in weighing the balance of forces in favour of stabilisation.

To conclude it seems that the countries that experienced continued high inflation did so because rent seekers had captured the political process following the breakdown of political institutions. This, rather than structural explanations and explanations based on ignorance amongst policy makers seems to be the reason for the high inflation. This view is supported by the sheer size of the seigniorage revenue extracted and by its distribution.

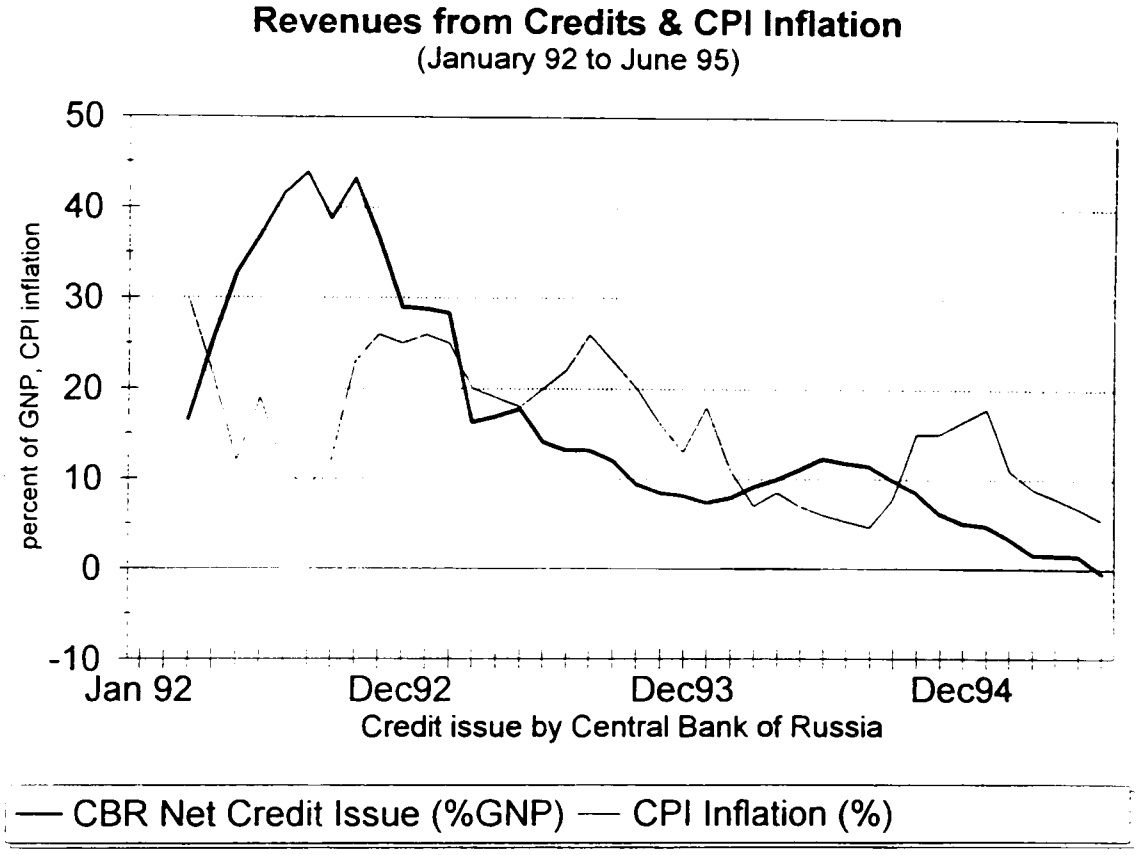
2.4 Why has Inflation Fallen in Most Countries as of 1996?

But if there were such great pressures for inflation, what then has allowed countries to stabilise over time? As seen from table 2.2, by 1995 more than half the countries had managed to reduce inflation below 50% per annum after several years of high inflation, and virtually every CIS country is now on track to bring inflation to 2-3% per month sometime in 1997. There are many possible explanations. Figure 2.4

illustrates one key reason in the case of Russia. Seigniorage declined rapidly from the unprecedented highs in 1992 to much smaller levels in 1995. This is true even for the same high inflation rates as occurred in 1992. The main reason for this appears to be the rapid development of financial markets which helps people avoid the inflation tax. When the payments system was slow, and there were few alternatives to holding funds in roubles, enterprises and households became hostages to the inflation tax. As agents found means to conserve on money balances, they avoided the inflation tax and money velocity rose. The levels of seigniorage gained in 1992 would certainly lead to hyperinflation in Russia today, so the benefits from inflation have been reduced sharply.

A second reason for the fall in inflation is the foreign financial assistance provided and the desire of politicians to become part of the world economic system. Substantial bilateral and multilateral aid to CIS countries has been conditional on agreement with the IMF over a monetary program. The IMF has made low inflation a key requirement of any agreed program. It is no surprise that every country that has stabilised has taken advantage of IMF loans when they embark on a program. There is still some dispute as to whether these benefits are marginal or significant. Sachs(1994b) argues that such short term assistance can provide key support for a political leader fighting off the interest groups that favour high inflation. Alternatively Gomulka(1994) argues that assistance can play only a minor role, and political determination at the start is key. No doubt the answer depends on the specific situation in the economy. In Russia, during the first year of reforms, the potential gains from seigniorage were far greater than any conditional aid that was offered. In addition, IMF programs required price and trade

Figure 2.4 Seigniorage and Inflation in Russia 1992-1994



liberalisation that would have seriously reduced the scope for gains worth well over $20 billion dollars for various interest groups. It is not surprising that the scope for these gains had to be reduced, and that opposition to high inflation had to increase, before the government could credibly sign on to an IMF program.

A third reason for the reduction in inflation is the improvements in the political system that have taken place particularly in the former rouble zone countries. This includes both the organisation of political parties and improvements in the policy making process. In countries where there are free elections, inflation has become one of the key concerns of the population. Granville and Shapiro(1996) report that a one percent reduction in inflation will reduce the number of Russians under the poverty line by 700,000. In opinion polls Russians report inflation is their second major concern after unemployment. If these opinions are channelled into the formal political system, then they are bound to affect politicians desire to increase their control over inflation.

Another reason why a well functioning political process reduces inflation is that it increases co-ordination among policy makers. After the initial collapse of the political system, rules for decision making were largely absent. In a few countries where one clear leader emerged decisions could be made coherently[11] taking into account all relevant costs and benefits. But this situation did not occur when many decision makers with competing interests became involved in policy making in a situation without well functioning rules for policy implementation. Aizenmann(1989) and Hørder(1996)[12] analyse the effects of this in a theoretical framework. If many different agents gain effective control over money issue - for example if the central bank responds to demand from the parliament, government and president - then high inflation would be the equilibrium outcome. Each group will try to sequester credits for their own benefit, and

[11] This leader could still choose high inflation as his prefereed policy as was the case for instance in Ukraine.
[12] Chapter 3 of this thesis.

they will only consider the costs that are specifically attributed to themselves. Alternatively, when there is one clear group or individual responsible for credit policy, then that person bears the full burden and blame for the costs of inflation.

An example where the absence of a well functioning decision making process caused inflation is the conduct of monetary policy in the CIS in 1992. After the break up of the former USSR, each of the CIS republics was effectively able to issue rouble credits. It was only natural that many of them would expand credit issue knowing that the inflation costs would be spread across all the republics while they gained the immediate benefits of seigniorage. This situation was only brought under control in July 1992 when clear limits on credits from the Russian Central Bank to other republics were put in place. Even then it took another year before these credits were fully stopped. In 1992 some 10% of GNP in monetary credits were given by Russia to the other republics.

Lack of a well functioning political process can also lead to indecision which again can result in high inflation. Alesina and Drazen(1991) present a theoretical model showing that when different decision makers (or groups of decision makers) are able to veto decision making, it can be individually rational for each of them to refuse agreements that would bring about stabilisation. They wait to take decisions in the hope that other groups will concede to better terms. In such a situation the stock of government debt can grow substantially, or a high inflation equilibrium can be sustained, while each interest group waits hoping that another will concede to paying higher taxes, or will accept a reduction in the credits they receive, in order to stop the inflation. The lack of agreements over budget plans, and the inability of governments to work out decisive stabilisation programs, probably reflected this type of indecision. Improved political processes and rules help prevent inflation caused by this type of "war of attrition" by penalising those who are hijacking the process.

It seems that in most cases where countries did not stabilise initially, the factors supporting continued high inflation has been eroded by subsequent economic and political developments. It appears that even in the former socialist economies which chose inflationary policies, stabilisation has occurred though with a substantial delay. While this is a positive development there are still lessons to be learnt from the early stabilisers as to what could have been done differently in the high inflation countries to promote early stabilisation and thus reduce the hardship suffered by the larger population.

2.5 Lessons for Stabilisation

When there is political chaos and uncertainty, it is tempting to argue that economic policies and strategies will play little role in determining whether a country stabilises. But the lesson from the former socialist countries is that, at least to some extent, this is incorrect. There is no doubt that large seigniorage revenues, a well organised opposition in favour of loose credit policies, and a corrupt environment reduce the chances that a politician interested in stabilising an economy will succeed. But there are lessons and examples from the CIS that show stabilisation is still possible even in these extreme environments. The aim of this section is to examine some of these lessons.

How economic policies affect outcomes is determined largely by the nature of political leadership in the economy. The economic policies implemented in the former socialist economies were not determined purely by historical legacies of institutions and fundamental economic factors. If this was the case then how could we explain the enormous differences in economic policies actually implemented? Was it predetermined destiny that Albania would join the group of rapid stabilisers while Romania and Bulgaria stayed behind with high inflation? And why did Kyrgyzstan manage to stabilise

early and generally follow liberal macroeconomic policies while all her neighbours were mired in interventionist policies with high inflation?

The success and failures of all these countries in part reflected differences in political leadership. In Ukraine there was undoubtedly an opportunity to enter into serious reforms right from the start. President Kravchuk won the support of the population for his strong nationalist stance, but there was little discussion of his economic priorities. A determined president could have called for economic reform and built a strong political base through popular support. If Kravchuk had been a spirited reformer as well as a nationalist then he might have succeeded. Likewise, amongst the Central Asian Republics President Akayev of Kyrgyzstan is the only example of a president that was determined to implement radical market reforms. He continuously fought with the parliament and government to gain power over economic policies and implement reforms. It was his popularity, and a series of referendums which he soundly won, that gave him the political support needed to implement stabilisation. It is easy to imagine that without his determination, and with a person more similar to Nazarbayev of Kazakhstan in power, Kyrgyzstan would never have implemented the program it chose.

In this section we look at the options facing a pro-stabilisation leader who at a given point in time has the opportunity to design an economic reform program. Since a key problem faced by reformers is the reversal of their stabilisation attempts, the question we pose is: what policy options help ensure that reforms can continue? There is a long literature on stabilisation and the optimal design of economic programs. This literature focuses mostly on Latin America and is concerned with issues such as wage controls, other price controls, and the choice of an optimal exchange rate regime at the start of stabilisation. We do not focus on these types of issues both because they are already well discussed in this literature, and because to some extent they are less relevant in former socialist countries. In many of the former socialist countries there was no need for wage and price controls. In these countries trade unions and workers seemed to have

weak bargaining power relative to enterprise directors. In Eastern Europe there wei few strikes and no evidence that wage demands would fuel inflation as they did in Latin America. In Poland for example workers elected enterprise directors in state enterprises, and wage controls were implemented to limit wage growth in the first few years of the program.

Instead we focus on the political arena where clear patterns across countries have emerged in terms of links between political developments and economic reforms. There are several options and issues worth considering. These relate to the underlying causes of inflation described in the previous section. We focus on four major policy options that we label: (1) poison pills (2) pre-emptive policy changes (3) conditional assistance and (4) deadlines and reform of the political process. There is very little theoretical work on these issues, and therefore the discussion will at times be superficial. We do however believe that these examples provide insights into important issues and are valuable starting points for future research.

2.5.1 Poison Pills

The leaders of stabilisation programs often claim that they only have a short period of time to carry out policies before opposition builds up and it becomes difficult to conduct reform. This is what Balcerowicz refers to as the "period of extraordinary politics" or what is sometimes called a window of opportunity. An extreme example is the situation faced by the Gaidar team. When they came to power different members of the team stated they were unlikely to last even six months. As shown in the empirical results tight monetary policy speeds up industrial decline and restructuring and hence the industrial lobby is a natural opposition to stabilisation. Loose credit helps postpone the eventual decline. This raises the possibility that short term stabilisation may be politically self sustaining. Once a country embarks on a stabilisation program that lasts long enough for real restructuring to start, the enterprises that are against reform will lose power as

their size declines, and their level of employment is reduced. This will naturally reduce their political power since the threat of employment cuts and strikes now is less punishing. This in turn will strengthen the pro-stabilisation forces and lead to a continuation of the stabilisation policies. However in addition to relying on such self-sustaining policies a pro-reform policy-maker acting in a window of opportunity can introduce a so called "poison pill" to sustain sound macroeconomic policies.

In corporate finance poison pills are a well known invention to prevent corporate take overs. Some countries have implemented similar devices in their economic policies. One example of an economic policy with "poison pill"-features is a currency board. In Estonia the central bank governor with the support of the government announced a fixed exchange rate, and introduced a currency board system, in July 1992. This was just prior to elections. By introducing such a system the governing politicians effectively changed the incentives of subsequent governments. The poison pill aspect of a currency board is that it is extremely difficult to reverse without risk of financial turmoil. Under the rules of operation the Bank of Estonia must always buy or sell foreign exchange on demand at a given exchange rate from all domestic entities. There are no provisions for suspension of foreign currency sales. The exchange rate is pegged and there are onerous procedures for changing it. The parliament must approve any change in the exchange rate, and this ensures there will be a real risk of news leakage and hence a run on foreign reserves prior to an agreement being reached in parliament. Unless there is wide consensus on changing the rules, it would be dangerous for any one group to open a Pandora's Box by trying to change the system.

A currency board locks in a number of important macroeconomic polices that are needed for stabilisation. First, by law the Bank of Estonia is not permitted to issue domestic credit. It can only issue base money through foreign exchange purchases. Second, the currency is fully convertible for current account transactions. And since the central bank must buy and sell foreign exchange resulting from current account

transactions, the money supply will adjust to ensure balance of payments equilibrium. With the exchange rate fixed, domestic prices will be anchored by import competition. Third, since the central bank cannot issue credits to the government or to commercial banks, the system forces an immediate adjustment in both the budget, industry and the banking sector. The government can only spend its tax revenues and must rely entirely on non-inflationary financing - this ensures that subsidies will be cut and price controls can be scaled back as they are not needed. Enterprises will not receive credits from the central bank and hence restructuring cannot be postponed. Finally, the banking system cannot be bailed out. While in many countries commercial banks with poor loan portfolios maintained liquidity by borrowing from the central bank, in Estonia these banks ran into severe problems early on and were forced into bankruptcy. Since the government could not afford to bail out the banks, depositors lost a fraction of their accounts. This had the positive result of forcing households to recognise the risks inherent in each bank, and encouraging them to place their money in safer banks. In an environment where many new banks are being created (for example some 2500 banks formed in Russia in 1992) this is an important start to limiting moral hazard problems in the banking system.

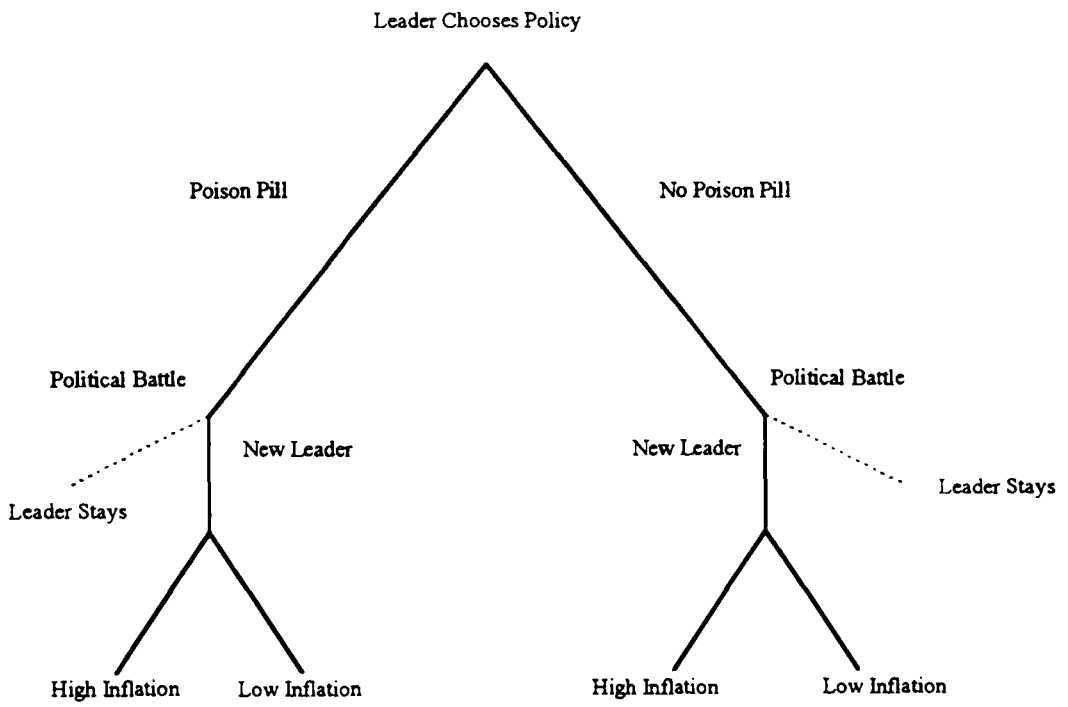
A second example of a poison pill also comes from Estonia. After fixing the exchange rate the Bank of Estonia sold futures contracts up to eight years ahead, at low fees, promising to sell foreign exchange at 8 Kroner per DM. We do not know the total amount of sales, but this is a very clear form of poison pill. Any central bank governor that in the future chooses to devalue the currency will face losses on these outstanding futures contracts. The intriguing aspect of the currency board system is that it changes the political payoffs to policy reversals. Figure 2.5 shows a simple sketch of how the payoffs might change. Suppose that in the first stage of a game the government is unsure of whether it will stay in power in the second stage, and if it does not, an alternative group which relies on anti reform support will come to power. Suppose further that if reforms last long enough, here two periods, they will not be reversed since the major

proponents of reversal will be sufficiently weakened. The payoffs to alternative policies are shown in figure 2.5. If in the second stage of the game the opponents come to power the net payoff from reversing reforms is B-A when there is a poison pill, or B when there is no poison pill. This makes it clear that there are two key criteria necessary for a poison pill to work:

1. the opponents must pay and perceive a penalty when they reverse reforms;
2. the opponents' perceived penalty must be greater than the perceived net gains from policy reversal.

Note that the effects of a poison pill may also be painful for other members of society. Therefore the risk of a poison pill is that if (1) and (2) are not satisfied, the poison pill will backfire. If the opponents choose to reverse policies in spite of the poison pill, then as the pill is invoked all members of society will bear the costs. A second problem arises if the new government is able to attribute the costs of invoking the pill on the previous government. Then even though the costs of the pill are potentially large, they may still not be borne by the persons in power and thus the poison pill might not prevent policy reversal and in fact worsen the realised outcome compared to the situation where there is policy reversal but no poison pill.

Figure 2.5 The Impact of a Poison Pill on the Subsequent Inflation Choice



A: Cost to the new leader of setting off the poison pill.

B: Benefit from high inflation to the new leader.

C: Benefit from low inflation to the new leader.

In Estonia the currency board was popular as it immediately stabilised prices after the spell of high inflation experienced while Estonia still used the rouble. It seems reasonable that the public would have attributed any failure of the system to the actual government that tried to reverse policies (witness the recent Mexican default or Turkey's early experience under Ciller). Given the relatively small amounts that are to be gained from breaking the rule it is quite possible that opponents to stabilisation would decide, once the currency board existed, to maintain the system once they arrived in power. While the currency board seems to have worked in Estonia it is not clear if such a system would be politically effective in a larger country such as Russia. In Russia as discussed previously the total benefits of breaking off pro stabilisation reforms were seigniorage revenues equal to 32.7% of GNP in 1992. Likewise the banking sector and the industrial sector in Russia, the two groups that would most oppose a currency board, were much larger than in Estonia. Estonia also had an "advantage" because ethnic Russians made up a disproportionately large portion of the population in the industrial sector. This made it easier for a nationalist government to implement stabilisation which primarily hurt industry.

2.5.2 Pre-emptive Policy Changes

It is also possible, at least in theory, that partial or pre-emptive policy changes may change the payoffs to political actors so that reforms are maintained. In Ukraine there was a power vacuum in the autumn of 1993 after a coal miners strike incited a political battle between the parliament and president. The result of the struggle was a compromise agreement to hold new elections for the parliament and the presidency. As the various groups waited for the elections, in December 1993 the governor of the central bank launched a single handed attempt to reduce inflation from hyperinflationary levels. He virtually stopped credit issue and there was an immediate decline in inflation

and output.[13] The policies met with substantial criticism from President Kravchuk, and he vowed to fire the governor once elections were over. In surprise results Kravchuk lost the elections to former Prime Minister Kuchma, and once Kuchma came to power he faced the choice of reversing the stabilisation or agreeing to it. Given that many of the costs of stabilisation had already been borne, and given a promise from the IMF to approve aid if stabilisation was maintained, Kuchma after his election faced a much different situation than that of December 1993. The past costs of stabilisation were already sunk, and any reversal would mean he would have to repeat the exercise again sometime later. By making a pre-emptive attack on inflation the central bank governor changed the incentives enough for Kuchma for him to eventually decide to continue the relatively tight monetary policies.[14]

A similar pattern was seen in Serbia. After an episode of hyperinflation in 1993, the minister of finance announced a stabilisation program in January 1994 with a pegged exchange rate. At the same time the government announced that the budget deficit would be 15% of GNP. Without other sources of financing this deficit could only be financed through money issue. Since the authorities had built up enough reserves to more than cover outstanding M1, the pegged exchange rate was credible for approximately four to five months if the budget deficit was implemented as planned. After this time the outstanding stock of base money would have surpassed foreign reserves, and with continued money issue people would expect an exchange rate collapse. As in the Ukrainian case, the initial public support for the stabilisation changed the nature of the political game. The pro-stabilisation ministers within the government were strengthened by the early support and success of the program as inflation fell. It was then clear that unless the budget was adjusted the program would break down. In

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[13] See later versions of Ukrainian Economic Trends.

[14] It was not at all clear that Kuchma would have chosen stabilisation in any case. He had previously been Prime Minister in Ukraine during a high inflation period, and in the election campaign he did not advocate stabilisation or radical reform.

April the cabinet finally agreed on a reduced deficit so failure was avoided. Once again it seems likely that the early stabilisation, and the subsequently changed payoffs to those supporting and opposing budget cuts, turned out to be sufficient to shift the balance of opinion in favour of budget cuts by April.

It should not be surprising that pre-emptive actions on the part of a small group with some temporary power over exchange rate policy, or monetary policy, would change subsequent incentives for political actors. But in practice it is not clear whether these will be enough to prevent the reversal of reforms. Many countries have stabilised for a temporary period and then reversed reforms. In Ukraine the decision to maintain course was in part due to the change of leadership, and was also helped by other factors such as the IMF money that was available if reforms were maintained. In Serbia the decision to stop financing the war ensured the budget could be kept in reasonable balance, and fingers had already been burnt from the severe hyperinflation in 1993. Pre-emptive strikes probably work in an environment where the costs and benefits of inflation are nearly balanced. If there are strong forces opposing the necessary stabilisation policies then high inflation may be unavoidable.

2.5.3 Conditional Assistance

There are many advocates of conditional foreign aid. There are both economic and political arguments for giving aid. As described in section 2.2, during the economic crises in former socialist countries budget revenues fell and there were legitimate demands for broad social programs. In such a situation inflation may be a logical choice by government officials. If a government could instead borrow to cover temporary spending needs and revenue shortfalls, then they could avoid the social costs of inflation. Indeed many of the requests for aid by recipient countries were constructed along these lines. However as we have previously argued the notion of fiscal crisis in many of the former socialist economies missed the nature of their underlying problems. It was the

breakdown of the political system, and lack of well-directed financing, that was at the heart of so-called fiscal crises.

A related reason for economic aid is to cover balance of payments needs. In the former socialist countries imports fell drastically when the CMEA trading regime ended and state orders were halted. There were also problems with developing a viable inter state payments system early on. Given the level of exports, foreign aid can support higher output and wages by limiting the decline in imports. But here aid can only have a small impact: at best it will be several percent of GNP, and such amounts are small compared with the declines in real GNP and purchasing power reported for CIS countries.

Since the direct economic impact of foreign aid most likely would be small, one main role of foreign aid should instead be to support weak governments that aim to introduce and maintain good policies (Sachs(1994b)). In this case small amounts of funds may be helpful if they translate into greater political power. In many CIS countries the liberal factions of governments had only limited control over state resources. When foreign assistance was made conditional on introducing policies they preferred, it could possibly tip the balance of political power in their favour. However given the large amounts of resources that were up for grabs in many countries (see table 2.3) it is no surprise that aid was ineffective at the start of reforms in many countries. The essential issue is whether there are enough net benefits from aid to the groups in power so that once they receive the aid they will be willing to implement the policies conditional on which the aid was granted. Since IMF programs require that the amount of credits issued are cut and that trade restrictions and other rent seeking policies are stopped, this will only happen when the net benefits of the policies favouring rent seeking groups decline, and only then will the political balance tip in favour of reformers. Thus the role of foreign aid in promoting initial reforms may be limited.

Aid may be more helpful in a role of ensuring policy co-ordination. When inflation and general economic breakdown is caused by a lack of co-ordination of policies across different interest groups, then the process of negotiations and conditional aid which the IMF begins may actually help end this lack of co-ordination (see below). For example. IMF programs demand that the government limit their foreign borrowing. In Mongolia and Ukraine, where there were brief periods where any ministry could take on foreign loans (and they did!), such simple rules could have helped co-ordinate overall fiscal and monetary strategies. The difficulty here is that each interest groups that has veto powers over these decisions must be willing to accept the conditions. Since typically the IMF deals only with the central bank and government, they may not be able to reach consensus when the parliament or other authorities that feel they get no benefits from foreign assistance. Because countries will only enter into aid programs when they are committed to reform, it is impossible to tell whether aid plays a critical role in the process of reform, or whether it is marginal or ineffective. Virtually every CIS country has now entered into some sort of IMF program. In response to early criticism the IMF introduced special financing in 1993 with reduced conditionality. This ensured that a large number of countries started programs, but it is not clear whether these programs sped up the process of stabilisation. One important role that early loans can play is to at least open up a clear dialogue with potential recipients. This allows them to better judge their own benefits and costs of reforms, along with providing technical assistance on program design. Since it also leads to small steps in the direction of reform, it may have acted as a "pre-emptive action" as described above which in turn made it more desirable for governments to continue the steps with broader IMF programs later on.

2.5.4 Budget Process and Deadlines

In former socialist countries poor economic policies were often caused by lack of co-ordination or rational indecision rather than because any single agent in absolute control chose them. Alesina and Drazen(1991) argue that wars of attrition, where one

party has a veto right over decisions needed to stabilise the economy, can result in long periods of socially costly inflation. In their model it is possible to introduce mechanisms that change the incentives of each group such that they are more willing to make early agreements and concessions. In Aizenman(1989) and Hørder(1996)[15] lack of co-ordination amongst policy makers drives the inflation process. If each ministry has the opportunity to effectively issue credits, say by pre-committing to spending and building up arrears, and if each of the spending agencies does not take into account the actions of other ministries, there is a potential for high subsequent inflation.

These arguments suggest that rules which force co-ordination and speeds up decision making may help to ensure that stabilisation is sustainable. Indeed, in many countries lack of co-ordination between agencies was an important factor causing inflation. In Ukraine the parliament had the legal right to make special demands for emergency credits and spending up to 1994. This meant the government, parliament and central bank were all effectively able to issue credits. In Russia in the first year after liberalisation there was no clear process for credit co-ordination. This was further exacerbated by the right of both the government and president to grant tax waivers and make spending promises, and of the parliament to legislate similar changes. High inflation ensued. Once credit policies and overall budgetary policies were co-ordinated inflation fell. The lesson that can be drawn from these experiences is that procedures and rules that enforce political co-ordination can play a key role in ensuring stabilisation is successful. The specifics will depend on the country in question, but the following are some basic rules:

1. There should be an ultimate arbiter that has the opportunity to penalise groups who do not make decisions. Such penalties should be obligatory though there may be discretion as to which group is penalised;

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[15] Chapter 3 of this thesis.

2. There must be a mechanism which ensures participation and encourages agreement between all major political groupings in the process;
3. There should be clear costs which can be attributed to each group when the process breaks down and deadlines are not met, and there must also be means for resolving the crisis (such as an election) if no ultimate agreement can be obtained;
4. There should be a mechanism for ensuring implementation of the budget as planned and legal requirements that prevent deviations outside of emergencies. There must be one arbiter held responsible for deciding when deviations are legitimate.

Even when such procedural rules are included in a stabilisation program, there may still be a problem of adherence. Such rules can only work when they are part of a program which is legitimately accepted by most political groups. If there is a "window of opportunity" when a leader can implement such rules, then they may in turn become difficult to change later on, thus locking in a stable budget making process which prevents wars of attrition, or inflation driven by un-coordinated policy making.

2.6 Conclusion

We believe that loose monetary policies and continued high inflation in the former socialist economies primarily reflected the political breakdown, the institutional breakdown and widespread corruption in these economies. Close examination of the policies has shown that credits and budget expenditures were directed to strong political lobbies rather than to reduce the social costs of adjustment. Since these strong lobbies were generally large industrial enterprises and the former political elite, the ultimate impact of high inflation was to slow structural adjustment. The enterprises that fought hardest for credits were undoubtedly the ones that needed the greatest structural reforms and downsizing in the transition process. By giving credits to these groups, loose monetary policies only delayed the onset of the output decline and may have had the perverse effect of strengthening the anti-reform lobby. However, in each country the

scope for rent-seeking and seigniorage declined over time as reforms progressed. So by 1995 the benefits of loose credit policies were markedly reduced, and it is no surprise that virtually every country has now entered into a stabilisation program.

These political explanations for high inflation provide lessons for stabilisation programs in the future. When instability is caused by political breakdown, and lack of checks and balances on leaders, then programs should be directed at these problems. This means focusing on policies which force or encourage co-ordination. Most importantly, democratic change can play a key role in ensuring that politicians are held responsible for their actions, and that the publics interests are channelled into the formal political process. The lesson from the CIS countries is that when the political system does not do this, high inflation and enormous rent-seeking can result. This means incorporating more political rules and conditionality into initial stabilisation programs.

