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A theory of markets, institutions, and endogenous preferences

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Abstract

The endogeneity of preferences implies that not only individual preferences—along with technologies, government policies, and the organization of society and markets—determine economic outcomes, but also that the economic, social, legal, and cultural structure of society affects preferences. This paper develops a general equilibrium model of incomplete markets in which preferences are endogenously determined. The key feature in the model is the interplay between the extent of the market, competitive endogenous interactions among individuals, and the heterogenous formation of preferences. We develop our model through an example in which individuals' attitudes toward risk are formed as a function of the exposure to market risks, market incompletenesses, and non-market uncertainties. The model can easily accommodate the consideration of the formation of other preference parameters, and their relationship with other characteristics of the economic, social, and institutional environment. We discuss and present empirical evidence that supports the implication that the degree of risk aversion responds to market arrangements.

Keywords: Endogenous preferences; Incomplete markets; General equilibrium; Risk aversion

1. Introduction

This paper is concerned with the study of the endogeneity of preferences. Preferences, as the foundation of behavior, play a crucial role in virtually all parts of economics, sociology, law, political science, psychology, and other social sciences. The development

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of preferences is considered to be governed by the diversity of elements and institutions that constitute the social, cultural, and economic environment. But, where do preferences originate? How are they formed? How does the economic, social, legal, and cultural environment shape the formation of preferences? In recent years concepts such as 'habit formation,' 'social norms,' 'cultural values,' 'conspicuous consumption,' and others have been formalized in various ways in the economics literature in an attempt to begin to answer these difficult questions. Yet, mainstream economic theory typically assumes that preferences are exogenous and stable. This assumption provides a solid foundation for generating predictions about responses to various changes in the environment where individuals operate. It also prevents the analyst from succumbing to the temptation to simply postulate the required shift in preferences to 'explain' all apparent contradictions to the theory. The traditional argument, however, is not that preferences are in fact stable but rather that it is psychologists, sociologists, anthropologists, and biologists who should study the formation of preferences, while economists should take them as given and analyze the implications for economic behavior (Friedman, 1962). There is, however, a fundamental methodological difference between the approach that economists take and that of all other social scientists, which is that the latter do not embed their analyses into powerful analytical frameworks (Becker, 1996). As analytical frameworks can lend precision to theories, generate new hypotheses, promote intelligibility, and clarify complex interactions, the analysis in other social sciences may be limited in various respects, and may thus present serious inconveniences to progress in this important area. This may be one reason why the pragmatic view that economists should leave the study of preference formation to other social sciences has been slowly changing in recent years.

In this paper we abandon the usual pragmatic view to develop a tractable framework for the study of the endogenous and competitive formation of preferences. We are also motivated in the analysis by recent developments in the study of preferences. The last decade has witnessed a number of qualifications, refinements, and criticisms of rational actor models. A great deal of this work involves 'anomalies' of various sorts, and often suggests cognitive limits on individual rationality and imperfections in preferences and values. We share the view that even though 'cognitive imperfections are sometimes important, [there are other] more significant weaknesses in standard models of rational choice for explaining behavior in real, as opposed to experimental, situations. Legal rules, culture, habitual behavior, social norms, available opportunities and information, and past acts of investments and consumption . . . frequently place more far-reaching constraints on choices than do conflicting selves, mistakes and distortions in cognitive perceptions. . . . [In fact,] modern economics has lost a lot by completely abandoning the classical concern with the effects of the economy on preferences and attitudes' (Becker, 1996, pp. 19–22). In short, preferences are endogenous to the environment, but formal frameworks for examining this interaction are scarce in modern economics.

Our aim in this paper is to develop a tractable framework for the analysis of the endogenous relationship between preferences and the environment where individuals operate. The endogeneity of preferences implies that the economic, social, legal, and cultural structure of society affects tastes regarding the consumption of goods, leisure, investment, and all other activities. Preferences help determine outcomes and are, in turn,

influenced by the economic and non-economic environment.[1] And as Becker (1993, p. 401) remarks, 'an important step in extending the traditional analysis of individual rational choice is to incorporate into the theory a much richer class of attitudes, and preferences [that reflect such two-way interactions].'

The analysis in this paper extends the traditional utility-maximizing approach using the consumer theory of complements to analyze endogenous preferences. In particular, we formalize the idea that the marginal rate of substitution *schedule* between states of nature may respond to the environment. The general approach follows Becker (1996) and has been recognized and applied in other applications.[2] The general equilibrium framework we develop to analyze the endogenous formation of tastes when preferences are partly the product of people's environments focuses on a feature of the environment that has not been examined previously: the extent of markets. The extent of the market—as a system in which resources and production are allocated on the basis of prices generated by voluntary exchanges—is a fundamental determinant of the nature and extent of the economic and social orders. Both the extent of markets and the lack of markets are some of the main 'institutions' that determine economic and non-economic outcomes and shape human interaction. They encompass, in a general sense, the extent and form of economic, legal, and social activities. The analysis of the extent of markets is especially important as they are a crucial determinant of economic and non-economic outcomes, and 'outcomes help form tastes' (Becker, 1996, p. 19).

In our analysis we will make the marginal rate of substitution between states of nature endogenous to the extent of markets. The model is developed in the context of a concrete example where the extent of markets (including public and private institutions) and the risk structure of the economy are endogenously related to individuals' attitudes toward risk. Although we concentrate on this example, an advantage of the framework is that any other parameter or feature of individual preferences can be easily incorporated into the

[1] The formation and evolution of norms and values have been analyzed among others by Arrow (1974), Becker and Madrigal (1994), Becker (1996), Kreps (1997), and Posner (1997). Sunstein (1993) and Posner (1997) discuss instances in which preferences may be a function of the initial allocation of legal entitlement, and the important positive and normative implications that derive from it. Bisin and Verdier (1998) present a theory of cultural transmission whereby interactions with peers, parents, and others determine the formation of cultural values. Mulligan's (1997) analysis centers on the role of endogenous altruism, whereby parents spend time and goods in order to influence their concern for children. Becker and Mulligan (1997) develop a model of patience formation in which individuals spend resources to increase their appreciation for the future. Cultural beliefs, social norms and societal organization, how they may endogenously evolve, and their importance for economic outcomes and economic growth and progress are examined in North (1990), Greif (1994), Bowles (1998), and other references therein.

