# DISCUSSION PAPER

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# EMPIRICAL MEASUREMENT OF CREDIT RATIONING IN AGRICULTURE: A METHODOLOGICAL SURVEY

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**ABSTRACT**

Empirical analysis of rural credit market failure has been of key scientific and political interest in recent years. The aim of this paper is to give an overview of various methods for measuring credit rationing of farms employed in the literature. Furthermore, based on a common analytical framework entailing a formal model of a credit rationed farm household, the methods are subjected to a comparative evaluation of their specific strengths or shortcomings. Six approaches are distinguished: measurement of loan transaction costs, analysis of qualitative information collected in interviews, analysis of quantitative information collected in interviews by using the credit limit concept, analysis of spill-over effects with regard to secondary credit sources, econometric household modelling, and the econometric analysis of dynamic investment decisions. The first approach defines credit rationing as the impossibility to take a loan due to prohibitively high, measurable transaction costs on loan markets, which is a price rationing mechanism. All other approaches at least implicitly define credit rationing as a persistent private excess demand in terms of a quantity restriction. The six approaches are more or less closely linked to the neo-classical efficiency concept. An explicit comparison with a first-best solution is impossible in the first three approaches, since they essentially rely on a subjective assessment of borrowers' access to credit, based on qualitative or quantitative indicators. The fifth and sixth approach allow a rigorous interpretation in the framework of neo-classical equilibrium theory. The fourth approach takes an intermediate position, since spill-over on segmented loan markets reveals a willingness to pay with regard to the supposedly less expensive but rationed primary source. Approaches are fairly data demanding in general, usually requiring specific data on loan transactions. Even so, most approaches are applicable to cross-sectional household data. Only dynamic modelling of investment decisions necessitates the availability of panel data, therefore restricting the applicability in low-income and transition countries. With the exception of the first, all methods surveyed might plausibly be used to empirically detect credit rationing.

JEL: Q 12, Q 14.
Keywords: agricultural finance, credit rationing, quantitative analysis, micro-econometrics.

**ZUSAMMENFASSUNG**

Die empirische Analyse von Marktversagen auf ländlichen Kreditmärkten ist in den vergangenen Jahren von hohem wissenschaftlichen und politischen Interesse gewesen. Ziel dieses Beitrags ist es, einen Überblick über verschiedene in der Literatur angewandte Methoden zur Messung von Kreditrationierung zu geben. Auf der Grundlage eines gemeinsamen analytischen Bezugsrahmens werden die Methoden darüber hinaus einer vergleichenden Bewertung im Hinblick auf ihre Stärken und Schwächen unterzogen. Es werden sechs Vorgehensweisen unterschieden: die Messung von Kredittransaktionskosten, die Analyse von in Interviews gewonnenen qualitativen Informationen, die Analyse von in Interviews erhobenen quantitativen Information unter Rückgriff auf das Konzept des credit limits, die Analyse von Überschusseffekten im Hinblick auf sekundäre Kreditquellen, ökonometrische Haushaltsmodellierung sowie die ökonometrische Analyse von dynamischen Investitionsentscheidungen. Die erste Vorgehensweise versteht unter Kreditrationierung die Unmöglichkeit, einen Kredit zu erhalten aufgrund von prohibitiv hohen, messbaren Transaktionskosten auf Kreditmärkten. Es handelt sich hierbei um einen Mechanismus der Preisrationierung. Alle anderen Vorgehensweisen defi-

nieren Kreditrationierung zumindest implizit als andauernde Überschussnachfrage, folglich eine Mengenbeschränkung. Die sechs Vorgehensweisen sind mehr oder weniger eng mit dem neoklassischen Effizienzkonzept verbunden. Ein expliziter Vergleich mit einer first-best Lösung ist in den ersten drei Vorgehensweisen jedoch unmöglich, da sie auf einer subjektiven Einschätzung des Kreditzugangs beruhen. Die fünfte und sechste Methode erlauben hingegen eine strikte Interpretation im Rahmen der neoklassischen Gleichgewichtstheorie. Die vierte Vorgehensweise nimmt eine Zwischenstellung ein, da Überschusseffekte auf segmentierten Kreditmärkten eine Zahlungsbereitschaft im Hinblick auf die primäre, rationierte Kreditquelle implizieren. Die Methoden erfordern die Verfügbarkeit von geeigneten Datensätzen über Kredittransaktionen. Die meisten Ansätze können allerdings auf Querschnittsdaten angewendet werden. Lediglich die dynamische Modellierung von Investitionsentscheidungen erfordert Paneldaten und beschränkt daher die Einsatzmöglichkeit in Entwicklungs- und Transformationsländern. Mit Ausnahme des ersten können alle Ansätze auf plausible Weise für die empirische Untersuchung von Kreditrationierung eingesetzt werden.

JEL: Q 12, Q 14.
Schlüsselwörter: Agrarfinanzierung, Kreditrationierung, quantitative Analyse, Mikroökonometrie.

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## LIST OF IMPORTANT SYMBOLS

| | |
|---|---|
| $c$ | consumption bundle |
| $E$ | initial endowment |
| $f$ | production function |
| $K$ | credit volume |
| $\overline{K}$ | credit volume under rationing |
| $L$ | Lagrangean function |
| $M$ | household income |
| $p$ | price of the variable input |
| $r$ | interest rate |
| $r^*$ | shadow interest rate under rationing |
| $T$ | public transfers |
| $u$ | utility function |
| $x$ | variable input |
| $y$ | farm output |
| $z^h$ | household characteristics |
| $z^y$ | fixed production inputs |
| $\lambda$ | Lagrangean multiplier |
| $\lambda$ | Lagrangean multiplier |
| $\mu$ | Lagrangean multiplier |

## 1 INTRODUCTION[1]

Access to credit is commonly regarded as a key requirement for economic growth and rising living standards in less developed rural areas. Consequently, in the development economics literature, credit policy analysis figures prominently and a large body of literature has evolved over recent decades (see BESLEY 1995 for an overview). One major pillar of this literature deals with the problem that poor households in developing countries, often with agriculture as a main source of income, cannot obtain as much credit as needed – if they obtain any credit at all – and therefore remain tightly credit rationed by formal lenders. Households may therefore be in a position either to accept these constraints or to resort to informal credit sources. Both possibilities are only second-best solutions that may further reinforce existing welfare gaps between rural dwellers and other parts of the population. The welfare gap may manifest itself in lower levels and higher uncertainty of rural incomes, which may be due to low labour productivity, lagged technology adoption, or little consumption smoothing capacity. A central policy issue is thus how to improve the performance of inefficient rural credit markets.

In the early 1990s, the breakdown of socialism in Central and Eastern Europe opened an additional field of research into credit rationing of rural households and farms. In many countries concerned, rural areas are characterised by a newly or traditionally established small-scale farm structure, which is asserted to result in similar problems of credit market failure as outlined above (SWINNEN and GOW 1999; KOESTER 2001). As noted by TANGERMANN and SWINNEN (2000, p. 198) with regard to these countries, capital markets are supposed to be among "the least understood aspects of the transition process in agriculture, although many studies suggest that they are key factors in CEEC [Central and Eastern European country] agricultural productivity growth, output recovery and rural development in general."

Credit rationing is thus a phenomenon of key importance for decision makers concerned with agricultural development issues world-wide. At the same time, (a) the conceptual understanding of what is meant by credit rationing and (b) how this can be made fruitful for an empirical analysis of real-world credit markets has been a topic of vivid research both in the theoretical and applied literature. With regard to both items, there exists now a voluminous, but rather heterogeneous and still expanding body of knowledge. In fact, these studies are neither uniform in their empirical approach nor do they necessarily draw on the same understanding of credit rationing. The aim of this paper is to give the interested applied researcher an overview of the various methods for measuring and empirically analysing credit rationing as employed in the literature. Furthermore, the methods will be subjected to a comparative evaluation of their specific strengths or shortcomings. It is hoped to equip the reader with a sufficient knowledge about methods used in the field to be able to assess the approach and meaningfulness of existing studies and to be guided in methodological considerations when planning or conducting own research.

Since the objective is not to study the theoretical literature, a fairly general analytical framework based on the microeconomic household modelling literature is developed, whereas specific theoretical questions on the causes of credit rationing and the conditions under which it occurs are not addressed. The reader will however find a number of key references in the theoretical section.

[1] The paper benefited from helpful comments by Raushan BOKUSHEVA, Laure LATRUFFE, and Peter WEINGARTEN.

The emphasis in this paper is on credit rationing of farm households by formal financial intermediaries in low income or transition economies. Studies on agricultural finance in Western countries are mentioned if they are of interest from a methodological point of view, but are not addressed systematically. Research taking a macro level perspective or dealing with non-agricultural businesses is only referred to where it seems appropriate. Likewise do I not attempt full coverage of the field of informal finance.