In addition there are more specific actions that leaders who face a short "window of opportunity" can take to co-ordinate economic policy and prevent reversal of reforms. We discussed how poison pills, pre-emptive policy strikes, checks and balances on budget processes, and conditional foreign assistance should be key ingredients in policy programs introduced in such a situation. These policies would need to be introduced alongside more standard and well-discussed fiscal measures (see for example Sargent(1983)).

What does this bode for the future paths of inflation of Eastern European and the CIS countries? We are optimistic. Since in many of these countries political processes are gradually being redefined, and since the benefits of seigniorage and rent-seeking have fallen, the root causes of high inflation have now been reduced. This suggests that in most of these countries we will not see recurring high inflations and instability, as observed for example in Latin America, in the future. Wherever there is a repeated breakdown of the political system, for example in war torn areas and where there is civil disorder, there may very well be further episodes of similar inflations. In these cases, the

lesson from the former socialist countries should provide guidelines as to how to prevent long episodes of disruption.

Chapter 3

Institutions and Inflation[1]

We present an overlapping generations model with three types of agents, private agents, and pairs of state and fiat agents. A state agent's income is the seigniorage revenue generated by the young fiat agent it is paired with. We introduce an equilibrium concept that allows us to study the welfare consequences of having more than one young state and fiat agent pair each period. We show that an economy will end up on the "slippery" side of the Seigniorage Laffer Curve as a consequence of having more than one seigniorage generating agent each period, and that both private and state agent welfare decreases as the number of state and fiat agent pairs increases. We show how Russia's inflationary performance in 1992-93 can be understood within the framework of our model.

[1] Charlie Bean and Ed Green supervised my work on this paper and provided invaluable advice. Thomas Sargent gave very helpful comments and suggestions. I had very useful discussions with Peter Boone, Nobuhiro Kiyotaki and David Webb. The paper also benefited from discussions from seminar participants at the Research Department of The Federal Reserve Bank of Minneapolis and the University of Århus.

" An association of monopolists working for their own interest (..) will also work for the interest of consumers." (Cournot 1838).

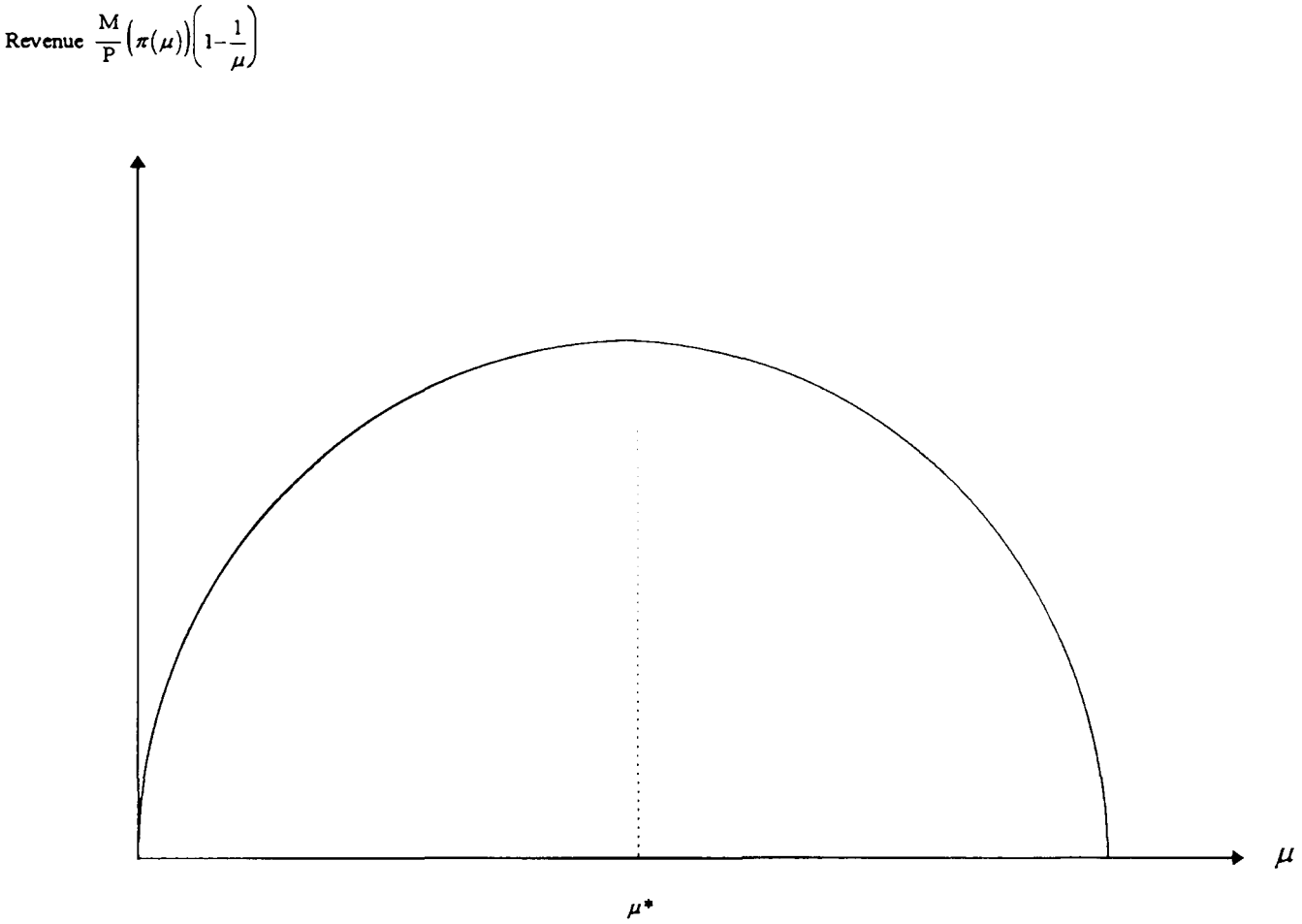
3.1. Introduction.

In this paper we present a model economy in which the structure of the monetary institutions plays a crucial role in determining the inflationary performance of the economy and affects the welfare of all agents in the economy. Our conclusion follows Cournot's reasoning in the sense that we conclude that the situation in which one agent co-ordinates the issue of fiat money and distributes the inflation tax revenue among the other claimants, Pareto dominates the situation in which all agents with money issuing rights generate their own inflation tax revenue by issuing fiat money separately.

The term "inflation tax" refers to the view that the depletion of the real value of nominal money balances caused by inflation can be seen as a tax on these money balances. The rate of inflation constitutes the tax rate, and outstanding nominal balances constitute the tax base. In this set-up tax revenue will be zero if the tax rate is zero, or if the base on which the tax is levied is zero. Bailey(1956) applied the principles of optimal taxation to the study of the optimal use of the inflation tax. In an economy where agents' money demand is a negative function of the expected rate of inflation[2], and inflation is a function of the money growth rate, one can derive the so-called Seigniorage Laffer Curve (figure 3.1). As the money growth rate increases from zero, inflation tax revenue increases, but since money demand falls as the money growth rate increases the tax base is reduced. Eventually this reduction in the tax base begins to dominate the positive effect on tax revenue coming from the increased tax rate and as the money growth rate increases above μ * tax revenue begins to fall. If the objective is to extract inflation tax revenue through issue of money balances, there is an optimal rate of growth of money in the economy and an associated optimal rate of inflation.

[2] Bailey uses Cagan's (1956) money demand function.

Figure 3.1 The Seigniorage Laffer Curve



The OECD economies have highly developed systems for tax collection. This is not the case in many developing countries who have yet to establish such institutions and in the transitional economies the collapse of the socialist economic system has severely impeded tax collection. Therefore the inflation tax has played an important role in these economies[3].

Many of the same economies have experienced episodes of very high inflation in which the economy has been almost entirely de-monetised. These episodes seem hard to reconcile with the optimal inflation tax literature, since they correspond to a situation in which the tax rate is set too high. A substantial economic literature is devoted to explaining these episodes - as Stanley Fischer has phrased it, the question is: "Why do countries end up on the slippery side of the Laffer Curve?" (Fischer 1984).

The literature contains several answers to Fischer's question. One set of models rely on a structure in which a unitary government issues money to finance a given deficit in an economy with a continuum of money-holding private agents. In all these models the source of the sub-optimality is the private sector formation of expectations of government policy. In Bruno and Fischer(1990) multiple equilibria exist and the stability of different equilibria depends on how agents' expectations are formed. If agents have rational expectations only the equilibrium on the slippery side of the Laffer Curve is stable. Calvo (1988) shows how high inflation equilibria can occur purely as a self fulfilling panic. Chang (1994) shows how currency substitution can occur purely as an expectational phenomenon given fundamentals and how this can affect the government's ability to levy the inflation tax. Cukierman (1992) presents a model in the tradition of Kydland and Prescott(1977) and Barro and Gordon (1983) where a government financing a deficit through the printing press will be forced on to the slippery side of the Laffer Curve in the absence of a commitment technology. Even though most of these models are based on reduced

[3] For the importance of seigniorage revenue in developing economies see Cukierman, Edwards and Tabellini (1992). For the importance of seigniorage in transitional economies see chapter 2 of this thesis.

form demand functions for money[4], the authors simply assume that inflation is welfare reducing and therefore go on to give policy advice on how to reduce inflation. Since the high inflation, low seigniorage equilibrium in these models occur as a result of private agent expectations of government policy, the policy advice in these models all have the same flavour: to tie down private agent expectations the government must introduce a nominal anchor for its monetary policy. In a sense one can say that this type of policy advice gets around the problem by introducing a mechanism that exogenously ties down government policy.

Another set of models focuses on the role of the design of government institutions for economic policy outcomes. Inefficient policies are caused by inappropriate design of institutions. Alesina and Drazen (1991) model delay in optimal policy reforms as the result of a war of attrition between two factions in government. Roubini and Sachs (1989) have used the same principle when explaining large fiscal deficits in countries with multi-party coalition governments. While these models address very important issues they pay relatively little attention to the foundations of their welfare analysis since they base their analysis on assumed reduced form welfare functions. Here we take the view that welfare economics should be based on economies built from first principles specifying agents' preferences, endowments, technologies and the environment. In monetary economics this imposes strong demands on the modeller since fiat currency has no value in the standard Walrasian equilibrium. Therefore the economist must specify frictions that give rise to a role for fiat currency. There are several ways of introducing these frictions[5]. In our model we will choose the overlapping generations framework which closes down the market for private claims between agents of different generations[6]. Some authors argue that a "currency in the utility function" formulation is another way of introducing fiat money into general equilibrium. While this type of formulation allows one to address issues from

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[4] This is not true for Chang (1994).

[5] For an overview of the models that have dominated the micro based analysis of monetary policy in the last 15 years see Kareken and Wallace (1980). See also Sargent (1987).

[6] Wallace (1980) presents the case for the overlapping generations model as the best available model of fiat money and stresses the importance of the missing market for generating value of money in equilibrium. He also takes issue with the claim that OLG models only capture the store of value function of money not the medium of exchange role (pp. 50-51).

monetary economics in the standard infinitely lived agent economy, it is at the same time susceptible to a very strong criticism in that one of the characteristics of fiat money is that it is intrinsically useless and therefore does not belong as an element in an agent's utility function[7]. Aizenman(1989) is one example of a general equilibrium model with an institutional explanation of sub-optimality of inflationary policies. The failure of several money issuing agents to co-ordinate their issue of fiat currency brings the economy on to the slippery side of the Laffer Curve. However his model relies on the currency-in-the-utility-function formulation and therefore makes the welfare analysis susceptible to the criticism mentioned above. Aizenman also fails to address in detail the strategic interaction between the different money issuing agents, and instead imposes a steady state exogenously. Zarazaga (1993) is a model built on the same principle as Aizenman which sees co-ordination failure as a cause of sub-optimal policy. He pays more attention to the dynamic strategic interaction of the money issuing agents by drawing on a model from the industrial organisation literature that addresses core issues in enforcement of cartels under imperfect information (Green and Porter (1984)). However Zarazaga's model is also based on a currency-in-the utility-function formulation and thus seems less applicable to issues related to inflation in fiat currency economies.

Our model belongs to the second set of models. We will try to answer Fischer's question by relying on an institutional explanation of the inefficient economic outcome that is high inflation. However we also want our model to satisfy the criteria that allows us to undertake welfare analysis. This implies that we must build the model from first principles and show how fiat money can enter the general equilibrium with positive value. The justification for seeking an institutional explanation for high inflation stems from the observation that high inflation is most often associated with weak government. Before outlining our model we will give an example of a situation where institutions seemed to play an important role for the inflationary performance of an economy.

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[7] See Wallace (1980) for a discussion of this issues(p.49) .

In January 1992 Russian prices were liberalised as part of an overall economic reform package. Liberalisation was followed by a step jump in prices of 245% in January but thereafter monthly inflation rates fell rapidly to around 10 percent in the summer of 1992. In the autumn of 1992 inflation began to take off again and towards the end of 1992 hyperinflation seemed imminent, when the monthly inflation rate accelerated from 12 percent in September to 23 percent in October and 26 percent in November. The main source of growth of the monetary base in 1992 was directed credits to various targeted sectors, and as table 3.1 illustrates there was a large increase in the amount of directed credits in the second half of 1992, at the same time as inflation began to accelerate. The key institutional fact regarding directed credits was that they in 1992 were granted by the central bank, on the initiative either of the bank itself, of various spending ministries, parliament or the president. As Sachs observes:

> "Until the spring of 1993, individual ministries, key members of parliamentary commissions, powerful industrial enterprises and influential regional authorities, all have had substantial sway on credit policy without any overall macroeconomic constraint."[8]

The importance of these credits for overall monetary conditions in Russia in this period is underlined by the fact that commercial bank intermediation played a very small role during 1992 and 1993. The fraction of the money stock made up of claims directly on the central bank (i.e. base money) was much larger than in the OECD economies. This is illustrated in table 3.2 which shows that the ratio of total commercial bank lending to Central Bank of Russia (CBR) bank credits was between 1 and 2.2 through out 1992 and 1993. Furthermore the asset quality of the Russian Central Bank's claims on the agents who received the directed credits was questionable because the distinction between subsidies and credits had all but disappeared in the Soviet planning system. Ultimately these claims were claims on the government budget, which meant than in effect the monetary system

[8] Sachs(1994a) p.49.

Table 3.1 Central Bank of Russia Credits 1992-1993

	1992				1993			
	Q1	Q2	Q3	Q4	Q1	Q1	Q3	Q4
Total CBR credits	34	127	113	203	95	50	96	49
Credit to Government	-63	72	102	65	33	-13	65	58
Credit to banks	74	-50	-17	91	16	52	21	-7
Directed credits	88	98	151	151	52	47	47	9
Other credits	14	-7	3	5	7	7	1	0
Liabilities to banks	27	141	170	65	43	2	27	15
Interstate loans	22	105	27	47	45	11	11	-2

Percentage change with respect to currency at the beginning of period. Q1=January-March etc.
Source: RET and Government Sources.

Table 3.2 Russian Banking Intermediation 1992-1993

	1992				1993			
	March	June	Sept.	Dec.	March	June	Sept.	Dec.
Total bank claims on rest of economy (1)	1010	1488	3306	5583	8814	13572	20711	27930
CBR directed credits to banks (gross) (2)	326	562	1273	2844	3884	5401	8025	8744
Commercial bank lending (excluding directed credits) (3=1-2)	684	926	2033	2739	4930	8171	12686	19186
Intermediation (3/2)	2.1	1.6	1.6	1.0	1.3	1.5	1.6	2.2

Source: RET and Government Sources.

operated as though it were a pure fiat currency system with several money issuing agents.

After Russian inflation began to accelerate in late 1992, the Russian government reformed the institutions dealing with allocation of directed credits. In October 1992 it was decided to establish a credit commission which was to co-ordinate the use of directed credits. The credit commission assumed its role from the spring of 1993, and as is evident from table 3.1, the flow of directed credits was reduced substantially. Consequently the establishment of the credit commission has been credited as a major reason why hyperinflation was avoided:

> "On October 7th 1992, the president issued a decree on the formation of a government commission on credit policy.....Empowering this commission probably saved Russia from hyperinflation."[9]

The effect of the high inflation in 1992 was to deplete the real value of rouble balances. A study has shown that the main loser was the household sector whose financial assets were mainly currency and low interest bearing deposits at the Sberbank[10]. But the beneficiaries of the directed credits, the state owned enterprises who held deposits and some currency were also hit (Layard and Richter (1994)).

In summary, until the establishment of the credit commission, there were several agencies issuing claims on the central bank independently of each other. The household sector holding money balances was hit by the implied inflation tax effect of these credits, but state owned enterprises were also affected to the extent that they held nominally fixed financial assets. In response to the rapid growth of directed credits in the second half of 1992, and accelerating inflation, the Russian government formed a credit commission which were to co-ordinate the use of directed credits. In the spring of 1993 the flow of directed credits was reduced and the acceleration of the inflation rate halted.

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[9] Aslund (1995) p.193.
[10] Sberbank is the Russian savings bank run by the government.

The events described above in our view justify taking the institutional approach to modelling inefficient policy outcomes. The case of Russia also gives us an opportunity to compare the welfare implications of different institutional regimes with Cournot's observations in mind.

Our model has a standard overlapping generations structure in which the endowments of private agents are such that they wish to move consumption from the first period to the second period (i.e. save) in an environment with no inflation. There are no storage possibilities except for fiat money balances that yield a real return of minus the inflation rate between one period and the next. Into this standard structure, we then introduce another set of agents which consists of pairs of agents which we call respectively the state agent and the fiat agent. These agent pairs also live for two periods. The state agent in a pair has the same preference structure as the private sector agents[11]. The fiat agent in a pair has as its sole role to issue fiat currency while young to extract seigniorage revenue. This seigniorage revenue is handed over to the state agent and supports his consumption. The fiat agent issues currency in a way that maximises the welfare of the state agent he is paired with.

The model thus has a structure in which private agents are always adversely affected by inflation while state agents benefit from it. However since the state agent only receives income while young he too must save and is therefore adversely affected by the amount of inflation in the period in which he is old. This rate of inflation is in turn determined by the actions of the next young fiat agent who is maximising the utility of his young state agent partner. We model the strategic interaction between young fiat agents of different generations as a game in which they each act once namely when they choose the growth rate of the money stock. We assume that the strategies of fiat agents are functions of the history of money issuance in the economy. In this way the fiat agent will take into account the effects of his action not only on the current inflation rate but also on future inflation rates.

[11] This formulation can be rationalised if one interprets the state agents as meaning households employed by the state sector.

We now outline the basic overlapping generations model. Then we present the money issuing game where the players are young fiat agents. This game is first analysed for the case where there is only one young agent pair each period, which is our model equivalent to the situation after the credit commission was established. Then we analyse the same game in the situation with multiple young agent pairs issuing money each period, which is our model's equivalent of the Russian situation prior to the establishment of the credit commission. Finally we compare the equilibrium outcomes in these two cases and conclude.

3.2. The Economy

The economy consists of an infinite sequence of agents arranged in overlapping generations. All agents live for two periods. We will use the term 'young' to refer to the time period in which the agent in born and 'old' to refer to the next period. There are three types of agents in the economy: private agents, and pairs of state and fiat agents. There is no population growth and each generation of private agents consists of a continuum of agents normalised to size 1, while each generation of state and fiat pairs consists of a set of agent pairs of size n. There is a single non-storable consumption good in the economy.

Private agent and state agent preferences are represented by a utility function $u:R^2 \rightarrow R$ which is defined over the agent's consumption while young and while old. We write this as $u^t(c_t^t, c_{t+1}^t)$ where the superscripts refer to the agent's birth date and the subscripts refer to the time period of consumption. The utility function is increasing, continuous and concave in both arguments and satisfies the conditions, $u_1 > 0,\ u_2 > 0,\quad u_{11} \leq 0,\ u_{22} \leq 0,\quad$ and $\quad u_1 / u_2 \rightarrow 0$ as $\quad c_t / c_{t-1} \rightarrow \infty$. The fiat agent paired with a state agent is concerned with maximising the utility of the state agent through money issuance as described below.

Private agents receive an exogenous positive endowment of the consumption good. State agents' income comes solely from their fiat partner who can issue currency while young and hand over the proceeds "the seigniorage" to the young

state agent they are paired with. Given their income stream, private agents and state agents will choose consumption and savings plans acting competitively in the markets for consumption goods and savings. The fiat agent has as its objective to maximise the utility of the state agent it is paired with by choosing a growth rate of the money stock while young. We first describe behaviour in the competitive markets and then describe the problem facing the fiat agents.

We distinguish agents in the competitive markets by superscripting private sector agents by a 'p' and state sector agents by an 's'. The endowment vector of a private agent is (e_t^p, e_{t+1}^p). We will analyse the case in which private agents in all generations receive an identical endowment w while they are young and nothing while they are old, thus the endowment vector of the private agents is $(e_t^p, e_{t+1}^p) = (w,0)$. With preferences and endowments specified as above private sector agents obviously wish to save some of their endowment for consumption in old age. However the consumption good is not storable and agents can only save by holding fiat money. The optimisation problem facing a private sector agent is thus,

$$(1) \qquad \underset{c_t^{pt}, c_{t+1}^{pt}}{\text{Max}}\ u^{pt}(c_t^{pt}, c_{t+1}^{pt}) \ \text{ s.t. } \ p_t c_t^{pt} + p_{t+1} c_{t+1}^{pt} = p_t w$$

Where p_t denotes the price of time t consumption in terms of fiat money. Standard Lagrangian optimisation will show that the optimal consumption allocation is characterised by,

$$(2) \qquad \frac{u_2^{pt}(c_t^{pt}, c_{t+1}^{pt})}{u_1^{pt}(c_t^{pt}, c_{t+1}^{pt})} = \frac{p_{t+1}}{p_t}$$

The private sector demand functions will be of the form $c_t^{pt} = c_t^{pt}(w, \frac{p_{t+1}}{p_t})$. We assume that both goods are normal goods which is identical to saying that both consumption while young and while old will increase as w increases. $\frac{p_{t+1}}{p_t}$ is the price of consumption at time t+1 relative to the price of consumption at time t,

which is identical to the inflation rate π_{t+1}. An increase in the inflation rate will have both an income effect, since increased inflation reduces the real value of the endowment in terms of time t+1 consumption, and a substitution effect since inflation also can be viewed as an increase in the price of consumption at time t+1 relative to consumption at time t. We impose the restriction that consumption at time t and at time t+1 are gross substitutes. This assumption ensures that savings will decrease when inflation increases and substantially reduces the number of equilibria in our model[12].

Assumption 1

Preferences are such that consumption at date t and at date t+1 are gross substitutes.

Given the above assumptions we may write the private agents demand functions as,

$$(3)\quad c_t^{pt} = c_t^{pt}(w_t, \pi_{t+1}) \quad \text{and} \quad c_{t+1}^{pt} = c_{t+1}^{pt}(w_t, \pi_{t+1})$$
$$\qquad\qquad +\quad +\qquad\qquad\qquad +\quad -$$

Where the (+) and(-) signs refer to the sign of the partial derivative of the consumption function with respect to the argument. Notice that given our assumptions on preferences and the optimality condition in (2) the consumption function at date t+1 must be convex to the origin in π_{t+1} i.e. decreasing at an increasingly slower rate as consumption becomes more valuable. The savings function for a private agent is,

$$(4)\quad s_t^{pt}(w_t, \pi_{t+1}) = w_t - c_t^{pt}(w_t, \pi_{t+1})$$
$$\qquad\quad +\quad -\qquad\qquad +\quad +$$

Since consumption at both dates is increasing in wealth, consumption at time t will increase by less than w and the savings function will be increasing in time t wealth. Savings are decreasing in inflation, but at a steadily slower rate (i.e.

[12] Sargent(1987) p.233.

$s^{pt}_{\pi\pi} > 0$) for exactly the same reason as consumption at time t+1 decreases steadily slower as inflation increases. Recall that the savings function in our model is identical to the private sector demand for real money balances. The indirect utility function of a private agent can be written, $u^{pt} = u^{pt}(c^{pt}_{t}(w_{t}, \pi_{t-1}), c^{pt}_{t+1}(w_{t}, \pi_{t+1}))$ The partial derivative with respect to inflation is negative since increased inflation reduces the feasible consumption set, thus

$$(5) \quad u^{pt} = u^{pt}(w_{t}, \pi_{t+1})$$

We now turn to the state agents. Each state agent when young receives a given amount of seigniorage from the fiat agent it is paired with. The assumption that state agents also only receive income while young is crucial since this is a way of ensuring that state agents also need to hold savings in the form of money balances. The effect of inflation on savings is a channel through which inflation can reduce state agent welfare.

We will initially analyse the case where there is only one state and fiat agent pair. Total seigniorage revenue at time t is $\frac{M_t - M_{t-1}}{p_t}$ i.e. the addition to the nominal money stock at time t divided by the price level. We call the growth rate in the nominal money stock $\frac{M_t}{M_{t-1}}$ for μ_t. Total seigniorage can thus be written,

$$(6) \quad \frac{M_t - M_{t-1}}{p_t} = \frac{M_t}{p_t}(1 - \frac{1}{\mu_t}).$$

The problem facing a state sector agent who has received a given amount of seigniorage from its fiat issuing partner is,

$$(7) \quad \underset{c^{st}_t, c^{st}_{t+1}}{Max}\ u^{st}(c^{st}_t, c^{st}_{t+1}) \text{ s.t. } p_t c^{st}_t + p_{t+1} c^{st}_{t+1} = \frac{M_t}{p_t}(1 - \frac{1}{\mu_t})p_t$$

We can use the results from the analysis of the private sector agent to describe the consumption and savings functions of the state sector agent, thus.

$$(8)\quad c_t^{st} = c_t^{st}\left(\frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right), \pi_{t+1}\right), \qquad c_{t-1}^{st} = c_{t-1}^{st}\left(\frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right), \pi_{t-1}\right) \text{ and}$$

$$s_t^{st}\left(\frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right), \pi_{t+1}\right) = \frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right) - c_t^{st}\left(\frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right), \pi_{t-1}\right)$$

We now go on to characterise equilibrium in the savings market, recalling that the state agent savings function is his demand for real money balances. Thus our savings market equilibrium condition is identical to the money market equilibrium condition,

$$(9)\quad \frac{M_t}{p_t} = s_t^{pt}(w_t, \pi_{t+1}) + s_t^{st}\left(\frac{M_t}{p_t}\left(1-\frac{1}{\mu_t}\right), \pi_{t+1}\right)$$

We can interpret (9) as the money demand function. Doing this we summarise the properties of the money demand function in proposition 1. First let us note that for finite inflation private sector savings demand will always be positive. State sector savings demand is zero for $\mu_t = 1$ since the state agent then has no income. As money growth increases the income effect causes state agent savings demand to go up, state agent savings are also decreasing in inflation. Also, let us note that the fiat agent that the state agent is paired with eventually will be choosing the growth rate of the money stock to generate income in a way that maximises utility of the state agent. State agent income will only be positive if seigniorage is positive, which it is for $\mu_t > 1$. Given our assumptions on preferences the fiat agent will always choose a positive level of seigniorage so in equilibrium $\mu_t > 1$.

Proposition 1

For $\mu_t > 1$:

$$\frac{d(\frac{M}{P})_t}{d\pi_{t-1}} < 0 \quad \forall t \quad , \frac{d^2(\frac{M}{P})_t}{d\pi^2_{t+1}} > 0 \quad \forall t, \frac{d(\frac{M}{P})_t}{d\mu_t} > 0 \quad \forall t$$

For proof see Appendix A.

We can now write the money demand function as,

$$(10) \quad \frac{M_t}{P_t} = \frac{M_t}{P_t}(\underset{-}{\pi_{t+1}}, \underset{+}{\mu_t}),$$

where the signs of the derivatives refer to the case where $\mu_t > 1$. We can substitute this money demand function into (8) to get,

$$(11) \quad c_t^{st} = c_t^{st}(\underset{+}{\frac{M_t}{p_t}(\pi_{t+1}, \mu_t)(1-\frac{1}{\mu_t})}, \underset{+}{\pi_{t+1}}) \ , \qquad c_{t+1}^{st} = c_{t+1}^{st}(\underset{+}{\frac{M_t}{p_t}(\pi_{t+1}, \mu_t)(1-\frac{1}{\mu_t})}, \underset{-}{\pi_{t+1}})$$

These consumption functions can be substituted into the state agents utility function giving us the indirect utility function $u_t^{st}(\pi_{t+1}, \mu_t)$. The growth rate of the money stock affects indirect utility because it is the source of seigniorage, which constitutes the state agents income. Inflation affects indirect utility in two ways, directly through its effects on the consumption set of the state agent and indirectly because it affects the holdings of money balances in the economy, which constitute the basis on which seigniorage revenue is created.

To solve the model we need to analyse the effects of inflation and money growth on the indirect utility function of the state agent. The general specification of preferences does not allow us to do this. In the following we will introduce additional assumptions on preferences that will allow us to derive an analytical solution of the model as a result holding in situations where the income of the state agent is small or inflation is high. The model can be solved numerically for more general allocations, as we will illustrate later in the paper.

Assumption 2

Preferences are such that $\frac{u_{\pi}^{st}}{u_{w}^{st}} \rightarrow 0$ for low w or high π .

One can show that assumption 2 on preferences holds for Constant Elasticity of Substitution (CES) utility functions which are of the form $u(c_t, c_{t+1}) = (\alpha_1 c_t^{\rho} + \alpha_2 c_{t+1}^{\rho})^{1/\rho}$. Assumption 1 is satisfied if ρ is sufficiently close to 1 (i.e. if the elasticity of substitution $1/(1-\rho)$ is high).

With these restrictions on preferences we can go on to characterise the indirect utility function of the state agent more precisely.

Proposition 2

For $\mu_t > 1$,

$$\frac{du^{st}}{d\pi_{t+1}} < 0 \ \forall t \qquad \frac{du^{st}}{d\mu_t} > 0 \ \forall t$$

For proof see Appendix B.

Thus we may write the indirect utility function as,

$$(12) \quad u^{st} = u^{st}(\underset{-}{\pi_{t+1}}, \underset{+}{\mu_t})$$

Where the signs of the derivatives again only refer to the case where $\mu_t > 1$. Also note that these analytical results hold only for the limiting cases where inflation is high or income is low. Later in the paper we will present numerical simulations of a more general case.

All that remains is to model the decision of the fiat agent on how much seigniorage to create when its objective is to maximise (12), and describe the equilibrium consequences for inflation, money demand and economic welfare. To do this we follow the Ramsey approach outlined by Lucas and Stokey (1983). Equilibrium money demand from the competitive savings market is substituted into the optimisation problem of the fiat agent who chooses the growth rate of the money supply and thus acts as a feasibility constraint on his optimisation problems.