[2] We are indebted to one referee for suggesting the following examples where the consumer theory of complements is also used to shift the familiar marginal rate of substitution (MRS) in various ways. For instance, labor supply is sometimes modeled in a household context with a three-dimensional utility function $u(c, h, w)$ with purchases of market consumption c, husband's time not working h, and wife's time not working w. Expanding the utility function this way endogenizes the MRS between consumption goods and household time. Long-run and short-run demand curves in price theory are also related, as substitution effects may be expected to be small in the short run but large in the long run when more factors can be adjusted. Our approach will share these basic ideas of the consumer theory of complements allowing, at the same time, individuals to spend time and resources to form their preference parameters as, for instance, in Becker and Mulligan (1997).

analysis. The main reasons for the specific choice of this example are the following. First, 'the major role of institutions in a society is to reduce uncertainty by establishing a stable structure to human interaction' (North, 1990). In this sense, we capture this general feature of institutions by examining the role that a stable structure where interactions take place, formally interpreted as markets, has in forming risk attitudes. Second, the ideas in our particular example are also related to and motivated by the work in Becker and Ehrlich (1972). They develop a theory of the demand for insurance that emphasizes the interaction between market insurance (the importance of exposure to market and non-market uncertainties), 'self-insurance' and 'self-protection.' Our general equilibrium model will emphasize two additional aspects: (1) self-insurance through preference formation (the formation of the risk aversion parameter), and (2) the endogenous relationships between the extent of the market and the *competitive interactions* among individuals. In this sense, it offers an applicable model of endogenous risk aversion. Third, an advantage of the example we use to develop the framework is concerned with the possibility of finding empirical support for the endogeneity of preferences. In our example, we need to establish a relationship between the existence of markets and institutions (or lack thereof) in certain states of nature and differences in risk aversion or other preference parameters. In particular, we would expect that the degree of risk aversion responds to market arrangements. In Section 3 we first discuss some instances where the empirical implications may be evaluated. We then provide an empirical analysis whose results are consistent with the general implication that the degree of risk aversion is endogenous to market arrangements. We estimate risk aversion coefficients in Bangladesh in a situation of severe hardship where markets are segmented and access to credit is fundamentally different for different households; we also examine a situation where markets are not segmented and appear to be well functioning for the same population of households. We find that there are significant differences in the estimates across households and market structures.

In summary, the model intends to provide a general, tractable framework for the study of the endogenous formation of preferences using the consumer theory of complements to capture the effects of the competitive interactions among individuals. The model may also accommodate the analysis of the endogenous relationship between different features of the environment and the formation of other parameters or types of preferences.

The rest of the paper is organized as follows. Section 2 develops an incomplete markets general equilibrium model where preferences are endogenously determined. The model is adapted to examine the endogenous relationship between the formation of attitudes towards risk, the extent of market completeness, and the exposure to individual and aggregate uncertainties. We provide a definition of equilibrium *in preferences* in the class of general equilibrium models that we consider, as well as some simulations of the specific example we develop. Section 3 discusses possible empirical applications, and offers an empirical analysis whose results are consistent with the implications of the model. Section 4 concludes.

2. A general equilibrium model of the competitive formation of preferences

This section is structured as follows. The first subsection describes the economy, defines its equilibrium, and offers a generalization of the equilibrium concept. In the

second subsection, we compute and characterize the equilibrium and we also provide some numerical simulations.

2.1. Description of the economy

2.1.1. Preferences

Consider a continuum of ex ante identical individuals in $[0, 1]$ that live for two periods. Their preferences over consumption are given by:

$$x_0 + \sum_{s=1}^{S} \tau(s)\left(x_1(s) - \frac{\bar{\rho}}{2}(x_1(s))^2\right),$$

where S represents the total number of possible states of nature, τ_s the probability associated with state s, x_i the consumption in period i and $\bar{\rho}$ is the parameter that governs the risk aversion of the individual. Individuals are endowed with w_0 units of the consumption good in the first period and $w_1(s)$ units of the consumption good in the second period in state s. Let V be the variance of the second period endowment. We assume that the aggregate endowment is far from the satiation point.

We model the endogenous formation of preferences as a *competitive sorting* of individuals among two classes of preferences. These preferences are identical to each other except for one parameter. We choose, without loss of generality, the parameter that represents the attitude towards risk. Let, for example, $\bar{\rho}$ take two values, $\bar{\rho}_1$ and $\bar{\rho}_2$, where we consider $\bar{\rho}_1 < \bar{\rho}_2$ with, for example, $\bar{\rho}_1 = \rho$ and $\bar{\rho}_2 = \rho(1 + V)$. We will thus examine the endogenous formation of preferences in terms of the formation of this specific parameter, which will in turn be a function of the structure of the environment. These attitudes toward risk are formed prior to any trading taking place in markets to open in the first period, and take into account all market and non-market uncertainties to which the individual is exposed. Let π be the proportion of individuals with a risk aversion parameter ρ in this economy.

2.1.2. Technology

Lower aversion to risk is assumed to be formed at a cost $\mathbf{C_1} > 0$, paid out of first period endowment, which is a loss to the economy. For example, without loss of generality, it may be modeled as an inverse function of the proportion π:

$$\mathbf{C_1} = \frac{c_1}{f(\pi)},$$

with $f'(\pi) > 0$ and $c_1 > 0$. The added utility resulting from a lower aversion to risk is partially offset by its cost, which we assume to be inversely related to proportion π. This inverse relationship is, clearly, not a necessary feature of our analytical framework. It is however quite convenient for some of the empirical evidence that will be discussed in Section 3. Particular applications may provide valuable guidance and explicit micro-foundations (e.g. psychological, biological, or sociological) into the appropriate functional forms that may be assumed for this cost process. We abstract from specific applications at

this point, and simply assume that the formation of a lower aversion to risk is costly, which may be interpreted in terms of time, effort, and resources as, for example, in Becker and Mulligan (1997).[3]

The variable V, the variance of the second period aggregate endowment, is our proxy for all non-market uncertainty. This choice is the logical one given that individuals can redistribute aggregate uncertainty across the population following different optimal rules but they cannot alter it. We further assume that market and non-market uncertainties enter the decision process of the individuals as a bonus $\mathbf{C_2} \geq 0$ in the utility of individuals whose attitude towards risk is governed by ρ. This parameter can be expressed, for example, as:

$$\mathbf{C_2} = c_2 \frac{\gamma V}{h(E) + \gamma V},$$

where c_2 is a non-negative constant, γ is a 'perception' parameter reflecting the perception with which agents contemplate aggregate uncertainty, and $h(E)$ is a positive function of the exposure to market uncertainties E (to be defined shortly), with a positive derivative. Again, as in the case of $\mathbf{C_1}$, this ad hoc functional form for $\mathbf{C_2}$ is not at all necessary or particularly relevant for our theoretical framework. It may be modeled in different ways in specific applications. Further, $\mathbf{C_2}$ may even be assumed to be zero. ($\mathbf{C_1}$, however, is always strictly positive). The only reason why we assume these specific functional forms is because in some of the empirical instances we discuss in Section 3 they will be especially meaningful and useful. In those instances these parameters will have a clear and intuitive interpretation which, at this point, we postpone until Section 3.