Before examining the different methodological approaches found in the literature, a reference framework for the understanding of credit rationing is set out from which criteria for evaluating the empirical methods can be derived. This is done in section 2. Section 3 is the main part of the paper which presents and explains the various methods. Section 4 provides a final discussion of their usefulness given the analytical framework.

## 2 ANALYTICAL FRAMEWORK FOR MEASURING CREDIT RATIONING

### 2.1 Defining credit rationing

Credit is a means to enable investment by solving a liquidity problem. The liquidity problem arises from the fact that outlays triggered by the investment precede (expected) future returns. Investment in turn is guided by certain higher-level goals such as profit or income generation. Credit *rationing* is understood as a situation where a *lack* of sufficient credit inhibits desirable investment, since the liquidity problem cannot be solved. That is, credit rationing is seen as the reason for too little or *under*investment.

To be more precise is not without difficulty, since there are various definitions of credit rationing used in the literature (this is discussed by JAFFEE and STIGLITZ 1990, pp. 847-849, and LEATHERS 1990, p. 782). However, to provide a common reference point for the discussion in this paper, it seems useful to further distinguish credit rationing and underinvestment as follows.

A potential borrower is regarded as being *credit rationed* if his *private* demand for credit persistently *exceeds* the loan amount offered by the lender, with the loan terms showing no tendency to change. A credit market outcome is characterised by *underinvestment* if the level of investment carried out by borrowers is persistently *below* the *socially* desirable level.

This definition deserves a number of comments. First, a difference is made between private and social desirability. The former is related to the goals of the individual borrower, whereas the latter is concerned with the goals of the society as a whole. On perfect markets in the sense of neo-classical equilibrium theory, private and social desirability coincide. It is therefore usually assumed that credit rationing is both privately and socially *undesirable* and *inefficient*, hence implying underinvestment. This is indeed the case as long as the interest rate accurately reflects society's scarcity of capital, which is therefore assumed to be given in the following. The issue is however taken up again in section 4.2. The qualification 'persistently' is used here to exclude situations of sluggish adjustment or short-term market dynamics, which are not the focus of this research. My interest is in stable or equilibrium situations of credit rationing.

### 2.2 A formal model of a credit rationed farm household

The aim of this paper is to evaluate methodologies that investigate credit rationing at the farm household level. For the further exposition, it seems therefore useful to formally analyse the effects a credit

constraint has on optimal resource allocation in a neo-classical producer-consumer model (PETRICK 2002).

Suppose there is a decision maker maximising consumption in periods 0 and 1 as expressed by an intertemporally additive utility function. The utility function is assumed to be twice differentiable and quasi-concave, and defined over consumption in period 0, $c_0$, and in period 1, $c_1$, so that $u = (c_0, c_1; z^h)$. $z^h$ parameterises the utility function and summarises exogenous household characteristics such as number of people in each sex or age category.

Agricultural production requires upfront financing such that expenses on variable inputs are due in period 0, while harvest occurs in period 1. To meet liquidity requirements for input purchases, the household can take a working capital loan of size $K$ in period 0, which has to be repaid in period 1. The production opportunities of the household are depicted by a twice differentiable, concave production function $y = f(x; z^y)$. $x$ represents a variable input that requires upfront financing (e.g. seed or fertiliser) and is thus subject to a liquidity constraint, $p$ is its price. Other variable inputs are ignored, to simplify the exposition. $z^y$ stands for fixed and exogenous inputs, such as land and machinery. The household faces a budget constraint in each period and a credit constraint in period 0. The budget in period 0 consists of initial endowment with liquid funds, $E$, an amount of credit taken, $K$, and exogenous public transfers $T$ (only obtained in period 0), all assumed to be non-negative. In equilibrium, the sum of these is equal to the expenses for the variable input plus consumption. The budget in period 1 entails revenues from production $y$, which in equilibrium is equal to repayment of credit taken in period 0 and consumption in period 1. $K(1+r)$ is repayment of credit, with $r$ the interest rate. In the subsequent formal exposition, all prices are normalised by the output price.

There is a rich body of theoretical literature investigating the causes of credit rationing and potential countermeasures. Contemporary contract theory argues that banks are not interested in granting credit to farm households in underdeveloped rural areas because it is particularly difficult to overcome information asymmetries and resulting screening, monitoring, and enforcement problems: clients are poor, have few assets to collateralise, act in an especially risk-prone environment, and give rise to high transaction costs (BINSWANGER and ROSENZWEIG 1986; HOFF and STIGLITZ 1993). The credit constraint may thus be due to unresolved problems of adverse selection, moral hazard, or costly state verification as a result of information asymmetries on the credit market (STIGLITZ and WEISS 1981; WILLIAMSON 1987), or due to enforcement problems (for an overview see GHATAK and GUINNANE 1999 and GHOSH et al. 2001). The probability that the constraint is binding for a given household will decrease with increasing availability of signalling and/or screening devices to overcome existing information asymmetries. Apart from a sufficient performance and satisfactorily risk exposition of the credit funded project (which is implicitly assumed to be given in the formulation of the model), availability of collateral, individual characteristics and skills of the borrower, and a positive credit history are assumed to be among the most important devices to avoid credit rationing (for a theoretical analysis see BESTER 1987 and DIAMOND 1989).

A simple way to introduce the credit constraint into the farm household model is by considering an upper bound of credit $\overline{K}(z^h, z^y)$ the household can obtain. The availability of devices to overcome credit rationing is dependent on household and production characteristics $z^h$ and $z^y$.

Furthermore, all prices may be understood to include a transaction cost component which adds to the nominal market price. These costs arise e.g. as a result of geographical distance between market partners, a lack of infrastructure, local monopolies, search and recruitment costs due to imperfect

information, or supervision and incentive costs as noted above (SADOULET and DE JANVRY 1995, p. 149 et seq.).

The farmer's problem can thus be formally summarised as follows:

$\max u(c_0, c_1; z^h)$ with respect to $c_0, c_1, x, K$, all > 0, subject to

$$E + K + T - c_0 - px = 0, \tag{1}$$

the budget constraint in period 0,

$$f(x; z^y) - c_1 - (1+r)K = 0, \tag{2}$$

the budget constraint in period 1, and

$$\overline{K}(z^h, z^y) - K \geq 0, \tag{3}$$

the credit constraint in period 0. The credit constraint may or may not be binding.

The first-order conditions of the optimal solution are represented by the derivatives of the Lagrangean with respect to all decision variables and the Lagrangean multipliers. Since (3) is an inequality, I use the Kuhn-Tucker conditions for this constraint:

$$\frac{\partial L}{\partial c_0} = \frac{\partial u(.)}{\partial c_0} - h = 0, \tag{4}$$

$$\frac{\partial L}{\partial c_1} = \frac{\partial u(.)}{\partial c_1} - l = 0, \tag{5}$$

$$\frac{\partial L}{\partial x} = -hp + l\frac{\partial f(.)}{\partial x} = 0, \tag{6}$$

$$\frac{\partial L}{\partial K} = h - l(1+r) - m = 0, \tag{7}$$

$$\frac{\partial L}{\partial m} = \overline{K}(z^h, z^y) - K \geq 0,\ m \geq 0,\ m\frac{\partial L}{\partial m} = 0. \tag{8}$$

Equations (4) and (5) characterise optimal consumption, (6) optimal production, and (7) credit demand. (1), (2), and (8) are the side conditions that have to be satisfied by an optimal solution. $h$, $l$, and $m$ are the Lagrangean multipliers.

I briefly examine optimal production if the credit constraint is *not binding*, that is $m = 0$. I substitute (7) into the first-order condition (6), which yields the following if $m = 0$:

$$\frac{\partial f(.)}{\partial x} = p(1+r). \tag{9}$$

This is identical to the standard allocation rule except that the input price has to be inflated by the interest rate, since expenses are due in an earlier period than revenues. (9) is independent of the utility function or any household characteristics, which demonstrates the separability of production and consumption choices as long as the credit constraint is not binding. However, in the complete household system, total income is determined by production decisions via farm profit. Due to the fact that production behaviour affects consumption (but not vice versa) the household model without a binding credit constraint is also called *recursive* (SINGH et al. 1986, p. 20).