The problem for the fiat agent is to choose a growth rate for the money stock at time t that maximises the utility of the state agent it is paired with. Every period a new fiat agent faces this problem. We introduce a strategic element in the interaction between fiat agents of different generations. In doing so we will assume that the action of the current state agent affects the actions of future state agents, or formally: that past actions are elements in the function (the strategy) that determines the action of an agent. In this way its actions today have consequences for the future. We now give a formal representation of an equilibrium concept where strategic interaction between fiat agents limits the money issuance. First we present the case where there is only one agent issuing money each period, and subsequently we extend the analysis to the case with several fiat agents each period.

Definition:

An equilibrium is a sequence of strategies $\{s_t\}_{t=0}^{\infty}$, private sector consumption allocations $\{(c_t^{pt}, c_{t+1}^{pt})\}_{t=0}^{\infty}$, and state sector consumption allocations $\{(c_t^{st}, c_{t+1}^{st})\}_{t=0}^{\infty}$, such that,

(i) Given $\mu_0, \mu_1, ,.. \mu_{t-1}$ and s_{t+1} .... s_{t+n}, s_t is chosen so that it maximises u^{st} $\forall$ $t, n \rightarrow \infty$.

(ii) Given the implied price sequence of the economy, $\{(c_t^{pt}, c_{t+1}^{pt})\}_{t=0}^{\infty}$ satisfies (1) and $\{(c_t^{st}, c_{t+1}^{st})\}_{t=0}^{\infty}$ satisfies (7).

(iii) The money market equilibrium condition (9) is satisfied.

Given the way we have set up our model, a sequence of strategies that satisfy (i) will also imply consumption sequences that satisfy (ii) and (iii) since money market equilibrium is embedded in the indirect utility function of the state agent. However we have chosen to include the money market equilibrium explicitly in the definition to make this point clear.

We derive our equilibrium concept from a game played between the young fiat agents of all generations. The game starts at date 0 and runs forever. Each period a new fiat agent enters and as a single act chooses a growth rate of the money stock. When choosing a growth rate, the current fiat agent bases his choice on past growth rates chosen by previous fiat agents. He also takes into account that his current action is an element in the strategies of future agents.

Call the set of players $SA = \{sa_t\}_{t=0}^{\infty}$. Each player chooses an action (a growth rate of money). The action set is $\mu_t = (-\infty, \infty)\ t = 0,1,2,.. \infty$. A strategy s is a choice of a growth rate, based on past growth rates chosen.

Formally the strategy of the first player who is active at time 0 is to choose an action, while for players active from time 1 and onwards, a strategy is a mapping from past actions to a current action. We can summarise this in the following notation.

$$s_0 = \mu_0,\ \ s_t : \mu_0 \times \mu_1 \times \ldots \mu_{t-1} \rightarrow \mu_t \quad \forall\, t \geq 1.$$

Given the definition of strategies, we will outline the equilibrium concept of the game. Call a sequence of strategies for all players $\{s_t\}_{t=0}^{\infty}$ a strategy profile of the game, and call the set of all possible sequences Σ. Let w be a mapping that maps the set of sequences into utility levels for state agents.

$$(13)\quad w : \Sigma \rightarrow u^{st} \quad t = 0,1,2,\ldots \infty.$$

In words, given a sequence of strategies, we will have a complete list of growth rates of the money stock for all periods. Given this information, we can use our OLG model developed above to back out the implied consumption levels for all state agents. Given the consumption levels of the state agents, we can back out their utility levels. If we think of all possible sequences of strategies, we can back out all possible consumption sequences for the state agents and therefore all possible utility levels for them. An equilibrium sequence of strategies is defined by a situation where the strategy of any player i maximises the indirect utility of his state agent partner, given the history of money issuing and given the strategies of all other players.

To narrow the set of equilibria we will assume in the following that agent play linear Markov strategies and ignore punishment type strategies of the type studied by Abreu (1988)[13]. In the following we look at the steady state equilibrium which has a constant rate of inflation. Given our assumptions this equilibrium will be unique. First we have to check that such an equilibrium indeed exists. A candidate sequence of equilibrium strategies is one in which every agent's strategy is to do the same as the previous agent. If the agent in last period expanded the money supply by 10 percent, the strategy of the current agent is to expand the money supply in this period by 10 percent and so forth.

[13] Punishment strategies belong in games where players move more than once. Even in single action games where players move in sequence threats can play a role. Our assumption in this setting is similar to an assumption that strategies are linear functions of last periods actions.

Proposition 3

If the strategy of every young fiat agent is to choose the same growth rate as the previous agent, then the inflation rate in the economy is equal to the growth rate of the money stock, formally,

If $\mu_t = \mu_{t-1} = \mu \ \forall t$, then $\pi_t = \pi = \mu \ \forall t$.

For proof see Appendix C

Therefore we can substitute the expression for the inflation rate with the money growth rate in the savings market equilibrium and in the indirect utility of the state agent at time t.

$$(14) \quad u^{st} = u^{st}(\underset{-}{\mu_t}, \underset{+}{\mu_t})$$

Let us just briefly recapitulate the steps that led us to equation (14). We assumed that all fiat agents were playing the strategy of choosing the same growth rate as their predecessor. Proposition 3 then says that the inflation rate is equal to the rate of money growth. This solution for the inflation rate allowed us to express the indirect utility function of a state agent at time t as a function solely of exogenous variables and the current growth rate of the money stock which is under the control of the fiat agent he is paired with. From this expression we can derive the growth rate that it is optimal for the fiat agent at time t to choose given that the strategies of all future players are to play what he plays. Now notice that the indirect utility functions of the young state agents are identical at all dates since $\mu_t = \mu \ \forall t$. Therefore the growth rate that is optimal at time t is also optimal at time t+1. Therefore the optimal strategy for the agent at time t+1 is to do what his predecessor did. We can therefore describe one sub game perfect equilibrium, which has a constant inflation rate. Let all players from date 1 and onwards play the strategy of doing what their predecessor did, and let the agent at time 0 choose the

growth rate of the money stock that maximises his indirect utility given the strategies of all players from date 1 and onwards. Then it will not be optimal for any player, choosing a growth rate at time t. to deviate from his strategy of choosing the same growth rate as his predecessor, given past actions and future strategies. Below we will derive the solution to equation (14). Assumption 2 is instrumental in getting us a simple analytical result.

Proposition 4

Given $\frac{u_{\pi}^{st}}{u_{w}^{st}} \to 0$ for low w or high π , the object of maximisation in these limiting cases for the fiat agent is total seigniorage revenue $\frac{M}{p}(\mu,\mu)(1-\frac{1}{\mu})$.

For all other cases the fiat agent will choose a point on the upward sloping part of the Seigniorage Laffer Curve.

For proof see appendix D.

What proposition 4 says is that if the derivative of the indirect utility function with respect to income is much larger than the derivative of the indirect utility function with respect to inflation, then the fiat agent will maximise the state agents utility by maximising total seigniorage revenue. On the other hand, if the effect of inflation on state agent welfare is non-negligible the fiat agent will choose a point on the upward sloping part of the Seigniorage Laffer Curve.

The unique solution for the growth rate of the money stock in the situation where all young fiat agents play the strategy of doing what the previous young fiat agent did can be found by differentiating the expression for total seigniorage revenue with respect to the growth rate of the money stock, setting this expression equal to zero and then solving for the optimal monetary growth rate.

The first order condition for maximisation of $\frac{M}{p}(\mu,\mu)(1-\frac{1}{\mu})$ over μ is

$$\frac{M}{p}(\mu,\mu)(\frac{1}{\mu^2})+(1-\frac{1}{\mu})[\frac{d(\frac{M}{p})}{d\mu_1}+\frac{d(\frac{M}{p})}{d\mu_2}]=0.$$

This expression forms a quadratic in μ. The solutions are,

$$(15)\quad \hat{\mu}=\tfrac{1}{2}\left\{1\pm\sqrt{1-\frac{4*\frac{M}{p}(\mu,\mu)}{s_\pi^p+s_\pi^s}}\right\}$$

Where we can rule out the root which is less than one since seigniorage revenue will be negative at this solution, so this must be a minimum. Thus the maximum value is

$$\hat{\mu}=\tfrac{1}{2}\left\{1+\sqrt{1-\frac{4*\frac{M}{p}(\mu,\mu)}{s_\pi^p+s_\pi^s}}\right\}$$

which is greater than 1.

So far we have showed how our equilibrium concept can be used to find a finite equilibrium money growth (and inflation) rate in the case with only one young state and fiat agent pair each period. We now go on to characterise the general case where there are n young pairs each period, within this framework we can analyse the welfare consequences of changes in the number of agents who have access to issuing fiat money, or credits that are automatically monetised by the monetary authorities.

The set-up with n pairs is very similar to the set-up in the case analysed above where there was only one pair. On the money demand side the underlying optimisation problem is unchanged for the private sector agent and we just need to include n state agents instead of one in the savings market equilibrium. On the money supply side we need to include the intra-temporal interaction between the n

money issuing young fiat agents in each generation alongside the inter-temporal interaction between young fiat agents of different generations which we have already modelled above. We first turn to the savings market equilibrium.

We have chosen to express the growth rate of money chosen by each fiat agent as a gross rate. When there are n young fiat agents this implies that the total gross growth rate of money can be expressed as $\mu_t = \sum_{i=1}^{n} (\mu_t^i - 1) + 1$ and agent j's share of total seigniorage can be expressed as $\delta_t^j = \frac{\mu_t^j - 1}{\sum_{i=1}^{n} (\mu_t^i - 1)}$ which when multiplied with total seigniorage revenue Γ_t gives the total income of agent j at time t, where,

$$(16) \quad \Gamma_t = \left\{ 1 - \frac{1}{\sum_{i=1}^{n} (\mu_t^i - 1) + 1} \right\} \frac{M_t}{p_t}(\cdot,\cdot)$$

So the problem of young state sector agent j at time t receiving seigniorage from its fiat partner j is,

$$(17) \quad \underset{c_t^{stj}, c_{t+1}^{stj}}{Max} \; u^{stj}(c_t^{stj}, c_{t+1}^{stj}) \;\; s.t. \;\; p_t c_t^{stj} + p_{t+1} c_{t+1}^{stj} = \delta_t^j \Gamma_t$$

Which yields a savings function,

$$(18) \quad s_t^{stj} = s_t^{stj}(\delta_t^j \Gamma_t, \pi_{t+1}) \quad (+, -)$$

Thus, the savings market equilibrium consisting of private sector agents, representative state agent j and n-1 other state agents is,

$$(19) \quad \frac{M_t}{p_t} = s_t^{pt}(w_t, \pi_{t+1}) + s_t^{stj}(\delta_t^j \Gamma_t, \pi_{t+1}) + \sum_{i \neq j}^{n} s_t^{sti}(\delta_t^i \Gamma_t, \pi_{t+1}) \quad (+, -) \quad (+, -)$$

We can use many of the properties of the money market equilibrium which we derived for the case where there was only one state agent. We summarise the properties of money market equilibrium in proposition 5, recalling again that given the restrictions we have imposed on preferences all fiat agents will choose growth rates $\mu_t^i > 1 \quad i = 1,2,....n \ \forall t$.

Proposition 5

For $\mu_t^j > 1$

$$\frac{d(\frac{M_t}{p_t})}{d\pi_{t+1}} < 0 \ \forall t, \ \frac{d^2(\frac{M_t}{p_t})}{d\pi_{t+1}^2} > 0 \ \forall t, \ \frac{d(\frac{M_t}{p_t})}{d\mu_t^j} > 0 \ \forall t$$

For proof see appendix E

We can now use our characterisation of money market equilibrium, to derive consumption functions and indirect utility functions for all n state agents just as we did in the single state agent case. The only difference, compared with the case where there was only one state-fiat agent pair each period, is that both the growth rate chosen by fiat agent j that state agent j is paired with and the growth rates chosen by the fiat agents of all other pairs currently young will matter for the given state agents indirect utility. This is because money market equilibrium is affected by all choices of growth rates. Thus the indirect utility function for young state agent j is $u^{stj} = u^{stj}(\pi_{t+1}, \mu_t^j, \sum_{i \neq j}^{n} \mu_t^i)$. This indirect utility function can be characterised more precisely and the results in a situation with positive seigniorage are just the same as for the single agent case i.e. indirect utility of agent j is decreasing in π_{t+1} and increasing in μ_t^j.

The objective of fiat agent j paired at time t with state agent j is to maximise $u^{stj} = u^{stj}(\pi_{t-1}, \mu_t^j, \sum_{i \neq j}^{n} \mu_t^i)$. We use the same equilibrium concept as above with the addition that the intra-temporal interaction between young fiat agents of the same generation is captured by modelling the choice of agent j as being a best response to the choices of the other n-1 fiat agents of his generation.

Definition:

An equilibrium is a sequence of strategies $\left\{\left\{s_t^i\right\}_{i=1}^{n}\right\}_{t=0}^{\infty}$, private sector consumption allocations $\left\{(c_t^{pt}, c_{t+1}^{pt})\right\}_{t=0}^{\infty}$ and state sector consumption allocations $\left\{\left\{(c_t^{st^i}, c_{t+1}^{st^i})\right\}_{i=1}^{n}\right\}_{t=0}^{\infty}$ such that:

(i) Given $\mu_0, \mu_1, ,.. \mu_{t-1}$, $\mu_t^{i \neq j}$ and $s_{t+1}^i, s_{t+2}^i, \ldots\ldots s_{t+n}^i, s_t^j$ is chosen so that it maximises u^{stj} $t = 0,1,2,\ldots.\infty$ $i = 1,2,\ldots..n$;

(ii) Given the implied price sequence of the economy $\left\{(c_t^{pt}, c_{t+1}^{pt})\right\}_{t=0}^{\infty}$ satisfies (1) and $\left\{\left\{(c_t^{sti}, c_{t+1}^{sti})\right\}_{i=1}^{n}\right\}_{t=0}^{\infty}$ satisfies (17);

(iii) The money market equilibrium condition (19) is satisfied.

Call the set of players $SA = \left\{\left\{sa_t^i\right\}_{i=1}^{n}\right\}_{t=0}^{\infty}$. Each player chooses an action (growth rate of money). The action set is $\mu_t^i = (-\infty, \infty)$ $t = 0,1,2,\ldots..\infty$ $i = 1,2,\ldots.n$. A players strategy s is a decision rule that determines the growth rate of the money stock, based on the past growth rates, and on the growth rate chosen by the other contemporaneous player.

Formally the strategies of the players at date 0 is to choose a growth rate of the money stock as a best response to the choice of the other contemporaneous players, while for players active from time 1 onwards, a strategy is a mapping from

past actions and the action of the other contemporaneous player to a current action. The following notation formalises this.

$$s_0^{i=j}: \mu_0^{i\neq j} \rightarrow \mu_0^{i=j};\ s_t^{i=j}: \mu_1 \times \mu_2 \times \ldots \mu_{t-1} \times \mu_t^{i\neq j} \rightarrow \mu_t^{i=j}\ \ \forall\, t \geq 1\ i, j = 1,2,\ldots n$$

where $\mu_t^{i\neq j} = \sum_{i\neq j}^{n} (\mu_t^i - 1) + 1$ i.e. the sum of the growth rates chosen by all the other young state agents of agent j's generation, and $\mu_{t-1} = \sum_{i=1}^{n} (\mu_{t-1}^i - 1) + 1$ is the total growth rate in period t-1, which of course is the sum of the growth rates chosen by all n young state agents in period t-1. Call a sequence of strategies for all players $\left\{\left\{s_t^i\right\}_{i=1}^{n}\right\}_{t=0}^{\infty}$, a strategy profile of the game, and call the set of all possible sequences $\hat{\Sigma}$. Let $\hat{w}$ be the mapping that maps the set of sequences into a set of utilities for the state agents.

$$(20)\quad \hat{w}\ :\ \hat{\Sigma} \rightarrow u_t^{sti}\quad t = 0,1,2,\ldots\ldots\infty\quad i = 1,2,\ldots n.$$

In words, if we are given a strategy sequence, we can back out utility levels for all agents from our OLG model. Given all possible strategies, $\hat{w}$ gives us a list of all possible utility levels for all state agents. An equilibrium is a sequence of strategies, so that each fiat agent maximises the indirect utility of the state agent he is paired with, given the history of money issue, the strategies of future agents and the actions of his contemporaries.

Again we assume that agents play linear Markov strategies. We also restrict our attention to symmetric equilibria. We now proceed to characterise the steady state equilibrium which has a constant inflation rate.

Recalling that $\mu_t = \sum_{i=1}^{n} (\mu_t^i - 1) + 1$ and imposing symmetry on all n young agent pairs in each generation, we see that a candidate equilibrium strategy

sequence is one where $\mu_t^i - 1 = [\mu_{t-1} - 1]/n \quad i = 1,2,\ldots n \; \forall \; t \geq 1$. That is, each young fiat agent chooses a growth rate that is $\frac{1}{n}$ times the total growth rate of last period. We now use the same line of argument as presented in the single pair case to determine whether such an equilibrium indeed exists.

First note that, if all agents from date t+1 onwards play this strategy, the agents at time t will know that the money growth rate that results from the sum of their growth rates will be the money growth rate in all future periods. Using the arguments in proposition 3, the constant rate of future inflation can therefore be determined as the sum of the growth rates chosen by the current agents.

$$(21) \quad \pi = \mu = \sum_{i=1}^{n} (\mu^i - 1) + 1$$

Substituting this expression into the savings market equilibrium and subsequently substituting this into the indirect utility functions of the young state agents at date t, we get the following set of indirect utility functions.

$$(22) \quad u^{stj} = u^{stj}(\mu_t^j + \sum_{i \neq j}^{n} (\mu_t^i - 1),\ \mu_t^j + \sum_{i \neq j}^{n} (\mu_t^i - 1))$$

Optimisation of (22) over μ_t^j will give us the growth rate that is optimal for fiat agent j at time t, given the growth rates chosen by all other young fiat agents i at time t, and given that the strategies of all of the players in subsequent periods is to choose a growth rate that is $\frac{1}{n}$ times the total growth rate in the previous period. Just as in the single pair case the indirect utility functions of the young state agents are identical at all dates. Therefore we will again have the result that the growth rate that is optimal at time t is also optimal at time t+1. Therefore the optimal strategy for the fiat agent at time t+1 is the same as the optimal strategy for an agent at time t. Therefore we can describe one sub-game perfect equilibrium in this game, which has a constant inflation rate. Let all players at time 1 and onwards play the strategy

of issuing money equivalent to $\frac{1}{n}$ times last periods total money growth, and let the agents at time 0 choose the optimal growth rates given the choice of the other contemporaneous agent and given the strategies of all future agents. Then it will not be optimal for any player choosing a growth rate at time t, to deviate from his strategy of choosing a growth rate of $\frac{1}{n}$ times the total growth rate from last period, given that is what the other contemporaneous players are doing, and given that this is what all future players will do. To determine the equilibrium money growth rate, we therefore just need to find the symmetric Nash equilibrium in growth rates at time 0, determined by optimisation of equation (22). We impose simplifying assumptions on the preference structure of the young state agents identical to the ones imposed in proposition 4 to derive an analytical solution.

Proposition 6

Given $\frac{u_{\pi}^{sti}}{u_{w}^{sti}} \to 0$ for low w or high π $\forall i$, then the object of maximisation in these limiting cases for fiat agent j is his share of total seigniorage revenue given the choice of the other n-1 young fiat agents (*),

$$\frac{M}{p}\left[\mu^{j}+\sum_{i\neq j}^{n}(\mu^{i}-1),\mu^{j}+\sum_{i\neq j}^{n}(\mu^{i}-1)\right]\left(1-\frac{1}{\mu^{j}+\sum_{i\neq j}^{n}(\mu^{i}-1)}\right)\left(\frac{\mu_{t}^{j}-1}{\sum_{i\neq j}^{n}(\mu_{t}^{i}-1)+\mu_{t}^{j}-1}\right).$$

The proofs are identical to the proofs of proposition 4 in appendix D, except for a constant term consisting of the choices of the other n-1 young fiat agents in a generation, which from the viewpoint of agent j are fixed in the Nash equilibrium setting. Therefore we omit the proofs.

So the object of maximisation for agent j is his share of the total seigniorage revenue, given the choice of the other n-1 agents of his generation. We now find the optimal growth rate chosen by agent j in this situation by differentiating (*) with respect to the growth rate chosen by j, holding the n-1 other agents actions fixed in

agent j's optimisation (so j's action is a best response to the action of the n-1 other agents in a Nash sense). We then impose symmetry setting i=j and solving for the equilibrium growth rate, which is a function of the total number of young fiat and state agent pairs in each generation (n).

Proposition 7

The growth rate chosen by agent j in a symmetric equilibrium with n young fiat agents is,

$$\mu^{T} = \frac{-b - \sqrt{b^2 - 4ac}}{2a} > 1 \quad \text{where,}$$

$$-b = \left[\frac{M}{p}(\cdot,\cdot)(n-1)(s_w^s - 1) + (ns_\pi^s + s_\pi^p)(2n-1)\right], a = n(ns_\pi^s + s_\pi^p),$$

$$c = \left[\frac{M}{p}(\cdot,\cdot)(1 + (n-1)(s_w^s - 1)) + (ns_\pi^s + s_\pi^p)(n-1)\right]$$

For proof see Appendix F.

We have now found an expression for the equilibrium growth rate chosen by all young fiat agents in a symmetric equilibrium. We can see how this growth rate is a function of the total number of young state and fiat agent pairs (n). The resulting equilibrium total growth rate of the money stock $\mu^{\#}(n)$ is found by using equation (21) to be,

$$\mu^{\#}(n) = n*(\mu^{T}(n) - 1) + 1$$

We have been unable to sign $\frac{d\mu^{\#}(n)}{dn}$ analytically, but in appendix G we show numerically that $\frac{d\mu^{\#}(n)}{dn} > 0$ so the total growth rate of the money stock increases with the number of young state and fiat agent pairs and as a consequence so does

the level of inflation in the economy. Now we summarise the welfare implications of having more than 1 agent issuing fiat money each period.

Proposition 8

Private agent welfare falls as the number of state and fiat agent pairs increases.
The welfare of a state agent in a generation of n is larger in the situation where the fiat agents of his generation co-ordinate their money supply decisions and share the total revenue than in the situation where they issue fiat money de-centrally.

For proof see appendix H

What proposition 8 says is that if there are several agents issuing fiat money each period, inflation will be higher and both private sector and state sector welfare will be lower, than in the case with one state and fiat agent only. The fact that state sector welfare is decreasing stems from the fact that too much inflation is created by n agents, reducing money demand excessively and thus reducing seigniorage revenue below the maximum attainable value. This is the same as saying that with $n>1$ agents issuing money, the economy ends up on the "slippery" side of the Seigniorage Laffer Curve.

The results in proposition 8 hold given assumption 2 on preferences and allocations is satisfied. That is, the analytical results hold only for allocations where state agent income is low or inflation is high. We now present a numerical simulation with no restrictions on allocations. In these simulations we allow private sector agents to have endowments both while young and while old. The simulations are done for Cobb-Douglas preferences with equal weights on consumption at both dates.

Table 3.3 reports the results of simulations of the n=1 case, while table 3.4 contains the results from the n=2 case. w is the second period wealth of the private sector agents, μ is the equilibrium growth rate of the money stock, and consequently also the equilibrium inflation rate. M/P is total savings, seig is seigniorage revenue, cs(y), cs(o) and us are consumptions of a young state agent, old state agent and the implied utility level respectively, cp(y), cp(o) and up are the same variables for the private sector agents.

On the basis of these simulations we can now draw a few conclusions: the total seigniorage revenue declines as w approaches 1 from below. Since first period income for the household sector agents is normalised to 1, this reflects the fact that because of the preference structure of households, their desired savings are only positive if they have higher real endowments in the first period than in the second. As a consequence of this, household utility increases as w increases (both because the endowment gets bigger and because the effect of inflation on savings is reduced). Conversely, state agent utility declines as w approaches 1; for w = 1, the state agents will not be able to consume at all.

Comparing the situation with one state agent with the situation with two state agents we observe the following; total money growth is higher in the case with two state-fiat agent pairs, but the total seigniorage revenue is lower. Obviously each state agent has lower utility than when there is a single state-fiat agent pair, but more importantly, each state agent has utility lower than if they had received half of the seigniorage a single state-fiat pair had extracted. These findings are illustrated in figures 3.2 and 3.3. Figure 3.2 shows the indirect utility function of a state agent as a function of the total money growth rate in the economy. The maximum utility is attained at a growth rate of the money stock 1.78 (in this example w = 0.3). Figure

Table 3.3. The model with one new state-fiat pair each period

w	μ	M/P	seig	cs(y)	cs(o)	us	cp(y)	cp(o)	up
0.1	2.68	0.533	0.334	0.167	0.062	-4.56	0.634	0.236	-1.90
0.2	2.11	0.392	0.206	0.103	0.049	-5.29	0.710	0.338	-1.43
0.3	1.78	0.300	0.131	0.065	0.037	-6.03	0.767	0.431	-1.11
0.4	1.56	0.229	0.082	0.041	0.026	-6.82	0.813	0.520	-0.86
0.5	1.41	0.173	0.050	0.025	0.018	-7.71	0.852	0.605	-0.66
0.6	1.29	0.128	0.029	0.014	0.011	-8.75	0.886	0.688	-0.49
0.7	1.19	0.089	0.014	0.007	0.006	-10.02	0.918	0.769	-0.35
0.8	1.12	0.056	0.006	0.0029	0.0026	-11.77	0.947	0.847	-0.22
0.9	1.05	0.026	0.0014	0.0007	0.0006	-14.65	0.974	0.924	-0.10

Table 3.4. The model with two new state-fiat pairs each period

w	μ	M/P	seig	cs(y)	cs(o)	us	cp(y)	cp(o)	up
0.1	5.3	0.395	0.321	0.080	0.015	-6.71	0.77	0.14	-2.20
0.2	3.14	0.282	0.192	0.048	0.015	-7.21	0.81	0.26	-1.56
0.3	2.32	0.212	0.121	0.030	0.013	-7.84	0.85	0.37	-1.17
0.4	1.88	0.162	0.076	0.019	0.010	-8.56	0.88	0.47	-0.89
0.5	1.62	0.117	0.045	0.011	0.007	-9.46	0.91	0.56	-0.68
0.6	1.42	0.087	0.026	0.0064	0.0045	-10.45	0.93	0.65	-0.50
0.7	1.28	0.058	0.013	0.0031	0.0025	-11.74	0.95	0.74	-0.35
0.8	1.16	0.039	0.005	0.0013	0.0011	-13.38	0.96	0.83	-0.22
0.9	1.08	0.014	0.001	0.0003	0.0002	-16.52	0.99	0.91	-0.11

Figure 3.2 Indirect Utility of State Agent

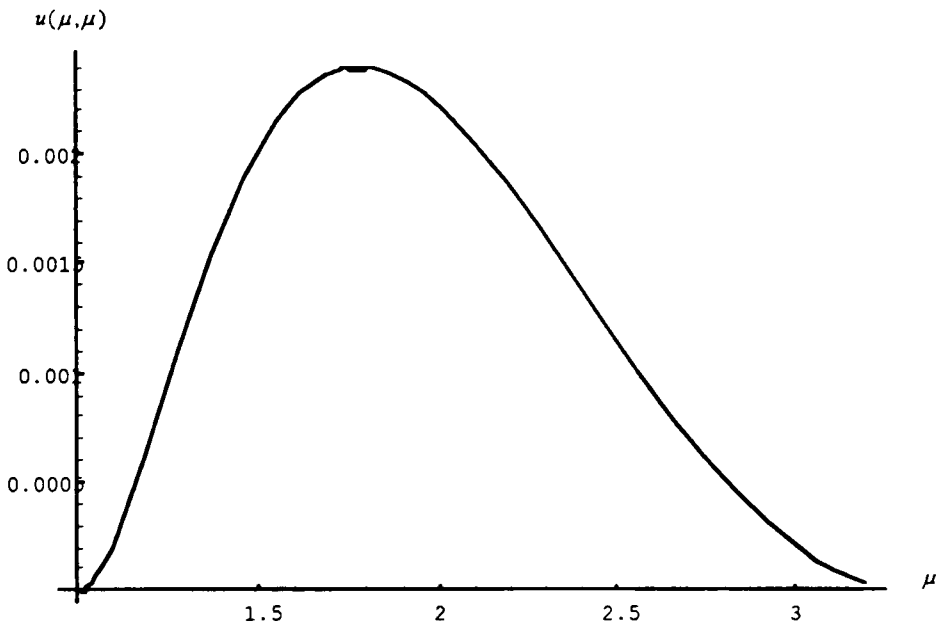
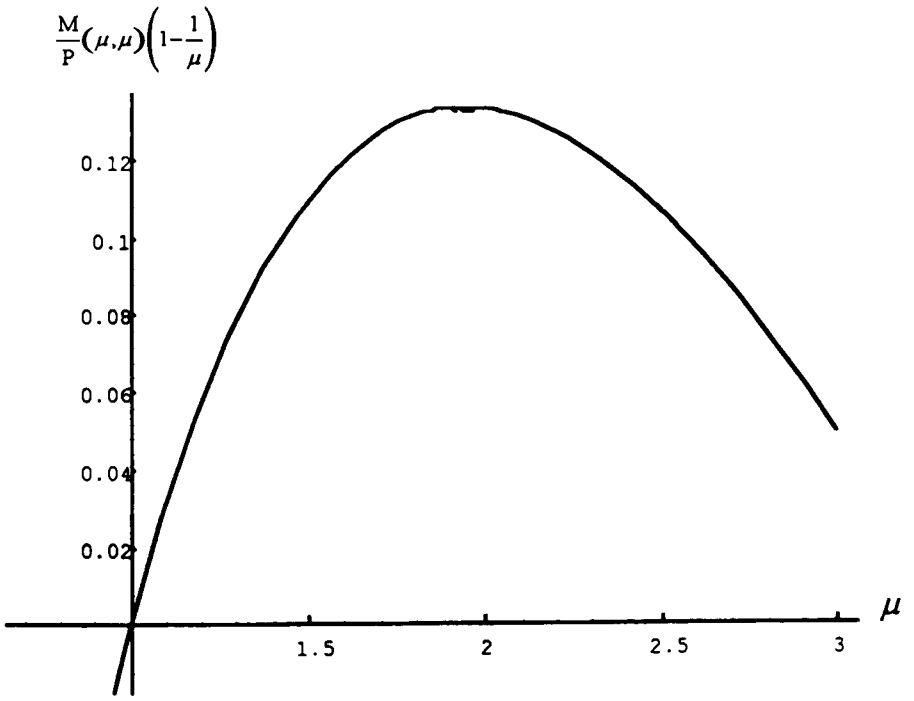


Figure 3.3 Seigniorage Laffer Curve



3.3 depicts the Seigniorage Laffer Curve, from which it can be seen that if the total growth rate of the money stock is 1.78, which it will be if there is only one young state agent each period, we are on the left side of the Laffer Curve. Looking at table 3.4, we see that the equilibrium money growth rate in the case with two state agents is 2.32 (again with w = 0.3), looking again at figure 3.3 we observe that this evidently is on the right - "slippery" - side of the Laffer Curve. Table 3.3 and 3.4 also show us that the private sector agents are worse off in the case with two state-fiat pairs than in the case with only one pair, for example the private sector utility (up) with one pair is -1.11, while it is -1.17 when there are two pairs (w = 0.3 in both cases). The conclusions from the numerical simulations are thus consistent with our analytical results.

