UNDER- AND OVERINVESTMENT AS A CONSEQUENCE OF INFORMATIONAL ASYMMETRIES – IMPLICATIONS FOR THE TRANSITION IN EASTERN GERMANY

by

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Under- and Overinvestment as a Consequence of Informational Asymmetries – Implications for the Transition in Eastern Germany

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Abstract

This paper analyses the conditions under which over- and underinvestment as a consequence of informational asymmetries on credit markets occur, with the underinvestment not going hand in hand with credit rationing. Furthermore the factors influencing the extent of these inefficiencies are identified. The results of this theoretical analysis are then transferred to the transition in Eastern Germany. This paper shows that there is a strong indication that the transition in Eastern Germany has been accompanied by substantial under- and over-investment.

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1 Introduction

Since the seminal paper of Stiglitz and Weiss (1981) a vast literature regarding the consequences of informational asymmetries on credit markets has emerged. A major part of this literature shows that informational asymmetries between banks and firms, with the firms having the informational edge, can lead to credit rationing as a consequence of adverse selections, adverse incentives, moral hazard or costly state verification problems. Another part of this literature describes how these informational asymmetries can lead to overinvestment resulting from selection and incentive effects.¹ This paper adds to the debate firstly by identifying the conditions under which inefficient capital allocations in form of under- and overinvestment do occur, with the underinvestment not going hand in hand with credit rationing, and secondly by determining the factors influencing the extent of these inefficiencies. The results of this theoretical analysis are then transferred to the transition in Eastern Germany. Investments have been a crucial component in this transition. Experience and anecdotal evidence indicate that the process has been plagued by various sources of inefficiencies. This study gives a theoretical foundation for the thesis that under- and overinvestment generated by informational problems on credit markets have impeded significantly the build up of a new capital stock in Eastern Germany.

The main results of this paper are: Informational asymmetries are not sufficient for allocational inefficiencies to occur, but the extent of informational problems must be sufficiently high, the rate of internal finance must be sufficiently low and entrepreneurs must operate near the break even point. If these conditions are fulfilled, the extent of both forms of inefficiencies will be generally higher, the smaller the rate of internal finance is. But whereas the overinvestment rises with an increasing expected profit of the entrepreneurs, the underinvestment decreases in this case. Transferring these results to Eastern Germany there is a strong indication that the transition has been accompanied by substantial over- and underinvestment. Furthermore one can proceed on a specific assumption concerning the risk-return-combination of the investment projects that underinvestment has been the more relevant problem.

The rest of this paper is organised as follows: Section 2 presents the underinvestment setup. Firstly the credit market with informational asymmetries and the benchmark case, a credit market not burdened with informational problems, are modelled. Afterwards the outcome of the two markets is compared and finally the implications are discussed. Section 3 describes analogously the overinvestment setup. Section 4 analyses the consequences of the theoretical issues for the transition in Eastern Germany. This paper ends with a summary and some remarks on related issues for further discussions considering the results of this paper.

2 Underinvestment

2.1 The Credit Market with Informational Problems

The credit market burdened with informational asymmetries is modelled similar to the one described by Stiglitz and Weiss (1981). The main differences are the division of the entrepreneurs into groups, the specification of the distribution of the probabilities of success of the projects and the assumption of constant marginal costs for loanable funds. The division of the entrepreneurs into groups is done for the consideration of the heterogenous landscape of firms in Eastern Germany concerning the success, the capital endowment and so on of the firms. The specification of the distribution implies that there are measurements for the average risk over the projects and for the extent of the informational problems. Both variables play a major role for the occurrence and the extent of underinvestment. In the Stiglitz-Weiss-world a specific restriction on loanable funds is a necessary condition for credit rationing to occur. Stiglitz and Weiss modelled this restriction in form of increasing marginal costs for loanable funds. Another possibility is for example the consideration of capital adequacy requirements for banks. In this paper it is assumed that a restriction on loanable funds has not posed a major problem in the transition in Eastern Germany, which is expressed by an absolutely elastic supply of loanable funds to the risk free interest rate. In what follows the credit market with informational problems is described in detail.

There are three groups of entrepreneurs (k = I to III), each consisting of a continuum of entrepreneurs. Every single entrepreneur has an initial endowment of wealth \( \bar{W}_k \), which he can either invest in his project or on the capital market. His project can either succeed, yielding a return \( R_s \), or fail, yielding no return. Regarding the investment on the capital market, the entrepreneur receives a riskfree rate of return \( \bar{\rho} \). Since the investment project is indivisible and requires an investment \( I \), with \( I > \bar{W}_k \), the entrepreneur must borrow from a bank to realise his project. Within each group the entrepreneurs only differ in the risk of their project, which is expressed by different probabilities of success \( p_i \), and the return of their project in case of success \( R_s \). The probabilities are distributed uniformly across the entrepreneurs within a group. The three groups exhibit the following differences:

- in the wealth of the entrepreneurs \( \bar{W}_k \) with \( \bar{W}_I > \bar{W}_II > \bar{W}_III \), within any group all entrepreneurs start with the same endowment,
- in the expected return of the entrepreneurs' projects \( \bar{R}_k \) with \( \bar{R}_I > \bar{R}_II > \bar{R}_III \), again within any group this expected return is the same for all entrepreneurs,
- in the average risk over all projects in the group with \( (1 - \bar{\mu}_{p,.I}) < (1 - \bar{\mu}_{p,.II}) < (1 - \bar{\mu}_{p,.III}) \)
- and in the extent of the informational problems between banks and entrepreneurs \( \bar{\sigma}^2_{p,.I} < \bar{\sigma}^2_{p,.II} < \bar{\sigma}^2_{p,.III} \).

Consequently, group I is the "best" group: The projects of its entrepreneurs exhibit the highest expected return, the highest rate of internal finance, the lowest average risk over the projects

\[ \bar{\mu}_{p,.k} \] is the mean, \( \bar{\sigma}^2_{p,.k} \) is the variance of the within a subgroup uniformly distributed probabilities of success of the projects. Why these moments are measurements for the average risk and the extent of the informational problems is explained later.

For respective analyses see for example Brinkmann and Horvitz (1995); Blum and Hellwig (1996).
and the informational problems are the smallest. Analogously group III is the “worst” group and group II takes a medium position.

The price for the project \( I \) and the riskfree rate of return of the alternative investment \( \bar{\rho} \) are identical for all entrepreneurs. So the index \( i \) indicates entrepreneur- respectively project-specific variables, the index \( k \) group-specific variables and variables without an index are the same for each entrepreneur.

Banks are able to divide the entrepreneurs into the three described groups, but they are unable to distinguish exactly the entrepreneurs within a group with regard to the specific risk of their project. The probability of success \( p_i \) is a private information of the entrepreneurs. One of the often discussed reasons for the existence of banks as intermediaries is their capability to reduce informational asymmetries between deficit and surplus units. Here it is assumed that banks know the distribution of \( p_i \) and that they obtain the necessary information to classify the entrepreneurs into subgroups, relating to the \( p_i \) of their project. It is further assumed that all subgroups of one group have the same variance \( \sigma_{p_{i,k}}^2 \) of the uniformly distributed \( p_i \). The greater the extent of the informational problems becomes, the more heterogenous are the subgroups concerning \( p_i \). In this sense the variance measures the extent of the informational asymmetries between banks and the entrepreneurs. It reflects the capability of banks to reduce informational problems. In what follows the focus is only on one subgroup as a representative for the whole group. It is assumed that the mean of the probabilities of success of this subgroup, indicated by \( \bar{\mu}_{p_{i,k}} \), reflects the average risk over all projects in the corresponding group. The continuum of the representative subgroup is normalised to one. Under this setup the credit market is described formally in the following fashion:

**Credit Demand**

\[
E(PE)_i \geq \bar{W}_k \cdot \bar{\rho}
\]

\[
E(PE)_i = p_i \cdot (R^*_i - (1 + \bar{r}_k) \cdot (\bar{I} - \bar{W}_k) - \bar{W}_k) + (1 - p_i) \cdot (-\bar{W}_k)
\]

\[
\bar{R}_k = p_i \cdot R^*_i
\]

\[
E(PE)_i = \bar{R}_k - p_i \cdot (1 + \bar{r}_k) \cdot (\bar{I} - \bar{W}_k) - \bar{W}_k
\]

\[
p_{k,c} = \frac{\bar{R}_k - p_i \cdot (1 + \bar{r}_k) \cdot (\bar{I} - \bar{W}_k) - \bar{W}_k}{(1 + \bar{r}_k) \cdot (\bar{I} - \bar{W}_k)} = \frac{l + \bar{q}_k - \bar{w}_k \cdot (1 + \bar{\rho})}{(1 + \bar{r}_k) \cdot (1 - \bar{w}_k)}
\]

\[
g_k(p_i) = \begin{cases} 
\frac{1}{p_k - p_k''} = d_k & \text{if } p_k'' \leq p_i \leq p_k' \\
0 & \text{otherwise}
\end{cases}
\]

\[
\bar{\mu}_{p_{i,k}} = \frac{p_k' + p_k''}{2} \Rightarrow \bar{\mu}_{p_{i,k}}^2 = \frac{(p_k' - p_k'')^2}{12}
\]

---

An entrepreneur realises his project, if the expected profit $E(PE)$, is at least as high as the profit of the alternative investment (equation 1). If the project succeeds, the entrepreneur's profit is $R^*_i$ minus principal and interest payments $(1 + r_k) \cdot (\bar{I} - \bar{W}_k)$ and minus the invested wealth. In case of failure the entrepreneur simply loses all his wealth. Therefore equation 2 describes the expected profit of an entrepreneur realising his project. This equation makes the informational asymmetries already obvious: the banks being unable to assess the specific risk of a project cannot charge a risk adequate interest rate $r_k$. But they can assess the average risk of the subgroup the entrepreneur belongs to, as they know the distribution of $p_i$. This implies that they charge each entrepreneur in one subgroup the same interest rate $r_k$, which is adequate to the average risk over the financed projects in that subgroup.