If optimal credit demand is effectively restricted by the credit limit, (3) holds with equality and the *credit constraint is binding*. From (8), it has the immediate consequence that $m > 0$. The link between the budget constraints in both periods and the credit constraint is given by equation (7), which now takes the following form:

$$(1+r) = \frac{h - m}{l}. \tag{10}$$

Solving this for $h$ and substitution into (6) yields after some rearrangement:

$$\frac{\partial f(.)}{\partial x} = \left( (1+r) + \frac{m}{l} \right) p. \tag{11}$$

The previous equation defines a *shadow interest rate* under the binding credit constraint, denoted *r**. It is a measure of the household internal value of liquidity. Since $m$ and $l$ are both strictly positive, the following holds:

$$r^* = r + \frac{m}{l} > r. \tag{12}$$

Under a binding credit constraint, the increased scarcity of liquid funds is thus reflected by a rise in the interest rate relevant for decision making. (11) can therefore be transformed as follows:

$$\frac{\partial f(.)}{\partial x} = p(1 + r^*). \tag{13}$$

As a consequence, the condition for an optimal allocation of the liquidity-requiring input (9) formally remains the same under the binding credit constraint except that the marked-up shadow interest rate must be used. Since the production function is concave in variable inputs, an increased input price in (13) results in a reduction of $x$ in order to increase the value of the marginal product. The binding credit constraint has therefore the consequence that optimal input use, to be denoted $x^*$ in the following, and hence output $y^*$ is reduced.

As a result, a set of consumption as well as input demand and output supply equations under the binding credit constraint obtains, which is linked by the household's full income *M** as follows:

$$M^* \equiv (1 + r^*)(E + T - px^*) + y^* = (1 + r^*)c_0^* + c_1^*. \tag{14}$$

Note that an increasing *r** will usually unambiguously reduce *M**. As can be seen from the left-hand (production) side of the equality (14), a change in *r** affects the relative prices of the output and the input and hence profit. A rise in *r** implies a relative rise in the price of the variable input under the credit constraint. Since profits are non-increasing in input prices, *M** will decrease if *r** increases. Hence, the binding credit constraint not only reduces farm output but also *the household's income and thus welfare*. In previous terminology, it leads to a situation of *underinvestment* which is *inefficient* from a first-best perspective.

A further implication of the binding credit constraint is that it *breaks the separability* of consumption and production decisions. As a result, input allocation depends on household preferences via the shadow rate of interest. This property of the interdependent household model can be used for an empirical test of market imperfections, as will be explained shortly. To demonstrate it formally, I analyse the effect that household characteristics $z^h$ have on *r** (the following parallels the exposition in BENJAMIN 1992, pp. 292-295).

The demand functions for consumption in period 0 and for the variable input under credit rationing form a liquidity equilibrium that implicitly defines the shadow interest rate as follows:

$$E + \overline{K}(z^h, z^y) + T - c_0^*(r^*, M^*; z^h) = px^*(r^*; p, z^y). \tag{15}$$

The left-hand side of this equation is household supply of liquid funds, and the right-hand side is farm demand for funds. Both are equated at the shadow interest rate $r^*$. Implicit differentiation yields the following relationship:

$$\frac{dr^*}{dz^h} = -\frac{d\overline{K}(.)}{dz^h} + \frac{dc_0^*(.)}{dz^h} \Bigg/ -\frac{dc_0^*(.)}{dr^*}\Bigg|_{u=const} - p\frac{dx^*}{dr^*}. \tag{16}$$

The denominator consists of the negative compensated interest rate effect on consumption in period 0 minus the interest rate effect on input demand times the input price.[2] Both are negative: consumption of $c_0^*$ falls if by an increase of $r^*$ its real price increases relative to that of $c_1^*$. The real price of the input likewise increases, which reduces input demand. Taken together, the denominator is unambiguously positive. The sign of the numerator depends on the total effect of a change in household characteristics on the availability of credit and on consumption of $c_0^*$. The overall effect of $z^h$ on $r^*$ is thus ambiguous. For example, the shadow interest rate rises if the net increase in consumption in period 0 as the result of an increase in family members outweighs a potentially improved access to credit.

Under non-separation, all reduced-form equations of the model ultimately depend on all exogenous variables of *both* the consumption and the production side (see SADOULET and DE JANVRY 1995, p. 160; I drop subscripts of consumption goods):

$$c^* = c^*(r, p, E, \overline{K}, z^h, z^y), \tag{17}$$

$$x^* = x^*(r, p, E, \overline{K}, z^h, z^y), \tag{18}$$

$$y^* = y^*(r, p, E, \overline{K}, z^h, z^y). \tag{19}$$

### 2.3 Criteria for evaluating methods to measure credit rationing

The subsequent section attempts to provide an overview of the recent literature on empirical credit market analysis at the micro level. Specifically, it is shown how credit rationing can be detected and which implications follow for the empirical analysis of causes and effects of rationing. To ease the assessment of the various approaches, the following requirements are postulated to be met by an ideal method:[3]

1. Based on an operational definition, the approach should allow the empirical measurement (quantification) of credit rationing of farm households.

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[2] The compensated interest rate effect can be obtained by taking the total derivative of demand for $c_0^*$ as follows: $\frac{dc_0^*}{dr^*} = \frac{\partial c_0^*}{\partial M^*}\frac{dM^*}{dr^*} + \frac{\partial c_0^*}{\partial r^*}$. The total effect on $c_0^*$ of a change in $r^*$ consists of the indirect effect via $M^*$ and the direct effect as given by the partial derivative. Since $dM^*/dr^*$ can be interpreted as the amount necessary to compensate the change in $M^*$ as the result of a change in $r^*$, the total derivative is a Slutsky equation for the intertemporal choice problem. In this equation, $dc_0^*/dr^*$ is the interest effect with utility held constant.

[3] 'Ideal' means here in accordance with commonly applied standards of empirical research, such as quantifiability, reliability, validity, practical applicability. These are of course to some extent subjective and open to debate.

2. It should be a reliable and valid indicator of credit market failure (or efficiency).
3. It should take into account the often limited data availability in low-income and transition countries. Applicability in field surveys with a large number of respondents is therefore an additional desideratum.
4. It should lend itself to plausible methods of data analysis that allow the examination of causes and effects of credit rationing and how credit rationing is itself influenced by the structural and policy environment of farm households.

In my opinion, the recent literature on the topic allows to distinguish six approaches to the empirical investigation of credit rationing:

1. A direct method based on measurement of loan transaction costs,
2. a direct method based on qualitative information collected in interviews,
3. a direct method based on the credit limit concept,
4. a direct method based on spill-over effects,
5. an indirect method based on econometric household modelling,
6. an indirect method based on an econometric analysis of dynamic investment decisions.

*Direct* methods are characterised by the fact that they immediately utilise observations made in the field, while *indirect* methods analyse the consequences of credit rationing by means of econometric modelling. However, there are a number of interdependencies between both types, because the two indirect methods usually are dependent on additional information provided by direct methods. I explain the six approaches in the following. How far the presented methods comply with the above criteria will be examined as a part of the subsequent discussion, which will in particular show that the definitions of credit rationing vary between approaches.

## 3 A SURVEY OF METHODS

### 3.1 Direct measurement of loan transaction costs

This method prescribes to directly collect information about additional, loan specific transaction costs borrowers face apart from nominal interest rates, such as costs of information collection, loan application, insurance of collateral, etc. These transaction costs may well make investment unprofitable and thus lead to exclusion of borrowers who might have been in a position to repay nominal interest rates. The explicit reason for credit rationing in this approach is thus that the price a borrower faces is effectively too high for him to pay. Writers of this tradition have claimed that loan transaction costs are the *ultimate reason for credit rationing* of certain types of borrowers, particularly small farms (ADAMS 1993; CUEVAS and GRAHAM 1986; LADMAN 1984; R. L. MEYER and CUEVAS 1992). This understanding of credit rationing hence departs from the definition of rationing as a *quantity* constraint as given in section 2.1, since the restriction works through the price variable. There is still a kind of price mechanism equating supply and demand.[4]

[4] Initially, high transaction costs have appeared as an argument for credit rationing in environments where there are governmentally imposed interest rate ceilings (e.g. LADMAN 1984, p. 107). Later contributions use this argument in a more general context of financial intermediation that seems to be independent of certain interest policies (e.g. CUEVAS and GRAHAM 1986; R. L. MEYER and CUEVAS 1992). The following quote documents that the literature on the current approach is imprecise with regard to the question of whether credit rationing

In case that these non-interest transaction costs are not "naturally" associated with financial intermediation (ADAMS 1993, p. 4), they may be taken as an *indicator for the efficiency of credit markets* (as proposed by R. L. MEYER and CUEVAS 1992, p. 310). Which transaction costs are necessary is of course difficult to distinguish; ADAMS (1993) argues that costs associated with regulation or loan targeting do *not* fall under this category.

A number of studies demonstrate that these non-interest costs – partly as a result of compulsory interest ceilings imposed on formal lenders – are a large additional cost component in many developing countries, particularly for relatively smaller loans. See ADAMS and NEHMAN (1979) on Bangladesh, Brazil, and Colombia, various contributions in ADAMS et al. (1984) mainly on Latin America, CUEVAS and GRAHAM (1986) on Bangladesh, Ecuador, Honduras, Panama, and Peru, AHMED (1989) on Bangladesh, R. L. MEYER and CUEVAS (1992) on Bangladesh, Dominican Republic, Honduras, Niger, Philippines, and Togo, and OLOMOLA (1999) on Nigeria.