The observation that the single state-fiat pair ends up on the left hand side of the Seigniorage Laffer Curve is explained by the fact that our simulation represents a case where the limiting condition in assumption 2 does not hold, thus the effect of inflation on state agent utility is non-negligible. Therefore the fiat agent will not go to the top of the Laffer Curve, but stay to the left where inflation is lower. The numerical example also shows that in the two agent case this concern with inflation is insufficient to keep the economy from ending on the slippery side of the Seigniorage Laffer Curve.

3.3. Conclusion

Economists have been puzzled by the fact that inflation rates in some countries have been consistently higher than an efficient use of the inflation tax would imply. In this paper we have sought to address this conundrum by starting from the observation that high inflation is often associated with weak governments. We have presented a model which explicitly models the institutional structure underlying the money creation process, and we reach the conclusion that inflationary equilibria that are sub-optimal, can be the result of having multiple agents issuing money in an un-coordinated way. This leads to welfare reductions for the household sector, but also for the credit issuers who actually extract fever

resources at a higher price due to the lack of co-ordination. While the paper does not address the desirability of redistributional policies implemented via inflation creation, it suggests that there are institutional reforms that can promote the efficiency with which the inflation tax is levied. Indeed in this paper co-ordination of monetary policies under a single agency constitutes a Pareto improvement on the situation with multiple money issuing agencies. In the light of this analysis, the creation of a credit commission in Russia to co-ordinate the issue of directed credits in the autumn of 1992, was a welfare improving policy.

Appendixes

Appendix A

Proof of Proposition 1

Total differentiating the expression for savings market equilibrium

$$\frac{M_t}{p_t} = s_t^{pt}(\underset{+}{w_t}, \underset{-}{\pi_{t+1}}) + s_t^{st}(\underset{+}{\frac{M_t}{p_t}(1-\frac{1}{\mu_t})}, \underset{-}{\pi_{t+1}})$$

we get,

$$d(\tfrac{M}{P}) = s_w^p dw^p + s_\pi^p d\pi + s_w^s((1-\tfrac{1}{\mu})d(\tfrac{M}{P}) + \tfrac{M}{P}\tfrac{1}{\mu^2}d\mu) + s_\pi^s d\pi$$

From which one can see that,

$$\frac{d(\frac{M}{P})}{d\pi} = \frac{s_\pi^p + s_\pi^s}{1 - s_w^s(1-\frac{1}{\mu})} < 0 \text{ for } \mu > 1$$

The numerator is always negative (see equations (4) and (8)), while the denominator is positive for $\mu > 1$, since the assumption that consumption at both dates are normal goods implies that $0 < s_w^s < 1$.

Since $s_{\pi\pi}^{pt}$ is positive (see equation (4)) and the same is true for $s_{\pi\pi}^{st}$ we see that

$$\frac{d^2(\frac{M}{P})}{d\pi^2} > 0 \ .$$

It can also be seen from the total differentiation that

$$\frac{d(\frac{M}{P})}{d\mu} = \frac{s_w^s \frac{M}{P} \frac{1}{\mu^2}}{1 - s_w^s (1 - \frac{1}{\mu})} > 0 \quad \text{for } \mu > 1$$

The numerator will always be positive, while the denominator again is positive for $\mu > 1$.

■

Appendix B

Proof of Proposition 2

Substituting the consumption functions (11) into the indirect utility function of the state agent gives,

$$u_t^{st}(\pi_{t+1}, \mu_t) = u_t^{st}[c_t^{st}(\frac{M_t}{p_t}(\pi_{t+1}, \mu_t)(1 - \frac{1}{\mu_t}), \pi_{t+1}), c_{t+1}^{st}(\frac{M_t}{p_t}(\pi_{t+1}, \mu_t)(1 - \frac{1}{\mu_t}), \pi_{t+1})]$$

Differentiating the above expression with respect to inflation we get,

$$du^{st} = u_c^{st} c_w^{st}[(1 - \frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi d\pi] + u_c^{st} c_\pi^t d\pi + u_c^{st+1} c_w^{st+1}[(1 - \frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi d\pi] + u_c^{st+1} c_\pi^{t+1} d\pi$$

From which it can be seen that

$$\frac{du^{st}}{d\pi} = u_c^{st} c_w^{st}[(1 - \frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi] + u_c^{st+1} c_w^{st+1}[(1 - \frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi] + u_c^{st} c_\pi^t + u_c^{st+1} c_\pi^{t+1}$$

This expression cannot be signed unambiguously. The first two terms and the last term are negative, while the third term is positive. We can use assumption 2, $\frac{u_\pi^{st}}{u_w^{st}} \to 0$ for low w or high π , to derive a limiting result. Given this assumption, u_w^{st} will dominate u_π^{st} and the sign of the expression will be determined by u_w^{st},

which in the above expression is $u_c^{st} c_w^{st}[(1-\frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi] + u_c^{st-1} c_w^{st-1}[(1-\frac{1}{\mu_t})(\frac{M_t}{p_t})_\pi]$. From proposition 1 we know that $(\frac{M}{p})_\pi < 0$ for $\mu > 1$, we can combine this with the fact that $u_c^{st}, c_w^{st}, u_c^{st+1}, c_w^{st+1}$ are all positive to get;

$$\frac{du^s}{d\pi} < 0 \quad \text{for } \mu > 1$$

Differentiating the indirect utility function with respect to the growth rate of the money stock we get,

$$\frac{du^s}{d\mu} = u_c^{st} c_w^{st}[(1-\frac{1}{\mu_t})(\frac{M_t}{p_t})_\mu + \frac{M_t}{p_t}(\pi,\mu)\frac{1}{\mu^2}] + u_c^{st+1} c_w^{st+1}[(1-\frac{1}{\mu_t})(\frac{M_t}{p_t})_\mu + \frac{M_t}{p_t}(\pi,\mu)\frac{1}{\mu^2}]$$

So noting the signs on the partials mentioned above once again, we get,

$$\frac{du^s}{d\mu} > 0 \quad \text{for } \mu > 1$$

■

Appendix C

Proof of Proposition 3

Let $\mu_t = \mu_{t-1} = \mu \ \forall t$,

Note first that a constant money growth rate through time in our economy implies a constant inflation rate since all periods are completely identical. Call this inflation rate π *

We then need to prove that $\pi^* = \mu$. The savings market equilibrium at time t in the economy with a constant growth rate of money is,

$$\frac{M_t}{p_t} = s_t^{pt}(w, \pi^*) + s_t^{st}(\frac{M_t}{p_t}(\pi^*, \mu)(1 - \frac{1}{\mu}), \pi^*)$$

Since neither the growth rate of the money stock, nor inflation is changing over time, we must also have,

$$\frac{M_{t+1}}{p_{t+1}} = s_{t+1}^{pt+1}(w, \pi^*) + s_{t+1}^{st+1}(\frac{M_{t+1}}{p_{t+1}}(\pi^*, \mu)(1 - \frac{1}{\mu}), \pi^*)$$

Since the savings functions for the agents at time t and t+1 are derived from identical preferences and endowments, it is apparent that the level of real money balances that satisfies the savings market equilibrium at time t is equal to the level that satisfies equilibrium at time t+1. Thus we get

$$\frac{M_t}{P_t} = \frac{M_{t+1}}{P_{t+1}}$$

from which it is evident that $\pi_{t+1} = \mu_{t+1}$; since the growth rate is constant we have proven that

$$\pi_t = \pi = \mu \quad \forall \, t .$$

■

Appendix D

Proof of Proposition 4

i) The indirect utility function of the state agent at time t is,

$$u^{st} = u^{st}[c^{st}(\underset{+}{\tfrac{M}{p}}(\mu,\mu)(1-\tfrac{1}{\mu}), \underset{+}{\mu}), c^{st+1}(\underset{+}{\tfrac{M}{p}}(\mu,\mu)(1-\tfrac{1}{\mu}), \underset{-}{\mu})] \quad ,$$

Differentiation yields

$$\frac{d(\cdot)}{d\mu} = u^{s}_{ct} c^{t}_{w} \{\frac{M}{p}(\mu,\mu)(\frac{1}{\mu^2}) + (1-\frac{1}{\mu})[\frac{d(\frac{M}{p})}{d\mu_1} + \frac{d(\frac{M}{p})}{d\mu_2}]\} + u^{s}_{ct} c^{t}_{\pi}$$

$$+ u^{s}_{ct+1} c^{t+1}_{w} \{\frac{M}{p}(\mu,\mu)(\frac{1}{\mu^2}) + (1-\frac{1}{\mu})[\frac{d(\frac{M}{p})}{d\mu_1} + \frac{d(\frac{M}{p})}{d\mu_2}]\} + u^{s}_{ct+1} c^{t+1}_{\pi}$$

Given assumption 2, namely that $\frac{u^{st}_{\pi}}{u^{st}_{w}} \to 0$ for low w or high π , the condition for an optimum reduces to

$$(u^{s}_{ct} c^{t}_{w} + u^{s}_{ct+1} c^{t+1}_{w})\{\frac{M}{p}(\mu,\mu)(\frac{1}{\mu^2}) + (1-\frac{1}{\mu})[\frac{d(\frac{M}{p})}{d\mu_1} + \frac{d(\frac{M}{p})}{d\mu_2}]\} = 0,$$

which is the same as saying that the object of maximisation is total seigniorage

$$\frac{M}{p}(\mu,\mu)(1-\frac{1}{\mu}).$$

■

For the general case we know that with an endowment structure where the agent receives all income in the first period u^{st}_{π} is always negative. This fact combined with the fact that $(u^{s}_{ct} c^{t}_{w} + u^{s}_{ct+1} c^{t+1}_{w})$ is always positive shows us that the condition

for optimum in the general case will only be satisfied if $\{\frac{M}{p}(\mu,\mu)(\frac{1}{\mu^2})+(\cdot)\frac{1}{\mu}(\frac{d(\frac{M}{p})}{d\mu_1}-\frac{d\frac{M}{p}}{d\mu_2})\}>0$, which is the same as saying that the economy must be on the upward sloping part of the Seigniorage Laffer-Curve.

■

Appendix E

Proof of Proposition 5.

Let $\mu_t^i > 1 \quad \forall i$

Differentiation of (19) yields,

$$d(\frac{M}{p}) = s_\pi^p d\pi + s_\pi^{sj} d\pi + + \sum_{i\neq j}^{n} s_\pi^{si} d\pi + s_w^p dw +$$

$$s_w^{sj}\left[\left\{d(\frac{M}{p})(1-\frac{1}{\sum_{i\neq j}^{n}(\mu^i-1)+(\mu^j-1)+1})(\frac{\mu^j-1}{\sum_{i\neq j}^{n}(\mu^i-1)+(\mu^j-1)})\right\}+\frac{M}{p}(\cdot,\cdot)\left\{\frac{1+\sum_{i\neq j}^{n}(\mu^i-1)}{\left(\sum_{i\neq j}^{n}(\mu^i-1)+\mu^j\right)^2}d\mu^j\right\}\right]$$

$$+\sum_{i\neq j}^{n}\left[s_w^{si}\left[\left\{d(\frac{M}{p})(1-\frac{1}{\sum_{k\neq j}^{n}(\mu^k-1)+(\mu^j-1)+1})(\frac{\mu^i-1}{\sum_{k\neq j}^{n}(\mu^k-1)+(\mu^j-1)})\right\}+\frac{M}{p}(\cdot,\cdot)\left\{\frac{\mu^k-1}{\left(\sum_{k\neq i}^{n}(\mu^k-1)+\mu^j\right)^2}d\mu^j\right\}\right]\right]$$

From which it can be seen that

$$\frac{d(\frac{M}{p})}{d\pi} = \frac{s_\pi^p + s_\pi^{sj} + \sum_{i\neq j}^{n} s_\pi^{si}}{\Delta} < 0 \quad \text{for } \mu > 1$$

where

$$\Delta = 1 - s_w^{sj}\left\{\left(1 - \frac{1}{\sum_{i\neq j}^{n}(\mu^i - 1) + (\mu^j - 1) + 1}\right)\left(\frac{\mu^j - 1}{\sum_{i\neq j}^{n}(\mu^i - 1) + (\mu^j - 1)}\right)\right\} - \sum_{i\neq j}^{n}\left[s_w^{si}\left\{\left(1 - \frac{1}{\sum_{k\neq j}^{n}(\mu^k - 1) + (\mu^j - 1) + 1}\right)\left(\frac{\mu^i - 1}{\sum_{k\neq j}^{n}(\mu^k - 1) + (\mu^j - 1)}\right)\right\}\right]$$

which is positive for $\mu_t^i > 1 \ \forall i$. The sign of the derivative with respect to inflation then follows from the fact that $s_\pi^p, s_\pi^{si} \ \forall i$ all are negative.

Just as in the single state agent case one can show that $\frac{d^2(\frac{M_t}{p_t})}{d\pi_{t+1}^2} > 0 \ \forall t$

Similarly one can show that,

$$\frac{d(\frac{M}{p})}{d\mu^j} = s_w^{sj}\left[\frac{M}{p}(\cdot,\cdot)\left\{\frac{1 + \sum_{i\neq j}^{n}(\mu^i - 1)}{\left(\sum_{i\neq j}^{n}(\mu^i - 1) + \mu^j\right)^2}\right\}\right] + \sum_{i\neq j}^{n}\left[s_w^{si}\left[\frac{M}{p}(\cdot,\cdot)\left\{\frac{\mu^k - 1}{\left(\sum_{k\neq i}^{n}(\mu^k - 1) + \mu^j\right)^2}\right\}\right]\right] \Big/ \Delta$$

which is positive for $\mu_t^i > 1 \ \forall i$.

Thus we have,

$$\frac{d(\frac{M_t}{p_t})}{d\pi_{t+1}} < 0 \ \forall t, \quad \frac{d^2(\frac{M_t}{p_t})}{d\pi_{t+1}^2} > 0 \ \forall t, \quad \frac{d(\frac{M_t}{p_t})}{d\mu_t^j} > 0 \ \forall t$$

■

Appendix F

Proof of Proposition 7

Given the assumptions in proposition 6

$$\text{(i)}\quad \mu^j : u_c^{st^i} c_w \left[\frac{d\left[\Gamma^j(\mu^j)\delta^j(\mu^j)\frac{M}{p}\left[\mu^j + \sum_{i\neq j}^{n}(\mu^i - 1),\ \mu^j + \sum_{i\neq j}^{n}(\mu^i - 1) \right] \right]}{d\mu^j} \right] = 0$$

is the μ^j which maximises the indirect utility function of young state agent j.

Expanding the above expression we get,

$$\text{(ii)}\quad \Gamma^j(\mu^j)\delta^j(\mu^j)\left[\frac{d(\frac{M}{p})}{d\pi}\frac{d\pi}{d\mu^j} + \frac{d(\frac{M}{p})}{d\mu^j} \right] + \frac{d\Gamma^j\delta^j}{d\mu^j}\left[\frac{M}{p}\left(\mu^j + \sum_{i\neq j}^{n}(\mu^i - 1), \mu^j + \sum_{i\neq j}^{n}(\mu^i - 1) \right) \right] = 0$$

$\frac{d(\frac{M}{p})}{d\pi}\frac{d\pi}{d\mu^j}$ and $\frac{d(\frac{M}{p})}{d\mu^j}$ are both derived in appendix E, if we keep in mind that $\frac{d\pi}{d\mu^j} = 1$ (see equation (21)), and $\frac{d\Gamma^j\delta^j}{d\mu^j}$ can be found using the definitions of Γ^j and δ^j in the main text, $\frac{d\Gamma^j\delta^j}{d\mu^j} = \frac{1 + \sum_{i\neq j}^{n}(\mu^i - 1)}{\left(\sum_{i\neq j}^{n}(\mu^i - 1) + \mu^j \right)^2}$.

Using this information, we may rewrite (ii) as,

$$\text{(iii)}\quad \frac{1 + \sum_{i\neq j}^{n}(\mu^i - 1)}{\left(\sum_{i\neq j}^{n}(\mu^i - 1) + \mu^j \right)^2}\frac{M}{p}\left(\mu^j + \sum_{i\neq j}^{n}(\mu^i - 1), \mu^j + \sum_{i\neq j}^{n}(\mu^i - 1) \right) + \frac{\left[(\mu^j)^2 + \mu^j \sum_{i\neq j}^{n}(\mu^i - 1) - \mu^j - \sum_{i\neq j}^{n}(\mu^i - 1) \right]}{\left(\sum_{i\neq j}^{n}(\mu^i - 1) + \mu^j \right)^2}\left[\frac{d(\frac{M}{p})}{d\pi}\frac{d\pi}{d\mu^j} + \frac{d(\frac{M}{p})}{d\mu^j} \right] = 0$$

Now we impose symmetry, ie. $\mu^j = \mu^i = \mu^T$ which implies that ,

(iv) $\sum_{i\neq j}^{n}(\mu^i-1)=(n-1)(\mu^T-1)$ and $\sum_{i\neq j}^{n}(\mu^i-1)+\mu^j=n(\mu^T-1)+1$

We use these expressions in the expressions for $\frac{d(\frac{M}{p})}{d\pi}\frac{d\pi}{d\mu^j}$ and $\frac{d(\frac{M}{p})}{d\mu^j}$ in Appendix E and get,

(v) $\frac{d(\frac{M}{p})}{d\pi}=\frac{s_\pi^p+ns_\pi^s}{1-ns_w^s\left[\left(1-\frac{1}{(n(\mu^T-1)+1)}\right)\left(\frac{1}{n}\right)\right]}$ and $\frac{d(\frac{M}{p})}{d\mu^T}=\frac{ns_w^s\left[\frac{M}{p}(\cdot,\cdot)\frac{1}{(n(\mu^T-1)+1)^2}\right]}{1-ns_w^s\left[\left(1-\frac{1}{(n(\mu^T-1)+1)}\right)\left(\frac{1}{n}\right)\right]}$

Now we substitute (iv) and (v) into (iii) and rearrange to get an expression for the μ^T that maximises the symmetric equilibrium version of (i). We get,

(vi) $\left[(1+(n-1)(\mu^T-1)\right]\frac{M}{p}(\cdot,\cdot)+\left[(\mu^T)^2+(\mu^T-1)^2(n-1)-\mu^T\right]\left[\frac{s_w^s\left[\frac{M}{p}(\cdot,\cdot)\frac{1}{(n(\mu^T-1)+1)^2}\right]+s_\pi^p+ns_\pi^s}{1-ns_w^s\left[1-\frac{1}{(n(\mu^T-1)+1)}\right]\left(\frac{1}{n}\right)}\right]=0$

This expression forms a quadratic in μ^T, which we can solve. We get,

(vii) $\mu^T=\frac{-b-\sqrt{b^2-4ac}}{2a}$ where,

$-b=\left[\frac{M}{p}(\cdot,\cdot)(n-1)(s_w^s-1)+(ns_\pi^s+s_\pi^p)(2n-1)\right]$, $a=n(ns_\pi^s+s_\pi^p)$, $c=\left[\frac{M}{p}(\cdot,\cdot)(1+(n-1)(s_w^s-1))+(ns_\pi^s+s_\pi^p)(n-1)\right]$

You can convince yourself that the largest of the two roots of the polynomial is the one associated with a maximum by recognizing that (v) is a inverted paraboloid (since a<0). The small root will have the signs (-, 0, +) in its neighbourhood while the largest root will have the signs (+, 0,-). The sign sequences for a first order derivative associated with a maximum is (+,0,-) so the largest root represents the maximum, while the smallest root represents a minimum.

■

Appendix G

Simulation to sign the derivative of the total money growth rate as a function of the number of state-fiat pairs (n).

We are performing the simulations on the expression reported in proposition 7.

The a, b and c terms match those in the expression in proposition 7.

```
b[n_]:=-(m*(n-1)*(w-1)+(n*s+p)*(2*n-1))
a[n_]:= n*(n*s+p)
c[n_]:= m*(1+(n-1)*(w-1))+(n*s+p)*(n-1)
```

y[n] is the growth rate chosen by a representative fiat agent.

```
y[n_]:= (-b[n]-(((b[n])^2)-4*a[n]*c[n])^(0.5))/(2*a[n])
```

z[n] is the total money growth rate in an economy with n identical fiat agents.

```
z[n_]:= n*(y[n]-1)+1
```

We have tried many different parameter values for the money stock, and the respective elasticities. We find that in all cases the sign of the derivative is positive. Changes in parameter values do not affect the shape of the graphs, only the absolute values.

Below we show one simulation for the following parameter values.

m=0.4 (money demand)

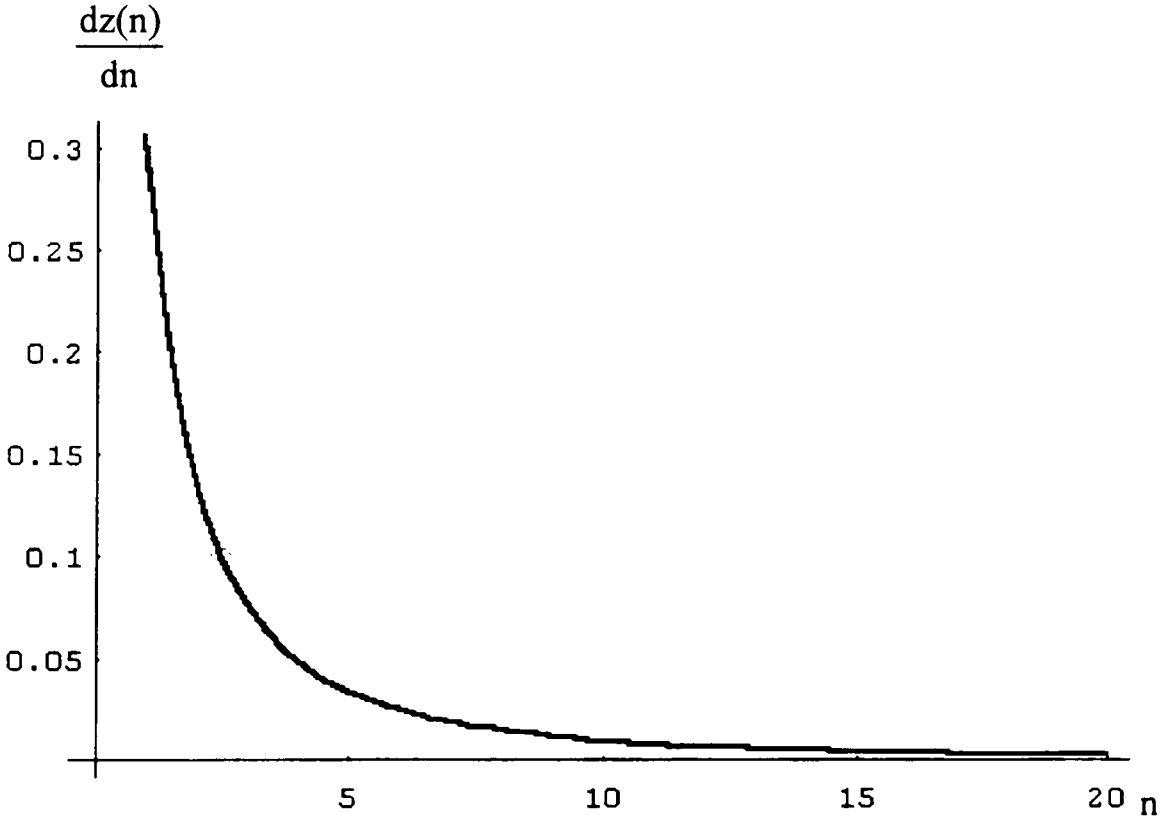
w=0.7 (income elasticity of savings for state agent)

s=-0.2 (price elasticity of savings for state agent)

p=-0.2 (price elasticity of savings for private agent)

We plot the graph of the simulation results for dz(n)/dn for n ranging from 1 to 20. As can be seen it is positive everywhere. The result of the full simulation is available from the author upon request.

Figure 3.4. Plot of $\frac{dz(n)}{dn}$



Appendix H

Proof of proposition 8

The private sector welfare implications of having more than one state and fiat agent pairs are straightforward. Inflation is increasing in n and the consumption set of the private agent is decreasing in inflation as can be seen from the agents indirect utility function (5). Thus the larger the number of fiat agents with access to money issue, the lower the welfare of the private sector.

We showed in the single state and fiat agent pair case that there was one unique optimum rate of money growth call it $\hat{\mu}$ (see equation (15)). Aggregating the actions of the n fiat agents in a generation we get a growth rate $\mu^{\#}(n)$. This growth rate is increasing in the number of agents (n). Since $\hat{\mu}$ maximises the expression, $\frac{M}{p}(\mu,\mu)(1-\frac{1}{\mu})$ (i.e. total seigniorage revenue), and since this maximum is unique, total seigniorage at the growth rate $\mu^{\#}(n)$ which is $\frac{M}{p}(\mu^{\#}(n),\mu^{\#}(n))(1-\frac{1}{\mu^{\#}(n)})$ must be smaller than total seigniorage at $\hat{\mu}$. Since a young state agent in both cases would get $\frac{1}{n}$ times the total, he would get less in the case where money issuance is decentralised, than in the case where it is centralised. Since $\hat{\mu}$ was proven to be the unique value for the growth rate of money that maximised the state agent indirect utility function, $\mu^{\#}(n)$ can not also maximise this, and thus the welfare of the young state agents is lower in the case where issuance is de-central.

■

Chapter 4

Inequality and Financial Development[1]

This paper investigates the link between inequality and financial development. A branch of models in economic development uses the financial sector as the transmission channel linking the income distribution with the real rate of economic growth. In this paper we investigate the first part of this channel, namely the link between inequality and financial development. We present a simple theoretical model, based on the other financial sector models, which uses a moral hazard argument to explain why poor agents are excluded from the financial sector. This model predicts that there exists a non-linear relationship between inequality and financial development, which is conditional on the level of per capita national income. In poor economies increased inequality increases the volume of intermediation, while in rich economies it reduces the volume. Using a new World Bank data set on inequality we test the predictions of the model which we find hold only partially.

[1] Charlie Bean supervised my work on this paper and provided invaluable advice. I thank Peter Boone, Helene Rey and Tommaso Valletti for useful discussions.

4.1 Introduction

In this paper we study the link between the level of inequality in the economy and the level of financial development. The purpose of the paper is twofold. First we want to illustrate how some recent models of economic development by Piketty(1997) and Aghion and Bolton (1997)[2] implicitly assume that there is a particular relationship between these two variables, and secondly we want to test whether this relationship holds using a new World Bank data set on income inequality. If the findings of the models are supported by the data it is not only important for the validity of the theoretical models, it may also help us in our design of economic policies for developing countries.

The emergence of the endogenous growth models (Romer (1986)) helped economists explain long run growth in rigorous theoretical frameworks. Separately the introduction of heterogenous agents into dynamic general equilibrium models has allowed the inclusion of distributional issues in these studies, notably the study of how inequality can affect economic growth rates. One branch of models[3], represented by the work of Piketty and Aghion and Bolton has relied on the financial sector as the transmission mechanism linking the income or wealth distribution of the economy with the rate of real economic growth. The link works through a moral hazard argument that excludes poor agents from access to intermediation and therefore to investment. The inability of some agents to invest optimally in turn affects the growth rate of the economy. In this study we focus on one of the two parts of this transmission channel, namely the link from inequality to

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[2] The analysis in this paper is based on working paper versions of the Piketty and Aghion and Bolton papers that the author read while at University of Chicago.

[3] There are several related papers: Townsend(1983) proxies intermediation with the degree of centralisation of exchange in the economy. He shows how this can affect the level of economic activity in the economy, but he does not study a growing economy. Galor and Zeira(1993) describe the distributional consequences of a financial sector that only allows agents to borrow a multiple of their own wealth. Greenwood and Jovanovic (1990) study how different initial wealth levels affect the optimal time for agents to enter a financial sector that through information gathering can provide higher returns on savings. In their paper special attention is given to the dynamic distributional consequences. Bencivenga and Smith(1991) embeds the technology used by Diamond and Dybvig(1983) into an endogenous growth model. Intermediation reduces liquidity holdings and thus increases the amount of the economy's portfolio invested in productive technology. In an endogenous growth setting, this increases the growth rate of the economy.

financial development. We are not attempting a full test of the moral hazard based models of growth, since this would imply that we included the second part of the transmission mechanism linking financial development and economic growth rates in the empirical investigation as well as the feed back from growth rates to the income distribution. What we are doing is to take the basic moral hazard mechanism from the Piketty model and exogenously vary the income distribution to derive predictions on the consequences of changes in inequality for the volume of financial intermediation in the economy.

The moral hazard based models suggest that there is a non-linear relationship between the degree of inequality and the volume of financial intermediation and that this relationship is contingent on the level of economic development in the economy (measured by the level of per capita national income). In a poor economy more inequality increases the volume of financial intermediation, while in a rich economy increased inequality reduces it. The effect of inequality on intermediation is particularly interesting for the poor economy. Embedding the positive effect of inequality on intermediation within a framework where increased intermediation leads to increased real investments and increased long run economic growth, as is the case in a branch of the endogenous growth literature, suggests that inequality in the earlier stages of development might help countries grow richer faster.