As a summary, we write the utility functions of the two types of individuals ($\bar{\rho}_1$-types and $\bar{\rho}_2$-types) as:

$$u_{\bar{\rho}_1} = x_0 + \sum_{s=1}^{S} \tau(s) \left(x_1(s) - \frac{\rho}{2} (x_1(s))^2 \right) + \mathbf{C_2},$$

$$u_{\bar{\rho}_2} = x_0 + \sum_{s=1}^{S} \tau(s) \left(x_1(s) - \frac{\rho(1+V)}{2} (x_1(s))^2 \right).$$

2.1.3. The financial structure

Once attitudes towards risk are formed, individuals trade during the first period in a possibly incomplete financial market. Because individuals have two different attitudes toward risk, trade is feasible in all markets. In particular, it is to be expected that the $\bar{\rho}_1$-types are willing to take on a larger risk than the aggregate. These financial markets are the ones that allow for hedging of what we have been referring to as market uncertainties. The fact that these markets may be incomplete may result in larger exposure than would result

[3] If utilities are interpreted as those of a family or a group, then it is also possible to think of examples in which individuals invest effort and resources in order to affect the preference parameters of other individuals in the same family or group, e.g. parents investing in their children's preferences (see Becker and Mulligan, 1997; Bisin and Verdier, 1998; Boyd and Richerson, 1985; Mulligan, 1997, and other references therein).

if no markets were missing. We call the measure of exposure E and we provide its precise mathematical definition below.

We call a financial structure a set of available assets in zero net supply and we denote it by F_i, where i represents the number of assets in that set. For simplicity, we assume that i is also the dimension of the space spanned by F_i. In order to have a sufficient statistic describing the degree of market completeness of the economy, we assume that a randomization takes place across financial structures, once attitudes towards risk have been irreversibly formed. In particular, we assume that the randomization is limited to $[F_S, F_0]$, where F_S is the financial structure associated with complete markets. F_S occurs with probability p and F_0 occurs with probability $(1-p)$. Hence the available ex ante financial structure is:

$$F = pF_S + (1-p)F_0.$$

The greater p is, the closer the economy is to delivering a complete financial structure. This form of parameterizing market completeness is quite convenient in the sense that it allows for a smooth and readily computable way of characterizing the equilibrium distribution of individuals and preferences as a function of the existing market or institutional structure.[4]

2.1.4. Timing of the economy

To summarize, the timing of this economy is as follows:

1. Individuals observe the degree of market completeness, p, and have certain perceptions of the importance of the aggregate uncertainty, γ. Given this information, irreversible preferences (attitudes towards risk in our case) are formed.
2. Randomization over financial structures takes place.
3. Payment of the costs of attitudes towards risk and trade takes place.
4. Delivery takes place.

2.1.5. Definition of the equilibrium

The problem of an individual once a certain financial structure F_i has been realized can be written as:

$$\max_{\theta_{F_i}} \left[x_0 + \sum_{s=1}^{S} \tau(s) \left(x_1(s) - \frac{\bar{\rho}}{2} (x_1(s))^2 \right) \right],$$

subject to:

$$\bar{w}_0 = x_0 + \theta_{F_i} \cdot q_{F_i},$$
$$x_1(s) = \theta_{F_i} \cdot R_{F_i}(s) + w_1(s),$$

where $R_{F_i,s}$ is the vector of asset payoffs associated with financial structure F_i in state s, θ_{F_i} is the individual's portfolio and q_{F_i} is the vector of asset prices. Here, $\bar{w}_0 = w_0 - \mathbf{C_1}$ if the

[4] See the analysis in Santos (1997) for a number of other valuable properties.

problem is that of a $\bar{\rho}_1$-type individual and $\bar{w}_0 = w_0$ if the problem is that of a $\bar{\rho}_2$-type individual. Furthermore, let $u_{\bar{\rho}_1,F_i}$ be the utility associated with a $\bar{\rho}_1$-type when the realized financial structure is F_i. Similarly with $u_{\bar{\rho}_2,F_i}$. Then, we define an equilibrium as follows:

Definition. An equilibrium in this economy is an array of portfolio positions $\bar{\theta}_{F_i}$, a vector of asset prices $\bar{q}_{F_i}$ associated with the realized financial structure F_i, and a proportion of $\bar{\rho}_1-$type individuals π such that:

(1) Individuals maximize utility given $\bar{q}_{F_i}$.
(2) Markets clear:

$$\pi\bar{\theta}_{\bar{\rho}_1,F_i} + (1-\pi)\bar{\theta}_{\bar{\rho}_2,F_i} = 0, \quad \forall i.$$

(3) All individuals enjoy the same utility in equilibrium:

$$p\bar{u}_{\bar{\rho}_1,F_S} + (1-p)\bar{u}_{\bar{\rho}_1,F_0} + \mathbf{C_2} = p\bar{u}_{\bar{\rho}_2,F_S} + (1-p)\bar{u}_{\bar{\rho}_2,F_0}.$$

Note that in this framework, market exposure is a proxy accounting for the loss of utility associated with the incompleteness of the exchange or the environment where individuals interact. A precise definition is provided in the next subsection. Clearly, it is a decreasing function of market completeness. Note also that modeling the degree of market completeness as a distribution whose support is a class of financial structures allows for smooth changes in the financial side of the economy. Introducing one additional asset is a discrete change in the economy which would otherwise prevent the traditional differential approach.

2.1.6. Discussion and generalization of the equilibrium concept

2.1.6.1. Discussion. The model intends to provide a method to endogenize preferences which in the particular case of our example we associate with the formation of a preference parameter (attitudes toward risk). In this respect, it is important to emphasize some aspects of the analysis. First, we do not necessarily assume or imply that preferences are chosen or formed either at will, consciously, or immediately. We have little to say about the conscious, cognitive, or purposeful *process* of choice or formation of preferences. Therefore, we focus only on the analysis of the *competitive forces* that shape them or may contribute to forming them such as markets, public and private institutions, and the socioeconomic environment. For expositional simplicity, however, we will continue using the terms 'choice' or 'formation' indistinguishably in the remainder of the paper. Second, as discussed above, it is not at all necessary that $\mathbf{C_1}$ and $\mathbf{C_2}$ take the ad hoc forms we have assumed, or even that preferences are distinguished by their attitudes toward risk. It is straightforward to consider other functional forms as well as differences in other preference parameters or classes of preferences depending upon the particular area or application we are interested in. Specific applications may also provide valuable guidance and explicit micro-foundations (e.g. psychological, cognitive, biological, or sociological) for the forms that these cost functions may take. Third, in this sense, the model strictly

focuses on the *competitive interaction* aspect (or the cross-sectional interaction effects) of the endogenous formation of preferences and their relationship with the economic and non-economic environments. In this sense, it also abstracts from aspects associated with the evolution over time of preferences.[5]

Lastly, it is possible to provide some initial intuition from the basic setup of the model. Note that the demand for less risk averse preferences is endogenously related to the extent of the markets where risks can be hedged. Moreover, markets and risk averse preferences will be substitutes when C_2 is negligible or is not inversely related to E too strongly.

2.1.6.2. Generalization of the equilibrium concept. Our example and equilibrium concept is nothing but a particular case of a more general type of economy which we describe next. Let there be an exchange economy of types $i \in \mathcal{I}$, where there is positive measure α^i of individuals of type $i \in \mathcal{I}$. Each type i is endowed with schedule $w^i(s) \in \mathbf{R}_+^L$ across date-events $s \in S = [s_0, s_1 \ldots, s_S]$ and where $w_l^i(s)$ is the endowment of an agent of type $i \in \mathcal{I}$ of good $l \in L$ in date-event $s \in S$.