The expected return $\bar{R}_k$ is the same for all projects within a group, but as the projects differ in their probability of success $p_i$ and their return in case of success $R^*_i$, there exists a mean preserving spread (equation 3). Substituting equation 3 into equation 2 it reveals that c. p. there is a positive relationship between the entrepreneur's expected profit and the risk of his project (equation 4).

From this follows that for every subgroup a critical value of the probability of success $p^\text{crit}_k$ exists (equation 5). Dividing denominator and numerator by $\bar{I}$, equation 5 shows that $p^\text{crit}_k$ depends on the project's rate of return $q_k$, the rate of internal finance $\bar{W}_k$ and the risk free interest rate $\bar{r}$, which are all exogenous variables, and on the charged interest rate $r_k$, which is an endogenous variable. If the probability of success of a project exceeds $p^\text{crit}_k$, the expected profit of the entrepreneur is too small compared to that of the alternative investment, so that he prefers the latter. Since a rising interest rate $r_k$ results in higher costs for the entrepreneur, it is obvious that $p^\text{crit}_k$ decreases if $r_k$ increases. Equation 6 maps the density function of the uniformly distributed $p_i$. The most risky project in a representative subgroup has a probability of success indicated by $p^*_k$, the probability of success of the safest project is $p^\text{saf}_k$.

Since only those entrepreneurs realise their project whose project has a $p_i$ which does not exceed $p^\text{crit}_k$, three possible states for the credit demand for each subgroup depending on the interest rate $r_k$ can be identified (equation 7): $r^*_k$ is the reservation interest rate of the entrepreneurs with the safest project, $r^\text{saf}_k$ is the reservation interest rate of the entrepreneurs with the most risky project in a subgroup. If $r_k \leq r^*_k$, all entrepreneurs will realise their project, i.e. $p^\text{crit}_k \geq p^*_k$, the credit demand is one. If $r^\text{saf}_k \geq r_k > r^*_k$, the investment on the capital market will be the better alternative for the entrepreneurs having the relatively safe projects, i.e. $p^\text{saf}_k \leq p^\text{crit}_k < p^*_k$. The credit demand of the subgroup will be smaller than one but higher than zero. Finally, if $r_k \geq r^\text{saf}_k$, even the entrepreneurs with the most risky projects will prefer the investment on the capital market, i.e. $p^\text{crit}_k < p^\text{saf}_k$, the credit demand of this subgroup will be zero.

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5 This implies that the risk of a project is measured in the sense of Rothschild and Stiglitz (1970).
Credit Supply — Determining the Interest Rate

(8) \( \eta_{i, p_0} \to \infty \)

(9) \( E(PB)_i = (1 + r_k) \cdot E(p_i)_k - 1 = E(PB)_k \)

\[
E(p_i)_k = \frac{\int_0^{p_{i, k}^a} p_i \cdot g_k(p_i) \cdot dp_i}{\int_0^{p_{i, k}^a} g_k(p_i) \cdot dp_i} = \begin{cases} \bar{\mu}_{p_i,k} & \text{if } p_{krit}^i \geq p_k^i \\ \frac{p_{krit}^i + p_k^i(r_k)}{2} & \text{if } p_{krit}^i < p_k^i < p_k^i \\ \end{cases}
\]

For \( p_{krit}^i \leq p_k^i \) \( E(p_i)_k \) is not defined. It is assumed that \( E(p_i)_k = p_k^a \) if \( p_{krit}^i \leq p_k^i \).

(11) \( E(PB)_k(r_k) = \frac{(1 + r_k) \cdot p_k^a + p_k^a(r_k)}{2} \) if \( p_{krit}^i < p_k^i < p_k^i \)

(12) \( E(PB)_k = \bar{\rho} \)

(13) \( \eta_{K_i, s_i} \to \infty \)

(14) \( r_k = \frac{1 + \bar{\rho}}{E(p_i)_k} - 1 = \begin{cases} \frac{1 + \bar{\rho} \cdot 2}{\bar{\mu}_{p_i,k} - 1} & \text{if } p_{krit}^i \geq p_k^i \\ \frac{(1 + \bar{\rho}) \cdot 2}{p_k^a + p_k^a(r_k)} - 1 & \text{if } p_{krit}^i < p_k^i < p_k^i \\ \frac{(1 + \bar{\rho})}{p_k^a} - 1 & \text{if } p_k^a \geq p_k^a \\ \end{cases} \)

It is assumed that the supply of loanable funds to the banks is absolutely elastic to the risk free interest rate \( \bar{\rho} \) (equation 8). This implies that in this model an equilibrium characterised by credit rationing in the sense of Stiglitz and Weiss (1981) cannot occur, since a positive relationship between the supply of loanable funds and the interest rate paid for it is a necessary condition for this. The absolutely elastic supply of loanable funds to \( \bar{\rho} \) implies that the quantity of credit supply plays no central role in this model. The deciding factor is the price, the interest rate \( r_k \), which is offered by the banks to the representative subgroup.

Banks are assumed to maximise the expected rate of return. If a financed project succeeds, the bank will get the principal and interest payments. Should a project fail, the bank will not receive any payment. The resulting expected rate of return of a credit granted to an entrepreneur \( i \) is shown in equation 9. \( r_k \) symbolises the interest rate and \( E(p_i)_k \) specifies the expected probability of repayment. Banks do not know the project specific probability of success, which corresponds with the project specific probability of repayment. Banks can only
assess the average probability of repayment in a representative group, expressed by the expected probability of success $E(p_i)_k$, since they know the distribution of $p_i$. Therefore an identical interest rate $r_k$ is offered to all entrepreneurs of a subgroup. This identical interest rate independently of the risk of the project implies that there is an interest subsidy of the entrepreneurs with relatively risky projects by those with relatively safe projects. Since the marginal entrepreneurs are those with the relatively safe projects, the marginal entrepreneurs are those who subsidise. This subsidy effect plays the central role for a possible equilibrium on the credit market which implies an underinvestment. Since $r_k$ and $E(p_i)_k$ are the same for all subgroup members, $E(PB)$ equals $E(PB)_k$.

Equation 10 shows that the expected probability of repayment $E(p_i)_k$ depends on the offered interest rate $r_k$. If $r_k \leq r_k^*$, all entrepreneurs of the representative subgroup want to realise their project and apply for credit. This implies that that $E(p_i)_k$ corresponds with the mean of the uniformly distributed probabilities of success $\bar{p}_{\rho,k}$. If $r_k^* > r_k > r_k^z$, the expected probability of success is smaller than $\bar{p}_{\rho,k}$, since the entrepreneurs with the relatively safe projects prefer the investment on the capital market, i.e. the average risk for the banks is higher. From the banks’ point of view an increasing interest rate between $r_k^*$ and $r_k^z$ leads to an adverse selection, as more and more entrepreneurs with relatively safe projects prefer an investment on the capital market. This means that the average risk of the banks’ loanportefeuille increases. There is a negative relationship between $r_k$ and $E(p_i)_k$. If $r_k > r_k^*$, no entrepreneur asks for a credit i.e. $p_i^c < p_i^u$. Equation 10 shows, that in this case $E(p_i)_k$ is not defined. It is assumed that the banks suppose that an increase in the interest rate beyond the reservation interest rate of the entrepreneurs with the most risky projects $r_k^o$ will not deteriorate their risk position any more, so that $E(p_i)_k$ equals $p_i^o$ if $r_k \geq r_k^o$.

Considering these aspects a two times kinked function of the expected rate of return depending on the offered interest rate $E(PB)_k(r_k)$ results (equation 11). For $r_k^o > r_k > r_k^z$ an increase of $r_k$ has two effects on $E(PB)_k$ : a positive effect due to higher interest revenues and a negative effect due to the higher risk, resulting from the decreasing share of entrepreneurs with a relatively safe project, expressed by a decreasing $E(p_i)_k$. In the world of Stiglitz and Weiss (1981) this adverse selection leads to an optimal interest rate for the bank, which is a further necessary condition for an equilibrium on the credit market characterised by credit rationing. But in this setting no optimal interest rate and therefore no credit rationing in the sense of Stiglitz and Weiss exists, since the uniform distribution of the probabilities of success $p_i$ implies that between $r_k^z$ and $r_k^o$ the banks’ expected rate of return $E(PB)_k$ is a linear function of $r_k$.

Banks want to offer that interest rate, which maximises $E(PB)_k$. But the competitive banking industry only allows them to yield the normal profit, which means that $E(PB)_k$ equals their costs of loanable funds $\bar{p}$ (equation 12). Solving the equations describing the supply side of the credit market, an absolutely elastic credit supply to the offered interest rate $r_k$ results, with $r_k$ covering the banks’ costs for loanable funds $\bar{p}$ and a risk premium, expressed by $1/E(p_i)_k$ (equations 13 and 14).

Equilibrium

Bringing the demand and supply side of the credit market together, shows that in any subgroup there can be three possible credit market equilibria. Under the first possible equilib-
rium, denoted by ASYM I, \( p_k^{\text{crit}} \geq p_k^* \), which means that all entrepreneurs of the subgroup conclude a credit contract and realise their project (equation 15). The equilibrium interest rate is smaller than \( r_k^* \) and the risk premium corresponds with \( 1/\mu_{p,k} \) (equation 16).

(15) \[ K_{\text{asyml},k}^* = 1 \]

(16) \[ r_{\text{asyml},k}^* = \frac{1 + \bar{\rho}}{\mu_{p,k}} - 1 < r_k^* \]

Under the second possible equilibrium (ASYM II) only a share of the entrepreneurs of the subgroup concludes a credit contract (equation 17), since the entrepreneurs with the relatively safe projects prefer the investment on the capital market. Formally, the share of the entrepreneurs, realising their project corresponds to the area under the density function between \( p_k^u \) and \( p_k^{\text{crit}} \). Equations 18 and 19 show therefore the variables determining the share of entrepreneurs realising their project. In ASYM II the interest rate lies between \( r_k^* \) and \( r_k^u \), covering the banks' costs for loanable funds and the risk premium \( 1/E(p_i)^* \), which is higher than \( 1/\mu_{p,k} \), since the entrepreneurs of the subgroup with the relatively safe projects are not in the banks' loanportefeuille (equations 20 and 21).