CUEVAS and GRAHAM (1986) provide an analysis of *determinants* of transaction costs of a sample of farms in Honduras, based on a generalised power function. Their results indicate that transaction costs as percentage of loan amount decrease with loan size, decline with increases in the interest rate, and are higher for private bank loans than development bank loans (p. 685).

SAITO and VILLANUEVA (1981) in their examination of the Philippine credit market take a slightly different approach in that they analyse capital and transaction costs of small farm lending that are *internal to the bank*. They conclude that these costs are much higher than for large-scale industry lending, which should be reflected in nominal interest rates.

A crucial question in assessing the value of this method for measuring credit rationing is thus how far transaction costs are included into the nominal interest rate, and how far these costs are inevitable. More liberal government policies may imply that transaction costs *are* in fact included in nominal interest rates, which says little about whether they are inevitable or not (see BESLEY 1994, 1995). If they are included, an efficiency analysis has to start with the financial intermediaries themselves (see KHITARISHVILI 2000 for such a study on Polish co-operative banking).

Furthermore, a theoretically consistent, precise measurement of transaction costs is impossible as long as the correct opportunity costs of transaction activities are unknown (SCHNEIDER 1987; TERBERGER 1994, pp. 125-134). If the institutional arrangement used to determine the value of an alternative activity is unclear, these opportunity costs cannot be calculated. If the optimal institutional arrangement is known, the exact volume of transaction costs accruing in the second-best situation might be of little additional value (HELLWIG 1988).

The method is assessed as follows:

- It uses a different and probably imprecise understanding of credit rationing as compared to the other approaches, since rationing here acts through a price and not a quantity mechanism. Transaction costs should not be claimed to measure the efficiency of a rural credit market, if this terminology is intended to suggest the comparison with an unobserved (and unreachable) first-best situation.

works through a quantity or a price mechanism: "In this paper we investigate the role of transaction costs of borrowing as a rationing mechanism in the agricultural credit markets of five less-developed countries. We show that borrowing transaction costs become an effective *non-price* rationing device in these markets" (CUEVAS and GRAHAM 1986, p. 680; italics added).

- The method requires collection of specific information in field surveys. Non-interest transaction costs should be included in the calculation of the effective costs of each borrower to obtain a relevant price variable. Their collection is therefore highly recommendable. At the same time, this procedure is less satisfactorily on theoretical grounds, since opportunity costs are almost impossible to measure, at least if the next best alternative institutional arrangement is unknown. A pragmatic operationalisation is thus necessary.
- The validity of the share of transaction costs in total lending costs as an indicator of market efficiency depends highly on the pricing policy of the respective bank (that is which costs are effectively passed on as part of the nominal interest rate and which accrue in addition to that). Since this is likely to be different for different banks, comparisons cannot necessarily be made and the indicator is thus of limited value.
- The absolute value of effective interest rates is also a difficult measure since it might be impossible to distinguish which costs reflect real expenses necessary for loan appraisal, monitoring etc. and which are simply slack in the intermediation process.

As a conclusion, this approach rightly stresses the importance of transaction costs in rural credit markets. However, in my opinion, it provides no adequate method to measure credit rationing. Due to its conceptual difficulties, it is regarded as inappropriate to analyse the determinants of credit rationing in terms of a cause-effect relationship.

### 3.2 Analysis of qualitative information collected in interviews

The idea of this method is to directly ask borrowers whether they would have liked to borrow more at the prevailing interest rate. In case of a positive answer, respondents are classified as 'credit constrained', which corresponds to an equality in equation (3) of the formal model. The same applies to non-borrowers who respond that they could not get credit although they liked to. This method to my knowledge was first applied by FEDER et al. (1989 and 1990) and, presumably independently, by JAPPELLI (1990). FEDER et al. (1989) provide empirical evidence that this indicator is a reliable measure of liquidity shortages in their sample of 600 Chinese farm households, where liquidity is defined as the sum of savings, cash, and fungible credit.

While the paper of FEDER et al. (1989) is at last driven by the desire to support policy formulation that stimulates *production*, JAPPELLI (1990) has a theoretically differently motivated point of departure. His aim is to analyse the characteristics of credit constrained households in the U.S. economy in order to challenge the life-cycle model of *consumption*. The life-cycle model in its simple form claims that current consumption is independent of current income – an independence that breaks down in the presence of binding borrowing constraints. Theoretically, an appropriate strategy would be to estimate a reduced form function for the demand for loans *in excess* of the binding borrowing constraint. This excess demand is supposed to depend on both demand and supply variables. Since excess credit demand (as the difference between optimal consumption[5] and debt ceiling) is unobservable, JAPPELLI exploits the specific qualitative information contained in the 1983 U.S. Survey of Consumer Finances on whether a respondent is credit constrained or not. This information was obtained in a similar fashion as in the study by FEDER et al. (1989). As a result, JAPPELLI estimates a Logit equation with the probability of being credit constrained as dependent variable. He finds that income, wealth, and age are the most important determinants of being credit constrained.

[5] In the standard version of the life-cycle model, current consumption only depends on life-cycle characteristics such as age or household composition (but not on current income, see DEATON 1997, pp. 359-360).

The approach of directly asking respondents about their rationing status was further refined by BAYDAS et al. (1994) and ZELLER (1994). BAYDAS et al. analyse a sample of micro-entrepreneurs in Ecuador, in which they further divided the group of constrained borrowers in those who are (a) *completely rejected*, i.e. who applied for a loan without success, or (b) *unsatisfied*, i.e. who applied but obtained a smaller loan than demanded. Together with the (c) *satisfied* borrowers who obtained as much as applied for and the (d) *non-applicants*, BAYDAS et al. identify four groups of respondents. Based on this distinction, they perform a multinomial Logit model to quantify *determinants* and *probabilities* for respondents to be in one of the four distinct groups.[6] ZELLER (1994) employs a similar approach of four categories to analyse formal and informal borrowing in Madagascar. Theoretically, he structures credit rationing as a *sequential process* where first potential borrowers decide whether to apply, and second lenders decide whether to grant a loan.[7] As a consequence, he uses this grouping to estimate a two-stage Probit model.

The above categorisation into four groups of potential borrowers was further developed by MUSHINSKI (1999), who divides non-applicants into (d1) *pre-emptively rationed* and (d2) *not interested* respondents. He argues that households of group (d1) may well have some *notional demand* for credit, although in effect they do not apply because – according to statements made in interviews – they fear rejection or high transaction costs of loan application. As a consequence, in an analysis of Guatemalan credit unions, the author estimates *notional demand offer probabilities* by means of a Probit model which identifies the probability that a household with positive notional demand for credit receives a loan offer. In a first-best world, this probability is supposed to be one, and a smaller value thus can be interpreted as an indicator of credit rationing. This claim seems however not to be warranted, as long as no information on returns on credit use is provided.

The results suggest that demand offer probabilities of credit unions are generally higher than those of banks, and that credit unions' lending decisions are not as much dependent on easily collateralisable wealth as those of banks.[8] Furthermore, the econometric analysis shows that ignoring notional credit demand may lead to implausible coefficients of the demand offer equations.

In contrast to all authors using the qualitative information approach described previously, KOCHAR (1997) uses survey data of rationing outcomes on segmented credit markets in rural India to analyse these outcomes as *jointly determined* by borrower and lender behaviour. This involves the application of jointly distributed bi- and trivariate Probit models with partial observability.[9] A major result of KOCHAR's analysis is that, conditional on the households' demand for credit, the degree of effective rationing is rather low.

In light of the criteria established above, the analysis of qualitative information collected in interviews can be assessed as follows:

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6 BARHAM et al. (1996) use principally the same categorisation to investigate the ability of Guatemalan credit unions to relax credit constraints of small-scale producers. However, they condense groups (c) and (d) into one group of *unconstrained* borrowers.

7 This two-stage structure was also used by HEIDHUES et al. (1998, p. 364) in their analysis of the Romanian credit market.

8 In order to circumvent the problem of modelling the interdependent decision process resulting in the choice of the lender (credit union or bank), MUSHINSKI focuses only on the lender offer decision, which he assumes to be independent from the households' choice of lenders. He thus understands the credit market outcome as a sequential process of first application and second acceptance or rejection, similar to ZELLER (1994).

9 In the approaches described so far there are single decisions among several alternatives, or sequences of single decisions. Opposed to that, in the KOCHAR model there are two (three) interdependent decisions, each between two alternatives, which involves the estimation of a system of equations with correlated disturbances. See GREENE (2000, pp. 849, 857).