Individuals of type $i \in \mathcal{I}$ are given a discrete set of well-behaved utility functions of the same cardinality, Ω^i, over which one is selected, i.e.:

$$\Omega^i = \left[u^{1_i}(\cdot), \ldots, u^{p_i}(\cdot)\right],$$

where:

$$u^{t_i} : \mathbf{R}^{LS} \to \mathbf{R} \quad \forall t_i \in [1_i, \ldots, p_i].$$

Indexing the set of utility functions by the type of individuals reflects any type of educational, social, institutional or cultural component that may play a role in the formation of preferences. The purpose is to investigate the impact of the market and the socioeconomic and non-economic environments in the formation of preferences.

The same cardinality is needed in order to compare the formation of preferences. For example, the following family of preferences has the same cardinality:

$$\left[x(s_0) + \sum_{j=1}^{S} \tau(s_j)\left(x(s_j) - \gamma(x(s_j))^2\right) \quad \forall \gamma \in \mathcal{G}\right],$$

where $x(s_i)$ represents consumption in event s_i. 'Utils' are units of endowment in state s_0, *independent* of the value of $\gamma \in \mathcal{G}$, and comparison is feasible. By standard theorems of existence, and under all the traditional assumptions, an equilibrium exists for a *given choice* or formation of preferences. The problem remains as for the existence of an

[5] Of course, cross-sectional and temporal aspects are generally related. One can think of the evolution over time of certain features of the market and non-market environments including the extent of market completeness. Presumably, for instance, markets have become more complete over time as it is now feasible or easier to hedge many more risks in the different states of nature through private and public institutions than it was, say, 100 or 1000 years ago. Our emphasis, however, is in providing a general equilibrium framework in which the effects on preferences of *competitive* or *cross-sectional* interactions in market and non-market (social, legal, cultural) environments can be studied.

equilibrium in *preferences*, prices, and allocations. A way of approaching the problem is the following. Assume that preferences are formed prior to any trading in commodities. Hence the different individual types play a game in normal form, where the actions are the choices or formation of preferences, and the payoffs are the utility they will obtain in the corresponding equilibrium. As is clear, this is where the same cardinality of preferences is needed. In order to guarantee the existence of a Nash equilibrium, individual types should also be able to play mixed strategies, and here is where we need that types are a continuum.

An equilibrium of this economy is an array of:

(1) Measures and corresponding utilities:

$$\left[\left(\alpha^{1_i}, u^{1_i}\right), \ldots, \left(\alpha^{p_i}, u^{p_i}\right)\right]_{i\in\mathcal{I}}$$

(2) Prices $q\in\mathbf{R}_{+}^{LS}$ and allocations:

$$\left(x^{1_i}(s_j), \ldots, x^{p_i}(s_j)\right)_{j\in[1,\ldots,S],i\in\mathcal{I}}$$

such that:

(a) The measures and the corresponding utilities are a Nash equilibrium of the game in normal form described above, and (b) Prices and allocations clear the corresponding economies and individuals maximize given their prices *and* their preferences.

2.2. Results

In this subsection we offer three propositions that characterize the equilibrium of the economy presented above. We also provide a useful representation result for the utility in equilibrium, which may have relevant implications for efficiency analysis.[6] In this framework preferences are formed competitively and, in general, the model will generate endogenous heterogeneity.

2.2.1. Computation of the equilibrium

Let F_i be the realized financial structure and π the proportion of $\bar{\rho}_1$-types. Let $R_{F_i}(s)$ be the payoff vector in state s. Define the following moments:

$$\Sigma_{F_i} = \sum_{s=1}^{S} \tau(s) R_{F_i}(s) R_{F_i}^{\top}(s),$$

$$\Sigma_{(F_i,1)} = \sum_{s=1}^{S} \tau(s) R_{F_i}(s) w_1(s),$$

[6] It is difficult to make normative statements when preferences are endogenous. In our context, market structures may tend to evolve endogenously, and the extent of market completeness may be a function of innovative efforts and incentives. It would then be difficult to make normative statements without knowing the reference point and the exact cost processes by which preferences are evolving.

$$\mu_{F_i} = \sum_{s=1}^{S} \tau(s) R_{F_i}(s),$$

$$u_{\bar{\rho}_1,F_0} = w_0 + \sum_{s=0}^{S} \tau(s)\left(w_1(s) - \frac{\rho}{2}(w_1(s))^2\right) - \mathbf{C_1},$$

$$u_{\bar{\rho}_2,F_0} = w_0 + \sum_{s=0}^{S} \tau(s)\left(w_1(s) - \frac{\rho(1+V)}{2}(w_1(s))^2\right).$$

Hence $u_{\bar{\rho}_1,F_0}$ is the utility a $\bar{\rho}_1$-type would derive if no hedging was possible, and similarly $u_{\bar{\rho}_2,F_0}$ for the $\bar{\rho}_2$-types. Then, the following proposition results:

Proposition 1. *Given revealed financial structure F_i and the proportion of $\bar{\rho}_1$-types π, then portfolio positions, asset prices, and utilities are given by:*

$$\bar{\theta}_{\bar{\rho}_1,F_i} = \frac{(1-\pi)V}{1+\pi V}\Sigma_{F_i}^{-1}\Sigma_{(F_i,1)},$$

$$\bar{\theta}_{\bar{\rho}_2,F_i} = -\frac{\pi V}{1+\pi V}\Sigma_{F_i}^{-1}\Sigma_{(F_i,1)},$$

$$\bar{q}_{F_i} = \mu_{F_i} - \frac{\rho(1+V)}{1+\pi V}\Sigma_{(F_i,1)},$$

$$\bar{u}_{\bar{\rho}_1,F_i} = u_{\bar{\rho}_1,F_0} + \frac{\rho}{2}\bar{\theta}_{\bar{\rho}_1,F_i}\cdot\Sigma_{F_i}\bar{\theta}_{\bar{\rho}_1,F_i} + \mathbf{C_2},$$

$$\bar{u}_{\bar{\rho}_2,F_i} = u_{\bar{\rho}_2,F_0} + \frac{\rho(1+V)}{2}\bar{\theta}_{\bar{\rho}_2,F_i}\cdot\Sigma_{F_i}\bar{\theta}_{\bar{\rho}_2,F_i}.$$

Proof. From the first order conditions, the demand for financial assets is given by $\theta_{F_i} = (\bar{\rho}\Sigma_{F_i})^{-1}\left(\mu_{F_i} - q - \bar{\rho}\Sigma_{(F_i,1)}\right)$. Using the market-clearing conditions, the price of the assets results from solving:

$$\left(\frac{\pi}{\rho} + \frac{(1-\pi)}{\rho(1+V)}\right)(\mu_{F_i} - q) = \Sigma_{(F_i,1)}.$$