(17) \[ 0 < K_{k,\text{asyml}}^* = \int \frac{g_k(p_i)}{p_i} dp_i < 1 \]

(18) \[ p_k^u \leq p_k^{\text{crit}} = \frac{(\mu_{p,k} - \sqrt{3\sigma^2}_{p,k})(1 + \bar{q}_k - \bar{w}_k)(1 + \bar{\rho})}{(1 + \bar{\rho})(2 - \bar{w}_k)(1 + \bar{q}_k)} < p_k^* \]

(19) \[ p_k^u = \mu_{p,k} - \sqrt{3\sigma^2}_{p,k} \]

(20) \[ r_k^u > r_{\text{asyml},k}^* = \frac{1 + \bar{\rho}}{E(p_i)^*_{\text{asyml},k}} \geq r_k^* \]

(21) \[ E(p_i)^*_{\text{asyml},k} = \frac{p_k^u + p_k^{\text{crit}}}{2} < \mu_{p,k} \]

The third possible equilibrium (ASYM III) is characterised by the fact that \( p_k^{\text{crit}} < p_k^u \), which means that no entrepreneur of the subgroup realises his project (equation 22). The cost covering interest rate offered by the banks implies that \( p_k^{\text{crit}} < p_k^u \), which means that the reservation interest rate even of the entrepreneurs with the most risky projects is smaller than the banks' reservation interest rate.

(22) \[ K_{\text{asyml},k}^* = 0 \]

2.2 The Credit Market without Informational Problems

On a credit market not burdened with informational problems (the benchmark case), banks know the probability of success \( p_i \) of any project, which means that they can offer each entrepreneur a risk adequate interest rate \( r_i \). In order to determine possible credit market equilibriu-
ria for a representative subgroup, the reservation interest rates of entrepreneurs and banks are determined.

One gets an entrepreneur's reservation interest rate by equating his expected profit from the project\(^6\) with his expected profit from the investment on the capital market (\textit{equation 23}) and solving this equation for \(r_i\). \textit{Equation 24} shows the result. It can be seen that there is a positive relationship between the risk of an entrepreneur's project \((1 - p_i)\) and the highest interest rate he is willing to pay \((\partial r_i^{\text{ResE}} / \partial p_i < 0)\).

\begin{equation}
E(PE)_i = \bar{R}_k - p_i \cdot (1 + r_i) \cdot (\bar{I} - \bar{W}_k) - \bar{W}_k = \bar{W}_k \cdot \bar{\rho}
\end{equation}

\begin{equation}
r_i^{\text{ResE}} = \frac{\bar{R}_k - \bar{W}_k \cdot (1 + \bar{\rho})}{(\bar{I} - \bar{W}_k) \cdot p_i} - 1 = \frac{1 + \bar{q}_k - \bar{w}_k \cdot (1 + \bar{\rho})}{(1 - \bar{w}_k) \cdot p_i} - 1
\end{equation}

Similarly the banks' reservation interest rate can be obtained by equating the banks' expected rate of return from their credit business and their refinancing costs. \textit{Equation 25} shows the decisive difference if compared to the credit market burdened with informational problems. The banks' expected rate of return depends on the specific risk \(p_i\) of the project to be financed and therefore on a project risk adequate interest rate \(\r_i\) (compare equations 9 to 11). Solving equation 25 for \(r_i\), one gets the banks' reservation interest rate (\textit{equation 26}). It covers the costs for loanable funds \(\bar{\rho}\) and a risk premium \(1 / p_i\). Therefore there is a positive relationship between the reservation interest rate and the risk of the project \((1 - p_i)\) for the banks' as well \((\partial r_i^{\text{ResB}} / \partial p_i < 0)\).

\begin{equation}
E(PB)_i = (1 + r_i) \cdot p_i - 1 = \bar{\rho}
\end{equation}

\begin{equation}
r_i^{\text{ResB}} = \frac{1 + \bar{\rho}}{p_i} - 1
\end{equation}

Only the entrepreneurs, whose reservation interest rate is not smaller than the reservation interest rate of the banks realise their project:

\begin{equation}
r_i^{\text{ResB}} \leq r_i^{\text{ResE}}
\end{equation}

Substituting \(r_i^{\text{ResE}}\) and \(r_i^{\text{ResB}}\) by the relevant equations 24 and 26 one obtains the result, that all projects are financed, whose expected rate of return is not smaller than the risk free interest rate. Since all projects of one subgroup have the same expected rate of return \(\bar{q}_k\), there are two possible equilibria: either all entrepreneurs of the subgroup conclude a credit contract and realise their project (equilibrium \textit{SYM I}, see \textit{equation 28}) or no credit contract is concluded and no project of that subgroup is realised (equilibrium \textit{SYM II}, see \textit{equation 30}). This is logical, since banks and entrepreneurs are riskneutral and all projects have the same expected rate of return. The result shows as well, that on contrary to the credit market burdened with informational problems, the rate of internal finance is irrelevant for a project to be realised or not. The Modigliani-Miller-Theorem holds on this frictionless credit market. On the credit market burdened with informational asymmetries it is not valid. In the Equilibrium SYM II the difference between the banks' and the entrepreneurs' reservation interest rates goes to the latter,

\begin{footnote}
\textit{For a more detailed explanation of \(E(PE)\), see analogously the comments to equations 2 to 4.}
\end{footnote}
due to the competitive banking industry. This implies that the equilibrium interest rate corresponds with the banks’ reservation interest rate (equation 29).

\[ K_{k, sym}^* = 1 \quad \text{with } \bar{\rho} \leq \bar{q}_k \]  

(28) \[ r_{i, sym}^* = r_{i, Res}^* = \frac{1 + \bar{\rho}}{p_i} - 1 \]  

(29) \[ K_{k, sym}^* = 0 \quad \text{with } \bar{\rho} > \bar{q}_k \]  

(30) \[ K_{k, sym}^* = 1 \quad \text{with } \bar{\rho} \leq \bar{q}_k \]  

2.3 Comparison – Underinvestment Is Possible

Equilibrium ASYM II – Underinvestment

In the Equilibrium ASYM II only a share of the entrepreneurs of the representative subgroup realises their project, with the marginal entrepreneurs, i.e. those with the relatively safe projects, subsidising the entrepreneurs with the relatively risky projects as a consequence of the informational asymmetries. This means that the marginal entrepreneurs face higher financing costs than on a credit market not burdened with informational problems. This implies that they would have realised their project in the benchmark case as well. And since in that situation either all or no entrepreneur realise the project, the corresponding equilibrium must be SYM I. Thus the only reason for not realising a project in ASYM II are the additional financing costs due to the informational problems on the credit market. Formally the extent of this underinvestment corresponds to the area under the density function between \( p_k^{\text{cr}} \) and \( p_i^* \) (equation 31).

\[ U_k = \int_{p_i^*}^{p_k^{\text{cr}}} g_k(p_i) dp_i \]  

(31) \[ U_k = \frac{1}{\sqrt{12 \cdot \sigma_{p_i,k}^2}} \left( \frac{\mu_{p_i,k} + \sqrt{3 \cdot \sigma_{p_i,k}^2}}{\mu_{p_i,k} - \sqrt{3 \cdot \sigma_{p_i,k}^2}} \right) \int \left[ (1 + \bar{q}_k - \bar{w}_k \cdot (1 + \bar{\rho})) \right] \]  

Figure 1 illustrates the underinvestment problem. The upper part shows the entrepreneurs’ and the banks’ reservation interest rate depending on \( p_i \) (compare equations 24 and 26). The lower part of figure 1 illustrates the density function of the within the representative subgroup uniformly distributed \( p_i \). The upper part shows that at any \( p_i \) the reservation interest rate of the banks is smaller than that of the entrepreneurs, which implies that in the benchmark case all projects are financed (areas 5 and 6 in figure 1). For realising all projects in the situation with informational problems the for all entrepreneurs identical interest rate must not exceed \( r_k^{\text{cr}} \). But at this and lower interest rates the banks calculate with a loss, as figure 1 shows: Area 1 illustrates the expected profit above the normal profit at the interest rate \( r_k^{\text{cr}} \), the areas 2 and 3 present the expected loss at this rate. Since area 1 is smaller than the sum of the areas 2 and 3, there is an expected loss in total. The equilibrium interest rate must be \( r_k^* \). At this rate

\[ \text{For simplicity reasons a linear relationship between } p_i \text{ and the reservation interest rates is assumed in figure 1. Actually the relationship is hyperbolic as equations 24 and 26 indicate. The linearity can be justified, if only a section, as in the figure, is looked at. Simulations confirm this aspect.}\]
the expected profit above the normal profit (area 4) is as high as the expected loss (area 3). The normal profit condition is fulfilled. But at \( r^*_k \) only the entrepreneurs represented by area 6 realise their project, which means that there is an underinvestment to the extent represented by area 5.

![Diagram](image)

Figure 1: Underinvestment as a Consequence of Informational Asymmetries

**Equilibrium ASYM I - No Underinvestment**

Under ASYM I all entrepreneurs of the representative subgroup conclude a credit contract and realise their project. That means that the entrepreneurs with the safest projects are willing to bear the additional financing costs resulting from the informational asymmetries. The project is the more attractive investment despite these additional costs. That means that these entrepreneurs would have realised their project as well in the benchmark case, where no subsidy costs occur. Therefore the corresponding equilibrium is equilibrium SYM I. The equilibrium ASYM I does not imply an inefficient capital allocation. (Still one has to consider that a different distribution of the entrepreneurs' surplus results due to the informational problems.)