- Qualitative information on loan rationing in rural credit markets directly corresponds with the casual observation of credit constrained farmers, that is farmers who complain about lack of access to credit.
- The categorisation of a certain respondent exclusively relies on his own subjective assessment of his situation. The validity of this statement may be questioned, although there are no plausible arguments why it should be less valid than any other information collected in field surveys.
- In any case, the qualitative information allows the consistent differentiation of respondents into those for whom liquidity is exogenous (i.e. not under the control of the respondent) and those for whom it is not.
- However, it is not necessarily a consistent measure of credit market efficiency, since no disequilibrium in terms of resource allocation is explicitly tracked down. Furthermore, it does not allow a quantification of the *severity* of credit rationing.
- Although it requires specific questions to be included in survey questionnaires, it is relatively easy to collect but still lends itself to multivariate methods of analysis. The causal determinants of the qualitative choice variable can principally be identified. A disadvantage of this type of modelling is that information on loan contract terms such as interest rate and loan size is discarded.
- A general problem is the theoretical structuring of the decision-making process on segmented credit markets where more than one source of credit is relevant. There may be good arguments to assert that choice between several sources is an interdependent process and even the decision of the lender to grant the loan may be involved in this. If this assertion holds, estimations based on sequential and independent decision processes might be inappropriate.

In summary, qualitative information on credit access has the advantage that it is relatively easily collected and interpreted. In addition, it may support an important assumption for econometric modelling, namely that credit is exogenously determined for credit constrained households.

### 3.3 Analysis of quantitative information collected in interviews by using the credit limit concept

In an attempt to overcome the qualitative nature of the indicator described previously, researchers at the International Food Policy Research Institute (IFPRI) developed the credit limit concept as a novel approach to measure rationing (DIAGNE 1999; DIAGNE et al. 2000). The idea is to ask a given respondent about *the maximum amount a lender is willing to lend him*, which is the credit limit of the respondent with regard to this lender (DIAGNE et al. 2000, p. 10).[10] The credit limit thus measures the borrower's *current access to credit*, $\overline{K}(z^h, z^y)$ in equation (3), which may be different for different loan sources. However, a given credit limit does not necessarily imply a binding credit constraint. The authors define a borrower as being credit constrained if "the optimal amount borrowed when borrowing under a credit constraint is strictly less than the optimal amount that would be borrowed if the credit constraint did not exist" (p. 17). In other words, the borrower is credit *constrained* only if his optimal loan size is *effectively restricted* by his credit *limit*. Furthermore, a distinction is made between *access* to credit and *participation* in credit markets. Households may choose not to participate in credit markets, although they have access to credit (i.e. a positive credit

[10] In the survey the respondents were asked "the maximum amount they *could* [subjunctive] borrow during the recall period from both informal and formal sources of credit" (DIAGNE et al. 2000, p. 29, italics in the original).

limit). Together with information about the optimal loan demand (or simply loan amount applied for), a metric quantification of the extent of credit rationing is possible.

The appealing feature of the credit limit concept is that it allows a metric quantification of credit access, which in turn may be used in econometric analyses. Furthermore, it principally allows to measure the success of a given credit expansion policy by its impact on perceived credit limits of the target group, and the effect this expanded credit limit has on other variables of household welfare.

In an application to Bangladesh and Malawi, DIAGNE et al. (2000) find that microfinance institutions promoted in the study area had a positive effect on borrowers' credit limits.

DIAGNE (1999) uses the credit limit variable to evaluate decisions to participate in credit programmes and access to credit by rural households in Malawi. His formal model has a two-stage structure, according to the choice-based sampling procedure of the survey which was stratified along programme membership status. The first stage consists of a four-alternative, two-level nested multinomial Logit model (see GREENE 2000, pp. 857-874) which depicts participation decisions as population conditional choice probabilities. In the second stage, these probabilities are used to estimate a reduced form recursive system of simultaneous equations of credit limits and amount borrowed as dependent variables. The results of the analysis show that participation decisions in certain credit programmes are highly driven by programme attributes other than the interest rate. Furthermore, the diversification of assets is more relevant for formal credit access than its total value. Increasing credit limits are only partially exploited by borrowers, which – according to the author – underlines the importance of access to credit as an insurance mechanism that is only utilised in case of emergency. Finally, informal credit is regarded as only a weak substitute of formal credit, since, in contrast to the latter, the former is mainly used for consumption purposes.

The characteristics of the credit limit concept are as follows:

- It requires specific questions to be included in survey questionnaires. In particular cases, it may be difficult to make respondents understand what is exactly meant by the question on credit limits (DIAGNE et al. 2000, p. 30), or some respondents may be ignorant about their credit limit.
- Compared to the qualitative indicator it provides a metric measure of credit rationing, which allows the application of more sophisticated methods of analysis.
- As the qualitative indicator, it is also not necessarily a consistent measure of credit market efficiency, since no comparison with an equilibrium first-best alternative is provided.

### 3.4 Analysis of spill-over effects with regard to secondary credit sources

The central theoretical assumption of this method is that credit sources other than bank credit are more expensive than bank loans. If a borrower makes use of these secondary sources, she is assumed to be unable to satisfy her financial needs from the primary source, though she has sufficient repayment capacity to serve the secondary source. She can therefore be treated as credit rationed with regard to the primary source. It might be possible, however, that there is also rationing on the side of the secondary source. Use of the secondary source due to unsatisfied demand with regard to the primary source is sometimes called 'spill-over' (BELL 1993, p. 202).

*Trade credit* in developed countries and *informal credit (moneylender)* in developing countries are the two secondary segments of credit markets usually referred to. Both are regarded as comparatively more expensive than formal bank loans, although lenders in these secondary segments usually are in a more advantageous position with regard to information asymmetries as compared with banks

(see the discussion on trade credit in JAFFEE and STIGLITZ 1990, p. 879, and on informal credit in ALEEM 1993 and CHRISTENSEN 1993).

As a metric indicator of credit rationing, PETERSEN and RAJAN (1995) and HARHOFF and KÖRTING (1998) use the criterion of fast payment discounts actually taken by a firm, in percent of fast payment discounts offered to it. If firms often do not make use of the advantageous fast payment discount, they are regarded as rationed with regard to their primary lender (bank). The full amount which is to be paid afterwards can hence be regarded as a form of trade credit, which costs usually by far exceed lending rates offered by banks (PETERSEN and RAJAN 1995, p. 426). However, these studies solely concentrate on the formal loan markets in the U.S. and Germany, respectively, and the effects lending relationships have on the access to credit.

BELL et al. (1997) estimate demand and supply functions under relatively restrictive assumptions of an unobserved regime switching model for segmented credit markets in rural Punjab.[11] Their analysis based on a cross sectional sample of farmers shows that the formal market is responsible for most rationing, demand is rather inelastic with regard to interest rates, and tying credit to output marketing made informal lenders willing to advance much bigger loans.

The method is assessed as follows:

- It requires detailed information on various loan sources used by respondents. For the more demanding analyses, panel data might be desirable.
- In case that the assumptions implicitly made are correct (secondary sources more expensive than primary, profit maximisation of borrower), this method provides a valid measure to quantitatively analyse rationing phenomena in segmented credit markets. Cause-effect modelling is principally possible.
- It is only relevant where segmented credit markets are important.
- It may be regarded as a shortcoming that the measurement of spill-over effects implies an underestimation of credit rationing if some rationed households do not turn to the secondary source of credit, but simply accept the constraints on the formal market instead.

### 3.5 Econometric analysis in the framework of a static, microeconomic household model

This method seeks to analyse the effects of credit rationing under implicit or explicit consideration of a farm household model and hence can take advantage of its theoretical results. It was demonstrated in section 2.2 that market imperfections such as credit rationing lead to important interactions between the production and the consumption sphere of the household. *Observable consequences* of these interactions are taken as a starting point for the econometric analysis of rationing phenomena in this approach.

As shown in the formal household model, a binding constraint on the credit market leads to the presence of a marked-up shadow interest rate in the first-order conditions for profit maximisation (equation (13)). As a consequence, marginal revenues of credit use should be *significantly different* from observable, exogenous interest rates. Furthermore, in the case of rationing, production and consumption decisions are *mutually dependent*. The econometric household modelling approach attempts to empirically detect both the household internal shadow price and the mutual dependency of consumption and production.

[11] This study hence provides a link to the following approach (section 3.5). I mention it here due to its emphasis on segmentation and spill-over effects.

In the credit market case, the presence of *credit rationing* is hence defined by its consequences for allocation decisions within the farm household. In addition, the credit market is understood to be *efficient* if the first-order condition for optimal credit allocation is met, namely that values of marginal productivity equal exogenous interest rates (see in particular CARTER and WIEBE 1990, pp. 1147-1148; SIAL and CARTER 1996, pp. 771-772, 777-779).