As for the utility in equilibrium, notice that we can write:

$$\begin{aligned} x_0 + \sum_{s=1}^{S}\tau(s)\left(x_1(s) - \frac{\bar{\rho}}{2}(x_1(s))^2\right) &= \bar{w}_0 + \sum_{s=1}^{S}\tau(s)\left(w_1(s) - \frac{\bar{\rho}}{2}(w_1(s))^2\right) \\ &+\theta_{F_i}\cdot\left[\mu_{F_i} - q - \bar{\rho}\Sigma_{(1,F_i)}\right] - \frac{\bar{\rho}}{2}\theta_{F_i}\cdot\Sigma_{F_i}\theta_{F_i} \\ &= \bar{w}_0 + \sum_{s=1}^{S}\tau(s)\left(w_1(s) - \frac{\bar{\rho}}{2}(w_1(s))^2\right) + \frac{\bar{\rho}}{2}\theta_{F_i}\cdot\Sigma_{F_i}\theta_{F_i}. \end{aligned}$$

The result follows by substituting above the definition of the first period endowment, $\bar{w}_0$, for each type and then recalling the respective definitions of the utility. □

The above proposition provides a description of the equilibrium that will arise in this economy with fixed F_i and π. The comparative statics have a clear intuition and show the relevance of the general equilibrium features of the analysis of endogenous preference formation. For instance, if we increase π, the amount shorted (longed) by a $\bar{\rho}_2$-type decreases whereas the amount longed (shorted) by a $\bar{\rho}_1$-type increases, the difference being made up by the additional measure of $\bar{\rho}_1$-types. If the security traded is a bond, the $\bar{\rho}_2$-types are going to be the ones shorting it. This is so because a greater degree of risk aversion lowers the marginal utility of consumption the next period and, given that both types have the same current marginal utility of consumption, this implies that the $\bar{\rho}_1$-types have a stronger preference for consumption tomorrow. The situation may be different if we have a richer set of securities, for then the hedging motive may play a role in the bond position that the $\bar{\rho}_2$-types may adopt.

The utility in equilibrium has two clearly interpretable parts. The first one, either in $u_{\bar{\rho}_1,F_i}$ or in $u_{\bar{\rho}_2,F_i}$, is the utility that individuals would obtain if no hedging was available. The second part is the gain in utility that individuals derive from hedging in the exchange. In the next proposition we provide a different representation result that will shed light on the role of the exposure on the formation of preferences.

2.2.2. Exposure and the equilibrium measure of different types

So far we have not really defined what we mean by exposure. Usually, financial economists refer to some direct measure of the dividend or price variance of portfolios as risk exposure. This definition is not satisfactory given that it does not distinguish the part of the variance that is freely taken by individuals from the part that has to be assumed because there is no possibility of hedging it away due to the incompleteness of markets. We offer next a measure of the exposure which is simply defined as the amounts of utils lost due to the exchange incompleteness. Define:

$$\epsilon_{F_i}(s) = w_1(s) - R_{F_i}(s) \cdot \Sigma_{F_i}^{-1} \Sigma_{(F_i,1)},$$

as the error associated with the projection of second period endowment w_1 onto the space spanned by the financial structure F_i. Hence, the following proposition results:

Proposition 2. *Given* (π, F_i), *then utilities in equilibrium can be represented as:*

$$\bar{u}_{\bar{\rho}_2,F_i} = u_{F_0} + \frac{\rho(1+V)}{2}\left(\frac{\pi V}{1+\pi V}\right)^2 \left(\beta_1 - \beta_{\epsilon_{F_i}}\right),$$

$$\bar{u}_{\bar{\rho}_1,F_i} = u_{F_0} + \frac{\rho}{2}\left(\frac{(1-\pi)V}{1+\pi V}\right)^2 \left(\beta_1 - \beta_{\epsilon_{F_i}}\right) + \mathbf{C_2},$$

where

$$\beta_1 = \sum_{s=1}^{S} \tau(s)(w_1(s))^2,$$

$$\beta_{\epsilon_{F_i}} = \sum_{s=1}^{S} \tau(s)(\epsilon_{F_i}(s))^2.$$

Proof. By the results in Proposition 1 we have:

$$\begin{aligned}\bar{u}_{\bar{\rho}_1,F_i} &= u_{F_0} + \frac{\rho}{2}\theta_{\rho,F_i} \cdot \Sigma_{F_i}\theta_{F_i} + \mathbf{C_2} \\ &= u_{F_0} + \frac{\rho}{2}\left(\frac{(1-\pi)V}{1+\pi V}\right)^2 \Sigma_{F_i}^{-1}\Sigma_{(F_i,1)} \cdot \Sigma_{(F_i,1)} + \mathbf{C_2}.\end{aligned}$$

Using the definition of the projection error it follows that:

$$\beta_{\epsilon_{F_i}} = \beta_1 - \Sigma_{F_i}^{-1}\Sigma_{(F_i,1)} \cdot \Sigma_{(F_i,1)}.$$

Substitute. Similarly for the $\bar{\rho}_2$-types. □

Note that as in Proposition 1, the utility has two parts: one coming from the pure consumption of the endowment and a second one coming from hedging. Note also that Proposition 2 clearly identifies the loss associated with the incompleteness of financial structure F_i as:

$$\frac{\rho(1+V)}{2}\left(\frac{\pi V}{1+\pi V}\right)^2 \beta_{\epsilon_{F_i}},$$

for the $\bar{\rho}_2$-types, for if markets were to be complete then $\epsilon_{F_S} = 0$ and hence $\beta_{\epsilon_{F_S}} = 0$. The ex ante utility is computed prior to the randomization of financial structures and hence for the $\bar{\rho}_2$-types is given by:

$$\bar{u}_{\bar{\rho}_2} = u_{F_0} + \frac{\rho(1+V)}{2}\left(\frac{\pi V}{1+\pi V}\right)^2 \left(\beta_1 - (p\beta_{\epsilon_{F_S}} + (1-p)\beta_{\epsilon_{F_0}})\right),$$

and similarly for the $\bar{\rho}_1$-types. Given that:

$$\beta_{\epsilon_{F_S}} = 0,$$

$$\beta_{\epsilon_{F_0}} = \beta_1,$$

then the ex ante measure of the loss of utility due to the incompleteness of the financial structure $F = pF_S + (1-p)F_0$ for the $\bar{\rho}_2$-types is:

$$\frac{\rho(1+V)}{2}\left(\frac{\pi V}{1+\pi V}\right)^2(1-p)\beta_1.$$

We then take as a measure of exposure:

$$E = (1-p)\beta_1,$$

which is the common factor affecting both the $\bar{\rho}_1$-types' and the $\bar{\rho}_2$-types' exposure. Using these results, the next proposition derives a simple condition to find the equilibrium proportion of $\bar{\rho}_1$-types in the economy.