**Equilibrium ASYM III - No Underinvestment**

Under ASYM III no entrepreneur realises his project. But this does not imply underinvestment. The corresponding equilibrium in the benchmark case is equilibrium SYM II, in which no entrepreneur realises his project either: The interest rate, which implies that \( r^\text{sym} = p^\text{a} \), i.e. the interest rate, which implies that only the entrepreneurs with the most risky projects want to invest into their project, does not include a subsidy effect any more, since only entrepreneurs with a project having the same risk apply for credit. But this interest rate does not cover the banks' costs for loanable funds and the necessary risk premium. That means that the banks must charge these entrepreneurs a higher interest rate. Yet, at this higher interest rate these entrepreneurs do not want to invest into their project anymore, but they prefer the alternative investment on the capital market. That means that in ASYM III entrepreneurs do not realise
their project because of additional financing costs resulting from informational problems on the credit market, but the projects' expected rate of return does not cover risk adequate financing costs. That means in the benchmark case no project would have been realised either. The corresponding equilibrium must be SYM II, so that ASYM III does not imply an inefficient capital allocation.\(^8\)

2.4 Implications

**Necessary and Sufficient Conditions for Underinvestment**

In this model underinvestment is characterised by the non realisation of efficient projects as a consequence of informational problems. Since all projects of one subgroup have the same expected rate of return and since banks and entrepreneurs are risk neutral, either all projects or no project of that subgroup are efficient. This is reflected by the possible equilibria in the benchmark case: either no or all projects are realised. Therefore the necessary condition for underinvestment is that all projects would have been financed in the reference situation, which means that

\[ (32) \quad \bar{q}_k \geq \bar{\rho} \]

is the necessary condition for the occurrence of underinvestment.

But this condition is not sufficient, since if all projects would have been financed in the reference situation, it is still possible that all of them are realised in a situation with informational problems as well (Equilibrium ASYM I). Therefore the sufficient condition for underinvestment is, that the entrepreneurs with the relatively safe projects cannot bear the additional costs resulting from the subsidy effect due to the informational problems. Formally does this mean that \( p_k^{\text{over}} \leq p_k \), which leads to the following sufficient condition for the occurrence of underinvestment:

\[ (33) \quad \sqrt{3 \cdot \bar{\sigma}_{\rho,k}^2 \left[ (1 + \bar{\rho}) \cdot (1 - \bar{w}_k) \right]} > \bar{\mu}_{\rho,k} \cdot (\bar{q}_k - \bar{\rho}) \]

Which magnitude do the model variables therefore normally have in case of underinvestment? The expected rate of return of the projects \( \bar{q}_k \) and the refinancing costs and the opportunity costs, both indicated by \( \bar{\rho} \), lie typically in a specific corridor: \( \bar{q}_k \) is not that low and \( \bar{\rho} \) is not that high that the entrepreneurs would not have realised their project in the reference situation, but they are not that high respectively that low that all entrepreneurs can bear the additional costs. Formally these results can be seen from the following expressions, resulting from equation 33:

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\(^8\) In this study it is assumed that the informational asymmetries concern only to the risk of the projects, but that all other variables are public knowledge. If it were not for the public knowledge of \( \bar{q} \) and \( \bar{q}' \) for example, and banks and entrepreneurs had a divergent view concerning the magnitude of this variable, it would depend on the fact who is right, whether there will be an inefficient allocation. If the bank is wrong, a red lining problem, resulting in underinvestments might occur. If the bank is right, the informational problems concerning \( \bar{q}_k \) and \( \bar{q}'_k \) will not result in underinvestments. The latter aspect was discussed by de Meza and Southey (1996).
The rate of internal finance \( \bar{w}_k \), the average risk over all projects in the subgroup \( \bar{\mu}_{p,k} \) and the extent of the informational problems \( \bar{\sigma}^2_{p,k} \) have no effect on a project's efficiency, and therefore on the necessary condition. But they play a central role for the sufficient condition: The subsidy goes over the external capital. This means that the lower the rate of internal finance the higher is the subsidy effect and therefore the capital costs for the entrepreneurs with the relatively safe projects. The same argument holds analogously for \( \bar{\mu}_{p,k} \) and \( \bar{\sigma}^2_{p,k} \). The higher the average risk \( (1 - \bar{\mu}_{p,k}) \) and the higher the extent of the informational problems the higher is the subvention effect and therefore the additional costs for the entrepreneurs with the relatively safe projects. This means that in case of underinvestment \( \bar{w}_k \) and \( \bar{\mu}_{p,k} \) are typically low and \( \bar{\sigma}^2_{p,k} \) is typically high. Formally the following equations, resulting from equation 33, describe these aspects:

\[
\bar{w}_k < 1 - \frac{\bar{\mu}_{p,k} \cdot (\bar{q}_k - \bar{\rho})}{\sqrt{3 \cdot \bar{\sigma}^2_{p,k} \cdot (1 + \bar{\rho})}}
\]

\[
\bar{\mu}_{p,k} > \frac{\sqrt{3 \cdot \bar{\sigma}^2_{p,k} \cdot (1 + \bar{\rho}) \cdot (1 - \bar{w}_k)}}{(\bar{q}_k - \bar{\rho})}
\]

\[
\bar{\sigma}^2_{p,k} > \frac{\bar{\mu}_{p,k} \cdot (\bar{q}_k - \bar{\rho})}{\sqrt{(1 + \bar{\rho}) \cdot (1 - \bar{w}_k) \cdot \sqrt{3}}}
\]

**Which Variables Determine the Extent of the Underinvestment?**

If the necessary and the sufficient conditions for underinvestment are given, the extent of the underinvestment will be the higher, the smaller \( \bar{q}_k, \bar{w}_k \), and/or \( \bar{\mu}_{p,k} \), and/or the higher \( \bar{\rho} \) and/or \( \bar{\sigma}^2_{p,k} \) are. Low \( \bar{w}_k \) and/or high \( \bar{\sigma}^2_{p,k} \) imply a high subsidy effect and therefore high additional capital costs for the entrepreneurs with the relatively safe projects. Low \( \bar{\mu}_{p,k} \) and/or high \( \bar{\rho} \) imply high capital costs as well and a low \( \bar{q}_k \) means that there is only small space for bearing additional costs. The following equations confirm these results formally:

\[
\frac{\partial U_k}{\partial \bar{q}_k} = \frac{-2 \cdot (1 + \bar{\rho})}{[(1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k)]^2} \left[ \frac{\bar{\mu}^2_{p,k}}{\sqrt{12 \bar{\sigma}^2_{p,k}}} \right] < 0
\]

---

9 \((1 + \bar{q}_k) - \bar{w}_k (1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k) > 1\) as long as \( \bar{q}_k \geq \bar{\rho} \), which is given in case of underinvestment.
\[
\frac{\partial U_k}{\partial \bar{w}_k} = \frac{-2 \cdot (1 + \bar{\rho})(\bar{q}_k - \bar{p})}{[(1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k)]^2} \cdot \frac{p_k^u}{\sqrt{12\sigma_{p,k}^2}} < 0
\]

\[
\frac{\partial U_k}{\partial \bar{\mu}_{p,k}} = \left[ 1 - \frac{(1 + \bar{q}_k) - \bar{w}_k(1 + \bar{\rho})}{(1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k)} \right] \cdot \left[ \frac{1}{\sqrt{12\sigma_{p,k}^2}} \right] < 0
\]

\[
\frac{\partial U_k}{\partial \sigma_{p,k}^2} = \frac{-\sqrt{3} \cdot \bar{\mu}_{p,k} \cdot \left[ 1 - \frac{(1 + \bar{q}_k) - \bar{w}_k(1 + \bar{\rho})}{(1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k)} \right]}{\sqrt{\sigma_{p,k}^2} \cdot 2 \cdot \sqrt{3} \cdot \sigma_{p,k}^2} > 0
\]

\[
\frac{\partial U_k}{\partial \bar{\rho}} = \frac{p_k^u}{\sqrt{12\sigma_{p,k}^2}} \cdot \frac{2 \cdot (1 + \bar{q}_k) \cdot (1 - \bar{w}_k)}{[(1 + \bar{\rho}) \cdot (2 - \bar{w}_k) - (1 + \bar{q}_k)]^2}
\]

**Which Groups Are Typically Subject to the Underinvestment Problem?**

This paper distinguishes between three groups of entrepreneurs. Group I is the “best” one. The entrepreneurs of that group exhibit the highest expected project return, the highest share of internal finance, the average risk over all projects in that group and the extent of informational problems are the smallest. Respectively group III is the “worst” and group II takes a “medium” position (see page 2 and 3).

Therefore one can proceed that in group I equilibrium ASYM I and therefore an efficient capital allocation occurs: The extent of the informational problems is so small and the share of internal finance so high, that there is only a small subsidy effect and the resulting (low) additional costs can be borne by the entrepreneurs with the safest projects, due to the high values of \(\bar{q}_k\) and \(\bar{\mu}_{p,k}\).

For group III it is likely that all entrepreneurs prefer the investment on the capital market due to the very low expected return of the project. Equilibrium ASYM III occurs. In this case \(\bar{q}_k\) is so small that it does not cover the capital costs in the benchmark case either, so that the non realisation of the projects goes hand in hand with an efficient capital allocation.

The underinvestment problem occurs in group II. The extent of the informational problems is sufficiently high and the rate of internal finance sufficiently small, that there is a considerable subsidy effect. The resulting additional costs can not be borne by the entrepreneurs with the relatively safe projects, since \(\bar{\mu}_{p,k}\) and \(\bar{q}_k\) are too small.

### 3 Overinvestment

#### 3.1 The Credit Market with Informational Problems

The only difference between the overinvestment setup and the one describing a possible underinvestment is the risk-return-combination of the investment projects: In the underinvestment model all projects of one group have the same expected return \(\bar{R}_k\) but may differ in the probability of success, which implies that there is a mean preserving spread. In the overin-
vestment setup all projects of one group yield the same return in case of success $R_k^s$, but may differ in the probability of success, which means that there is no mean preserving spread. This idea goes back to de Meza and Webb (1987), who have shown in that article that there can be overinvestment as a consequence of informational asymmetries on the credit market.

In what follows the main differences to the de Meza-Webb-Model are the division of the entrepreneurs into three groups and the specification of the distribution of the probabilities of success of the projects. Furthermore constant marginal costs for loanable funds are assumed.\(^{10}\)

Since the overinvestment setup differs only in the risk-return-combination of the projects, only those equations which differ from the respective equations of the underinvestment setup are presented in the following formal description of the credit market.