**Table 1: Econometric analyses of credit market imperfections using a household modelling framework**

| *Study* | *Estimated function(s) type (form)* | *Estimation method* | *Data* | *Imperfection detected* | |
|---|---|---|---|---|---|
| | | | | *shadow rate* | *Inter-depen-dency* |
| IQBAL (1986) | FD (linear) | 2SLS | India 1970-71 | n.a. | +[a] |
| CARTER (1989) | Prof (Q), Prod (Q), FD (CD) | OLS, 2S-SC | Nicaragua 1981 | – | n.a. |
| CARTER and WIEBE (1990) | Prod (CD) | OLS | Kenya ? | + | n.a. |
| FEDER et al. (1990) | OS (CD) | 2S-SC | China 1987 | – | + |
| SIAL and CARTER (1996) | FD (Tobit), OS (mixed)[b] | 2S-SC | Pakistan 1987-88 | + | n.a. |
| KOCHAR (1997a) | FD (mixed)[b] | 2S-SC | India 1981-82 | n.a. | – |
| PETRICK (2002) | OS (Q) | 2S-SC | Poland 1998-99 | + | + |

Notes: [a] endogenous interest rate and significant life cycle variables; [b] equation entails both logarithmic and linear or quadratic terms. Abbreviations: Estimation method: OLS = ordinary least squares, 2SLS = two-stage least squares, 2S-SC = two-stage with selectivity correction; Function: type: Prof = profit function, Prod = production function, OS = output supply, FD = factor demand; form: Q = quadratic; CD = Cobb-Douglas; n.a. = not analysed.

Source: Author's compilation.

Table 1 lists a number of studies that basically follow this approach. With the exception of FEDER et al. (1990) and PETRICK (2002), all studies either concentrate on the shadow interest rate *or* on the detection of interdependencies between production and consumption spheres of the household. Investigations of the shadow rate either estimate a structural production function (CARTER, CARTER and WIEBE) or a reduced-form output supply equation in connection with a selectivity correction (FEDER et al., SIAL and CARTER, PETRICK).[12] The selectivity correction may require additional qualitative information concerning the exogeneity of the credit variable, since it might be argued that the output supply equation can consistently only be estimated for borrowers who self-classified as being credit rationed (FEDER et al. 1990; see section 3.2). Both approaches are capable of yielding an estimate of the relevant shadow rate as follows.

Under the binding credit constraint, $\overline{K}$ has the character of a fixed resource in the household decision making process. The expression $\partial y / \partial \overline{K}$ can thus be interpreted as the *marginal (direct plus indirect) effect of credit on production*. In the production function approach, it may be suspected that $\overline{K} = px$, which means that credit is fully used to finance variable inputs under the liquidity constraint and only the direct credit effect is considered. If in the estimation a value of $\overline{K}$ deflated by $p$

[12] The methodology of FEDER et al. (1990) is applied to trace *income* and *nutrition* effects of credit based on rural household data from Madagascar by ZELLER (1995) and on data from Cameroon by SCHRIEDER (1996).

is employed, say $\tilde{K} = \bar{K} / p$, the obtained estimate of $\partial y / \partial \tilde{K}$ can be substituted for $\partial f(.) / \partial x$ in equation (13) in order to estimate the shadow interest rate *r**. This must be higher than the observed market interest rate *r* (see equation (12)). The difference between estimated *r** and market interest rate can be regarded as a measure of credit rationing or credit market efficiency (SIAL and CARTER 1996, pp. 777-779).

In contrast, the reduced-form model (19) captures both direct *and* indirect effects. There may be *positive* indirect effects, for example via certain consumption or education expenses, which induce an additional mark-up of $\partial y / \partial \tilde{K}$.[13] They would hence provide additional rationale for an excess credit demand. On the other hand, if the estimate of $\partial y / \partial \tilde{K}$ turns out to be low compared to the observed market interest rate (as in FEDER et al. 1990), this is an indication that *negative* indirect effects are at work. In this case, additional credit does contribute little to increase farm output. In the presence of a perceived excess credit demand by the household, it may thus be concluded that credit is in fact used to finance non-productive consumption expenses, which compete with inputs for liquid funds (FEDER et al. 1990, p. 1156). It can be regarded as an advantage of the reduced-form approach that it is not necessary to exactly know for which purposes the loan was in fact used, since all direct and indirect effects are captured.

The estimates of the shadow interest rate are then sometimes employed in a factor demand or supply function in order to analyse the shadow price elasticity. Studies that examine household interdependencies usually take factor demand functions directly as their starting points. The table illustrates that a variety of functional forms is used.

The results are not uniform and differ by country. While CARTER (1989) finds that credit has even a negative effect on farm output in his Nicaraguan sample, CARTER and WIEBE (1990) and SIAL and CARTER (1996) report shadow prices of up to 300 and 78 percent net of repayment in Kenya and Pakistan, respectively. A notable result is that of FEDER et al. (1990), who find that the marginal product of credit is low although demographic characteristics of the household have significant influence on production decisions. They conclude that farms are in fact credit rationed but funds are diverted away to non-productive activities or used to finance long-term investment (p. 1156). PETRICK (2002), by drawing on the methodology of FEDER et al. (1990), estimates an output supply equation for Polish farm households. His finding is that farm households display shadow interest rates of on average 226 percent net of principal, and that demographic characteristics play a significant role in determining output. KOCHAR (1997a) investigates how formal sector loans affect outcomes on the land lease market in India. He finds no significant relationship between both. The study of IQBAL (1986) is a bit separate from the others since he motivates the inclusion of household characteristics into his borrowing function by considerations of life-cycle behaviour and not by the attempt to explicitly detect interdependencies between production and consumption (p. 196). These variables partly turned out to be significant. Furthermore, he allows for an endogenous interest rate that differs across farms.

A related study not mentioned in the table due to its different approach is LEE and CHAMBERS (1986), who take a dual producer model as a starting point. They test for the significance of expenditure constraints in U.S. agriculture. The intuition behind the test rests on the homogeneity condition for the profit function. If profit is homogenous in all prices, this supports the absence of any con-

[13] The line between direct and indirect effects is probably difficult to draw. It might well be argued that increased management skills due to better health as a result of consumption expenditures or better education are quite important inputs in the production process (see HEIDHUES 1994).

straint, if it is homogenous only in output prices, this supports the constrained model (p. 861). LEE and CHAMBERS find evidence for the latter in the time-series data set used in their investigation.[14]

I assess the household modelling approach as follows:

- Adopting the household modelling framework has the major advantage of yielding a theoretically consistent definition of credit rationing and a straightforward interpretation of credit market efficiency. Econometric modelling offers a wide range of quantitative analysis including causal inference. The quantitative nature of results enhances comparability and interpretation.
- Econometric modelling is more data demanding than some of the qualitative methods described previously. However, it is not necessary to have available a time-series or panel data set, as the large number of cross-sectional studies demonstrate.
- Estimating an econometric model is methodologically more ambitious than previous approaches and hence to a larger extent subject to criticism. Crucial error sources are the non-experimental nature of the data as well as the exact specification of the functions (for example with regard to functional form and choice of regressors).

The household modelling approach hence offers a promising way to combine theoretical reasoning with quantitative analysis, while the data demands remain manageable.

### 3.6 Detecting violations of perfect market implications in an econometric analysis of dynamic investment decisions

As the previous one, this approach attempts to track down credit rationing by empirically detecting violations of implications of a theoretical decision making model. It thus also has an explicit theoretical foundation in which credit rationing is interpreted, at least in the more recent studies. A central implication of the neo-classical assumption of perfect and complete capital markets is that investment decisions can be made independently of the financial structure of an enterprise, similar to the analysis in section 2.2. In the investment literature, this insight is reflected in the Fisher Separation and Modigliani-Miller Theorems (see for example SCHMIDT and TERBERGER 1997).[15] If in reality investment is observed to depend on financial structure, this is interpreted as evidence for imperfect capital markets. It hence provides a first test for the presence of credit rationing (called a 'financial sensitivity test' in the sequel, following HAYASHI 1987, p. 101).[16]

**Table 2: Econometric analyses of credit market imperfections using farm investment equations**

| *Study* | *Financial variable(s)* | *Estimation method* | *Data* | *Imperfection detected* | |
|---|---|---|---|---|---|
| | | | | *financial sensitivity* | *orthogonality* |

[14] By means of an indirect production function, BHATTACHARYYA and KUMBHAKAR (1997) compare the ratio of unobserved shadow prices of inputs to market prices in order to analyse market imperfections for a sample of Indian farms. Their emphasis is on the effects of various distortions on output, therefore they do not provide direct evidence for credit market failure and their study is not further investigated here.