Proposition 3. *The proportion π of individuals whose coefficient of risk aversion is ρ can be determined from the equation:*

$$\frac{\rho}{2}\left(\frac{(1-\pi)V}{1+\pi V}\right)^2 p\beta_1 - \frac{c_1}{f(\pi)} + \frac{c_2\gamma V}{h((1-p)\beta_1)+\gamma V} = \frac{\rho p(1+V)}{2}\left(\frac{\pi V}{1+\pi V}\right)^2\beta_1.$$

Proof. It follows immediately from Proposition 2 and the equilibrium condition. □

The model can almost be solved in closed-form. It is important to note that if $\mathbf{C_2}$ were not inversely related to E, then the amount of $\bar{\rho}_1$-types would generally decrease (it would never increase) with the completeness of markets. In other words, the formation of preferences that are less averse to risk (self-insurance through preference formation) and 'insurance' markets would always act as substitutes. However, given our choices for $\mathbf{C_1}$ and $\mathbf{C_2}$, it is more difficult to characterize the solution to the above equation. Of course, we can solve it numerically as a function of the degree of market completeness. For instance, given our choices of $\mathbf{C_1}$ and $\mathbf{C_2}$, and positing a relation of the form $\gamma = g(p)$ with $g'(p) < 0$, we offer three numerical simulations in Figs. 1–3. We compare economies across different degrees of market completeness; that is, by moving p from 0 to 1 we graph the proportion of $\bar{\rho}_1$-types in the economy versus p. Different choice of parameters can generate non-linear behavior of the population types. For example, Fig. 1 shows an economy in which the proportion of $\bar{\rho}_1$-types always decreases as markets are being completed. This is the general implication of the model, which arises when preference formation is costly and $\mathbf{C_2}$ is not inversely related to E very strongly. This is not the case in Figs. 2 and 3 where, at some point, as markets are completed, the increasing *relative* importance of non-market uncertainties results in an increasing proportion of $\bar{\rho}_1$-types. In Fig. 3 a minimal greater than zero degree of market completeness is required to deliver a positive measure of $\bar{\rho}_2$-types. Up to that degree the proportion of $\bar{\rho}_1$-types is at the corner $\pi = 1$: everybody in the population is a $\bar{\rho}_1$-type and there is no change with the completeness of markets. As mentioned above, it is straightforward to show that a necessary condition for the proportion of $\bar{\rho}_1$-types to increase with market completeness is that $d\mathbf{C_2}/dE < 0$.

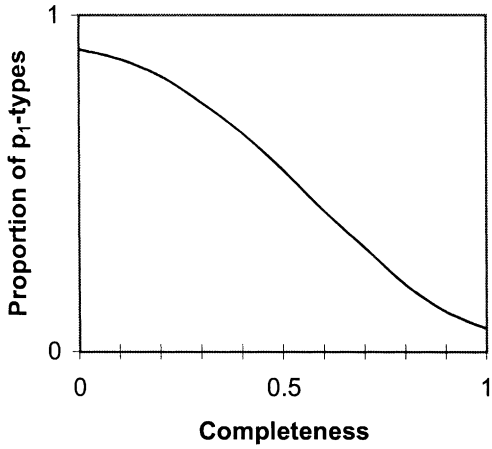

Fig. 1. General case.

It may appear that some results and comparative statics could depend upon the specific form of the utility function we have chosen. This is not the case, as the implications generalize to a broad class of preferences. In fact, the different comparative static results relating the market structures and the proportions of different types of individuals in the economy can be obtained with a general type of utility function using the Implicit Function theorem.

Lastly, we offer an intuitive extension of the analysis that shows how the framework can easily accommodate other ideas and specifications even in the context of the specific example we have examined. Rather than modeling the endogenous formation of preferences as a competitive sorting of individuals across preferences that differ in one parameter, it may be modeled as sorting of individuals across different subjective

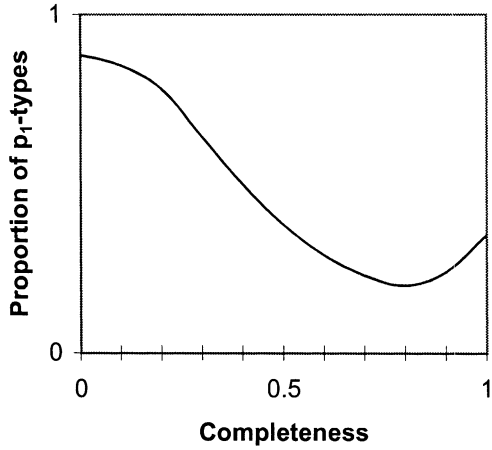

Fig. 2. Increasing and decreasing population types.

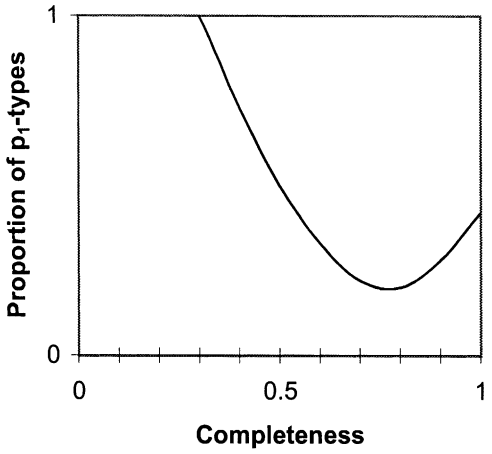

Fig. 3. Homogeneous and heterogeneous population types.

probability distributions. Some social scientists, including sociologists, psychologists and cultural anthropologists, may argue that different exposures to market and non-market risks and uncertainties, might generally lead to changes in the subjective probability distribution with which individuals perceive possible states of nature rather than to differences or changes in preference parameters. In the presence of market incompleteness, individuals can only consume their own endowment in those states that cannot be reached through any financial trade. If those states are characterized by a very high marginal utility of consumption, individuals may be implicitly inclined to believe, at a cost, that they are low probability states. The cognitive process which may induce this behavior is beyond the scope of this paper and is not relevant to make this point. Hence, individuals may sort themselves across a class of subjective probability distributions rather than across preferences with different preference parameters and same probability distributions. For example, let the continuum of identical individuals form their subjective probabilities by choosing one probability distribution out of the class $\left[\tau^a(s), \tau^b(s)\right]$, and define all the moments with respect to each of the available probability measures as:

$$\mu^l_{F_i} = \sum_{s\in S} \tau^l(s) R_{F_i}(s),$$

$$\Sigma^l_{F_i} = \sum_{s\in S} \tau^l(s) R_{F_i}(s) \cdot R_{F_i}(s),$$

$$\Sigma^l_{(F_i,1)} = \sum_{s\in S} \tau^l(s) R_{F_i}(s) w_1(s),$$

$\forall l = a, b$. Then, the following proposition can be proven along the same lines as the previous proposition:

Proposition 4. *Given the revealed financial structure F_i and the proportion π of a-types, the equilibrium is given by:*

$$\bar{q}_{F_i} = \left[\pi\left(\Sigma^a_{F_i}\right)^{-1} + (1-\pi)\left(\Sigma^b_{F_i}\right)^{-1}\right]^{-1} \times \left[\pi\left(\Sigma^a_{F_i}\right)^{-1}\left(\mu^a_{F_i} - \rho\Sigma^a_{(F_i,1)}\right) + (1-\pi)\left(\Sigma^b_{F_i}\right)^{-1}\left(\mu^b_{F_i} - \rho\Sigma^b_{(F_i,1)}\right)\right],$$

$$\bar{\theta}^l_{F_i} = \left(\rho\Sigma^l_{F_i}\right)\left[\mu^l_{F_i} - q - \rho\Sigma^l_{(F_i,1)}\right], \quad \forall l = a, b,$$

$$\bar{u}_{a,F_i} = u_{a,F_0} + \frac{\rho}{2}\bar{\theta}^a_{F_i} \cdot \Sigma^a_{F_i}\bar{\theta}^a_{,F_i} + \mathbf{C_2},$$

$$\bar{u}_{b,F_i} = u_{b,F_0} + \frac{\rho}{2}\bar{\theta}^b_{F_i} \cdot \Sigma^b_{F_i}\bar{\theta}^b_{F_i}.$$