**Credit Demand**

\[(44) \quad R_i = p_i \bar{R}_k^s \]

\[(45) \quad E(PE)_i = p_i [\bar{R}_k^s - (1 + r_k) \cdot (1 - \bar{W}_k)] - \bar{W}_k \]

\[(46) \quad p_{\text{asym}, k}^{\text{crit}} = \frac{(1 + \bar{\rho}) \cdot \bar{W}_k}{\bar{R}_k^s - (1 + r_k) \cdot (1 - \bar{W}_k)} = \frac{(1 + \bar{\rho}) \cdot \bar{w}_k}{\bar{q}_k^s - r_k + \bar{w}_k \cdot (1 + r_k)} \]

\[(47) \quad K_{\text{asym}, k}^D = \begin{cases} 
\frac{1}{\bar{C}_{\text{asym}, k}} \int g_k(p_i) dp_i = \begin{cases} 
1 & \text{if } p_{\text{asym}, k}^{\text{crit}} \leq p_k^u \\
0 & \text{if } p_k^u < p_{\text{asym}, k}^{\text{crit}} \leq p_k^z \\
0 & \text{if } p_{\text{asym}, k}^{\text{crit}} > p_k^z 
\end{cases}
\end{cases} \]

In the underinvestment setup the groups can be distinguished by the expected return of the project $\bar{R}_k$, in this set up the groups can be distinguished by the return of the project in case of success ($\bar{R}_k^{s} > \bar{R}_m^{s} > \bar{R}_l^{s}$). Within a group $\bar{R}_k^{s}$ is the same for all entrepreneurs. Equation 44 shows that due to different probabilities of success there is on contrary to the underinvestment model no mean preserving spread. This implies c. p. a negative relationship between the entrepreneur expected profit and the risk of his project (equation 45).

This results again in a critical value for the probability of success $p_{\text{asym}, k}^{\text{crit}}$. But on contrary to the underinvestment model an entrepreneur only realises his project, if its probability of success is not lower than the critical value. Otherwise he prefers the alternative investment on the capital market. As can be seen from equation 46 the critical value depends on the project's rate of return in case of success $\bar{q}_k$, the rate of internal finance $\bar{w}_k$ and the risk free interest rate $\bar{\rho}$, which are all exogenous, and the interest rate $r_k$, which is endogenous. Since an increasing interest rate results in higher costs for the entrepreneurs, it is obvious that $\partial p_{\text{asym}, k}^{\text{crit}} / \partial r_k > 0$.

Since only those entrepreneurs ask for credit, whose project's $p_i$ is not lower than $p_{\text{asym}, k}^{\text{crit}}$, in this setup there exist as well three possible states of credit demand for each subgroup, depending on $r_k$: If $r_k \leq r_k^z$, all entrepreneurs of that representative subgroup will realise their

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\(^{10}\) Concerning the reason for the division of the firms into groups and the specification of the distribution of the probabilities of success of the projects see the respective comments in the underinvestment setup on page 2. For consistency reasons in this overinvestment setup constant marginal costs for loanable funds are assumed too.
project. In this case $p_{\text{asym,k}}^{\text{crit}} \leq p_k^u$, the credit demand is one. If $r_k^u < r_k \leq r_k^z$, only a part of the entrepreneurs asks for credit, since for those with the relatively risky projects the expected profit is lower than with the investment on the capital market, i.e. $p_k^u < p_{\text{asym,k}}^{\text{crit}} \leq p_k^z$. Finally, if $r_k > r_k^z$, even the entrepreneurs with the safest projects will not ask for credit, the alternative investment on the capital market is more favourable for all entrepreneurs. Consequently the credit demand in this case will be zero (equation 47).

**Credit Supply – Determining the Interest Rate**

$$E(p_i)_k = \frac{\int (1 + r_k) \cdot g_k(p_i) \cdot dp_i}{\int g_k(p_i) \cdot dp_i} = \begin{cases} \overline{\mu}_{p_i,k} & \text{if } p_{\text{asym,k}}^{\text{crit}} \leq p_k^u \\ \frac{p_{\text{asym,k}}^{\text{crit}} + p_k^z}{2} & \text{if } p_k^u < p_{\text{asym,k}}^{\text{crit}} < p_k^z \\ (1 + r_k) \cdot p_k^z & \text{if } p_k^z \geq p_{\text{asym,k}}^{\text{crit}} \\ \end{cases}$$

For $p_{\text{asym,k}}^{\text{crit}} \geq p_k^z$ $E(p_i)_k$ is not defined by equation 41. It is assumed that $E(p_i)_k = p_k^z$ if $p_k^{\text{crit}} \geq p_k^z$.

$$E(PB)_k(r_k) = \begin{cases} (1 + r_k) \cdot \overline{\mu}_{p_i,k} & \text{if } p_{\text{asym,k}}^{\text{crit}} \leq p_k^u \\ \frac{p_{\text{asym,k}}^{\text{crit}} + p_k^z}{2} & \text{if } p_k^u < p_{\text{asym,k}}^{\text{crit}} < p_k^z \\ (1 + r_k) \cdot p_k^z & \text{if } p_k^z \geq p_{\text{asym,k}}^{\text{crit}} \\ \end{cases}$$

$$r_k = \frac{1 + \overline{\rho}}{E(p_i)_k} - 1 = \begin{cases} \frac{1 + \overline{\rho}}{\overline{\mu}_{p_i,k}} - 1 & \text{if } p_{\text{asym,k}}^{\text{crit}} \leq p_k^u \\ \frac{(1 + \overline{\rho}) \cdot 2}{p_k^u + p_{\text{asym,k}}^{\text{crit}}(r_k)} - 1 & \text{if } p_k^u < p_{\text{asym,k}}^{\text{crit}} < p_k^z \\ \frac{(1 + \overline{\rho})}{p_k^z} - 1 & \text{if } p_k^z \geq p_{\text{asym,k}}^{\text{crit}} \\ \end{cases}$$

In the overinvestment setup the informational problems on the credit market exist as well in informational asymmetries between banks and entrepreneurs. Again the banks do not know the specific risk of a project $p_i$, but they are able to assess the average risk over the financed projects in one subgroup, expressed by the expected probability of success $E(p_i)_k$. As in the underinvestment setup the banks’ offer an identical interest rate to all subgroup members as a consequence of the informational problems. This implies again that the entrepreneurs with the relatively safe projects subsidise those with the relatively risky ones. But an important fact is that due to the different modelling of the risk-return-combination of the investment projects, in this setup the entrepreneurs with the relatively risky projects are the marginal entrepreneurs. This means that - on contrary to the underinvestment setup - the marginal entrepreneurs are those who are subsidised.

The different modelling of the risk-return-combination of the projects results in a different expression for $E(p_i)_k$ (equation 48). A rising interest rate implies that in the first place those entrepreneurs with the relatively risky projects prefer the alternative investment on the capital
market. This implies that as long as the offered interest rate does not exceed the reservation interest rate of those entrepreneurs with the most risky projects $r_k^*$, all entrepreneurs ask for a credit, so that $E(p_i)_k = \overline{\mu}_{p,k}$. Further increases of $r_k$ imply that more and more entrepreneurs with relatively risky projects do not ask for a credit any more, which means that $E(p_i)_k$ rises as well as long as $r_k < r_k^*$. This means that $E(p_i)_k > \overline{\mu}_{p,k}$ if $r_k^* < r_k < r_k^*$. For $r_k > r_k^*$, $E(p_i)_k$ is not defined by equation 48. For the sake of simplicity it is assumed that in this case $E(p_i)_k = P_i^*$, which says that banks suppose that an increasing of $r_k$ above $r_k^*$ does not lead to a further improvement of their risk position.

As can be seen from equation 49 these aspects result again in a two times kinked function of the banks' expected rate of return depending on the offered interest rate $E(PB)_k(r_k)$. For increases of the interest rate between $r_k^*$ and $r_k^*$ there are two positive effects on the banks' expected rate of return of their credit business: one positive effect due to higher interest revenues and a second positive effect resulting from the favourable selection of the entrepreneurs.

Solving the supply side equations an absolutely elastic credit supply to the offered interest rate $r_k$ results, covering the banks' refinancing costs $\overline{\rho}$ and a risk premium, expressed by $1/E(p_i)_k$ (equation 50).

**Equilibrium**

Solving the equations describing the demand and the supply side of the credit market shows that as well in the overinvestment setup there are three possible credit market equilibria ASYM I to ASYM III for each representative subgroup. Under ASYM I $p_{asym,k}^{asym} \leq P_i^*$, which means that all entrepreneurs of that subgroup conclude a credit contract. The equilibrium interest rate does not exceed the reservation interest rate of the entrepreneurs with the most risky projects, respectively the equilibrium risk premium is $1/\overline{\mu}_{p,k}$ (equations 51 and 52).

\begin{align*}
(51) & \quad K_{asym}^* = 1 \\
(52) & \quad r_{asym}^* = \frac{1 + \overline{\rho}}{\overline{\mu}_{p,k}} - 1 \leq r_k^*
\end{align*}

Under ASYM II $r_k^* < r_k \leq r_k^*$, i.e. $p_i^* < p_{asym,k} < P_i^*$, which implies that only a share of the entrepreneurs realise their project. For the entrepreneurs with the relatively risky projects the alternative investment on the capital market is more favourable (equation 53). Formally the share of entrepreneurs realising their projects corresponds to the area under the density function between $p_{asym,k}^{asym}$ and $P_i^*$. The equations 47 and 48 therefore show the variables determining the share of entrepreneurs concluding a credit contract. Under ASYM II the risk-premium $1/E(p_i)_k < 1/\overline{\mu}_{p,k}$, due to the favourable selection among the entrepreneurs, initialised by an increasing interest rate (equation 57).

\begin{align*}
(53) & \quad 0 < K_{asym}^* = \int_{p_{asym,k}^{asym}}^{P_i^*} g_k(p_i) \cdot dp_i < 1 \\
(54) & \quad f(p_{asym,k}^{asym}) = \\
& \quad (1 + q_k) \cdot (p_{asym,k}^{asym} \cdot P_i^* + (p_{asym,k}^{asym})^2) - (1 + \overline{\rho}) \cdot \overline{w}_k \cdot (p_i^* - p_{asym,k}^{asym}) - 2 \cdot (1 + \overline{\rho}) \cdot p_{asym,k}^{asym}
\end{align*}
\[ P^*_k = \mu_k + \sqrt{3\sigma^2_{\mu_k}} \]

\[ r^*_k \leq r_{\text{asym},k} = \frac{1 + \bar{\rho}}{E(p_i)_{\text{asym},k}} < r^*_k \]

\[ E(p_i)_{\text{asym},k} = \frac{p^*_k + p^{\text{crit,*}}_{\text{asym},k}}{2} < \mu_k \]