There has not yet been a full empirical investigation of a model like the one outlined above, but many empirical studies have documented the linkages between inequality and real development and between real and financial development separately. The seminal study of the role of inequality is Kuznets' finding that income inequality first rose and then declined with economic development (measured as the level of per capita national income)[4], and the Kuznets curve has been omnipresent in development economics. The role of the financial sector in development has also been the subject of many studies. Goldsmith (1969) noted how the ratio of financial institutions' assets to GNP rose with the level of GNP

[4] See J.Williamson(1991) chapter 1 for a summary of Kuznets findings and references to further empirical evidence testing the Kuznets relationship. See also Kuznets (1971).

using data from 1860 to 1963 covering both developing and developed economies. McKinnon (1973) in a cross-country study showed how the ratio of private credit to national income per capita increased with the level of national income, while the ratio of currency to income showed no systematic pattern of correlation with the level of income, suggesting that it was financial intermediation rather than nominal variables in general that were important for development. All these studies are relevant for the first part of the transmission channel in the moral hazard model. A combination of the fact that financial development is positively correlated with the level of per capita national income with the Kuznets curve is consistent with a model of a transmissions mechanism of the moral hazard type in a heterogenous agent model. For poor economies an increase in national income is positively correlated with increased inequality (Kuznets) and with increased volumes of financial intermediation (Goldsmith), thus suggesting a positive partial correlation between the inequality and financial development. For richer economies an increase in national income is positively correlated with a reduction in the level of inequality (Kuznets) and positively correlated with increased volumes of financial intermediation (Goldsmith), thus suggesting a negative partial correlation between inequality and financial development. These correlation patterns are consistent with several directions of causation. When the theorist suggests an economic model he is also suggesting a direction of causation between the variables. In the case of the moral hazard model of the first part of the transmission mechanism, the causation runs from distribution to the level of financial development, since changes in the wealth distribution determines who has access to the financial sector. What we do in the empirical part of this paper is to test this relationship directly using a newly published World Bank data set on inequality.

The second part of the transmission mechanism linking financial development and economic growth has already been tested empirically. In cross-country studies covering 80 countries from 1960-89, King and Levine(1993a, 1993b) find that financial development is positively correlated with long run real growth[5]. They also

[5] Townsend(1983) has emphasised the distinction between inside money and outside money in affecting economic activity. His thesis is that it is inside money (or credit) more than outside money (fiat currency) that affects economic activity. This thesis is supported by the empirical

find that initial values of the financial variables help in explaining subsequent ten year averages of growth rates. These findings thus support the Schumpeterian view that financial development leads real development (Schumpeter(1969)) against Robinson's suggestion (Robinson(1952)) that economies with good real prospects would have high demand for financial services which would lead to development of the financial sector[6].

In the first part of this paper we present a simple model of the link between inequality and financial development. The model is based on the moral hazard mechanism used in Piketty(1997). By varying the level of inequality, which in our model is equivalent to introducing a mean preserving spread on the wealth distribution, we can derive an empirically testable hypothesis linking inequality and financial development. In the second part of the paper we test this hypothesis using World Bank data on inequality.

4.2 The Model[7]

The economy consists of two types of agents: entrepreneurs and investors. There is an equal number of each type represented by a continuum of agents normalised to size 1. Agents live for two periods. We will analyse a simple two period model but the results will carry over into an infinite horizon overlapping generations model. Investors have endowments $(e_t, e_{t+1}) = (z_t, 0)$ and standard preferences $U(c_t, c_{t+1})$ which are continuous and concave. They have access to a

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studies of Goldsmith(1969) and McKinnon(1973). As mentioned above Townsend's paper deals with the level of economic activity and the empirical studies he quotes are on levels data. However recently related findings have emerged in the empirical growth literature. King and Levine's analysis suggests that inside money can affect economic growth rates. McCandless and Weber's(1995) study suggests that there is little or no role for money in explaining economic growth. They also quote a number of other studies (their table 4, p.9) each with different conclusions on the matter.

[6] Lucas (1988) seems to support this view (p.6): "I will also be abstracting from all monetary matters, treating all exchange as though it involved goods-for-goods. In general, I believe that the importance of financial matters is very badly over-stressed in popular and even much professional discussion and so am not inclined to be apologetic for going to the other extreme."

[7] The derivation of the cutoff level of wealth, which determines who has access to intermediation follows Piketty(1997).

savings technology yielding a safe return of $1+r_t$. The optimisation problem of an investor is

$$(1) \quad \max_{c_t, c_{t+1}} U(c_t, c_{t+1}) \text{ s.t. } c_t + \frac{c_{t+1}}{1+r_t} = z_t$$

We assume that consumption at the two dates are gross substitutes so that savings are increasing in the rate of return on storage between period t and t+1. Thus the savings function of a representative investor is

$$(2) \quad s_t = s_t(\underset{+}{z_t}, \underset{+}{r_t})$$

We will think of $1+r_t$ as being the return on deposits placed at an intermediary. We assume that there is perfect competition in intermediation so that the rate of return on a deposit equals the rate of return on the assets of the intermediary. The intermediary lends to entrepreneurs who have access to a constant returns to scale production technology for a homogeneous good $Y_{t+1} = F(K_t, L_t)$ where K_t is capital and L_t is labour. Entrepreneur i has an endowment of one unit of inelastically supplied labour, one unit of labour effort and w_{it} endowment units of the consumption good at date t and nothing at date t+1. $w_{it} \sim G(w)$ and the support of G is $\left[w^l, w^h\right]$. Output depends on labour effort which is chosen by the entrepreneur and is either 0 or 1. The supply of labour effort is private information to the entrepreneur. Since the technology is CRS we can re-normalise by the size of labour input to get $k = \frac{K}{L}$ and $f(k) = \frac{Y}{L}$. The distribution of output per labour unit $\phi(k)$ depends on the supply of labour effort in a particular way;

(3) if labour effort is 1

$\phi(k) = f(k)$ with probability p
$= 0$ with probability 1 - p

if labour effort is 0

$\phi(k) = f(k)$ with probability q
$= 0$ with probability 1 - q

$0<q<p<1$

This set up is standard for moral hazard models. With this type of technology the good and the bad outcomes can occur both when the entrepreneur supplies high and low effort. Thus the lender cannot determine the effort level of the borrower by observing output. Since we assume that the lender cannot directly monitor borrower behaviour it seems that the lender will always face moral hazard when lending to an entrepreneur: The entrepreneur will promise to supply high effort and borrow accordingly. After receiving the loan he will supply low effort. Consequently the probability of a bad outcome increases compared to the conditions under which the loan was given. However if a bad outcome is realised the lender will be unable to deduce whether it was chance or low effort that caused it. Under these circumstances lender profits are reduced compared to the full information case where promises can be enforced. To get around this moral hazard problem the lender designs an incentive compatible contract that will induce the borrower to supply high effort. In our set up incentive compatibility will be tied to the amount of collateral the borrower has tied up in the project himself. An entrepreneur with a lot of his own wealth invested in a project will want to pay the cost of high effort in return for a reduction in the probability of a bad outcome which would eliminate his savings. The lender will be able to lend profitably to entrepreneurs of this type. Thus the incentive compatibility constraint determines a cut off level of wealth. Entrepreneurs with wealth below this level will be unable to borrow. We now proceed to derive this cut off level of wealth.

There are two possible choices of capital good input depending on whether labour effort is supplied or not. If labour effort is 1, the entrepreneur will invest $k_1 = k : pf'(k) = 1 + r_t$. If labour effort is 0 he will invest $k_2 = k : qf'(k) = 1 + r_t$. Since f has the standard neo-classical properties $k_1 > k_2$. We assume that $k_2 < w^l$ and $k_1 > w^h$ which is equivalent to assuming that high effort entrepreneurs will wish to borrow while low effort entrepreneurs will have sufficient endowment of the consumption good to self finance their project. Entrepreneurs do not have access to the deposit technology at the intermediary who lends to entrepreneurs[8]. Entrepreneurs are born at time t and given their endowment, they invest and receive the returns at time t+1 where they consume. The optimisation problem of the ith entrepreneur is,

$$(4) \qquad \max_{e, c_{it+1}, k_t} \; E_t(c_{it+1} - e) \text{ s.t. } c_{it+1} = \phi(k_t) - (1 + r_t)(k_t - w_{it})$$

Entrepreneurs are maximising their expectation at time t of consumption at time t+1 This maximisation problem reduces to maximising the expected return from the investment project net of the cost of effort. Given our analysis of the production process, expected consumption can take two values depending on the choice of effort;

$$(5) \qquad \begin{aligned} E_t c_{it+1}(e = 1, k, w_i, r) &= pf(k_1) - (1 + r_t)(k_1 - w_{it}) \\ E_t c_{it+1}(e = 0, k, w_i, r) &= qf(k_2) - (1 + r_t)(k_2 - w_{it}) \end{aligned}$$

We assume that

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[8] This assumption is made to simplify the description of equilibrium. If entrepreneurs could save at the same intermediary, changes in the income distribution would affect both the amount of funds allocated and the amount of funds saved in the intermediary at a given interest rate. The assumption made eliminates the second effect. Nothing substantial would change in the analysis if the supply of funds effect was included except that the interest rate would have to change less to equilibrate supply and demand of funds after a change in income inequality because there are additional savers in this economy. While entrepreneurs cannot save at the intermediary which lends to high effort entrepreneurs they still have access to a return of 1+r so their investment decision is identical to the one analysed in Piketty.

i) $E_t c_{it+1}(e=1,k,w_i,0)-1>E_t c_{it+1}(e=0,k,w_i,0) \quad \forall w_i$

ii) $E_t c_{it+1}(e=1,k,w_i,r)-1>E_t c_{it+1}(e=0,k,w_i,r)$ for $r<r^*, \ \forall w_i$

Assumption (i) implies that if the rate at which the entrepreneur can borrow is zero, he will supply high effort and undertake the high investment. Assumption (ii) says that as long as the interest rate in the economy is below r* entrepreneurs will supply full effort and undertake the high investment. This is, of course, the interesting case as there are no high effort entrepreneurs in the high interest rate economy. In the following we restrict our analysis to that case.

The intermediary has to decide how much to lend to an entrepreneur. In the economy where the intermediary can only observe project outcomes and not effort (which is private information), the intermediary must ensure that incentive compatibility holds. The intermediary will therefore only lend an amount to the entrepreneur that ensures it will be optimal for him to supply the effort he promised ex ante when he borrowed. The intermediary offers the contract based on the observed project outcome;

(6) $\left[d_f,d_s\right]=\left[0,(1+r_t)(k-w_{it})/p\right]$

In case of project failure the borrower pays nothing to the intermediary, in case of project success he pays $(1+r_t)/p$. With this contract the intermediary breaks even since expected return on its lending portfolio is $1+r_t$.

The incentive compatibility constraint for a borrower with wealth w_{it} is

(7) $p\left[f(k_1)-d_s\right]-1>q\left[f(k_1)-d_s\right]$

The intermediary will only lend to an agent if the above holds. If the constraint is violated it will be optimal for the agent to promise to supply high effort, invest k_1 and then supply low effort.

The incentive compatibility constraint implies that agents with wealth below a certain level will not be able to borrow the amount necessary to finance investment in the optimal high effort project. The other option available to them is to invest k_2 and to supply low effort. This project they can self finance. The cut off wealth level is

$$(8) \quad w^* = k_1 - \left[pf(k_1) - p/(p-q)\right] / \left[1 + r_t\right]$$

Agents with wealth below this level will not be allowed to borrow sufficient funds to finance the high effort project. If we view the desired lending volume of the intermediary as the demand for loanable funds, we can describe loan demand $l(r)$ as

$$(9) \quad l(r) = \int_{w^*(r)}^{w^h} \left[k_1(r) - w\right] dG(w)$$

$l(r)$ depends on both the distribution of entrepreneurial wealth $G(w)$, the production function since this is important for determining k_1 and the interest rate, both through its effect on k_1 and on $w^*(r)$.

Equilibrium is the situation in which the savings market clears given the wealth distribution for entrepreneurs $G(w)$, the information structure, the production function $f(k)$ and wealth levels for savers z. The equilibrium rate of interest is the interest rate that solves:

$$(10) \quad s(z,r) = l(r)$$

We have already described the supply of loanable funds above[9], and we saw that $s = s(\underset{+}{z}, \underset{+}{r})$. We now describe the properties of the loan demand schedule. We pay particular attention to how it depends on the interest rate so that we can plot the loanable funds market in a diagram and how changes in the distribution of entrepreneurial wealth affects the demand schedule. This last relationship is at the core of our subsequent empirical analysis.

We can find $\frac{dl}{dr}$ by applying Leibniz's rule[10] to equation (9). We get,

$$\frac{dl}{dr} = -\left[k_1(r) - w^*\right] g(w^*(r)) \frac{dw^*}{dr} + \int_{w^*(r)}^{w^h} k_1'(r) g(w) dw$$

$$= -\left[k_1(r) - w^*\right] g(w^*(r)) \frac{dw^*}{dr} + k_1'(r)\left[1 - G(w^*(r))\right]$$

This implies that

$$(11) \quad \frac{dl}{dr} < 0$$

since $\left[k_1(r) - w^*\right] > 0$ by assumption, $g(w^*(r)) > 0$, $k_1'(r) < 0$ by the standard neoclassical assumption on the production function, $\left[1 - G(w^*(r))\right] > 0$ and as is proved in Piketty(1997) $\frac{dw^*}{dr} > 0$ for $r < r^*$ which is the case we are studying. Figure 4.1 shows the market for loanable funds. Given (11) the loan demand schedule is downward sloping.

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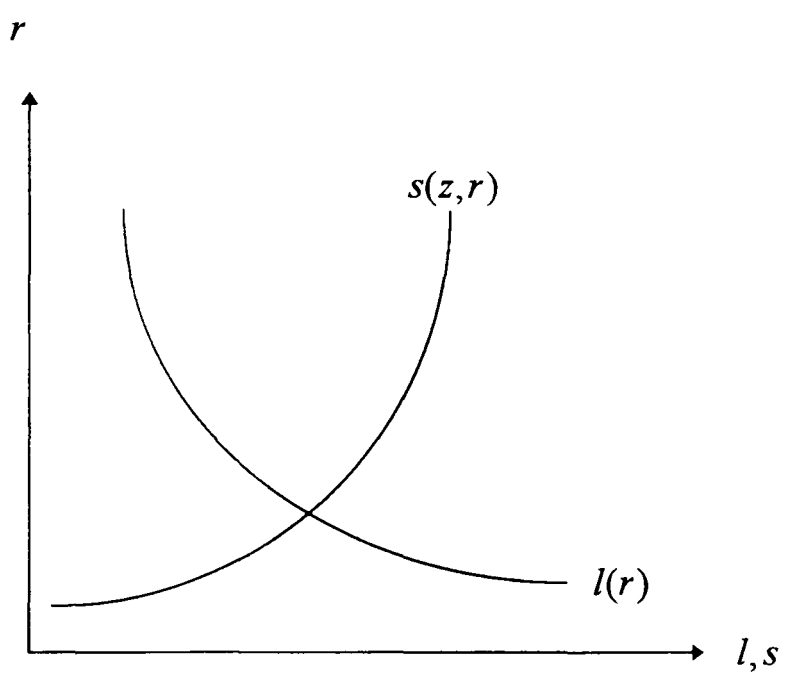
[9] By assuming that entrepreneurs with excess capital i.e. low effort entrepreneurs with surplus capital do not place their funds with the intermediary who lends to high effort entrepreneurs, we are abstracting from the situation where the supply schedule for loanable funds is also dependent on $G(w)$.

[10] See Bartle(1976) p.245.

Figure 4.1 The Market for Loanable Funds



We are interested in what the predictions are of this model concerning the link between inequality and the volume of intermediation, since this is the relationship we want to base our test of the model on. We want to separate out the effect from changes in the level of national income per capita from the analysis since this variable previously has been shown to affect the volume of intermediation. To do so we can model an increase in inequality as a mean preserving spread on the distribution of entrepreneurial wealth. A mean preserving spread places more weight on the tails of the distribution without changing the mean. Thus a mean preserving spread on a wealth distribution increases the variance of the distribution. Formally a mean preserving spread can be defined in the following way[11]:

For two distributions $G^{\alpha}(w)$ and $G^{\beta}(w)$ with support $\left[w^{l}, w^{h}\right]$, $G^{\beta}(w)$ is said to be a mean preserving spread on $G^{\alpha}(w)$ (or equivalently $G^{\alpha}(w)$ second order stochastically dominates $G^{\beta}(w)$) if the following conditions are satisfied:

i) $\int_{w^{l}}^{w^{h}} \left[G^{\alpha}(w) - G^{\beta}(w)\right] dw = 0$ (Identical means)[12] and,

ii) $\int_{w^{l}}^{w^{\#}} \left[G^{\beta}(w) - G^{\alpha}(w)\right] dw \geq 0 \quad w^{l} \leq w^{\#} \leq w^{h}$

This is the definition of a mean preserving spread given by Rothschild and Stiglitz(1970,1971). We will also assume that the two distributions we study satisfy the single crossing property, namely

iii) $G^{\beta}(w) - G^{\alpha}(w) \leq 0 \ (\geq 0)$ when $w \geq (\leq) \hat{w}$

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[11] See Sargent(1987) pp. 64-65. and Mas-Colell, Whinston and Green(1995) pp.197-199.
[12] See Sargent(1987) p.58 for the derivation of the mean of a non-negative random variable.

Figure 4.2 Mean Preserving Spread Satisfying the Single Crossing Property[13]

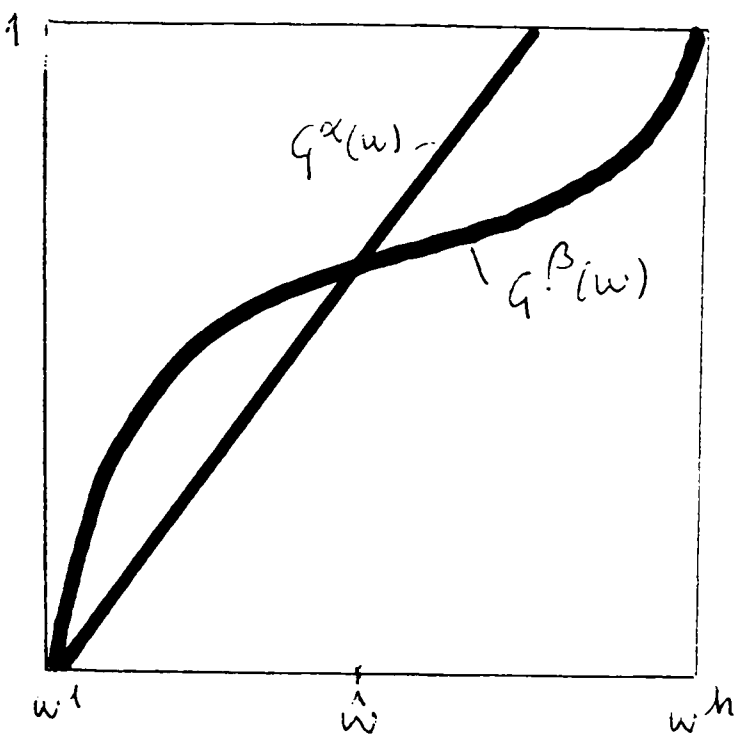
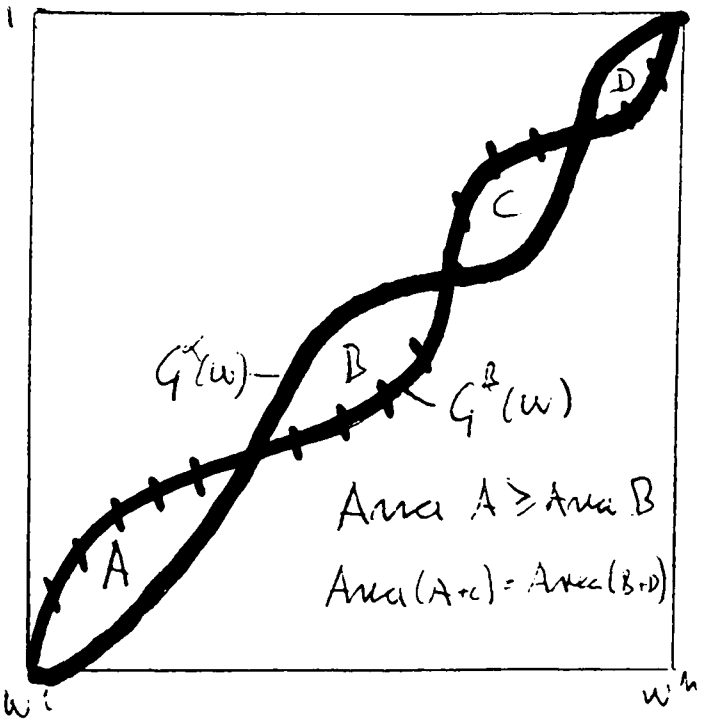


Figure 4.3 Mean Preserving Spread Violating the Single Crossing Property



[13] Sources: 4.2.:Sargent(1987); 4.3.: Mas-Colell, Whinston and Green(1995).

This is a type of mean preserving spread illustrated in figure 4.2. A mean preserving spread that does not satisfy condition (iii) is illustrated in figure 4.3. This assumption greatly simplifies the subsequent analysis. Given that we in our data work study changes only at top and bottom quintile of the wealth distribution this is also a sensible assumption.

Given the above definition we can describe what happens to the loan demand curve when there is a mean preserving spread of the distribution of entrepreneurial wealth.

Loan demand is given by,

$$(9) \qquad l(r) = \int_{w^*(r)}^{w^h} [k_1(r) - w] dG(w)$$

This can also be written

$$l(r) = 1 - \int_{w^l}^{w^*(r)} [k_1(r) - w] dG(w)$$

Using the integration by parts rule $\left(\int v du = uv - \int u dv\right)$ on the above expression, we get

$$l(r) = 1 - [k_1(r) - w] G(w) \Big|_{w^l}^{w^*} - \int_{w^l}^{w^*} G(w) dw$$

$$(12) \qquad = 1 - [k_1(r) - w^*] G(w^*) - \int_{w^l}^{w^*} G(w) dw$$

We can use (12) to describe the effects of a mean preserving spread on the loan demand schedule holding the interest rate constant. Index the loan demand

function by the spread ranking of the distribution so that $l^{\alpha}(r)$ is the loan demand function associated with $G^{\alpha}(w)$, and $l^{\beta}(r)$ is associated with $G^{\beta}(w)$. Then,

$$(13)\quad l^{\alpha}(\bar{r}) - l^{\beta}(\bar{r}) = \left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right]\left(w^* - k_1(\bar{r})\right) + \int_{w'}^{w^*}\left[G^{\beta}(w) - G^{\alpha}(w)\right]dw$$

We can use the definition of a mean preserving spread satisfying the single crossing property to sign $l^{\alpha}(\bar{r}) - l^{\beta}(\bar{r})$. By condition (ii) $\int_{w'}^{w^*}\left[G^{\beta}(w) - G^{\alpha}(w)\right]dw$ is always positive. The sign of $\left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right]\left(w^* - k_1(\bar{r})\right)$ is ambiguous. $\left(w^* - k_1(\bar{r})\right)$ is always negative, but as can be seen from condition (iii) the sign of $\left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right]$ changes as w^* changes relative to $\hat{w}$. If $w^* \geq \hat{w}$ then $\left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right] \geq 0$. This implies that $\left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right]\left(w^* - k_1(\bar{r})\right)$ is negative and hence $l^{\alpha}(\bar{r}) - l^{\beta}(\bar{r})$ can be negative. If on the other hand $w^* \leq \hat{w}$, then $\left[G^{\alpha}(w^*) - G^{\beta}(w^*)\right]\left(w^* - k_1(\bar{r})\right)$ is positive and thus $l^{\alpha}(\bar{r}) - l^{\beta}(\bar{r})$ is positive.

This ambiguity arises because a mean preserving spread has two effects. It affects the average wealth of agents with access to the intermediated sector, and it affects the total number of these agents. A mean preserving spread will always increase the average wealth of the agents with access to intermediation, since only the wealth levels above the cut off point w^* affects this average. Since we are investigating the effects of a mean preserving spread holding the interest rate constant, the size of the optimal investment project does not change in our analysis, therefore the average amount each entrepreneur needs to borrow is reduced by the average wealth effect of a mean preserving spread. This effect thus suggests that increased inequality should reduce the amount of intermediation. However this need not be the case, because the mean preserving spread also changes the number of

Figure 4.4a Mean preserving Spread in a Relatively Poor Economy

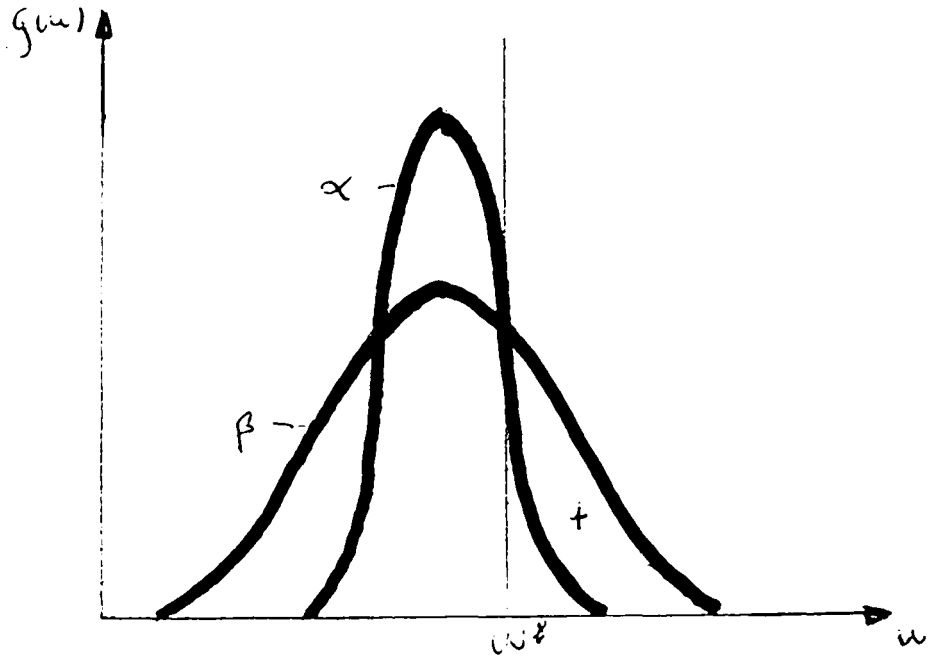
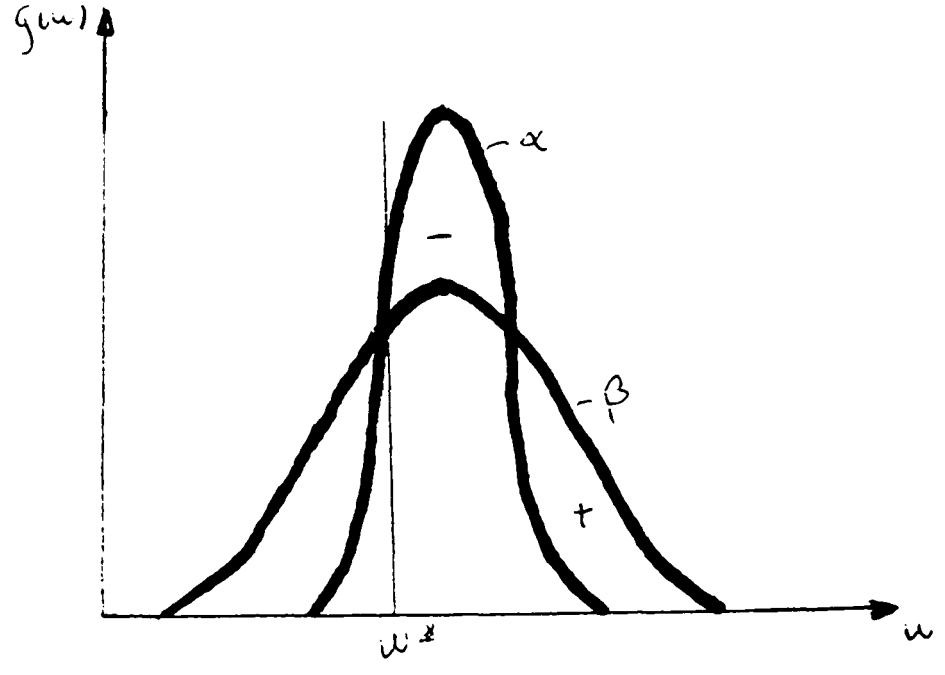


Figure 4.4b Mean Preserving Spread in a Relatively Rich Economy



entrepreneurs with access to intermediation. When one performs a mean preserving spread one shifts mass from the centre of the distribution towards the tails. Assume that this is done in a way so that equal probability mass is shifted to the top and bottom tails of the distribution. If the cut off point for borrowing lies at a relative high point in the support, more mass is shifted above the cut off point by a mean preserving spread, and thus there will be more borrowers in this economy, this is illustrated in figure 4.4a. If on the other hand the cut off point for borrowing lies at a relatively low point in the support, then more mass is shifted below the cut off point, and there will be fewer borrowers in the economy, this is illustrated in figure 4.4b.

Since $\hat{w}$ is a given point in the support, one can say that the dependence of the sign of $l^{\alpha}(\bar{r}) - l^{\beta}(\bar{r})$ on the location of w^* implies a conditionality on the level of national income of the relationship between inequality and the volume of financial intermediation. An economy with a high w^* is on average poorer than an economy with a low w^*, thus the result above can be interpreted as saying that for a poor economy increased inequality will increase the volume of financial intermediation if the numbers effect dominates the average effect, while for a rich economy more inequality will unambiguously reduce the volume of intermediation since both effects work in the same direction.

To sum up: In a poor economy increased inequality shifts the loan demand schedule (figure 4.1) to the right for a given interest rate. In a rich economy the curve shifts to the left.