In summary we have developed a framework which, in the context of the example, can be interpreted as an examination of the interaction between market insurance and self-insurance through preference formation, that is between the extent of the market and competitive interactions among individuals with different risk averse preferences. The main implication of the model in this context is that the degree of risk aversion should be expected to respond to the environment. Even within the context of this example, the choices we have discussed are clearly not exhaustive. Different types of preferences (as apposed to different parameters or different subjective probability distributions) across which individuals could sort themselves out can in fact deliver interesting applications and can be easily considered.[7]

3. Applications and empirical evidence

Theories that deal with unobservables typically sacrifice some predictive power. However, like human capital theory, the theory of endogenous formation of time preference in Becker and Mulligan (1997), and other theories our theoretical framework can offer relevant empirical predictions. Next, we first discuss some possible applications and environments where the implications of the model may be empirically evaluated. We then offer an empirical analysis whose results are consistent with the basic empirical prediction that the degree of risk aversion is endogenous to market arrangements.

[7] For instance, alternative characterizations could incorporate the distinction between risk and Knightian uncertainty (Knight, 1921); Gilboa, 1987; between risk and disappointment aversion (Gul, 1991), different 'preferences for flexibility' (Kreps, 1979, 1992), and others.

3.1. Applications

3.1.1. Institutions, institutional change, and preference formation

During the last couple of decades a great deal of research has focused on the interaction between institutions, organizations, and preferences. North (1990, pp. 3–4, italics added) defines institutions as 'the rules of the game in a society or, more formally, are the humanly devised *constraints that shape human interaction.* In consequence they structure incentives in human exchange, whether political, social, or economic. Therefore, they are the framework within which human interaction takes place.' The central focus of institutional analysis is 'on the problem of human interaction. ... The *major role* of institutions in a society is to *reduce uncertainty* by establishing a stable structure to human interaction.' Insofar as the amount of uncertainty in the different socioeconomic and institutional environments is related to certain aspects of preferences (e.g. values, norms, traditions, risk aversion), the general equilibrium analysis developed above may help provide useful insights.

In our framework 'institutions' are analytically equivalent to 'market completeness,' in the sense that they reduce uncertainty and provide a stable structure to human interaction. In this sense, the model may be useful to examine the relationship between private and public institutions on one hand and preferences on the other. To the best of our knowledge it would then represent the first formal general equilibrium framework where these ideas can be integrated and testable empirical implications may be derived. Yet, the implementation of appropriate empirical analyses will likely be a challenging task, even though the literature developed in the last decades on the economics of institutions provides us with valuable evidence on kinds of organizations and forms of governance across time and space, including their associated socioeconomic norms, values, and traditions.[8]

3.1.2. The demand for religion

Economic progress and the development of markets and institutions have usually been able to provide better means to insure against a number of risks. There are however many instances where markets and institutions do not exist or are incomplete, and where risks cannot be hedged at any price. One of these risks, probably the most important one, concerns the state of the afterlife. Markets and public institutions cannot guarantee any minimum utility if, or whenever, that state of nature occurs. Today, as throughout history, however, certain religious beliefs, superstitions, and other cultural and social beliefs can be interpreted, at least crudely, as providing some 'insurance' in states of nature where markets do not exist such as the afterlife. The empirical evidence presented in Azzi and Ehrenberg (1975) and Glaeser and Glendon (1997) suggests that individuals are religious and participate in religious activities to deal with issues concerning the afterlife. It is apparent that 'markets' are drastically incomplete when dealing with the state of the afterlife. In fact, it is difficult to think of a more incomplete situation. This striking incompleteness, therefore, may represent a rather surprising but fertile ground for finding empirical evidence on the specific example we have considered when developing our framework. Within the context of

[8] See for instance Bowles (1998), Greif (1994), North (1990), Williamson (1985), and other references therein.

our example, religious believers can be interpreted as individuals that are less averse to certain risks in states of nature involving the afterlife. Glaeser and Glendon (1997) find that the demand for the expression of religion appears to come predominantly, and almost equally, from religion's role as a provider of *security* for the afterlife and from religion's role as a social institution. Much of the empirical evidence they present shows how one major role that religion plays is in enabling individuals to *feel* more secure about life after death. This *endogenous insurance* motive may be readily interpreted within the context of our example. As beliefs are embedded in preferences, the demand for certain types of beliefs (however they are assumed to operate cognitively, either through the formation of aversion to certain risks or through changes in the subjective probability distribution (Propositions 3 and 4)) and the demand for certain institutions such as religion, are clearly related to this drastic incompleteness.[9] Again, here we abstract from making any claims or assumptions about the nature, speed, or other aspects of the cognitive or cultural *process* by which consciously or unconsciously religious preferences may be formed. Certainly, we do not wish to imply that religious preferences are chosen or formed at will. The aim of the framework simply is to examine the endogenous formation of preferences and the competitive *forces* that may shape them. In this specific example, the endogenous relationships between market (in)completeness and *competitive* interactions among individuals can be interpreted as such 'self-insurance' through preference formation.

Significant differences in risk attitudes, religious beliefs, and market completeness may be observed across time and space. Barski et al. (1997), for instance, find few differences in attitudes toward risk across religious believers and non-believers in the United States today. This may be explained in our model. Note that taking financial sophistication as a proxy for economic and institutional development, our parametrizations of $\mathbf{C}_1$ and $\mathbf{C}_2$ can capture this effect: economic development *does not* necessarily deliver a less religious society, as two effects enter with different signs (see Figs. 2 and 3). $\mathbf{C}_1$ may be interpreted in this case as the amount of time and resources devoted to acquiring or forming such lower aversion to risks (e.g. through practice, meditation, and church attendance). It is thus sensible to assume that there may be economies of scale, that is the greater the proportion of individuals π, the less costly is to form these preferences.[10]

On a related matter, anthropologists McElreath (1998) and Henrich (1998) find that indigenous individuals in Tanzania and Chile exhibit significant risk-seeking behavior

[9] This effect is also emphasized in Posner (1995). The data from the General Social Survey examined in Glaeser and Glendon (1997) show that people who believe in the afterlife are more likely to be older, female, have lower incomes, have less confidence in science, have worse health, and are less likely to read a newspaper often. It would not be difficult to argue (but it would be difficult to prove) that these individuals may be facing, or at least perceiving, a greater proportion of their relevant risks coming from non-market uncertainties (market incompleteness) than other types of individuals do. See Greeley (1989) and Iannaccone (1998) for theoretical analysis and empirical evidence, mostly on the supply side of the economics of religion.