Equilibrium \textit{ASYM III} is characterised by the fact that no entrepreneur of the representative subgroup realises his project (\textit{equation 58}). The interest rate which covers the banks’ costs for loanable funds and an adequate risk premium implies that \( p^{\text{crit,*}}_{\text{asym},k} > p^*_k \), so that the reservation interest rate of the entrepreneurs with the safest projects is lower than the banks’ reservation interest rate.

\[ K_{\text{asym},k} = 0 \]

\subsection*{3.2 The Credit Market without Informational Problems}

Analogously to the underinvestment setup the entrepreneurs’ reservation interest rate can be determined:

\[ r_{\text{Res},i} = \frac{(1 + \bar{q}_k)}{(1 - w_k)} - \frac{(1 + \bar{\rho})w_k}{(1 - w_k)p_i} + 1 \]

\textit{Equation 59} shows that in this setup there is a negative relation ship between \( r_{\text{Res},i} \) and the risk of a project. Since between the banks’ reservation interest rate (which is the same as in the benchmark case in the underinvestment setup) and the risk of a project there is a positive relationship (\textit{equation 26}), there exists as well a critical value for \( p_i \) on a credit market in the benchmark case in this setup. The projects must have at least a probability of success \( p^{\text{crit}}_{\text{sym},k} \) otherwise \( r_{\text{Res},i} < r_{\text{Res},i} \), and the project is not realised.

\[ p^{\text{crit}}_{\text{sym},k} = \frac{1 + \bar{\rho}}{1 + \bar{q}_k} \]

This means that as well in the situation without informational problems there can be three possible equilibria for each subgroup. Either all entrepreneurs conclude a credit contract, if \( p^{\text{crit}}_{\text{sym},k} \leq p^*_k \) (equilibrium \textit{SYM I}, \textit{equation 61}), only a share of the entrepreneurs realise their project, if \( p^*_k \geq p^{\text{crit}}_{\text{sym},k} > p^*_k \) (equilibrium \textit{SYM II}, \textit{equation 62}) or no entrepreneur concludes a credit contract, if \( p^{\text{crit}}_{\text{sym},k} > p^*_k \) (equilibrium \textit{SYM III}, \textit{equation 63}). Due to the competitive banking industry the equilibrium interest rate corresponds with the banks’ reservation interest rate in the equilibria SYM I and SYM II.

\[ K_{\text{sym},k} = \int_{p^*_k}^{p^*_k} g_k(p_i) \cdot dp_i = 1 \]

\[ 0 < K_{\text{sym},k} = \int_{p^{\text{crit}}_{\text{sym},k}}^{p^*_k} g_k(p_i) \cdot dp_i < 1 \]
3.3 Comparison – Overinvestment Is Possible

Equilibrium ASYM II - Overinvestment

The corresponding equilibrium in the benchmark case is SYM II. In both situations only a share of the entrepreneurs realise their projects. But the number of realised projects in the situation with informational projects must be higher (\( p_{\text{asyk}}^{\text{crit}} < p_{\text{symk}}^{\text{crit}} \)), due to the subsidy effect combined with the competitive banking industry, as figure 2 illustrates.

![Figure 2: Overinvestment as a Consequence of Informational Asymmetries](image)

The upper part shows the entrepreneurs' and the banks' interest rates depending on \( p_i \) (compare equations 26 and 59). The lower part illustrates the density function of the uniformly distributed \( p_i \). In the benchmark case all projects, whose probability of success is at least \( p_{\text{symk}}^{\text{crit}} \) are financed. The size of the realised projects therefore corresponds with area 5 under the density function. Due to the competitive banking industry the whole surplus (the area between the two "reservation interest rates curves") accrues to the entrepreneurs. Realising the same projects in the situation with informational asymmetries demands an equilibrium interest rate \( r_{k,2} \). But with this interest rate the banks would expect a profit above their normal profit (areas 3 and 4). Therefore the interest rate decreases to \( r_{k,2} \), where the expected profit above the normal level (area 4) equals the expected loss (areas 1 and 2). But \( r_{k,2} \) is that low, that

\[ K_{\text{asyk}} = 0 \]

For simplicity reasons a linear relationship between \( p_i \) and the reservation interest rates is assumed in figure 2. Actually the relationship is hyperbolic as equations 26 and 59 indicate. The linearity can be justified, if only a section, as in the figure, is looked at. Simulations confirm this aspect.
more entrepreneurs than in the situation without informational problems realise their project. The size of this overinvestment corresponds with area 6 under the density function. Therefore ASYM II always implies an overinvestment. Equation 64 describes the overinvestment formally.

\[ (64) \quad O_{ill, k} = \int_{p_{w, k}^{crn}}^{p_{v, k}} g_k(p_i) \cdot dp_i \]

**Equilibrium ASYM I – Overinvestment Is Possible**

Under ASYM I all projects are financed. This situation can imply overinvestment. It implies an inefficient capital allocation, if \( p_{sym, k}^{crn} \leq p_k^u \) and \( p_{sym, k}^{crn} > p_k^u \). In this case the corresponding equilibrium in the benchmark case reference situation is SYM II, so that the number of realised projects is higher with informational asymmetries. Equation 58 describes this overinvestment formally. But if \( p_{sym, k}^{crn} < p_k^u \) and \( p_{sym, k}^{crn} \geq p_k^u \), the corresponding equilibrium is SYM I, which means that in both situations all projects are financed, the informational asymmetries do not lead to an overinvestment.

\[ (65) \quad O_{ill, k} = \int_{p_k^u}^{p_{w, k}^{crn}} g_k(p_i) \cdot dp_i \]

**Equilibrium ASYM III – No Overinvestment**

Under ASYM III no project is realised. In this case no project would have been financed in the benchmark case either, the corresponding equilibrium is SYM III (\( p_{sym, k}^{crn} > p_k^i \) and \( p_{sym, k}^{crn} > p_k^i \)). There is no inefficient capital allocation despite the informational asymmetries. The expected profit from the projects is so small, that the alternative investment on the capital market is more favourable for all entrepreneurs of the subgroup in any case.

### 3.4 Implications

**Necessary and Sufficient Conditions for Overinvestment**

In this setup overinvestment is characterised by the realisation of inefficient projects as a consequence of informational asymmetries. Inefficient projects are financed, because there is an interest subsidy of the marginal entrepreneurs due to the informational problems. The necessary and the sufficient condition for overinvestment is that in the representative subgroup there are efficient and inefficient projects. Formally does this mean that \( p_k^u < p_{sym, k}^{crn} \leq p_k^i \), which leads to:

\[ (66) \quad \overline{\mu}_{p, k} \cdot \sqrt{3 \cdot \overline{\sigma}_{p, k}^2} \frac{1 + \overline{p}}{1 + \overline{q}_k} \leq \overline{\mu}_{p, k} + \sqrt{3 \cdot \overline{\sigma}_{p, k}^2} \]

Which magnitude do the model variables therefore typically have in case of overinvestment? The rate of return in case of success \( \overline{q}_k^* \), the refinancing costs and the opportunity costs \( \overline{p} \), and the average risk over the projects in the representative subgroup \( \overline{\mu}_{p, k} \) typically lie in a specific corridor: \( \overline{q}_k^* \) is not that high and \( \overline{p} \) and \( \overline{\mu}_{p, k} \) are not that low that only efficient projects exists in that subgroup. But these variables are not that low respectively that high either
that all projects are inefficient. Formally these can be seen from the following equations, which result from the transformation of equation 66.

\( \frac{(1 + \bar{\rho})}{\mu_{p,k}} - 1 > \bar{q}_k^* \geq \frac{(1 + \bar{\rho})}{\mu_{p,k} + \sqrt{3 \cdot \sigma^2_{p,k}}} - 1 \)

\( (1 + \bar{q}_k^*) \cdot \left( \frac{\mu_{p,k} + \sqrt{3 \cdot \sigma^2_{p,k}}}{\mu_{p,k}} \right) < \bar{\rho} \leq (1 + \bar{q}_k^*) \cdot \left( \frac{\mu_{p,k} + \sqrt{3 \cdot \sigma^2_{p,k}}}{\mu_{p,k}} \right) \)

\( \frac{(1 + \bar{\rho})}{(1 + \bar{q}_k^* \sqrt{3 \cdot \sigma^2_{p,k}})} > \bar{\mu}_{p,k} \geq \frac{(1 + \bar{\rho})}{(1 + \bar{q}_k^* \sqrt{3 \cdot \sigma^2_{p,k}})} \)

The rate of internal finance \( \bar{w}_k \) has no effect on the efficiency of a project, therefore it has no influence on the occurrence of overinvestment (see equation 66). The extent of the informational problems \( \sigma^2_{p,k} \) is typically high in case of overinvestment: The higher \( \sigma^2_{p,k} \), the more heterogenous are the entrepreneurs in the subgroup concerning the risk of their project. This means that the expected returns differ strongly in that subgroup. This again raises the chance of having efficient and inefficient projects. Equation 70, resulting from equation 66, shows this formally.

\( \sigma^2_{p,k} \geq \sqrt{\frac{1 + \bar{\rho}}{1 + \bar{q}_k^* \sqrt{3 \cdot \sigma^2_{p,k}}} - \mu_{p,k}} \)

\[ (70) \]

Which Variables Determine the Extent of the Overinvestment?

Analysing the variables, which determine the extent of the overinvestment, this paper focuses on the Equilibrium ASYM II, which means that there are still projects which are not financed, which means that there is still a further “need” for subsidies, which is not the case with Equilibrium ASYM I.