To illustrate this point we have performed simulations of the effects of a mean preserving spread on the volume of loans demanded. The simulation is performed using a normal distribution[14]. We hold the mean constant and look at the effects of changing the variance of the distribution. The simulated economy has a population

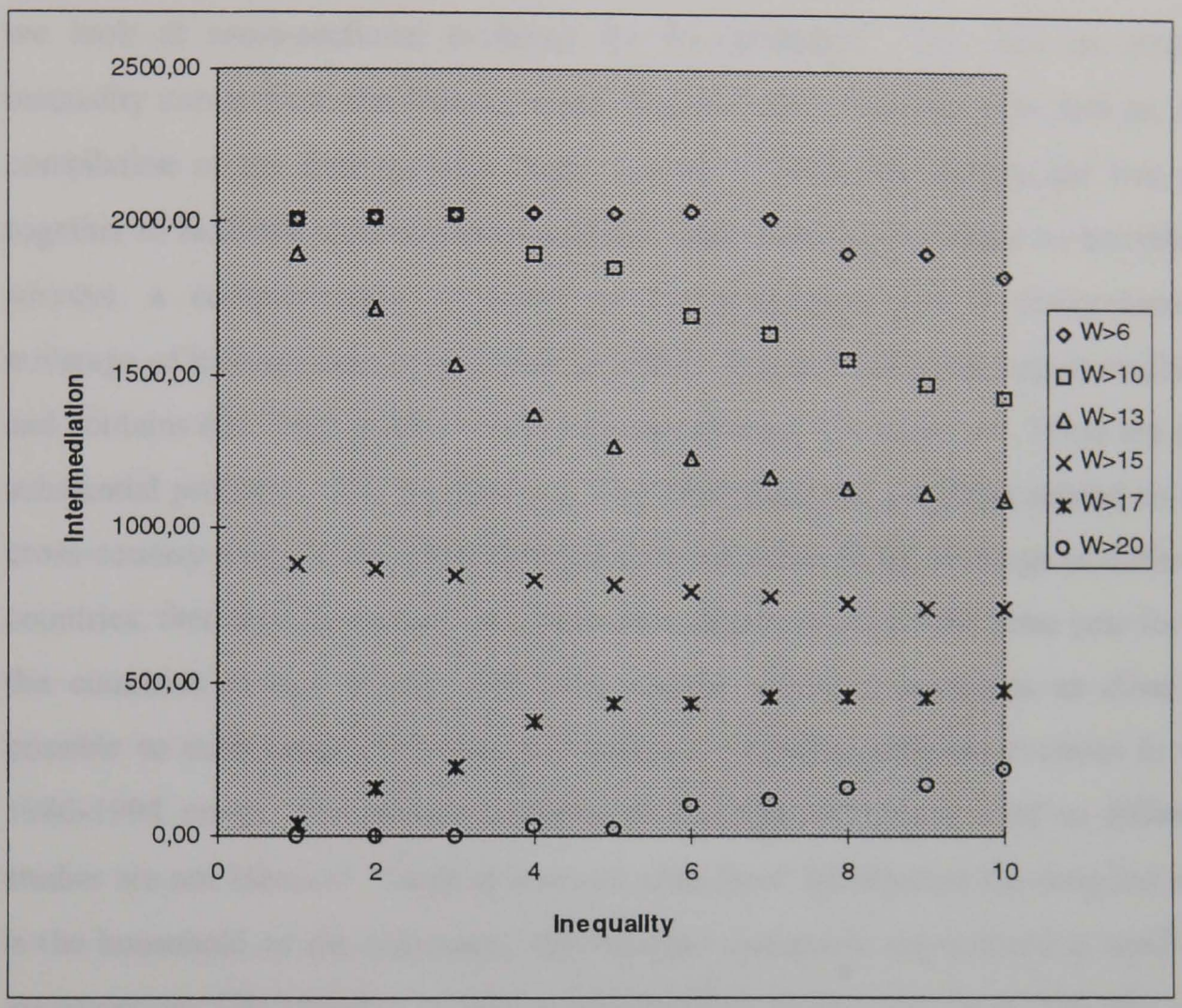
[14] This simulation is strictly speaking not a true representation of our problem since the support of a normal distribution is $(-\infty, \infty)$, however as long as we make sure that the k_1 we choose is larger than any actual realisation, we can still use a simulation based on a normal to illustrate our point.

of size 100, k_1 equals 30 and the average per capita income is 15. An increase in the variance of income is equivalent to an increase in the degree of inequality in the economy. As figure 4.5 illustrates: For values of w* above the mean (w>15) increased inequality increases the volume of loans demanded. That is, a poor economy with a more egalitarian income distribution will have less satisfied loan demand than an economy with the same mean income, but a higher degree of inequality. The reverse is true for economies where w* is below the mean (w<15) i.e. relatively rich economies. These results are identical to the predictions of the theoretical model above.

So given the upwards sloping savings supply schedule the equilibrium effects of a mean preserving spread of the wealth distribution depends on the level of per capita income in the economy. For a poor economy, a mean preserving spread will shift the l curve in figure 4.1 to the right, thus increasing the equilibrium volume of financial intermediation, while for a richer economy it will shift it to the left, reducing the volume of financial intermediation. We summarise the hypothesis that can be derived from the above analysis concerning the transmission mechanism between inequality and financial development.

Hypothesis: The relationship between inequality and financial development is conditional on the level of per capita national income in the following way: for low income countries higher inequality increases the amount of intermediation; for high income countries it decreases the amount of intermediation.

Figure 4.5 Simulations of Inequality and Intermediation.



- Inequality increases from 0 (lowest) to 10 (highest). Each step is equivalent to a mean preserving spread on the wealth distribution.
- Each set of points traces the change in intermediation as inequality changes for an economy with a given cut-off level of wealth.

4.3 Empirical evidence.

4.3.1 Data

To examine the links between financial development and income inequality, we look at cross-sectional evidence for 50 countries[15]. The data on income inequality comes from the Deininger and Squire (1996) data set. This data set is a compilation of the findings of a large number of inequality studies and was put together to facilitate cross-sectional analysis. Only observations based on household surveys, a comprehensive coverage of the population and a comprehensive coverage of income sources has been included. The data set is the largest available and contains 682 "high quality" observations covering 108 countries. There are still substantial problems with the data set. The most pertinent problems related to the cross-country analysis are firstly that the data set varies in its coverage of different countries, therefore we cannot be sure to have observations for the same year for all the countries in our sample. We have chosen yearly observations as close as possible to each other. Our data set contains countries with observations in the 1986-1994 range. The second problem is that the definitions used in different studies are not identical. These differences arise from: (i) Whether the recipient unit is the household or the individual; (ii) Whether income or expenditure is used for measurement; (iii) Whether income is measured gross or net of taxes; The first two differences are the most serious since the difference between gross income and net of tax income is most significant for inequality studies in economies where the tax system is used for re-distributive purposes. This is mostly the case in highly developed economies that are not part of our sample. Deininger and Squire have analysed the importance of the differences in definition of the recipient unit and the difference between income and expenditure studies. They find that only the income expenditure difference has significant effect on the data analysis. In spite of these problems we have chosen to conduct the empirical investigation. The Deininger and

[15] The constraint on the size of the sample comes from the inequality data set. Financial data is available for a large group of countries through the IFS and standard cross-sectional controls are available for more than 100 countries. The King and Levine data set for the investigation on the link between financial development and growth thus consists of 119 countries.

Squire data base is the best available and can help shed some light on an important question. Furthermore we have where possible addressed the problems of data definition. The conclusions of our empirical investigation should however be read with the above problems in mind.

The Deininger and Squire data set contains two types of measures of inequality; Gini coefficients and cumulative quintile shares of income. The data set has the widest coverage for Gini coefficients, but this measure is not directly related to our model since redistribution of income anywhere in the income distribution affects the Gini coefficient, while we are interested in agents crossing a cut off point. Therefore we rely on quintile income shares to measure inequality. We use the ratio of the income share of the top 20 percent of the population to the income share of the bottom 20 percent of the population. We call this variable *Inequality*. This is a relative measure of inequality and gives us information of how poor the least well off members of the society are relative to the richest members. An increase in *Inequality* is equivalent to introducing a mean preserving spread on the wealth distribution in our model. Alternatively one can think of capturing the fraction of agents below the cut off point. This is done through the variable *Poverty* which measures the income share of the lowest quintile of the population. In using income shares for the entire population to test the hypothesis on the link between inequality and financial development, we are implicitly assuming that this variable is a good instrument for the key variable in our theoretical model which is the wealth of agents in the entrepreneurial sector. It is not unrealistic to assume that income and wealth are highly correlated especially since some income is flow income from the agent's stock of wealth. Further, if the entrepreneurial sector covers a significant share of the total economy one would expect the distribution covering the economy to be a good proxy for the distribution of the entrepreneurial sector. However the fact that a one to one mapping does not exist between the variable in our theoretical model and the instrument, induces us to urge further caution when interpreting the empirical results.

To measure the degree of financial development, we use the ratio of financial sector claims on non-bank private sector[16] to GDP. We call this variable *Intermediation*. This measure of financial depth is also used by Townsend(1983) and King and Levine (1993a,b).

Our model suggests that the sign of the effect of changes in inequality on the level of financial development is conditional on the level of economic development in the economy (measured as per capita national income). For low income countries there should be a positive correlation between inequality and financial depth, for high income countries the correlation should be negative. We use GDP per capita reported in US$ as a measure of the level of economic development[17]. We call this variable *Income*.

4.3.2 Preliminary Investigation

Figure 4.6 shows a scatter plot of pairs of *Intermediation* and *Inequality* for the entire sample. As is evident from the plot there is no obvious linear relationship between the variables. The correlation matrix in table 4.1 shows a small negative relation between the two variables. Likewise there is no obvious relationship between *Poverty* and *Intermediation* as can be seen from figure 4.7. The correlation matrix in table 4.2 shows a small positive relation. Figure 4.8 shows that after conditioning on *Income* there is still no obvious relationship between *Intermediation* and *Inequality*.

4.3.3 Regressions

Our model pays particular attention to the demand side in the financial sector. We have ignored potentially interesting features on the loan supply side. In the empirical section we compensate for this by introducing various controls which might affect the supply of funds. Political stability is important for savers' reliance

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[16] Claims on non-bank private sector is the IFS 32.d. series. GDP is the IFS series (99.b).
[17] Population is IFS series 99.z, We use annual averages of the exchange rate of the national currency to US$ to convert our GDP measure into US$ (IFS country exchange rate series...af).

Figure 4.6 Plot of Intermediation and Inequality

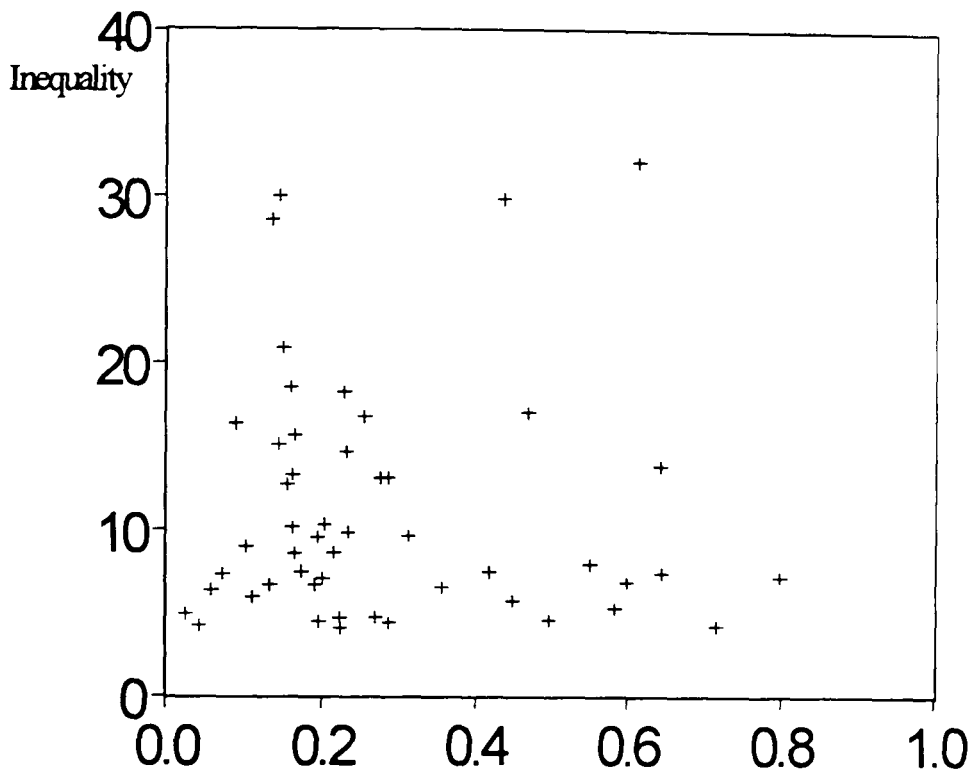


Table 4.1 Correlation Matrix

	Inequality	Intermediation
Inequality	1.0	-0.026
Intermediation	-0.026	1.0

Figure 4.7 Plot of Intermediation and Poverty

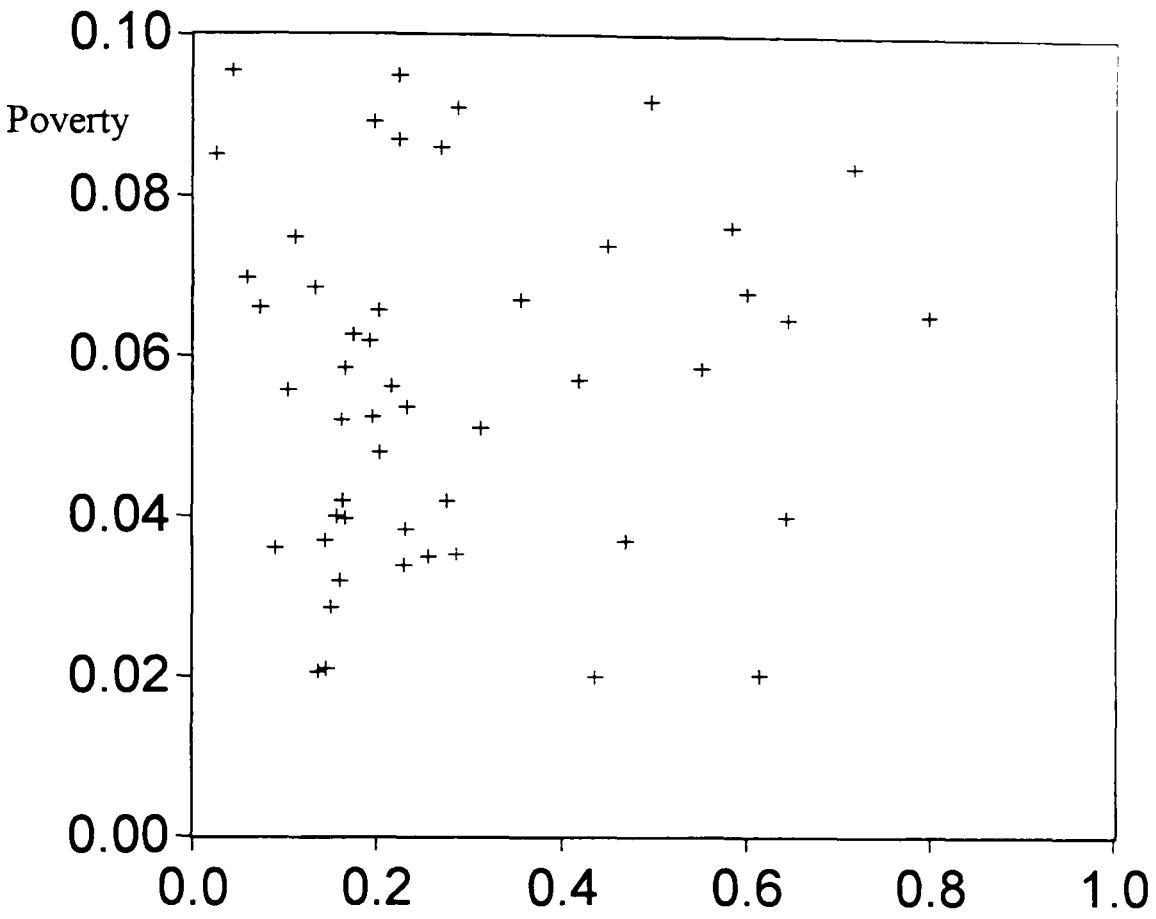
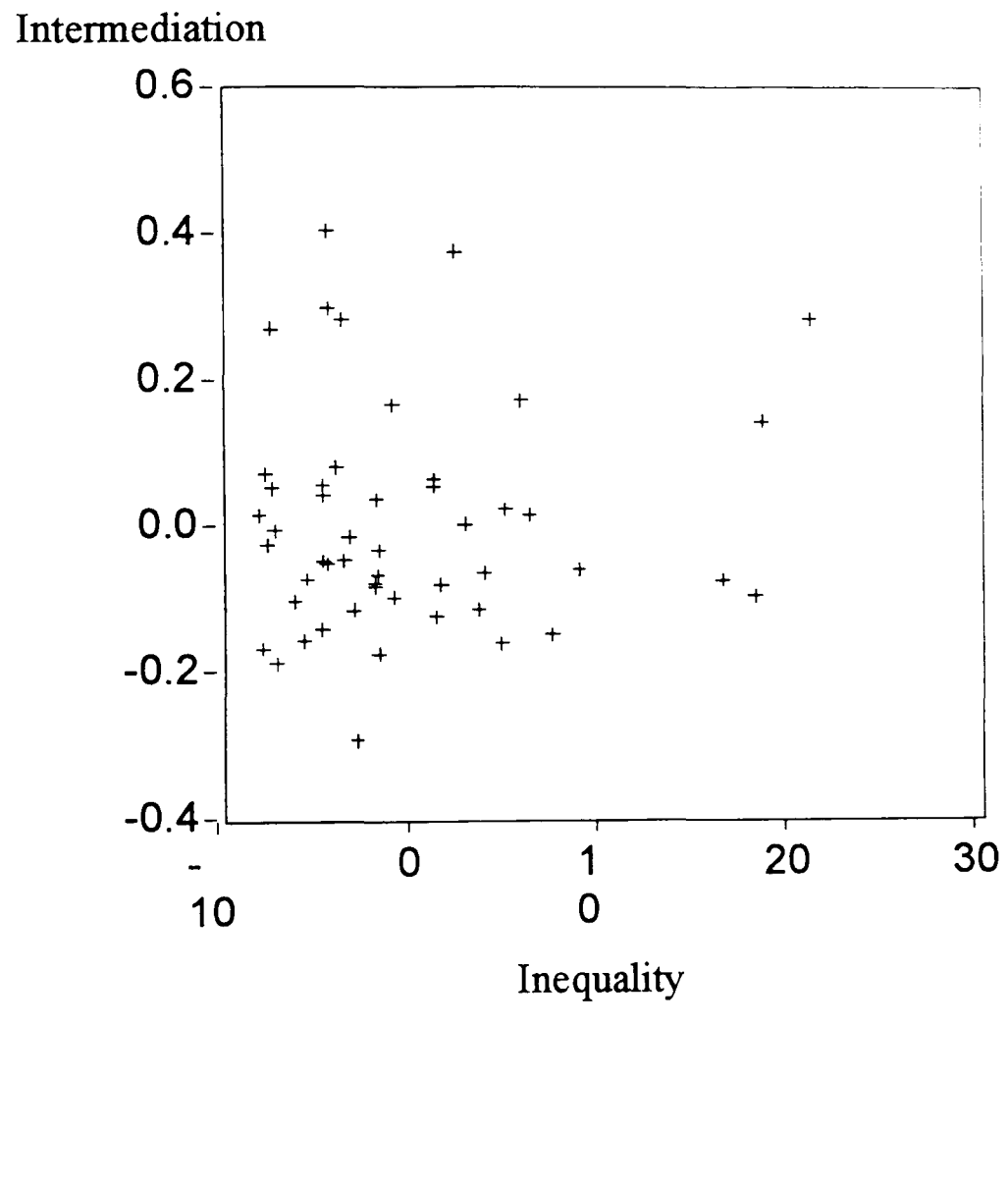


Table 4.2 Correlation Matrix

	Poverty	Intermediation
Poverty	1.0	0.057
Intermediation	0.057	1.0

Figure 4.8 Plot of Intermediation and Inequality after Conditioning on Income



on the financial sector. The governments share in GDP might play a role too, the infrastructure of the economy such as the size of the agricultural sector and population density could be important, and the openness of the economy might affect the interest elasticity of savings supplies.

To test our hypothesis we ran the following OLS regression.

$$\begin{aligned} Intermediation = {} & \beta_0 + \beta_1 Income + \beta_2 Income \times Inequality \\ & + \beta_3 Income^2 \times Inequality + \beta_4 Inequality \\ & + \beta_5 Income^2 + Controls \end{aligned} \tag{14}$$

The *Income* term and interaction terms between *Income* and *Inequality* are directly derived from our theoretical analysis. These terms contain the non-linear relationship between *Intermediation* and *Inequality* conditional on the level of *Income*. This can be seen when we differentiate the expression with respect to *Inequality*. We get;

$$\frac{\partial\ Intermediation}{\partial\ Inequality} = \beta_2 Income + \beta_3 Income^2 + \beta_4 \tag{15}$$

We expect to find a positive relationship between *Intermediation* and *Inequality* for low income countries, while we expect to find a negative relationship for high income countries. Equation (15) describes a second order polynomial in *Income*. The sign switches will take place at the income levels which are the zeros of this polynomial and these can be found using the standard formula

$$(z_1, z_2) = \frac{-\beta_2 \pm \sqrt{\beta_2^2 - 4\beta_3\beta_4}}{2\beta_3}.$$

As is normal procedure in regressions with interaction terms we include all the terms used in interaction separately, i.e. *Income*, *Income*^{2} and *Inequality* even though our model does not hold any predictions on the coefficients of these

variables. We add a number of controls to the regression. *Open* defined as the sum of exports and imports as a proportion of nominal GDP, measures the degree of openness of the economy. This variable is taken from the Summers and Heston(1991) data set. *Govt* is defined as the real government share of GDP expressed in percent and is also taken from Summers and Heston(1991). *Civ* and *Pol* are the Gastil indicies of civil and political liberties. The Civil Liberties index runs from 1 which is a ranking given to the most free countries to 7 which is given to the least free. The ranking is done by a research team at Freedom House[18]. *Rev* measures the average number of revolutions and coups per year and is taken from King and Levine(1993a). *Latin* and *Africa* are dummy variables controlling for countries in Latin America and sub-Saharan Africa respectively. We use the same categories as King and Levine(1993). *Popden* is population density measured as total population divided by area in square kilometres. *Agriculture* is the share of the agricultural sector in value added as a share of GDP at market prices. Both these are calculated from the World Bank 1995 data set available on-line at the LSE.

Table 4.3 contains the coefficient estimates of regression (14). β_3 and β_2 are both significant at the 5-percent level while β_4 is only significant at the 20 percent level. We calculate the roots of the above polynomial on the basis of these coefficients; they are $(z_1, z_2) = (613, 3835)$. These roots are calculated as a non-linear combination of our OLS coefficient estimates. We use the Wald test to test the significance of these roots; z_1 is greater than zero with probability 0.8, and (z_1, z_2) are different from each other with probability 0.93. The roots imply that in countries with a GDP per capita between US$ 613 and 3835 there is a positive relationship between *Inequality* and *Intermediation* while the relationship is negative for income levels above US$ 3835 and below US$ 613. The positive effect

[18] See J.E.Ryan (1994) litt: The Comparative Survey of Freedom 1993-1994 Survey Methodology pp.671-695 in: Freedom in the World: The Annual Survey of Political Rights And Civil Liberties: Freedom House, NewYork. Political rights enable people to participate freely in the political process (the checklist on which the ranking is based includes amongst other things: elections, parties, opposition rights access to office, political decentralisation.) Civil liberties are the freedoms to develop views, institutions and personal autonomy apart from the state (the checklist includes: free media, freedom of assembly, equality under the law, absence of political terror, free business organisation, free religion, personal freedoms, freedom from government corruption.)

is largest at the top point of the polynomial located at $-\frac{\beta_2}{2\beta_3}$ which is equal to US$ 2224. Notably both sign switches take place at income levels contained in our sample. The first root is the income level where the effect of increased inequality on intermediation goes from negative to positive and the second root is the level where the switch is from positive to negative. The data suggests that the model predicting a sign switch when one goes from poor to rich countries is only partially right. For very poor countries the effect of increased inequality on intermediation is negative, which is contrary to the predictions of the theoretical model. A calculation using our regression coefficient values suggest that *Intermediation* (measured as claims on non-bank private sector as a percentage of GDP) in a country with a GDP per capita of US$ 1000 will increase by 0.3 percent if *Inequality* is increased by 1 (i.e. if the ratio of the income share of the top quintile to the bottom quintile goes up by 1). In our sample *Inequality* takes on values between 4.06 (in Bangladesh with per capita GDP of US$ of 191) and 32.11 (in South Africa with GDP per capita of US$ of 2960), so a change of *Inequality* by 1 is realistic. However the conclusion on the impact on *Intermediation* rests on a cross-country regression and is therefore merely suggestive. Taking this analysis one step further one is tempted to use the results from King and Levine (1993a) (see specifically their table IX on p.733) which suggest that a 0.3 percent change in *Intermediation*[19] will increase the average growth rate of the economy in the subsequent decade by less than 0.01 percent. Thus the implied effects of changes in inequality on real GDP growth are quantitatively small. If these results are to be taken at face value, changing inequality would therefore not seem to be the policy variable one should focus on if one wishes to increase real GDP growth in an economy.

[19] Our variable *Intermediation* is equivalent to King and Levine's *Privy1*. According to King and Levine table IX a change in *Privy1* by 1 percent will increase the average annual growth rate of the economy in the subsequent decade by 0.037 percent.

Table 4.3 Intermediation and Inequality.

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.111768	0.059917	-1.865369	0.0705
Agriculture	-0.442560	0.264718	-1.671815	0.1035
Civ	0.000675	0.033478	0.020168	0.9840
Govt	0.000543	0.002548	0.212990	0.8326
Income	-3.70E-05	4.88E-05	-0.759190	0.4528
IncomeInequality	1.33E-05	5.89E-06	2.256279	0.0304
$Income^2$	1.49E-08	7.44E-09	1.998278	0.0535
$Income^2$Inequality	-2.99E-09	1.43E-09	-2.094445	0.0435
Inequality	-0.007033	0.005479	-1.283686	0.2077
Latin	-0.122272	0.064822	-1.886292	0.0676
Open	0.001266	0.000858	1.475728	0.1490
Pol	0.025964	0.022937	1.131973	0.2653
Popden	2.36E-05	7.49E-05	0.315472	0.7543
Rev	0.074272	0.093013	0.798513	0.4300
C	0.208794	0.160509	1.300824	0.2018
R-squared	0.669804	Mean dependent var	0.282949	
Adjusted R-squared	0.537726	S.D. dependent var	0.192654	
S.E. of regression	0.130987	Akaike info criterion	-3.821992	
Sum squared resid	0.600514	Schwarz criterion	-3.248385	
Log likelihood	39.60286	F-statistic	5.071266	
Durbin-Watson stat	1.660729	Prob(F-statistic)	0.000047	

Of the interaction terms neither *Inequality* nor *Income* per se have significant coefficients while this is the case for $Income^2$. This suggest that there is a non-linear relationship between *Intermediation* and *Income*. Of the controls only *Agriculture* and the two regional dummies *Latin* and *Africa* are significant at the 10-percent level. *Agriculture* has a negative coefficient which indicates a negative relationship between the share of agriculture in the economy and the degree of intermediation. This seems sensible as one would expect agricultural economies to have a less developed infrastructure overall than an economy with large industrial and service sectors. *Open*, though only significant at the 85 percent level, has a positive coefficient which is in accordance with what we expect given our model. A more open economy is likely to have a higher interest elasticity of savings supply; the s-curve in figure 4.1 is therefore flatter and when loan demand goes up, equilibrium intermediation goes up more than in a closed economy. The negative coefficients on the two regional dummies suggest that countries located in Latin America or Sub Saharan Africa have smaller financial sectors than other countries. This result is in line with other studies which also find negative effects from a location in these two areas.

Govt, *Civ* and *Pol* also have positive coefficients but neither are significant. *Rev* surprisingly has a positive coefficient, even though one would expect agents in politically unstable countries to save outside the formal financial sector which is an easy target for a dictator in need of funding. However the coefficient is not significant so we should not pay too much attention to this result. The structural control *Popden* is also non significant. There are no obvious outliers as can be seen in figure 4.9 which plots the regression residuals. In table 4.4 we report the result of regression (14) after dropping the insignificant controls. This does not change the previous results significantly, the relationship between *Inequality* and *Intermediation* now takes on positive values at a per capita GDP between US$ 548 and 4418 with a peak at 2483. For these coefficient estimates the Wald test shows that z_1 is greater than zero with probability 0.85, and (z_1, z_2) are different from each other with probability 0.98.

Figure 4.9 Residuals From Inequality Regression (Table 4.3)

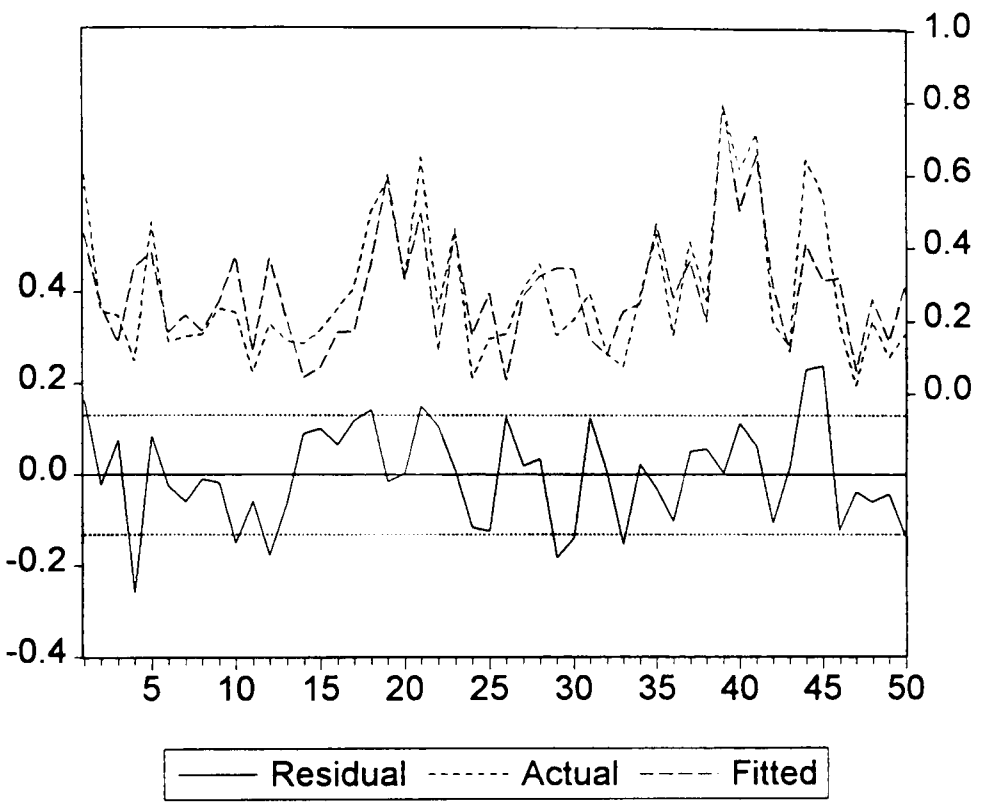


Table 4.4 Intermediation and Inequality (excluding some controls).