[15] There is a similar implication in the consumption literature, namely that consumption decisions can be made independently of current income (which is known as the permanent-income or life-cycle thesis). See HAYASHI (1987).

[16] HAYASHI (1987) uses the notion of an 'excess sensitivity test' for a well-specified problem in the consumption literature. I take 'financial sensitivity' as simply indicating the significance of financial variables for investment outcomes.

| | | | | | |
|---|---|---|---|---|---|
| *Traditional approaches* | | | | | |
| DE HAEN (1976) | increase in net debt; income – consumption | 2SLS | Germany 1952-74 | +[a] | n.a. |
| GROLIG (1980) | weighted profit of previous periods | OLS | Germany 1968-77 | + | n.a. |
| KLAIBER (1988) | weighted profit; depreciation; liquidity[b]; equity; public transfers; consumption | OLS | Germany 1985-86 | + | n.a. |
| WEERSINK and TAUER (1989) | farm income; change in external debt | GLS | U.S. 1974-83 | +[c] | n.a. |
| FEDER et al. (1992) | formal credit; informal credit | OLS; Tobit | China 1987-88 | +[d] | n.a. |
| KUIPER and THIJSSEN (1996) | equity to equity plus debt | VAR | The Netherlands 1949-91 | + | n.a. |
| PETRICK (2002a) | long-term credit | 2S-SC | Poland 1997-99[e] | + | n.a. |
| *Stochastic investment models* | | | | | |
| HUBBARD and KASHYAP (1992) | net worth | GMM | U.S. 1914-87 | + | + |
| BENJAMIN and PHIMISTER (1997) | profits/capital; long-term loans/capital | GMM | France 1989-93 | – | +[f] |
| BIERLEN and FEATHERSTONE (1998) | cash-flow | VAR | U.S. 1976-92 | + | n.a. |

Notes: [a] income – consumption had a negative effect on investment; [b] different liquidity specifications including contributions and withdrawals of the farm household; [c] negative sign for income; [d] formal (informal) credit significant for crop-related investment in one (zero) of four provinces under investigation; formal (informal) credit significant for housing investment in one (four) of four provinces; [e] pooled data; [f] formulation that allows for transaction costs not rejected. Abbreviations: Estimation method: OLS = ordinary least squares, 2SLS = two-stage least squares, GLS = Generalised Least Squares, 2S-SC = two-stage with selectivity correction, VAR = vector autoregression, GMM = Generalised Method of Moments; n.a. = not analysed.

Source: Author's compilation.

The literature related to this approach can be grouped into a more traditional and a more recent branch. The theoretical foundation of the more traditional studies is often rather pragmatic (if there is one at all) and generally does not allow for uncertainty in the decision model. In contrast, more recent models explicitly base their research on stochastic investment models, which was probably eased by the development of corresponding econometric tools for time series and panel data analysis.

The older and theoretically more pragmatic approach is to simply add a liquidity or financial variable to the existing investment function (comprising output or capital as explanatory variables) or explain investment by a liquidity variable alone (see J. R. MEYER and KUH 1957 on business investment). Later research is based on a flexible accelerator model (KRELLE 1978), augmented by a financial variable. The flexible accelerator can be derived from a dynamic decision model of the farm household under static expectations, where the rationale for investment is either the presence of adjustment costs (MACCINI 1991) or financial constraints (STEIGUM 1983). Early examples with reference to German agriculture include DE HAEN (1976), GROLIG (1980), and KLAIBER (1988), see Table 2.

DE HAEN (1976) investigates the consumption and investment decisions of farm households in Lower Saxony by estimating a simultaneous system of behavioural equations. He finds that an increase in net debt has a significantly negative effect on investment; however, increasing liquidity reserves surprisingly act in the same direction as additional debt. In GROLIG's analysis of German farm accountancy network data, a weighted mean of profit levels of previous periods was taken to reflect profit expectations. In various farm subgroups, these had a positive effect on investment, which might be interpreted as a liquidity effect (see WITZKE 1993, p. 248). KLAIBER uses a host of liquidity-related variables to explain investment behaviour of farms in Baden-Württemberg, most of which turned out to be significant. A drawback of his analysis may be that he did not check endogeneity of regressors, which is likely to be a problem in the cross-sectional data set used for the estimations. In the development economics literature, FEDER et al. (1992) found a significant effect of credit on crop-related capital and housing investment in at least some of the investigated Chinese provinces. As KLAIBER (1988), FEDER et al. (1992) based their study on cross-sectional data. PETRICK (2002a) investigates the effect of long-term credit access on farm investment, drawing on cross-sectional data from Poland. He finds that this variable has a highly significant influence in the investment decision.

WEERSINK and TAUER (1989) explicitly compare the explanatory power of different investment specifications by embedding various theoretical views in a single equation. This also includes cash farm income and increase in external debt. Based on their sample of New York dairy farms, the authors find that both are significant determinants of investment, although income has a negative sign. KUIPER and THIJSSEN (1996) also postulate a general investment equation which integrates several theoretical standpoints. Accordingly, they do not pretend to estimate a structural model provided by theory but rely on an Error-Correction Model known from macroeconomics. This is based on a vector autoregression (VAR) procedure, and hence provides a methodological link to the paper by BIERLEN and FEATHERSTONE (1992) presented below. They find that increasing equity to equity plus debt plays a significant role in determining investment of Dutch farms.

In all these studies, liquidity variables hence turned out to have a significant influence on investment, which is evidence for the thesis of credit rationing.[17] However, in most of the mentioned papers the theoretical framework is rather ad hoc. Often the analysis directly starts with a postulated investment function, which is usually different for the studies in the lower part of Table 2.

More recent and methodologically sophisticated research extends the traditional approach by explicitly founding the analysis on a *stochastic* optimisation problem. A general description of such a problem can be found in CHOW (1997, pp. 22-23). The model may be regarded as a generalisation of the formal model of section 2.2 for the case of a multi-period decision under uncertainty. This type of extended model can be solved by dynamic programming or the Lagrange method.

Similar to the static model, the absence of financial constraints prescribes that firm behaviour obeys the first-order condition of the dynamic optimisation problem (so-called stochastic Euler-equation, see BOND and MEGHIR 1994, pp. 199-200). In principle, the condition postulates that in each period the expected marginal profit from investment equates its dynamic shadow value. If this condition is empirically rejected, the perfect market model is dismissed and financial constraints are assumed to be relevant.

[17] A related study that uses financial variables to explain the qualitative decision whether to invest at all is ELHORST (1993).

To avoid specification error, the usual procedure is to split the sample based on a priori information into a constrained and an unconstrained subgroup. Qualitative information on credit rationing may therefore be desirable. For the constrained group a modified investment equation including financial variables is then estimated. There are two broad approaches pursued in the literature (see BOND and MEGHIR 1994, p. 200): (a) using a VAR forecasting procedure in order to estimate the marginal profit from investment, which allows an excess sensitivity test, or (b) estimate the investment function as an empirical Euler equation by employing the Generalised Method of Moments (GMM; see JOHNSTON and DINARDO 1997, pp. 327-345). The latter allows an empirical rejection of the Euler-equation. Due to its utilisation of the orthogonality condition in the framework of a GMM estimation, this rejection has been called 'orthogonality test' by HAYASHI (1987). In both cases, time series or panel data is a necessary prerequisite. There are analogous applications in the consumption literature, following HALL and MISHKIN (1982).

Frequent results are that firms classified a priori as constrained display a higher sensitivity to financial variables than unconstrained ones, and the perfect market Euler equation is rejected by the constrained subsample. A recent survey of the literature is HUBBARD (1998). For illustrative purposes, I briefly summarise three studies dealing with the agricultural sectors in the U.S. and France, respectively.

HUBBARD and KASHYAP (1992) use a large panel of aggregate U.S. farm data to estimate investment functions based on Euler-equations. They test two variants of the Euler-equation against the data, one that implies perfect capital markets, and one including financial variables due to an additional borrowing constraint. The financial variable they use is the farms' net worth, which is supposed to influence investment decisions as a measure of borrowing capacity. In adjacent periods with high net worth (that is without constraints), the assumption of perfect capital markets (and thus the first Euler-equation) should hold, while borrowing constraints should be significant in periods with low net worth. Farm net worth is therefore the implicit criterion to distinguish constrained and unconstrained observations to avoid misspecification of the model. The results of their estimations suggest that (a) the model implying perfect capital markets was rejected by the data, (b) including financial variables as explanatories substantially improved the fit of the model, and (c) the effect of changes in net worth was significantly more important in times of a deteriorating economic environment for farming. Overall, the importance of capital market imperfections could thus be proven, with farms' net worth as a significant determinant.