The overinvestment is a consequence of the subsidy effect. Therefore the extent of the overinvestment is the higher the stronger this subsidy effect is. This effect again is the stronger the smaller \( \bar{w}_k \), since the subsidy results from external finance. The effect is the stronger, the higher \( \bar{q}_k^* \) and/or \( \bar{\mu}_{p,k} \) and/or the smaller \( \bar{\rho} \), due to the positive effect of these variables on the expected return of the projects, which means that only a small subsidy effect is needed for realising projects, which would not have been financed in the benchmark case. Equations 71 to 74 confirm these results formally.

A rising extent of the informational problems raises the probability of the occurrence of an overinvestment, but the effect on the extent of the overinvestment is ambiguous: on the one hand a rising \( \sigma^2_{p,k} \) implies that the number of projects lying in the “overinvestment interval” \([ p_{\text{asymp},k}, p_{\text{asymp},k}' \) decreases, but on the other hand the equilibrium interest rate decreases as well, which has a positive effect on the overinvestment. Which effect will be outweighed depends on the already existing extent of the overinvestment. If the share of realised inefficient projects \( (p_{\text{asymp},k} - p_{\text{asymp},k}'))/(p_k^* - p_k^*') \) is already high, the effect of the decreasing
diff in rate of internal finance and the number of realised projects. In that paper they therefore show that, due to specific incentives, overinvestment might occur despite having the positive relationship.
sity outweighs the effect of the decreasing interest rate, so that the overinvestment is reduced (equation 75). For a clearer presentation $A$ stands for $2 \cdot \{E(p,k) \cdot (1 + \bar{q}_k' - (1- \bar{\rho})) + (1 + \bar{q}_k') \cdot P_{\text{asym},k}^c + (1 + \bar{\rho}) \cdot \bar{w}_k \}$ in the equations 71 to 75.

\[
\frac{\partial O_{H,k}}{\partial q_k'} = \frac{d_k \cdot [(1 + \bar{\rho})^2 \cdot (1 - \bar{w}_k)] \left[ (p_{\text{asym},k}^c)^2 - \frac{\bar{w}_k}{2} \cdot (p_k^c - p_{\text{asym},k}^c)^2 \right]}{(1 + \bar{q}_k')^2 \cdot E(p,k) \cdot p_{\text{asym},k}^c \cdot A} > 0
\]

under the condition\(^\text{13}\) that \( (p_{\text{asym},k}^c)^2 - \frac{\bar{w}_k}{2} \cdot (p_k^c - p_{\text{asym},k}^c)^2 > 0 \)

\[
\frac{\partial O_{H,k}}{\partial \bar{w}_k} = \frac{-d_k \cdot (1 + \bar{\rho}) \cdot (p_{\text{asym},k}^c - p_k^c)}{A} < 0
\]

\[
\frac{\partial O_{H,k}}{\partial \bar{\rho}} = \frac{-d_k \cdot (1 + \bar{\rho})}{E(p,k) \cdot p_{\text{asym},k}^c} \left[ (p_{\text{asym},k}^c)^2 - \frac{\bar{w}_k}{2} [2(p_{\text{asym},k}^c)^2 + (p_{\text{asym},k}^c - p_k^c)^2 (1 - \bar{w}_k)] \right] \cdot A \cdot (1 + \bar{q}_k') \cdot E(p,k) \cdot p_{\text{asym},k}^c < 0
\]

under the condition\(^\text{14}\) that \( (p_{\text{asym},k}^c)^2 - \frac{\bar{w}_k}{2} [2(p_{\text{asym},k}^c)^2 + (p_{\text{asym},k}^c - p_k^c)^2 (1 - \bar{w}_k)] > 0 \)

\[
\frac{\partial O_{H,k}}{\partial \mu_{p,k}'} = \frac{d_k \cdot 2 \cdot (1 + \bar{q}_k') \cdot p_{\text{asym},k}^c - (1 + \bar{\rho}) \cdot \bar{w}_k}{A} > 0
\]

\[
\frac{\partial O_{H,k}}{\partial \bar{\sigma}_{p,k}^2} = \frac{-6 \cdot d_k^2}{A} \cdot \left[ \frac{(p_{\text{asym},k}^c - p_{\text{asym},k}^c)}{(p_k^c - p_{\text{asym},k}^c)} \cdot 2 \cdot A - \left( (1 + \bar{q}_k') \cdot p_{\text{asym},k}^c - (1 - \bar{\rho}) \cdot \bar{w}_k \right) \right] \leq 0
\]

\[
\frac{\partial O_{H,k}}{\partial \bar{\sigma}_{p,k}^2} = \frac{-6 \cdot d_k^2}{A} \cdot \left[ \frac{(p_{\text{asym},k}^c - p_{\text{asym},k}^c)}{(p_k^c - p_{\text{asym},k}^c)} \cdot 2 \cdot A - \left( (1 + \bar{q}_k') \cdot p_{\text{asym},k}^c - (1 - \bar{\rho}) \cdot \bar{w}_k \right) \right] \leq 0
\]

**Which groups are Typically Subject to the Overinvestment Problem?**

One can postulate generally that in Group I (for a description see page 2) there is no overinvestment: The return in case of success $\bar{q}_k'$ is that high and the average risk $(1 - \bar{\mu}_{p,k}')$ and the heterogeneity of the subgroup members concerning their risk $\bar{\sigma}_{p,k}'$ are that small, that all projects are efficient, which means that ASYM I and SYM I are the relevant equilibria. For Group III one can proceed that all investors prefer the investment on the capital market due to the low $\bar{q}_k'$ and $\bar{\mu}_{p,k}'$, so that there is no overinvestment problem either (ASYM III and SYM III occur). An inefficient capital allocation in form of an overinvestment might occur in Group II: $\bar{q}_k'$ and $\bar{\mu}_{p,k}'$ are not that low that all projects of the representative subgroup are inefficient but they are not that high and $\bar{\sigma}_{p,k}'$ is not that small either that all projects are effi-

\(^\text{13}\) The condition expresses that $\partial O_{H,k}/\partial q_k' > 0$, if there is still a „need“ for a further subsidy. If in the situation with informational problems all or nearly all projects in the subgroup are already realised, there is no need for the whole additional subsidy funds resulting from a increasing $\bar{q}_k'$. If there is no need for the whole funds anymore, there is even a negative relationship between $\bar{q}_k'$ and $O_{H,k}$.

\(^\text{14}\) The condition expresses that $\partial O_{H,k}/\partial \bar{\rho} < 0$, if there has been an overinvestment problem before the increase of $\bar{\rho}$. If the relevant equilibria were ASYM I and SYM I, an increasing $\bar{\rho}$ might even lead to overinvestment.
cient. This means that it is likely that in group II ASYM I and SYM II or ASYM II and SYM II occur, which means that there is an overinvestment problem in that subgroup.

4 Implications for the Transition in Eastern Germany

Section 2 and 3 have shown that informational problems are not sufficient for the occurrence of under- and/or overinvestment, but that the model variables must have a specific magnitude. This section therefore analyses by the help of indicators which magnitude the model variables might have had in the East German manufacturing sector during the 1990s. The study focuses on the manufacturing sector, since especially in this sector the capital stock plays a central role and since this sector has often been considered as the “Achilles heel” of the transition in Eastern Germany. The results indicate strongly that the build up of a new capital stock was accompanied by a sizeable magnitude of over- and underinvestment.

Description of the Model Variables for the East German Manufacturing Sector

Among others the Deutsche Bundesbank analyses balance sheets of East German enterprises annually. Due to these analyses the success of the enterprises in the manufacturing sector differed widely between the firms from 1992 to 1997: on average half of the analysed firms made a loss, 25% yielded a profit-turnover ratio of less than 2% and the average profit-turnover ratio of the uppermost quartile was roughly 10%. In view of these figures the later presented simulations were conducted for 14% (15%), 5.5% (5%) and 3% (4%) for the rate of return before financing costs $\bar{\gamma}$ ($\bar{\gamma}'$).

In the balance sheets analysed by the Deutsche Bundesbank, the own funds ratio differed as well considerably between the firms in the manufacturing sector from 1992 to 1997: the ratio was on average negative in the lowest quartile, 8% in the second, 21% in the third and 52% in the uppermost quartile. Keeping these figures in mind, the simulations were done for 50%, 10% and 5% for the rate of internal finance $\bar{\omega}$.

From 1995 to 1998 21 out of 1000 enterprises went bankrupt in the East German manufacturing sector. Taking this as an indicator for the average probability of loan losses, one gets for $\overline{\mu_{p,a}}$ 2.1%. Considering the heterogeneity of East German firms concerning their success, their own funds ratio and their ownership structure, it is assumed that the credit risk differed as well between the firms, so that the simulation was conducted for 1%, 2% and 3% for the average risk over the projects $\overline{\mu_{p,a}}$.

The extent of informational asymmetries is not captured by any single indicator, that allows a quantitative assessment of the respective model variable. Considering again the heterogeneity of the firms, it is assumed that were groups of firms - first and foremost those in

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15 For a detailed description of these analyses see the publications given in the next footnote.
16 Deutsche Bundesbank (1996a-1999a), own calculations.
17 The own funds ratio is the own funds as % of the balance sheet total less adjustments to capital accounts.
18 Deutsche Bundesbank (1996a-1999a), own calculations.
20 For comparison: The Dresdner Bank AG presents in their annual report for 1998 a relation of non performed loans to total loans of 0.18%. Dresdner Bank AG (1999).
the ownership of West German and foreign investors - whose credit risk could be assessed rather well by the banks. But it is supposed that with a big share of the firms the credit risk was difficult to assess, since they were very young or just privatised, not yet established on the markets, which means that relevant information simply did not exist. Keeping in mind the figures for \(1 - \bar{\mu}_{p,k}\), the simulation was done for 0.6%, 0.8% and 0.9% for \(\sigma_{p,k}\).

The annual interest expenses of banks having their residence in Eastern Germany was on average 3.8% from 1992 to 1998.\(^{21}\) The government bond yields\(^{22}\) in real terms reached on average 3.5% in the same period.\(^{23}\) Therefore the simulations were done for 4% for the refinancing and opportunity costs \(\bar{\rho}\).