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.125966	0.053690	-2.346158	0.0240
Agriculture	-0.223693	0.215414	-1.038435	0.3053
Income	-5.65E-05	4.43E-05	-1.274992	0.2097
IncomeInequality	1.44E-05	5.36E-06	2.681182	0.0106
$Income^2$	1.53E-08	6.84E-09	2.241482	0.0306
$Income^2$Inequality	-2.90E-09	1.27E-09	-2.290338	0.0274
Inequality	-0.007017	0.005200	-1.349295	0.1848
Latin	-0.162801	0.055526	-2.931984	0.0055
Open	0.001605	0.000564	2.844221	0.0070
C	0.287522	0.097120	2.960477	0.0051
R-squared	0.637612	Mean dependent var	0.282949	
Adjusted R-squared	0.556075	S.D. dependent var	0.192654	
S.E. of regression	0.128361	Akaike info criterion	-3.928963	
Sum squared resid	0.659060	Schwarz criterion	-3.546558	
Log likelihood	37.27715	F-statistic	7.819895	
Durbin-Watson stat	1.816469	Prob(F-statistic)	0.000002	

We also tried running regression (14) substituting the *Inequality* variable with *Poverty*. The regression coefficients are reported in table 4.5. The results are very different from the regression using *Inequality*: even though the roots are estimated to be located at US$ 433 and 4393 and thus are similar to the previous findings, the sign of the coefficient on $Income^2Poverty$ is positive implying that the estimated polynomial has a U-shape rather than an inverted U-shape. The sign switches are therefore the opposite of what was the case for the *Inequality* regression. Increases in *Poverty* increases the amount of *Intermediation* for poor countries with GDP per capita below US$ 433 and for rich countries with GDP per capita above US$ 4393. For countries with per capita income between these two values increased *Poverty* reduces *Intermediation*. z_1 is greater than zero with probability 0.5, and (z_1, z_2) are different from each other with probability 0.77. The signs and significance of the controls are very similar to the earlier results using *Inequality*. However *Poverty* is only significant at the 40 percent level making the conclusions here weaker than when using the *Inequality* variable. Figure 4.10 plots the residuals from this regression, again there are no obvious outliers.

Table 4.6 reports the *Poverty* regression excluding insignificant controls. In this regression the *Poverty-Intermediation* relationship is negative for income levels between US$ 509 and 4567. In this regression z_1 is greater than zero with probability 0.6 and (z_1, z_2) are different from each other with probability 0.77.

The sign switches found using the *Poverty* are completely contrary to the predictions of our theoretical model. However the hypothesis we derived in the theoretical section is based on changes both at the top and at the bottom of the income distribution, this is captured better by our *Inequality* variable than by our *Poverty* variable, which only contains information about income of the bottom quintile.

Table 4.5 Intermediation and Poverty.

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.117769	0.065176	-1.806931	0.0794
Agriculture	-0.454761	0.269512	-1.687351	0.1004
Civ	-0.003190	0.033866	-0.094191	0.9255
Govt	0.001139	0.002538	0.448960	0.6562
Income	0.000251	0.000133	1.882797	0.0681
$Income^2$	-4.45E-08	1.98E-08	-2.253734	0.0306
IncomePoverty	-0.002698	0.001838	-1.467538	0.1512
$Income^2$Poverty	5.59E-07	2.60E-07	2.147786	0.0387
Latin	-0.120947	0.072284	-1.673223	0.1032
Open	0.001137	0.000863	1.317403	0.1963
Pol	0.030787	0.023084	1.333675	0.1909
Popden	3.38E-05	7.12E-05	0.475201	0.6376
Poverty	1.065360	1.861116	0.572431	0.5707
Rev	0.081135	0.093347	0.869174	0.3907
C	0.068312	0.234200	0.291684	0.7723
R-squared	0.672753	Mean dependent var	0.282949	
Adjusted R-squared	0.541854	S.D. dependent var	0.192654	
S.E. of regression	0.130401	Akaike info criterion	-3.830962	
Sum squared resid	0.595152	Schwarz criterion	-3.257355	
Log likelihood	39.82712	F-statistic	5.139487	
Durbin-Watson stat	1.712743	Prob(F-statistic)	0.000041	

Figure 4.10 Residuals From Poverty Regression (Table 4.5)

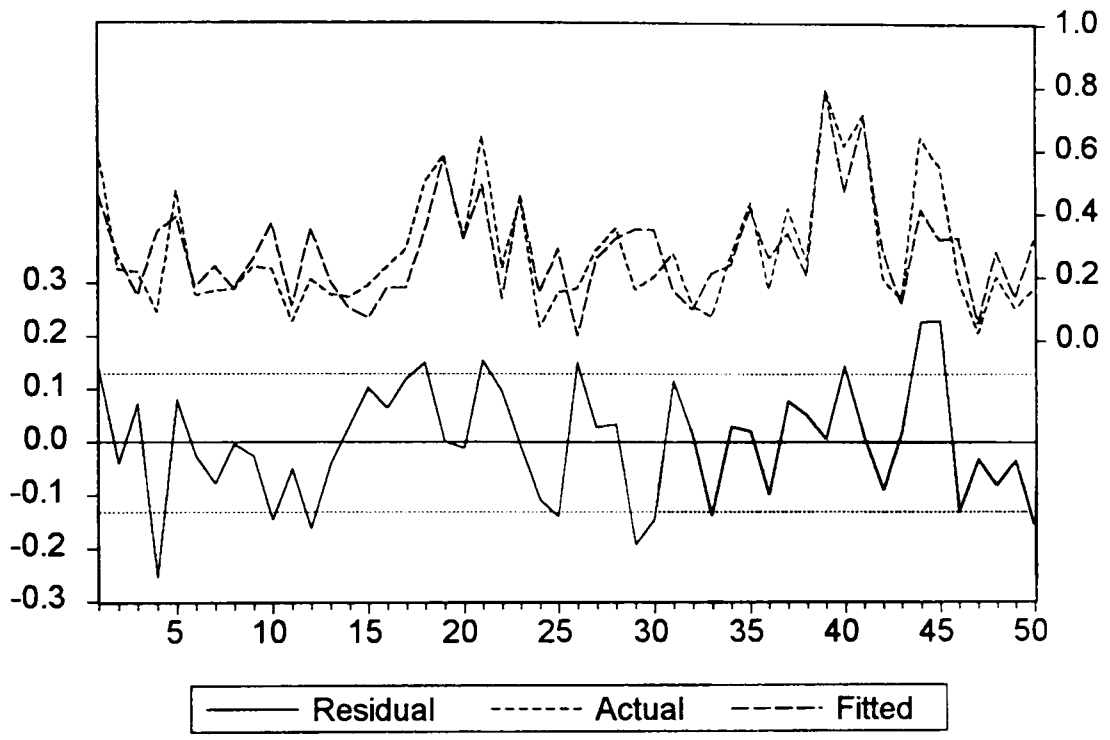


Table 4.6 Intermediation and Poverty (excluding some controls).

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.124087	0.058865	-2.107988	0.0415
Agriculture	-0.402287	0.241940	-1.662756	0.1044
Income	0.000243	0.000116	2.090351	0.0432
$Income^2$	-4.14E-08	1.77E-08	-2.331044	0.0250
IncomePoverty	-0.002660	0.001653	-1.609317	0.1156
$Income^2$Poverty	5.24E-07	2.36E-07	2.217275	0.0325
Latin	-0.120023	0.066793	-1.796952	0.0801
Open	0.001333	0.000544	2.451486	0.0188
Pol	0.027543	0.013901	1.981422	0.0546
Poverty	1.218290	1.640385	0.742686	0.4621
C	0.087741	0.151982	0.577310	0.5670
R-squared	0.661369	Mean dependent var	0.282949	
Adjusted R-squared	0.574540	S.D. dependent var	0.192654	
S.E. of regression	0.125663	Akaike info criterion	-3.956766	
Sum squared resid	0.615855	Schwarz criterion	-3.536121	
Log likelihood	38.97223	F-statistic	7.616958	
Durbin-Watson stat	1.744376	Prob(F-statistic)	0.000001	

As mentioned earlier the Deininger and Squire data set contains observations using different data definitions of income levels; some observations are income based and some are expenditure based. Some observations are of household units some are of individuals. To control for the income/expenditure difference we split the sample into two sub-samples; one contains the income based observations and one contains the expenditure based observations. We then run regression (16) estimating (z_1, z_2) separately in the two sub-samples. Next we control for the difference between household based and individual based observations in the same way in regression (17).

$$
\begin{aligned}
&Intermediation = \beta_0 \\
&+\beta_1 D_1 Income + \beta_2 D_1 Income \times Inequality + \beta_3 D_1 Income^2 \times Inequality \\
(16)\quad &+\beta_4 D_1 Inequality + \beta_5 D_1 Income^2 \\
&+\beta_6 D_2 Income + \beta_7 D_2 Income \times Inequality + \beta_8 D_2 Income^2 \times Inequality \\
&+\beta_9 D_2 Inequality + \beta_{10} D_2 Income^2 + Controls
\end{aligned}
$$

$$
\begin{aligned}
&Intermediation = \beta_0 \\
&+\beta_1 D_3 Income + \beta_2 D_3 Income \times Inequality + \beta_3 D_3 Income^2 \times Inequality \\
(17)\quad &+\beta_4 D_3 Inequality + \beta_5 D_3 Income^2 \\
&+\beta_6 D_4 Income + \beta_7 D_4 Income \times Inequality + \beta_8 D_4 Income^2 \times Inequality \\
&+\beta_9 D_4 Inequality + \beta_{10} D_4 Income^2 + Controls
\end{aligned}
$$

In regression (16) we pay attention to the fact that some countries (17 countries) in our sample use income based measures while others (33 countries) use expenditure based measures. We allow the sign switch point to be estimated separately for these different definitions by introducing two dummy variables. D_1 takes the value 1 when the data is income based and zero otherwise. D_2 takes the

value 1 when data is expenditure based and zero otherwise. The sign switch points for the income based data are

$$(18)\quad (z_1, z_2) = \frac{-\beta_2 \pm \sqrt{(\beta_2)^2 - 4\beta_3\beta_4}}{2\beta_3}$$

and for the expenditure based data the switch points are

$$(19)\quad (z_1, z_2) = \frac{-\beta_7 \pm \sqrt{(\beta_7)^2 - 4\beta_8\beta_9}}{2\beta_8}$$

Table 4.7 reports the regression coefficients for regression (16). While both types of data definitions still estimate a positive sign switch point, the point varies significantly. For the expenditure measure the sign is positive for income levels between US$ -3006 and 327 while it is positive for levels between US$ 152 and 6496 for the income based measure. For the expenditure based observations z_1 is different from zero with probability 0.63 and (z_1, z_2) different from each other with probability 0.66. For the income based observations z_1 is different from zero with probability 0.1 and (z_1, z_2) are different from each other with probability 0.69. The z_1 estimated from expenditure based data is more significant than the z_1 estimated from income based data. This is not too surprising given that the share of expenditure based observations in the sample is largest (33 against income based data 17). The two z_1's estimated using the two sub-samples are different from each

Table 4.7 Intermediation and Inequality (Income and Expenditure Data)

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.129996	0.062589	-2.076964	0.0465
Agriculture	-0.375299	0.277041	-1.354671	0.1856
Civ	-0.016372	0.032658	-0.501310	0.6198
D_2Income	0.000265	0.000136	1.956748	0.0597
D_2IncomeInequality	-1.38E-05	1.66E-05	-0.832392	0.4118
$D_2Income^2$	5.41E-09	1.32E-08	0.410800	0.6841
$D_2Income^2$Inequality	-5.15E-09	2.74E-09	-1.881044	0.0697
D_2Inequality	0.005054	0.007378	0.685080	0.4986
Govt	0.000322	0.002662	0.120864	0.9046
D_1Income	-4.78E-06	5.76E-05	-0.082857	0.9345
D_1IncomeInequality	8.11E-06	9.71E-06	0.835613	0.4100
$D_1Income^2$	5.42E-09	1.16E-08	0.466438	0.6443
$D_1Income^2$Inequality	-1.22E-09	2.43E-09	-0.501467	0.6197
D_1Inequality	-0.001204	0.009148	-0.131646	0.8961
Latin	-0.130277	0.063053	-2.066146	0.0475
Open	0.001200	0.000819	1.465506	0.1532
Pol	0.020604	0.022699	0.907699	0.3713
Popden	-1.12E-05	8.02E-05	-0.140110	0.8895
Rev	0.094094	0.088715	1.060630	0.2973
C	0.181658	0.164822	1.102145	0.2792
R-squared	0.747809	Mean dependent var	0.282949	
Adjusted R-squared	0.588087	S.D. dependent var	0.192654	
S.E. of regression	0.123646	Akaike info criterion	-3.891489	
Sum squared resid	0.458651	Schwarz criterion	-3.126680	
Log likelihood	46.34030	F-statistic	4.681961	
Durbin-Watson stat	1.437849	Prob(F-statistic)	0.000088	

Table 4.8 Intermediation and Inequality (Household and Individual Data)

	OLS Regression: Dependent Variable is Intermediation			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Africa	-0.147815	0.065471	-2.257697	0.0314
Agriculture	-0.374445	0.301189	-1.243225	0.2234
Civ	-0.009769	0.036562	-0.267184	0.7912
Govt	0.000745	0.002633	0.282912	0.7792
D_3IncomeInequality	2.04E-05	1.12E-05	1.815683	0.0794
D_3Income	-7.83E-05	6.36E-05	-1.231575	0.2277
$D_3Income^2$	2.09E-08	8.75E-09	2.388728	0.0234
$D_3Income^2$Inequality	-3.92E-09	2.26E-09	-1.735104	0.0930
D_3Inequality	-0.011551	0.016039	-0.720176	0.4770
Latin	-0.132549	0.079934	-1.658240	0.1077
Open	0.001346	0.000885	1.521901	0.1385
D_4IncomeInequality	6.82E-06	1.81E-05	0.376563	0.7091
D_4Income	4.39E-05	0.000119	0.368497	0.7151
$D_4Income^2$	9.21E-09	3.46E-08	0.265983	0.7921
$D_4Income^2$Inequality	-2.63E-09	6.64E-09	-0.396313	0.6947
D_4Inequality	-0.002320	0.008841	-0.262447	0.7948
Pol	0.027505	0.025936	1.060492	0.2974
Popden	3.04E-05	9.69E-05	0.313367	0.7562
Rev	0.082552	0.099794	0.827225	0.4146
C	0.185086	0.182280	1.015396	0.3180
R-squared	0.706298	Mean dependent var	0.282949	
Adjusted R-squared	0.520287	S.D. dependent var	0.192654	
S.E. of regression	0.133435	Akaike info criterion	-3.739111	
Sum squared resid	0.534145	Schwarz criterion	-2.974302	
Log likelihood	42.53086	F-statistic	3.797069	
Durbin-Watson stat	1.657451	Prob(F-statistic)	0.000556	

other with probability 0.62. The results highlight the fact that the exact location of the income interval where the effect is positive is sensitive to data definitions used in the regression.

Similarly regression (17) checks for the importance of differences between Household based data (11 countries) and Individually based (39 countries). D_3 takes the value 1 when the data is based on household units and zero otherwise. D_4 takes the value 1 when data is based on individual units and zero otherwise. Table 4.8 reports the coefficients of regression (17). The positive intervals lies between income levels of US$ 646 and 4557 for household based data, while the interval is between US$ 403 and 2190 for individually based data. The z_1 estimated using household data is different from zero with probability 0.57 and (z_1, z_2) are different from each other with probability 0.96. For the individual based sub-sample z_1 is different from zero with probability 0.21 and (z_1, z_2) are different from each other with probability 0.28. The two z_1's estimated using the two sub-samples are different from each other with probability 0.15. These findings again support the conclusion that the non-linear relationship between measures of inequality in the economy and the volume of intermediation exists and is conditional on the level of per capita GDP. However the data suggests that there are two sign switches; one at very low per capita income levels (around US$ 500) from negative to positive and one (around US$ 4000) from positive to negative. The negative effect at very low income levels is contrary to the predictions of our model. Also the exact location of the income interval where the effect of inequality is positive varies across different data definitions.

4.4 Conclusion

We set out to investigate the link between inequality and financial development. Our investigation is based on a simple model linking these two variables. The model relies on moral hazard in cutting off poorer agents from intermediation. This is the same mechanism as is used other recent theoretical

models like Piketty(1997) and Aghion and Bolton (1997). We exogenously change the degree of inequality by looking at a mean preserving spread to the wealth distribution of entrepreneurs. The experiment suggests that one should expect to find increased intermediation in poor economies as inequality is increased. In rich economies one should expect to find that increased inequality reduces the amount of intermediation. This difference arises because there are two effects on intermediation of a mean preserving spread: first it increases the average wealth of the entrepreneurs in the intermediated sector, which given the size of the optimal investment project reduces the amount of borrowing in the economy. Second it changes the number of people in the intermediated sector. In the poor economy it increases the number of agents with access to intermediation, in the rich economy it reduces this number.

In the poor economy the average effect and the numbers effect work in opposite directions. Thus, if the numbers effect dominates the average effect, which we assume it does, inequality increases intermediation. In the rich economy both effects of a mean preserving spread work in the same direction: there will be fewer agents with access to intermediation, and they will on average be richer. For a given size of investment project in the economy, this reduces the amount of borrowing. Thus increased inequality will unambiguously reduce intermediation in a rich economy.

Next we go on to test the hypothesis that the relationship between inequality and intermediation is conditional on the level of national income in a non-linear way as described above. We use data from a new World Bank data base covering a cross-section of countries. The data set is the best available but there are still definitional problems reducing the cross-country compatibility of the inequality indicator. With this qualification in mind we find the predictions of the theoretical model to be only partially borne out by the data. The analysis shows that increased inequality increases intermediation in poor economies with income levels between US$ 500 and US$ 4000. For income levels above US$ 4000 increased inequality reduces intermediation as is predicted by our model. However in very poor

economies (with GDP per capita below US$ 500) increased inequality reduces intermediation. This is contrary to the predictions of our model. The exact location of these switching points vary across different data definitions. However for both the full sample regressions that use the *Inequality* variable the estimated roots (z_0 around 500, z_1 around 4000) are significant. The specific location of the interval is sensitive to the data definitions used as regression (16) and (17), using sub-samples with more homogeneous observations, show. Thus the numbers above are merely suggestive. The regressions run using the *Poverty* variable instead of *Inequality* find similar roots. However the polynomial estimated has a U-shape rather than an inverted U-shape as is the case for all the inequality regressions and indeed is suggested by the theoretical model. Therefore the sign switches found using the *Poverty* variable are the opposite of the ones described above. *Poverty* however only contains information about the bottom quintile of the income distribution and is thus a poorer instrument than *Inequality* for capturing the effects of a mean preserving spread. Therefore the *Poverty* findings do not falsify the theoretical model given the findings of the *Inequality* regressions.

In the endogenous growth literature the models predict that increased intermediation increases the real growth rate of the economy. This is the second part of the channel from inequality to growth which we do not investigate in this paper. However we can rely on King and Levine's (1993a) findings to get a grip on the overall effect of inequality on real growth. When we do so, we find that the real effect of increased inequality are very small for a model transmitting the effect through the financial sector, so perhaps Lucas(1988) was right when he suggested that financial variables had been overemphasised in the growth literature.

All in all we find support for the existence of the first part of the financial transmissions mechanism linking inequality and growth, namely the inequality intermediation link. But the sign effects derived from the data are only partially consistent with the predictions of our theoretical model. Furthermore the scale of the effects is very small suggesting that one should look for other channels linking inequality and real growth before giving policy prescriptions on this issue.

Table 4.9 Data set

			Income	Intermediation	Inequality	Poverty	Popden	Agriculture
1	Algeria	1988	2279.68	0.60	6.85	0.0680	9.937	0.11
2	Banglades	1989	191.91	0.22	4.06	0.0950	737.042	0.37
3	Bolivia	1990	657.78	0.22	8.58	0.0562	6.032	0.32
4	Botswana	1986	1139.95	0.09	16.36	0.0360	1.915	0.05
5	Chile	1989	2174.63	0.47	17.03	0.0370	17.082	0.08
6	Colombia	1988	1296.70	0.14	15.11	0.0370	27.952	0.17
7	Costa Rica	1989	1789.60	0.16	12.68	0.0400	57.768	0.17
8	DOM	1989	953.86	0.16	13.26	0.0420	142.760	0.18
9	Ecuador	1994	1480.02	0.23	9.82	0.0536	37.828	0.12
10	Egypt	1991	657.20	0.22	4.72	0.0871	54.187	0.17
11	Ghana	1989	360.26	0.06	6.33	0.0697	61.021	0.49
12	Greece	1988	6407.59	0.19	6.65	0.0619	76.636	0.14
13	Guatemala	1989	940.76	0.14	30.00	0.0210	82.062	0.26
14	Guinea Bissau	1991	238.46	0.14	28.57	0.0206	27.266	0.44
15	Guyana	1993	568.94	0.17	7.48	0.0627	3.774	0.35
16	Honduras	1992	630.90	0.23	14.67	0.0384	46.171	0.17
17	India	1989	346.81	0.29	4.36	0.0910	251.788	0.28
18	Indonesia	1990	590.23	0.50	4.56	0.0920	93.509	0.21
19	Israel	1992	12636.80	0.58	5.25	0.0763	238.641	0.02
20	Jamaica	1989	1700.98	0.31	9.61	0.0510	216.105	0.07
21	Jordan	1991	944.45	0.64	7.37	0.0647	41.071	0.07
22	Kenya	1992	309.36	0.23	18.24	0.0339	42.524	0.23
23	Korea, R.	1988	4330.45	0.45	5.72	0.0739	424.475	0.1
24	Laos	1992	263.68	0.04	4.21	0.0955	18.842	0.58
25	Lesotho	1987	228.35	0.15	20.90	0.0287	54.394	0.16
26	Madagascar	1993	243.38	0.16	8.52	0.0585	21.065	0.32
27	Mauritania	1988	503.88	0.29	13.12	0.0353	1.857	0.29
28	Mauritius	1991	2558.76	0.36	6.48	0.0670	529.707	0.1
29	Mexico	1989	2464.80	0.16	18.53	0.0320	42.198	0.08
30	Morocco	1991	1105.23	0.20	7.05	0.0657	55.649	0.2
31	Nicaragua	1993	462.24	0.28	13.12	0.0420	30.476	0.3
32	Niger	1992	299.22	0.11	5.90	0.0748	6.527	0.39
33	Nigeria	1992	311.21	0.07	7.32	0.0660	110.308	0.26
34	Pakistan	1988	355.89	0.27	4.69	0.0861	134.081	0.23
35	Panama	1989	2116.09	0.44	29.90	0.0200	31.116	0.12
36	Philippines	1988	645.19	0.16	10.10	0.0520	194.188	0.23
37	Portugal	1990	6805.47	0.42	7.44	0.0570	106.808	0.06
38	Senegal	1991	730.59	0.26	16.75	0.0350	37.245	0.2
39	Singapore	1988	9762.81	0.80	7.15	0.0652	4266.471	0.005
40	South Africa	1993	2960.64	0.61	32.11	0.0202	32.567	0.04
41	Spain	1989	9814.55	0.72	4.21	0.0839	77.481	0.05
42	Sri Lanka	1990	472.75	0.20	4.41	0.0892	262.536	0.23
43	Tanzania	1993	123.67	0.13	6.64	0.0685	28.739	0.49
44	Thailand	1990	1527.08	0.64	13.80	0.0400	107.621	0.13
45	Tunisia	1990	1525.88	0.55	7.91	0.0586	49.318	0.16
46	Turkey	1987	1651.66	0.19	9.53	0.0524	67.447	0.17
47	Uganda	1989	303.95	0.03	4.92	0.0852	69.303	0.54
48	Venezuela	1989	2269.94	0.20	10.29	0.0480	20.837	0.06
49	Zambia	1991	403.50	0.10	8.92	0.0557	11.155	0.16
50	Zimbabwe	1990	660.52	0.16	15.66	0.0398	25.342	0.14

Table 4.9 (cont.)

			pol	civ	Rev	Africa	Latin	govt	Open
1	Algeria	1988	6	6	0.10000	0.0000	0.0000	25.8	38.43
2	Bangladesh	1989	4	4	0.62000	0.0000	0.0000	42.1	25.83
3	Bolivia	1990	2	3	1.1500	0.0000	1.0000	19.3	46.87
4	Botswana	1986	2	3	0.0000	1.0000	0.0000	40.1	119.05
5	Chile	1989	4	3	0.19000	0.0000	1.0000	16.1	65.78
6	Colombia	1988	2	3	0.04000	0.0000	1.0000	11	30.15
7	Costa Rica	1989	1	1	0.0000	0.0000	1.0000	19.2	73.49
8	DOM	1989	1	3	0.36000	0.0000	1.0000	9.3	67.28
9	Ecuador	1994	2	3	0.57000	0.0000	1.0000	14.1	58.9
10	Egypt	1991	5	5	0.16000	0.0000	0.0000	31.1	74.22
11	Ghana	1989	6	5	0.53000	1.0000	0.0000	20.8	41.48
12	Greece	1988	2	2	0.19000	0.0000	0.0000	13.9	54.36
13	Guatemala	1989	3	3	0.47000	0.0000	1.0000	11.4	39.78
14	Guinea Bissau	1991	6	5	0.19000	1.0000	0.0000	26.8	61.77
15	Guyana	1993	3	3	0.0000	0.0000	1.0000	25.9	52.52
16	Honduras	1992	2	3	0.32000	0.0000	1.0000	14.4	65.49
17	India	1989	2	3	0.12000	0.0000	0.0000	30.1	18.04
18	Indonesia	1990	6	5	0.27000	0.0000	0.0000	14.6	52.61
19	Israel	1992	2	2	0.0000	0.0000	0.0000	24.7	64.41
20	Jamaica	1989	2	2	0.0000	0.0000	1.0000	13.4	113.58
21	Jordan	1991	4	4	0.15000	0.0000	0.0000	28.4	144.21
22	Kenya	1992	4	5	0.05000	1.0000	0.0000	24	55.22
23	Korea, R.	1988	2	3	0.40000	0.0000	0.0000	8.3	71.64
24	Laos	1992	7	6	0.00000	0.0000	0.0000	10.7	31.7
25	Lesotho	1987	5	6	0.05000	1.0000	0.0000	30.2	148.06
26	Madagascar	1993	2	4	0.08000	1.0000	0.0000	18.5	41.84
27	Mauritania	1988	6	6	0.19000	1.0000	0.0000	16.1	114.08
28	Mauritius	1991	1	2	0.0000	1.0000	0.0000	14.8	133.96
29	Mexico	1989	4	3	0.0000	0.0000	1.0000	9.3	32.15
30	Morocco	1991	5	5	0.08000	0.0000	0.0000	22.4	49.93
31	Nicaragua	1993	4	5	0.23000	0.0000	1.0000	34	68.59
32	Niger	1992	5	4	0.16000	1.0000	0.0000	26.5	40.49
33	Nigeria	1992	5	5	0.55000	1.0000	0.0000	14.4	73.74
34	Pakistan	1988	3	3	0.32000	0.0000	0.0000	19.2	36.05
35	Panama	1989	4	3	0.16000	0.0000	1.0000	29.8	63.8
36	Philippines	1988	2	3	0.46000	0.0000	0.0000	15.1	55.04
37	Portugal	1990	1	2	0.27000	0.0000	0.0000	22	75.2
38	Senegal	1991	4	3	0.04000	1.0000	0.0000	23.1	54.17
39	Singapore	1988	4	5	0.0000	0.0000	0.0000	8.4	378.75
40	South Africa	1993	5	4	0.04000	1.0000	0.0000	25.5	43.83
41	Spain	1989	1	1	0.08000	0.0000	0.0000	12.1	39.45
42	Sri Lanka	1990	4	5	0.08000	0.0000	0.0000	18.5	67.37
43	Tanzania	1993	6	5	0.21000	1.0000	0.0000	40.4	62.93
44	Thailand	1990	2	3	0.48000	0.0000	0.0000	13.9	75.83
45	Tunisia	1990	5	4	0.0000	1.0000	0.0000	18.6	89.33
46	Turkey	1987	2	4	0.32000	0.0000	0.0000	11.2	42.74
47	Uganda	1989	6	4	0.52000	1.0000	0.0000	15	18.42
48	Venezuela	1989	1	3	0.31000	0.0000	1.0000	16	55.21
49	Zambia	1991	2	3	0.05000	1.0000	0.0000	31.5	59.47
50	Zimbabwe	1990	6	4	0.32000	1.0000	0.0000	34.9	59

Chapter 5

Search in Financial Markets[1]

This paper uses a random matching framework to study an economy without intermediaries in the financial market. Investors search for investment projects that are held by entrepreneurs. Projects have different returns and a reservation return rule is derived. An endogenous growth setting is used to describe the effect the absence of the intermediary has on the economy's growth rate.

[1] Charlie Bean supervised my work on this paper and provided invaluable advice. I thank Peter Boone for valuable comments.

5.1 Introduction

In this paper we set out to describe an economy without intermediation and analyse what the consequences are of the absence of this institution. This type of analysis is relevant for some emerging economies that to a large extent rely on (foreign) venture capital to finance the restructuring of the economy, and for the general analysis of economies where a financial sector has not yet been developed. It also captures the situation where disintermediation takes place by choice and agents meet directly in the market place rather than through intermediaries as is increasingly the case in the market for large scale corporate loans.

An intermediary can be viewed as a trading post for investment projects where potential investors with placement needs meet potential entrepreneurs with financing needs[2]. One way of studying the importance of such an institution is to compare the situation where it exists with the situation where it is absent. This approach is the most primitive way of studying the importance of institutions since one does not address the question of how the institution emerges; all institutional features are exogenously imposed by the economist. This simplistic comparative statics approach however has the advantage of helping one to address interesting questions relatively easily compared to literature where financial institutions are derived endogenously[3]. When analysing intermediation the obvious institutional alternative is autarchy where agents' consumption is entirely determined by their endowment stream[4]. However this pure Robinson Crusoe set up is not the only viable alternative to the situation where the institution exists. Diamond (1982) suggests that one uses the random matching framework as the benchmark. In this set up agents do not passively accept their fates as Robinson Crusoes but set out to look for counterparties. In the case of financial markets these agents could be investors and entrepreneurs looking for suitable matches. The entrepreneur would

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[2] See Gertler (1988) for a survey of the models of intermediaries that have been most influential recently.

[3] Townsend who is a proponent of the endogeneity approach uses this more simplistic approach as a first step to getting a handle on the importance of intermediation for growth (see Townsend(1983)).

[4] Alvarez and Jermann(1996), Kehoe and Levine(1996) and Kocherlakota(1995) are all examples where autarchy is the alternative to intermediation.

be looking for an investor to finance a project, and the investor would be looking for a good project to place his savings in[5]. In this paper we use this search and matching approach as our benchmark. To describe the situation without intermediation, we adapt the random matching model known from labour economics as was first described by Jovanovic (1979) and in particular the reservation rule set up derived for example in Sargent (1987). We embed the analysis in a standard endogenous growth set up taken from Romer(1986). In this setting we contrast the outcome of the search economy with the outcome in an economy with intermediation between investors and entrepreneurs.