A comparable model is estimated by BENJAMIN and PHIMISTER (1997) for French farm panel data. Two main differences to HUBBARD and KASHYAP (1992) are that BENJAMIN and PHIMISTER (a) use a different selection criterion to distinguish constrained and unconstrained periods, and that (b), in addition to variables of financial structure, they also explicitly include positive transaction costs of borrowing in their extended Euler-equation. Their data set has the advantage that it allows the identification of adjacent periods in which farms' borrowed additional funds. For these periods, credit constraints are assumed to be absent, and the Euler-equation reflecting perfect capital markets should apply. In periods for which borrowing constraints are assumed to be present, an extended Euler-equation that allows for transaction costs of borrowing should hold. Both cases are estimated with or without additional financial variables by a GMM estimator. The results also reject the perfect capital market model. The extended Euler-equation which allows for transaction costs and uses the selection criterion, however, was not rejected. In both cases, inclusion of financial variables could *not* improve the fit of the model. A general result is thus that different investment behaviour under credit constraints could be detected empirically, although the role of financial variables could not further be enlightened.

BIERLEN and FEATHERSTONE (1998) base their study on a panel of individual U.S. farm data.[18] The authors distinguish periods with or without credit rationing as well as subgroups of farms that are more or less likely to be constrained. Their selection criteria are farm individual level of assets, debt-to-asset ratio, age of operator, and certain business cycles. They estimate investment equations for the different subgroups by a VAR forecasting method. Cash-flow as an additional explanatory variable proved to be significant (a) in 'bust' periods and (b) for high-debt and younger-operator farms, according to expectations of relevant credit constraints. Farm debt level was identified as being the most important determinant of rationing.

For the purposes of this paper, the following evaluation can be given:

- By preserving a theoretical foundation, the more recent studies provide a major extension of the previous static household modelling approach since they explicitly incorporate time and uncertainty.
- Although less theoretically elaborate, also the earlier contributions are capable of detecting an effect of financial variables on investment.
- A major disadvantage of the method is its enormous data requirements, at least for the more sophisticated approaches. In the absence of sufficiently large panel data it might not yield satisfying results, which is why there are few studies on developing or transition countries.
- Most advantages and drawbacks of econometric modelling mentioned earlier also apply here.

## 4 DISCUSSION AND CONCLUSIONS

The final section aims at synthesising the results of the previous survey by discussing the characteristics of the various approaches along the lines of the criteria proposed in section 2.3. I conclude with some general comments on measuring credit rationing.

### 4.1 Definition and measurement of credit rationing

The previous analysis has shown that the surveyed methodological approaches define credit rationing in different ways which are partly incompatible. This applies in particular for the first approach mentioned, which understands credit rationing as present if high (quantifiable) transaction costs make borrowing unprofitable for the farmer. In contrast, all other approaches identify credit rationing with an excess demand where the interest rate shows no tendency to bring supply and demand into equilibrium. This leads to an upper credit limit that is not dependent on the borrower's return on the loan. A rather simple way to 'measure' this is by asking prospective borrowers whether they obtained as much credit as desired, as in the second approach. The result is a qualitative indicator. A refinement of this procedure is represented by the third approach, in which respondents are asked to quantify their desired loan volume and the exogenous credit limit, so that the extent of credit rationing is measured by a metric indicator. In both approaches, nothing is said, however, about the actual repayment capacity of the borrower and the return on the loan he is able to achieve. Whether there is in fact a positive excess demand is hence only concluded from the respondents subjective assessment. On segmented credit markets, the observed behaviour of the borrower to switch between credit sources is also a qualitative indicator of credit rationing with regard to the primary source (as in the second approach). An advantage to the qualitative indicator of the second approach is that the switch to the allegedly more expensive secondary source (trade or informal credit) provides evidence

[18] The theoretical basis of their study is GILCHRIST and HIMMELBERG (1995).

that the borrower was in fact capable or at least willing to pay the interest rate of the primary source (bank or formal lender).

The fifth and sixth approaches measure credit rationing by econometrically investigating their consequences within the farm-household decision process. In case that this procedure is regarded as valid, i.e. the theoretical premises and the methodological way of data analysis are accepted, both approaches produce metric measures of credit rationing which achieve a high degree of economic meaningfulness. By meaningfulness I mean the explicit detection and quantification of disequilibria and non-separabilities.

### 4.2 Identification of credit market inefficiency

It has been argued above that the quantification of transaction costs is conceptually difficult if not impossible, because correct opportunity costs of resource use are usually unknown. Furthermore, which share of the transaction costs has to be borne by borrowers and therefore is included into the calculation may differ between lending sources. Finally, it might be difficult to decide which transaction costs are the result of necessary screening and monitoring activities and which are true inefficiencies in the intermediation. The validity of this indicator as a measure of credit market efficiency is therefore rather dubious.

The second and third approaches do not measure the repayment ability of the borrower and therefore a priori cannot discriminate between efficient and inefficient rationing. In other words, it remains unknown whether bank and borrower simply had divergent views concerning the viability of the borrower's project or her repayment capacity, or whether the borrower was in fact able to pay a higher interest rate. This applies to a lesser extent to the fourth approach, since borrowers document their willingness to pay the primary source by switching to the more expensive secondary source.

Under the assumption that the exogenous interest rate can be taken as an adequate benchmark, the fifth approach allows to correctly identify credit market inefficiencies. On theoretical grounds, it is therefore among the most satisfactory approaches. The same is true with regard to the sixth approach, which tests whether loan access of farms is independent of financial variables, as postulated to hold on efficient credit markets. However, detecting interdependencies between financial variables and investment behaviour might be to a higher degree open to alternative interpretations than the quantification of a shadow interest rate in excess of market rates (see HUBBARD 1998).[19]

At this point a key problem of conceptualising efficiency deserves mentioning which restricts the range of interpretation particularly of the fourth and fifth approaches. Both approaches take the neoclassical first-best environment as a benchmark for their efficiency analysis. It was stated above that credit rationing coincides with underinvestment if the assumptions of the formal model in section 2.2 are made. On the other hand, a central reason for credit rationing is seen in the presence of asymmetric information or enforcement problems. However, on markets with asymmetric information, the co-ordination mechanism of prices is severely distorted, so that prices do not necessarily reflect economy-wide scarcities (STIGLITZ 1987). As a result, the intimate connection between credit rationing and underinvestment breaks down. In a series of papers, DE MEZA and WEBB (1987; 2000) have shown that credit rationing as a private excess demand does not necessarily coincide with underinvestment as compared to a first-best world, and that it even may imply too much lending if in-

[19] A particular problem in the investment literature is capturing investment opportunities of different firms and separate these from shifts in financial variables (HUBBARD 1998, pp. 199-200), which arguably might be more problematic than measuring ex-post productivities in static production models.

formation asymmetries are present. The consequence for the interpretation of the results of the fifth approach is that it still detects credit rationing, but that underinvestment can only claimed to be present under the assumption that the market interest rate is not biased as a result of informational asymmetries. Similarly, if researchers using the sixth approach find that there is a dependence between financial variables and investment, this is evidence for a market failure, but the direction of misallocation cannot be predicted – there may even be too much investment as compared with a first-best solution.

### 4.3 Data requirements and potential for advanced data analysis

All approaches pursue a micro-level analysis, which generally requires the availability of household or farm data. This type of data is usually not available from standard official sources, particularly in low-income or transition countries, which might be an ultimate barrier to the application of any of the approaches. All approaches presuppose access to suitable cross-sectional micro data, the more sophisticated analyses of the sixth approach even demand panel data. Furthermore, many approaches rely on specific data concerning respondents' loan transactions. It will therefore often be difficult to work with existing (micro) data sets, so that specifically designed surveys remain the only alternative. On the other hand, data requirements are such that they can be managed in surveys with a large number of respondents without stretching their abilities and resources too far.

Comprehensive survey data sets will usually allow the application of advanced methods of statistical and econometric data analysis, as the previous overview has demonstrated. This commonly includes the statistical modelling of cause-effect relations. The analysis will be the more powerful, the more specifically the available data is tailored to the research question at hand. A case in point is the qualitative indicator used in the second approach, which not only allows a direct analysis of the determinants of falling in the group of rationed borrowers, but is also of value with regard to the distinction of borrower groups for second-stage analyses, as in the fifth approach. Similar indicators of group affiliation are also required for the sixth approach.

### 4.4 Concluding remarks

The empirical analysis of credit rationing has attracted considerable attention by applied researchers in previous years. This methodological survey has shown that there are various approaches pursued in the literature, with specific strengths and drawbacks. A general conclusion is that the more sophisticated the approaches in terms of micro-econometric analysis, the more economically meaningful are the results. However, meaningfulness is conditional on the theoretical premises one makes, which also are stronger for more advanced econometric methods. Since the theoretical progress in the analysis of (rural) credit markets is still rather rapid, future insights on the theoretical level are likely to spur new lines of empirical research and induce current methodologies to be refined and re-examined.

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