**Simulations**

<table>
<thead>
<tr>
<th>Exogenous variables</th>
<th>Simulation I</th>
<th>Simulation II</th>
<th>Simulation III</th>
</tr>
</thead>
<tbody>
<tr>
<td>expected rate of return before financing costs (\bar{q}_k) resp.</td>
<td>14%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>rate of return in case of success before financing costs (\bar{q}_k^+)</td>
<td>15%</td>
<td>5.5%</td>
<td>4%</td>
</tr>
<tr>
<td>rate of internal finance (\bar{w}_k)</td>
<td>50%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>average risk over the projects (1 - \bar{\mu}_{p,k})</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>extent of informational problems (\bar{\sigma}_{p,k})</td>
<td>0.6%</td>
<td>0.8%</td>
<td>0.9%</td>
</tr>
<tr>
<td>refinancing and opportunity costs (\bar{\rho})</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

**Results**

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>underinvestment (U_k)</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>overinvestment (O_{II,k})</td>
<td>0%</td>
<td>12%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Simulations of efficient and inefficient capital allocations on credit markets with informational problems

The table presents the conducted simulations. According to the theoretical analyses in the sections 2 and 3, for simulation I it is assumed that the group with those firms showing the highest rates of return, is also the “best” group for all other group specific variables. The same applies analogously for the simulations II and III. The results show that while under the second scenario under- and overinvestment do occur, the simulations I and III result in efficient allocations.

**Implications**

The interesting fact is that in the 1990s the predominant economic variables in the East German manufacturing sector had a magnitude, corresponding to the second scenario. This strongly indicates the occurrence of significant over- and underinvestment.

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\(^{22}\) Yield of government bonds with an initial maturity of more than 4 years, as long as the medium of the actual maturity is more than 3 years.

It is however not possible to identify which of these misallocations was more dominant, since empirically one cannot determine which projects are of the "underinvestment type", having the same \( q_i \), and which are of the "overinvestment type", having the same \( q_i^{-} \). If an equal occurrence of both project types is assumed, than underinvestment might have been the more relevant problem, since due to their weak profitability, it is more likely that East German firms were not able to bear the necessary additional costs than being able to subsidise a significant number of other firms.

It is important to make one point clear: the result of this paper is not that – concerning to the simulations – that there was an underinvestment of 25 % and an overinvestment of 12 % during the 1990s in the East German manufacturing sector, since the used indicators do not satisfy the requirements for a reliable quantitative result. The indicators can give only a rough assessment of the respective variables. But the important point of this paper was to give a sound theoretical foundation for the thesis that the transition in the East German manufacturing sector has been accompanied by the parallel existence of significant over- and underinvestment due to informational problems on the credit markets.

5 Summary and Final Remarks

The Basic Story of this Study

There are informational asymmetries between banks and entrepreneurs about the specific risk of the projects to be financed. Whereas the entrepreneurs know the specific risk of the projects the banks are only able to classify the entrepreneurs into specific risk categories. The higher the extent of informational problems is, the more heterogenous are the entrepreneurs within a risk category concerning the risk of their project. Since all entrepreneurs within a risk category are charged the same interest rate, there will be a subsidy of the entrepreneurs with the relatively risky projects by those with the relatively safe projects. Depending on the risk-return-combination of the investment projects this subsidy effect can either lead to over- or underinvestment. If there is a mean preserving spread, the marginal entrepreneurs will be those with the relatively safe projects, which implies that the marginal entrepreneurs are those who subsidise. This means that the subsidy effect will lead to underinvestment, if there are entrepreneurs who cannot bear the additional costs. If there is no mean preserving spread, but all projects in a risk category have the same return in case of success but differ in risk, the marginal entrepreneurs will be those with the relatively risky projects, i.e. the entrepreneurs who are subsidised. In this case overinvestment will occur, if there will be entrepreneurs who only realise their projects because of the subsidy. For the occurrence of these inefficiencies there must be a sufficiently high subsidy effect, which means that the informational problems must be sufficiently high and the rate of internal finance must be sufficiently low. In case of underinvestment the expected profit of the entrepreneurs with the relatively safe projects must be smaller than their opportunity costs, which is the risk free interest rate, but without these additional costs their expected profit from the project must be at least as high as their opportunity costs. In case of overinvestment the expected profit of the entrepreneurs with the relatively risky projects must be smaller than their opportunity costs, if it there is no subsidy. But the expected profit must be at least as high as their opportunity costs if they are subsidised.
During the transition in Eastern Germany there have been substantial informational problems between banks and firms, since most of the firms have been very young or just privatised, which means that relevant information has not existed. The rate of internal finance has been relatively low and a big share of entrepreneurs has operated narrowly under or above the break even point. These aspects indicate a strong evidence for substantial over- and underinvestment. If an equal occurrence of both project types (the "mean-preserving-spread-projects", i.e. the underinvestment-type-projects and the overinvestment-type-projects) were assumed, underinvestment might have been the more relevant problem, since due to their weak profitability, it is more likely that East German firms were not able to bear the necessary additional costs than being able to subsidise a significant number of other firms. The results for Eastern Germany are supported by simulations.

Aspects for Further Discussion

Project types: Crucial for the parallel occurrence of under- and overinvestment is the assumption, that both types of projects exist: the "mean-preserving-spread-projects" (underinvestment-type-projects) and the overinvestment-type-projects. Crucial for the question, which kind of inefficiency outweighs, is the share of underinvestment-type-projects compared with the share of overinvestment-type-projects. The question is, whether there is a way of identifying the project types. Generally, existing studies speak for a dominance of the underinvestment-type-projects, since empirical evidence indicate a positive relationship between the rate of internal finance and investments. But de Meza and Webb (1999) show that there might be incentive mechanisms implying overinvestment although having a positive relationship between these two variables.

Government Intervention: The transition in Eastern Germany has been accompanied by a huge number of government programs promoting investments. Considering the setups of this study these programs soothe underinvestment but reinforce overinvestment. As long as one cannot identify the project type, which means as long as one cannot assess whether the over- or underinvestment problem is more severe, market failure as a consequence of informational asymmetries does not hold as an argument for those government interventions. Furthermore even with the underinvestment-type-projects the government programs may lead to overinvestment and/or pure windfall profits (compare Gale (1991)). The same arguments hold for other areas of government programs promoting investments, for example in the financial support of start-ups.

Informational Asymmetries about Other Variables: In this study it is assumed that the informational asymmetries concern only to the risk of the projects, but that all other variables are public knowledge. If it were not for the public knowledge of specific variables, and banks and entrepreneurs had a divergent view concerning the magnitude of this variable, it would depend on the fact who is right, whether there will be an inefficient allocation. If the bank is wrong, a red lining problem, resulting in underinvestment, might occur. If the bank is right, the informational problems will not result in underinvestment (compare de Meza and Southey (1996)).

Other transition economies: A further interesting point to discuss is, in what respect the results of this study can be transferred to other transition economies.
List of Symbols

d  density of the uniformly distributed \( p_i \)
\( E(PE) \)  expected profit of an entrepreneur
\( E(PB) \)  expected profit of a bank
\( E(p_i) \)  expected probability of repayment
\( \bar{I} \)  price of an investment project
\( L^S \)  supply of loanable funds
\( K^D \)  credit demand
\( K^S \)  credit supply
\( O \)  overinvestment
\( p \)  probability of success of an investment project
\( p^* \)  probability of success of the most risky investment projects
\( p^\ddagger \)  probability of success of the safest investment projects
\( q \)  expected rate of return on an investment project
\( q^\ddagger \)  rate of return on an investment project in case of success
\( R \)  expected return on an investment project
\( R^\ddagger \)  return on an investment project in case of success
\( r \)  credit interest rate
\( r^* \)  reservation interest rate of the entrepreneurs with the most risky projects
\( r^\ddagger \)  reservation interest rate of the entrepreneurs with the safest projects
\( U \)  underinvestment
\( W \)  wealth of an entrepreneur
\( w \)  rate of internal finance
\( \eta_{x,y} \)  elasticity of \( x \) concerning \( y \)
\( \rho \)  riskfree interest rate
\( \sigma^2_{\rho_i} \)  variance of the uniformly distributed \( p_i \)
\( \mu_{\rho_i} \)  mean of the uniformly distributed \( p_i \)
\( \bar{x} \)  a bar indicates an exogenous variable
\( x_i \)  \( i \) indicates a project-specific variable
\( x_k \)  \( k \) indicates a group-specific variable
\( x^* \)  * indicates a variable in equilibrium
References

Blum, Jürg und Martin Hellwig (1996)


Clemenz, Gerhard (1996)
Credit Markets with Asymmetric Information. Berlin 1986.


Dresdner Bank AG (1999)


Hellwig, Martin (1991)

Hillier, Brian (1997)
The Economics of Asymmetric Information. London 1997.

Leland, Hayne E. and David H. Pyle (1977)

Mayer, Colin (1988)

Meza, David de und Clive Southey (1996)

Meza, David de und David Webb (1987)

Meza, David de und David Webb (1999)
Rothschild, Michael and Joseph E. Stiglitz (1970)


Thadden, Ernst-Ludwig von (1995)


List of Used Statistics

Deutsche Bundesbank (1994a)

Deutsche Bundesbank (1996a)

Deutsche Bundesbank (1996b)

Deutsche Bundesbank (1997a)

Deutsche Bundesbank (1997b)

Deutsche Bundesbank (1998a)
Deutsche Bundesbank (1998b)

Deutsche Bundesbank (1999a)

Deutsche Bundesbank (1999b)

Statistisches Bundesamt (1993a)

Statistisches Bundesamt (1994a)

Statistisches Bundesamt (1995a)

Statistisches Bundesamt (1995b)

Statistisches Bundesamt (1995c)
Statistisches Jahrbuch 1995 für die Bundesrepublik Deutschland. Wiesbaden 1995.

Statistisches Bundesamt (1996a)

Statistisches Bundesamt (1997a)

Statistisches Bundesamt (1997b)

Statistisches Bundesamt (1998a)

Statistisches Bundesamt (1998b)

Statistisches Bundesamt (1998c)
Statistisches Bundesamt (1999a)

Statistisches Bundesamt (1999b)

Statistisches Landesamt Berlin (1999)