Search models have been used in several other fields of economics. Stigler (1961) and McCall(1970) are among the first papers in the literature. Diamond (1982) studies aggregate issues, while Kiyotaki and Wright(1989) applies the set up to the study of monetary theory[6]. The search framework has also been used previously to describe financial markets. Bester(1995) uses the set up to describe the emergence of intermediators. He assumes that an intermediary can commit ex ante to handing over a certain return to an investor. This helps the intermediary extract a larger fraction of the surplus in a bargaining situation with the entrepreneur than the investor could himself in direct bargaining. On the other hand the investor cannot monitor the search behaviour of the intermediary[7], therefore he might choose to search for an entrepreneur himself to avoid ending up in the situation where the intermediary accepts excessively risky projects.

In our set up there are two types of agents, investors and entrepreneurs. Entrepreneurs are agents endowed with a technology that can transform the endowment the investor invests today into consumable output in the future. The entrepreneurs have only a passive role in the market for investment funds; they accept funding from any investor. This seems a reasonable assumption given that all

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[5] Autarchy might still be the equilibrium outcome of a search process. This would happen if e.g. the information structure was such that moral hazard problems would rule out a viable financial contract between the matched agents.

[6] See Wallace (1997) for a survey of search models of money.

[7] This problem is related to the criticism facing Diamond's(1984) model of intermediation as a set up which exploits economies of scale in monitoring. The question asked in response to Diamond's model is, who monitors the monitor ?

investors are identical. We also assume that entrepreneurs consume all returns from production and hence face no intertemporal allocation decisions. This allows us to focus on the actions of the investor in the analysis.

Investors have an initial endowment of the consumption good. They face a decision on how much to invest over time and how much to consume, that is they are choosing optimal savings and consumption plans over an infinite horizon. The return from investing is the key variable affecting this decision. We describe two settings with different returns, the search economy and the intermediated economy, and determine the equilibrium paths of consumption and savings in both. The institutional analysis in this simple setting boils down to a comparison of these two sets of paths for the variables of the economy.

In the search economy the investor is paired randomly with an entrepreneur at a given rate. If the investor decides to accept the match with a given entrepreneur, production begins. The production process yields a flow of output that is divided among the investor and the entrepreneur at a predetermined rate. Production continues until the project is hit by an adverse shock; these shocks hit projects at a given rate.

Investors that have their endowment tied up in production cannot simultaneously engage in search, thus there are two separate states an investor can be in: search or production. Entrepreneurs differ in the productivity of their technology. Each investor knows the distribution of returns of the technologies in the economy. When an investor meets an entrepreneur he is informed of the return that the project can yield. He then has to decide whether to accept that technology and thus engage in production, or to continue searching for an entrepreneur with a better technology. When making this decision the investor also knows the distribution of returns of the entire population of investment projects.

In the intermediated economy the investor faces the same distribution of entrepreneurial projects. Intermediation is simply modelled as a pooling of resources

by all investors who then fund entrepreneurs. We abstract from transactions costs in this set up and thus the return to a given investor is just the expected return of the entire set of entrepreneurial projects minus the share to the entrepreneur which is assumed to be identical to the share he receives in the search economy.

We now describe the search economy and the intermediated economy to derive the expected returns faced by an investor. We then use these returns to describe the optimal consumption and savings paths for the investors in the economy.

5.2 The Search Economy[8]

We describe the outcome in the search economy given the investor has decided to invest $k^{\#}$. The entrepreneurs all have a production function $y = f(k, K, l)$ where k is the investment by the investor the entrepreneur is paired with, K is the sum of total investment in the economy and l is the amount of labour supplied by the entrepreneur. We assume that the entrepreneur has one unit of labour which is inelastically supplied. The output of the production function is to be interpreted as an instantaneous flow return per unit of time. Because we only describe the steady state in the search economy we can suppress the time subscripts. Match-specific heterogeneity is introduced by assuming that once a match occurs, a productivity parameter α is drawn randomly from a probability distribution $G(\alpha)$. Thus a project with productivity α_j has a flow return of $y = \alpha_j f(k, K, l)$. The investor's decision of whether to engage in a given project with return α_j can be described by a reservation return rule. The investor will have a reservation return α_r; if $\alpha_j \geq \alpha_r$ the investor will accept the project, if not he will reject it and continue searching for another project. It is crucial for the description of the search economy how the relative values of searching and producing affects the reservation return of an investor.

[8] The derivation of the basic model follows Pissarides (1990).

There is an equal number of investors and entrepreneurs in the economy, each represented by a continuum of size 1. When searching investors meet entrepreneurs in random pairwise matches. These matches are described by a Poisson process with a given arrival rate[9] $\gamma > 0$. In adopting a fixed arrival rate we are abstracting from the existence of a search externality since the arrival rate is not a function of the number of agents searching. An investor with a reservation return α_{ri} will move from search to production according to a Poisson process with transition rate

$$(1) \quad p_i = \gamma \left[1 - G(\alpha_{ri})\right]$$

Where $\left[1 - G(\alpha_{ri})\right]$ is the fraction of the investment projects with returns above the agents' reservation return.

Call the searching state for the investor V_1 and the producing state V_2. Let V_{1i} be the return to a representative investor i who is searching for an investment project, and V_{2j} the present discounted value from engaging in production given that the investment project has return α_j.

An investor who after meeting an entrepreneur discovers that the return of his project is α_j will only accept the match if

$$(2) \quad V_{2i} \geq V_{1i}$$

Because the return from production in a given match is increasing in the return of the investment project in that match, and the return from searching is independent of that specific return, since it depends only on the distribution of returns in the economy, a reservation productivity α_{ri} will exist, and satisfy

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[9] In the search literature it is sometimes assumed that the matching rate is described by a matching function which depends on the relative number of the two types of agents in the economy. We make the simplifying assumption that the arrival rate is constant and thus independent of the number of active searchers.

$$(3) \quad V_{2ri} = V_{1i}$$

All projects with a return $\alpha_j \geq \alpha_{ri}$ are accepted.

Let r be the discount rate in the economy. Then the value of being in the searching state for a representative investor i is equal to the discounted value of the probability of switching to the productive state p_i times the expected value of being in that state plus the probability of staying in the search state $1-p_i$ times the value of being in that state.

$$V_{1i} = \frac{1}{1+r}\left(p_i V_{2i}^e + (1-p_i)V_{1i}\right)$$

This can also be written

$$(4) \quad rV_{1i} = p_i(V_{2i}^e - V_{1i})$$

where V_{2i}^e is the expected value of being in the productive state for an investor who is currently searching. Since the investor knows that the return will be at least equal to his reservation return, V_{2i}^e can be defined as the expected value of V_{2j} conditional upon the return being higher than his reservation return, or

$$(5) \quad V_{2i}^e = E\left(V_{2j} \middle| V_{2j} \geq V_{2ri}\right)$$

Let s be the rate at which adverse shocks hit investment projects forcing investor and entrepreneur to separate, and ω be the share of the investment project return that accrues to the investor. The value of being in the productive state for an investor who has invested k^* and is engaged in a project with return α_j can then

be written as the present discounted value of the flow return from the investment project plus the probability of remaining in this state $(1-s)$ times the value of being in this state plus the probability of switching to the searching state (s) times the value of searching:

$$V_{2j} = \frac{1}{1+r}\left(\omega\alpha_j f(k^{\#},K,1) + sV_{1i} + (1-s)V_{2j}\right)$$

This can also be written

$$(6) \quad rV_{2j} = \omega\alpha_j f(k^{\#},K,1) + s\left(V_{1i} - V_{2j}\right)$$

Having described the value functions and the properties that the reservation rate of return must satisfy, we proceed in a partial equilibrium setting to solve for the reservation rate of return.

First use (6) to get

$$rV_{2ri} = \omega\alpha_{ri} f(k^{\#},K,1) + s\left(V_{1i} - V_{2ri}\right)$$

Then substitute from (3) to get

$$(7) \quad rV_{1i} = \omega\alpha_{ri} f(k^{\#},K,1) + s\left(V_{1i} - V_{1i}\right) = \omega\alpha_{ri} f(k^{\#},K,1)$$

Equation (7) says that any project that has a return equal to or higher than the permanent income from searching will be accepted. To express the reservation return in terms of purely exogenous variables, we take conditional expectations over equation (6) to get

$$rV_{2i}^{e} = \omega\alpha^{e} f(k^{\#},K,1) + s\left(V_{1i} - V_{2i}^{e}\right)$$

We solve this for V_{2i}^{e} and substitute into (4) to get

$$rV_{1i} = p_i\left(\frac{\omega\alpha^{e} f(k^{\#},K,1) + sV_{1i}}{r+s} - V_{1i}\right)$$

Then we use (7) to substitute out rV_{1i} to obtain the final expression for α_{ri}

$$(8) \quad \alpha_{ri} = p_i\left(\frac{\alpha^{e}}{r+s+p_i}\right)$$

In equilibrium all investors are the same, so they all have the same reservation rate of return

$$(9) \quad \alpha_{r} = p\left(\frac{\alpha^{e}}{r+s+p}\right)$$

Projects with a rate of return below α_r will not be carried out in this economy.

Steady state in the search economy is the situation in which, given the reservation returns of investors and the structural features of the search process, the flow of funds in and out of investment projects are equal so that the stock of invested funds is constant. If we call the fraction of funds engaged in production z, the steady state is characterised by,

$$zs = p(1-z)$$

or

$$(10) \quad z = \frac{p}{s+p}$$

Equations (1), (9) and (10) together with the distribution of project returns $G(\alpha)$ describe the equilibrium values of p, z α_r and $\alpha^e = E(\alpha|\alpha \geq \alpha_r)$ as a function of the exogenous variables γ, s and r.

The expected flow return $\varphi(k^{\#})$ to an investor investing $k^{\#}$ in the search process is

$$(11) \quad \varphi(k^{\#}) = z\omega\alpha^e f(k^{\#}, K, 1)$$

This is the investors share of the expected return from a project with an investment $k^{\#}$, rescaled by z. This rescaling reflects the fact that he will be searching some of the time and producing some of the time. In steady state a fraction z of the funds invested will be engaged in production.

5.3 The intermediated economy.

When describing the intermediating institution we should be careful not to make assumptions that clash with the assumptions made in the random matching framework since this would undermine the validity of the comparative static analysis.

If we view the intermediary as an institution where all investors place their endowments and all entrepreneurs receive their funding, then the equilibrium outcome in this economy will be one in which an investor who has invested $k^{\#}$ receives an expected flow return $\phi(k^{\#})$, where

$$(12) \quad \phi(k^{\#}) = \omega E(\alpha) f(k^{\#}, K, 1)$$

One can describe the main differences in returns on investment in the search economy and the intermediated economy by comparing equations (11) and (12). In the search economy the distribution of project returns above the reservation return

plays a role through $\alpha^e = E(\alpha|\alpha \geq \alpha_r)$ while in the intermediated economy the entire distribution of project returns plays a role through $E(\alpha)$. In the search economy only a fraction z of each unit invested is engaged in production while in the intermediated economy the entire unit engages in production. Finally, to ensure consistency across the institutional regimes we assume that the fraction of total returns that an investor receives is the same in the search economy and in the intermediated economy i.e. the ω in equation (12) is the same as the ω in equation (11).

We have now described the expected returns to an investor in the search economy (11) and in the intermediated economy (12). Variables that affect the nature of the search process such as the separation rate and the discount rate will affect the relative returns in these two investment regimes as will changes in the distribution of project returns. We now embed the two regimes in a simple general equilibrium framework which provides us with a set up in which we can compare the equilibrium outcomes in the two economies and show how these vary when the variables mentioned above are changed.

5.4 Equilibrium

We can now use equations (11) and (12) as the production functions facing investors respectively in the search economy and in the intermediated economy, and use these production functions to characterise the optimal investment and consumption paths in a standard endogenous growth set up. This solution is represented as two first-order differential equations which we derive below[10]. To simplify the analysis we adopt a specific functional form for $f(\cdot,\cdot,\cdot)$. We assume that,

$$(13) \quad f(k,K,l) = k^{\nu} K^{\theta} l^{\beta}$$

[10] This derivation follows Lucas(1988) pp.8-9.

Where $0<\nu<1$, $0<\theta<1$ and $0<\beta<1$. We study the special case from Romer(1986) where $\nu=1-\theta$ which is a situation with indefinite growth in equilibrium.

To simplify notation we will for now aggregate all potential productivity parameters in a single parameter A. We then conduct the analysis of the investment and consumption decisions of the investor in general terms and subsequently substitute in for the values of A in the search economy and the intermediated economy respectively.

We also adopt a specific utility function, namely $u(c(t))=\ln(c(t))$. This function is adopted because it gives the simplest solution in terms of notation thus allowing us to focus on the comparative statics. We describe the infinite horizon investment and consumption plans for a representative investor j with an initial endowment $k_j(0)$ of the consumption good of the economy. We study his optimisation problem given the information available at time zero. This is the simplest possible approach since it allows us to carry the analysis through entirely in expected value terms, which implies that we can use representative agent analysis both in the intermediated economy and in the search economy. The intermediated economy will always be a representative agent economy since all agents are in an identical situation at each point in time because they receive a share of the aggregate output each period. This is not the case in the search economy where individual agents will be in different situations at a given point in time depending on the history of productivies of the entrepreneurs they have been matched with up to that time. Only at time zero before they have entered the search process will the situation for all agents be the same and thus only at time zero can we justify the representative agent approach in the search economy. The time zero optimisation problem of a representative investor is,

$$(14)\quad \max_{\{c_j,k_j\}} \mathrm{E}_0 \int_0^{\infty} e^{-rt}\ln(c_j(t)) \quad r>0$$

s.t. $\dot{k}_j(t) = Ak_j(t)^{\nu} K(t)^{\theta} - c_j(t)$ and $k_j(0)$ given.

where $K(t) = \int_0^1 k_i(t)di$ i.e. the total investment of all i investors in the economy.

Since all investors are identical we suppress the subscripts in the remainder of the analysis. Standard dynamic optimisation gives us the two first-order differential equations characterising the optimal paths for $k(t)$ and $\lambda(t)$ where $\lambda(t)$ is the marginal utility of consumption which in our set up equals $\frac{1}{c(t)}$.

(16) $\frac{\dot{\lambda}(t)}{\lambda(t)} = r - A\nu k(t)^{\nu-1} K(t)^{\theta}$ and,

(17) $\dot{k}(t) = Ak(t)^{\nu} K(t)^{\theta} - \frac{1}{\lambda(t)}$

We can find the steady state equilibrium values of $k(t)$ and $\lambda(t)$ by finding the intersection of the two curves $\dot{k}(t) = 0$ and $\dot{\lambda}(t) = 0$ in a phase plane diagram. When doing so we use what is sometimes referred to as a rational expectations assumption, namely that in equilibrium $K(t) = k(t)$. This is called the rational expectations assumptions because individual agents need to make a forecast of $K(t)$ when choosing $k(t)$. In the rational expectations equilibrium the sum of the agents' choices add up to the forecasted value and thus agents' actions are consistent with the actual outcome. Equilibrium is then characterised by the two first order differential equations,

(16') $\frac{\dot{\lambda}(t)}{\lambda(t)} = r - A\nu k(t)^{\nu+\theta-1}$ and,

(17') $\dot{k}(t) = Ak(t)^{\nu+\theta} - \frac{1}{\lambda(t)}$

If $\nu + \theta \geq 1$ there is ongoing growth in equilibrium. A detailed analysis of this situation is given in Romer(1986). In figure 5.1 we reproduce Romer's figure 3 showing the phase plane diagram of (16') and (17'). This diagram shows that if $\nu + \theta \geq 1$ the $\dot{k}(t) = 0$ and $\dot{\lambda}(t) = 0$ loci never intersect and there is ongoing growth in equilibrium. Romer shows how the competitive equilibrium trajectory is located between the two loci as is illustrated in the diagram.

Let us now characterise the balanced growth path of this economy with $\nu + \theta = 1$ which is the simplest case of endogenous growth. We notice from (16') that,

$$\frac{\dot{\lambda}(t)}{\lambda(t)} = r - A\nu \text{ since } \frac{1}{c} = \lambda \text{, this is equivalent to,}$$

$$(18) \quad \frac{\dot{c}(t)}{c(t)} = A\nu - r \text{, thus}$$

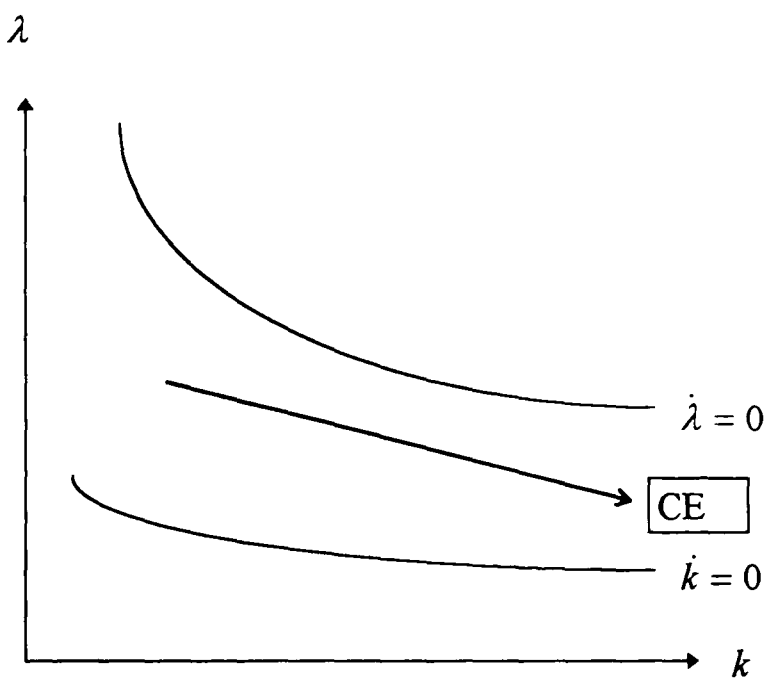
$$(19) \quad c(t) = c(0)e^{(A\nu - r)t}$$

For balanced growth we then guess that,

$$(20) \quad k(t) = k(0)e^{(A\nu - r)t}$$

With $k(0)$ given we need to determine $c(0)$. This can be done by differentiating (20) which yields, $\dot{k}(t) = (A\nu - r)k(0)e^{(A\nu - r)t}$. We substitute this into the capital accumulation identity $\dot{k}(t) = Ak(t) - c(t)$ and combine with (19). This gives

Figure 5.1. Phase Plane Diagram With $\nu + \theta \geq 1$.



$$(21)\quad (A\nu - r)k(0) = Ak(0) - c(0)$$

from which $c(0)$ can be determined.

The balanced growth equilibrium is thus described by equations (19) (20) and (21).

Thus far in the equilibrium analysis we have suppressed the differences between the intermediated economy and the search economy. By substituting the different values of A for the search economy and intermediated economy respectively from equations (11) and (12) we can now describe the different equilibrium paths for these two economies.

Equilibrium in the Search Economy

$$(22a)\quad c(t) = c(0)e^{(z\omega\alpha^e\nu - r)t}$$

$$(22b)\quad k(t) = k(0)e^{(z\omega\alpha^e\nu - r)t}$$

$$(22c)\quad (z\omega\alpha^e\nu - r)k(0) = z\omega\alpha^e k(0) - c(0)$$

Equilibrium in the Intermediated Economy

$$(23a)\quad c(t) = c(0)e^{(\omega E(\alpha)\nu - r)t}$$

$$(23b)\quad k(t) = k(0)e^{(\omega E(\alpha)\nu - r)t}$$

$$(23c)\quad (\omega E(\alpha)\nu - r)k(0) = \omega E(\alpha)k(0) - c(0)$$

We will now look at how changes in the economic environment have different effects in the two economies and use this analysis to highlight what the economic consequences are of the absence of financial intermediaries.

5.5 Comparative Statics

If factors in the environment that only affect the search and matching process, and not the intermediated economy, change, it will obviously affect the difference between these two economies.

One such factor is the separation rate. If the separation rate of investment projects s increases then equation (9) shows that the reservation productivity of investors will fall. This makes intuitive sense: an increase in the separation rate reduces the expected duration of a future investment project match and hence the present value of this project falls. Therefore investors will be less choosy today when faced with a project with a given productivity since the value of the investment project they might be matched with if they continue to search has been reduced. A reduction in the reservation productivity reduces $\alpha^e = E(\alpha|\alpha \geq \alpha_r)$ since lower productivity projects are now included in the distribution of accepted projects. The reduction in the reservation productivity increases the arrival rate of acceptable projects p (see equation (1)).

If s increases and p falls as a consequence, the effect on the total fraction of invested funds engaged in production (z) is apparently ambiguous as can be seen from equation (10). However the effect of s on z is of a first-order nature, while the effect through p is second order in nature. Therefore we conclude that an increase in s will reduce z. Thus the consequence of an increase in the separation rate of investment projects is that the expected productivity of projects carried out falls as investors accept lower productivity projects. The fraction of invested funds that are engaged in production at a given point of time also falls. Therefore the productivity per unit invested, $z\alpha^e$ unambiguously falls.

By contrast a change in the separation rate has no effect on the intermediated economy in our set up. Looking at equations (22a) and (22b) we see that the increased separation rate reduces the growth rate in the search economy. Also from equation (22c) it can be seen that for a given initial capital stock the initial level of consumption is reduced as $z\alpha^e$ falls. Thus an increase in the separation rate reduces the growth rate in the search economy and also the initial value of consumption for each value of the initial capital stock.

While changes in the separation rate exclusively affect the search economy, changes in the discount rate of investors affects both the intermediated and the search economy. An increase in the discount rate r reduces the reservation productivity of investors. This reduction is again caused by the fact that the present value of future matches falls, this time because they are discounted at a higher rate. This makes the value of a project available today relatively more attractive, thus reducing the reservation productivity. Thus α^e falls as r increases. However the reduction in the reservation productivity increases p, so z increases. Thus an increase in the discount rate reduces the expected productivity of the investment projects undertaken in the economy, but increases the fraction of each unit invested that is engaged in production at each point in time. Thus the effect on $z\alpha^e$ is ambiguous depending on which of the two effects dominates.

The increase in the discount rate has an additional effect on the search economy since it reduces the present discounted value of investments. This effect shows up in our model through the direct entry of r in equations (22a) and (22b). An increase in r will cause investors to consume more today and invest less. This effect on its own will reduce the future growth of consumption and the capital stock. In the search economy the negative effect on the growth rate of the increase in r can be overturned if $\omega z\alpha^e$ increases sufficiently i.e. if the increase in the discount rate causes the per unit productivity of invested funds to increase by an amount larger than the increase in r so that $\frac{d(\omega z(r)\alpha^e(r)-r)}{dr} \geq 0$. This can happen if the positive effect of r on z is large and the negative effect of r on α^e

is small. Thus an increase in r might either increase or decrease the growth rate in the search economy.

As equations (23a) and (23b) show an increase in the discount rate also affects the intermediated economy, but only through one of the channels discussed above, namely through the increase in consumption today at the expense of investment for future consumption. In the intermediated economy an increase in the discount rate will therefore unambiguously reduce the growth rate

The last factor in our model that affects the difference between the intermediated economy and the search economy is the distribution of investment projects available to investors in the economy. In the intermediated economy only the expected return of investments matters as investors are completely isolated from idiosyncratic shocks since all projects are pooled at the intermediary. In the search economy this is not the case. An investor receives a return that is entirely determined by the specific match he is engaged in. Therefore changes in the dispersion of the distribution of returns affect the search behaviour of investors. An increase in the dispersion of investment returns that leaves the expected value of project returns unchanged will affect behaviour in the search economy since investors now have the opportunity to engage in future matches with projects that have higher returns than under the old, less-dispersed distribution. An increase in dispersion of a distribution that leaves the mean unchanged is called a mean-preserving spread. The simplest possible type of mean-preserving spread is one which moves probability mass from the centre of the distribution and places more weight on the tails without affecting the mean. A distribution $G^{\theta}(\alpha)$ is a mean preserving spread on the distribution $G^{\beta}(\alpha)$ if

$$(24)\quad E(\alpha)=\int_{\alpha^l}^{\alpha^h}\alpha dG^{\beta}(\alpha)=\int_{\alpha^l}^{\alpha^h}\alpha dG^{\theta}(\alpha)$$

$$(25)\quad \int_{\alpha^l}^{\alpha^*}\left[G^{\theta}(\alpha)-G^{\beta}(\alpha)\right]d\alpha\geq 0 \quad \alpha^l\leq\alpha^*\leq\alpha^h$$

In addition it satisfies the single crossing property (which implies that the mean preserving spread is of the kind that moves probability mass from the centre of the distribution to the tails) if,

$$(26)\quad G^{\theta}(\alpha) - G^{\beta}(\alpha) \geq 0 (\leq 0) \text{ for } \alpha \leq \hat{\alpha} (\geq \hat{\alpha})$$

where $\hat{\alpha}$ is some α in the support of $G^{i}(\alpha)$ $i = \beta, \theta$.

In our model such a mean preserving spread is equivalent to an increase in $\alpha^{e} = E(\alpha | \alpha \geq \alpha_{r})$ for a given α_{r}. This is can be seen if one writes (24) as,

$$(27)\quad \int_{\alpha^{l}}^{\alpha_{r}} \alpha dG^{\beta}(\alpha) + \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\beta}(\alpha) = \int_{\alpha^{l}}^{\alpha_{r}} \alpha dG^{\theta}(\alpha) + \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\theta}(\alpha)$$

If we rearrange and use integration by parts we get that,

$$(28)\quad \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\theta}(\alpha) - \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\beta}(\alpha) = \int_{\alpha^{l}}^{\alpha_{r}} \left[G^{\theta}(\alpha) - G^{\beta}(\alpha)\right] d\alpha + \alpha_{r}\left[G^{\beta}(\alpha_{r}) - G^{\theta}(\alpha_{r})\right]$$

By equation (25) the first term on the right hand side is always positive. The second term is positive for $\alpha_{r} \geq \hat{\alpha}$ where $\hat{\alpha}$ is the same as in equation (25)[11]. Thus for an α_{r} satisfying this condition we get that

$$(29)\quad \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\theta}(\alpha) - \int_{\alpha_{r}}^{\alpha^{h}} \alpha dG^{\beta}(\alpha) \geq 0$$

[11] Our proof therefore holds only for the reservation return satisfying this condition. For other values of the reservation productivity we cannot provide a proof and rely on the intuitive explanation.

Since $\alpha^e = E(\alpha|\alpha \geq \alpha_r) = \int_{\alpha_r}^{\alpha^h} \alpha d\overline{G}(\alpha)$ where $\overline{G}(\alpha) = G(\alpha)/[1-G(\alpha_r)]$ and since a rebasing of the probability distribution will only increase the relative size of the two terms in the right direction since $1-G^{\theta}(\alpha) \leq 1-G^{\beta}(\alpha)$, we get that

$$(30) \quad \int_{\alpha_r}^{\alpha^h} \alpha d\overline{G}^{\theta}(\alpha) - \int_{\alpha_r}^{\alpha^h} \alpha d\overline{G}^{\beta}(\alpha) \geq 0$$

We therefore conclude that α^e under the more dispersed distribution $\alpha - G^{\theta}(\alpha)$ is larger than α^e under the less dispersed distribution $\alpha - G^{\beta}(\alpha)$. So a mean-preserving spread can be modelled as an exogenous increase in α^e for a given α_r.

From equation (9) we can see that this implies that the search equilibrium value of α_r increases. As mentioned above this makes intuitive sense. Investors now have increased opportunities to be matched with high return projects in the future than before the mean-preserving spread, therefore they will be more choosy about which projects to accept today. A further consequence of the equilibrium increase in α_r is that z falls. The equilibrium growth effects in the search economy are thus ambiguous depending on whether or not the increase in α^e is significantly large to offset the reduction in z so that $z\alpha^e$ increases and with it the equilibrium growth rate in the economy.

While the mean-preserving spread affects the growth rate in the search economy because it alters agents search behaviour and thus their returns from investing, it has no effect on the growth rate in the intermediated economy where only the mean of the distribution, which has been left unchanged, matters.

5.6 Conclusion

In an economy where investors place their funds with intermediaries and entrepreneurs borrow from these institutions, only the expected return of the

available projects matter for the return investors get and consequently this is the only factor related to the match between entrepreneurs and investors that affects the growth rate. If there are no intermediaries and investors instead are located in an economy where they have to seek out entrepreneurs themselves, additional factors affect the growth rate of the economy. This is because several factors affect the search behaviour of investors, which in turn affect the return they can expect to obtain from the search process. To understand this it helps to remind oneself why investors are searching. Given an investment opportunity in the search economy an investor can either commit his funds now, or continue searching in the hope that he will get a project with a higher return. This extra search however comes at a cost since his investment funds are idle during the searching period, and in an economy with discounting this affects the present value of his returns.

These two factors work in opposite directions in the case where the discount rate is increased. An increased discount rate causes investors to be less choosy thus lowering their expected return from a given project. This implies that agents spend less time searching and thus more time producing. Depending on which effect dominates, the expected return in the search economy goes up or down. The same two factors are at play in the situation where the dispersion of returns on investment projects goes up.

All in all the search economy contains an additional channel through which the discount rate of the agents can affect the growth rate of the economy, and also a channel through which the dispersion of investment returns matter rather than solely the mean as is the case in the intermediated economy. In addition the search economy provides a set up in which there are equilibrium credit constraints. Because z is never unity, there are always funds in the economy searching for investment opportunities. The flip side of this is that some entrepreneurs are denied funding because investors are looking for better opportunities. This credit constraint binds more the higher is the reservation productivity of investors, i.e. the lower is investors discount rate and the higher is the dispersion of investment returns.

We have presented the simplest possible framework within which the search economy can be compared with the intermediated economy. Our model fails to address the important question: why do intermediaries emerge ? This is one possible extension that could be added in the future. Another shortcoming of our analysis is that we do not continuously allow agents to update their investment and consumption plans as a function of the history of the previous matches they have engaged in. While economists do not normally allow the entire history to determine the next step of the agent, they normally allow the current state to affect next periods allocation thus linking the periods. We have completely abstracted from this by performing the analysis entirely in terms of time zero expectations. This can be justified by the fact that in our set up even finding this type of solution would be complicated by the existence of an externality in the investment decision that would feed back into individual decision rules. While our model therefore is simplistic it does provide a first step towards understanding how the absence of intermediation affects the economy.

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