[10] Note that, on the one hand, if market uncertainties are well insured (a low value of E) then non-market risks become *relatively more important,* and this increases the utility effect of a low degree of risk aversion (C_2). On the other hand, since there are further means of insurance, agents can afford greater degrees of risk aversion. Also, it is generally considered that market sophistication and economic development are associated with scientific progress. That is, there is a negative correlation between p and the perception parameter γ as we have assumed. These multiple effects aggregate to generate rich non-linear behavior that can contribute to explaining several phenomena in this field, for example, why certain societies like the US may be very religious though they are highly developed.

while reporting a great deal of religious and superstitious beliefs. As predicted by the specific parametrizations in the model in the general case when $\mathbf{C}_2$ is not inversely related to E too strongly, greater market (in)completeness will tend to induce less (more) risk-taking behavior.

The formation of religious and related beliefs is not only an issue of profound current and historical relevance for humankind. It is also an issue whose analytical examination has been largely neglected by the social sciences. The application of the general equilibrium framework to this field may represent a useful theory of the *demand* for beliefs and values. The model in Section 2 was developed by considering specific functional forms for $\mathbf{C}_1$ and $\mathbf{C}_2$ largely with the specific example of this drastic incompleteness in mind.

3.2. Empirical evidence

The basic empirical prediction of the model is that risk aversion attitudes will be endogenously related to market arrangements. We next provide estimates of risk aversion coefficients across household groups facing different market arrangements in two situations. The first situation we examine is quite drastic. The conditions were quite severe, markets were segmented, and different households were facing very different market structures. We also examine a second situation for the same population where circumstances were less drastic and markets were not segmented. The objective of this subsection is to provide a suitable empirical analysis that is at least consistent with the empirical predictions of the framework.

In the autumn of 1988, Bangladesh experienced some of the worst floods in its history. Approximately 60% of its land area was inundated during the first week of September. In many areas more than 50% of the autumn crop was destroyed. One of the hardest hit areas was Sirajganj in which the International Centre for Diarrhoeal Disease Research in Bangladesh (ICDDRB) had been carrying special studies on a large sample of households since 1982. To aid in flood assessment a questionnaire was incorporated into the regular rounds of the ongoing system. Data on damage during the flood, assets losses and sales, rice prices, grain stocks, positions in borrowing (credit markets), weight data and diarrhoeal disease for children aged 6–36 months, and many other variables were collected during two rounds (October–January and January–April). Foster (1995) used this unusually rich dataset to study the structure of credit markets. A model of intertemporal resource allocation is developed and Euler equations relating growth patterns of children to the cost of borrowing by households are then derived from the stochastic dynamic model and tested using these micro-level data.[11] The evidence he obtains for the Fall 1988 indicates that for 'landless households' markets are segmented, and that within villages there is additional variation in the cost of borrowing across landless households. With respect of 'landowning

[11] In order to conserve space, the reader is referred to Foster (1995) for many details of the data, estimation procedures, and results of the analysis of credit markets for the Fall 1998 period. The main distinction between his analysis and others testing for consumption smoothing and credit market imperfections is that he uses measures of body size. In contrast to data on consumption, these anthropometric data has a number of valuable advantages (see Foster, 1995).

Table 1
Descriptive statistics

	Fall 1988		Fall 1992	
	Children in landed households (N=656) Mean[a] (std. dev.)	Children in landless households (N=462) Mean (std. dev.)	Children in landed households (N=480) Mean (std. dev.)	Children in landless households (N=302) Mean (std. dev.)
Weight growth[b]	1.658 (6.261)	1.851 (6.399)	1.562 (6.121)	1.732 (6.224)
Weight[b]	−34.421 (13.941)	−37.473 (14.436)	−32.440 (13.023)	−34.902 (13.890)
Age (months)	24.333 (8.077)	23.370 (8.107)	23.928 (8.203)	24.127 (8.066)
Male	0.583 (0.499)	0.515 (0.500)	0.531 (0.507)	0.509 (0.502)
Diarrhoeal disease[c]	0.285 (0.451)	0.274 (0.477)	0.207 (0.381)	0.226 (0.396)
Rice price (Tk/kg)	12.561 (0.487)	12.585 (0.485)	15.703 (0.411)	15.772 (0.432)
Days between rounds	90.481 (6.180)	91.566 (8.226)	190.311 (7.230)	191.180 (8.311)
Some borrowing	0.462 (0.499)	0.640 (0.480)	0.313 (0.450)	0.450 (0.448)
Amount borrowed given some borrowing (×1000 Tk)	1.029 (0.809)	0.715 (0.628)	0.851 (0.750)	0.606 (0.633)

[a] All means except for weight growth and days between rounds are from the first round of each of the surveys. Mean amounts borrowed in both periods are in September 1988 Thaka.

[b] Weight and weight growth are standardized for age and sex by taking 100 times the log of the ratio of a child's weight to the corresponding National Center for Health Statistics (NCHS, 1977) standard. For example, a weight of −34.421 indicates the children in landed households were roughly 34.421 smaller in terms of weight than a healthy child in a developed world. Weight growth refers to the difference in weight between the two rounds of the surveys.

[c] Diarrhoeal disease refers to the proportion of days in previous 2-week period and in the population respectively.

households' there is no evidence of either market segregation by village or variation in the cost of borrowing within the village.

The primary interest in his analysis is the study the effectiveness of existing credit market during periods of extreme scarcity such as those caused by the flood in 1988 in smoothing fluctuations in the consumption and weights of young children. In our case, we are interested in examining whether estimates of preference parameters may be different in periods of extreme scarcity and segmented markets where different households face different market arrangements, and periods where credit markets function well and markets appear to exhibit a greater degree of completeness. In order to implement this idea we use the same Fall 1988 data for 74 villages, as well as data from the same population from 4 years later (Fall 1992, survey rounds of January–April and September–December) when the situation was substantially improved and circumstances were largely normalized. The basic data for the Fall 1988 is described in Foster (1995) and included in Table 1 along with the data for 1992 which are described in Pitt et al. (2001).

We focus on the analysis of these data.[12] We first estimate the linear approximation to the Euler equation developed in Foster (1995) for landless and land-owning households using a

[12] A basic description of the main features of the data and the differences across periods can be briefly provided. Children in 1988 are smaller than in 1992, suggesting adverse effects of the floods on child weight especially for landless households. These effects on child weight explain the relatively faster growth over the subsequent 3-month period in 1988 relative to 1992. Weight and weight growth is also different across landed and landless households in both periods. Diarrhoeal disease was more important in the 1988 post-flood period than in 1992. Lastly, the proportion of children from households that borrowed in the post-flood period is greater than in 1992 and, conditional on some borrowing, the mean amount borrowed is also greater. This suggests that credit markets played a particularly important role as a response to the 1988 flood.

maximum likelihood procedure. In order to conserve space, we abstract from reproducing a number of details and refer the reader to his article. In order to evaluate the structure of credit markets, it is of primary interest to examine the coefficients related to borrowing. Foster (1995) shows how under the assumption that everybody household faces the same cost of borrowing the variables on own household borrowing and village borrowing should have zero coefficients.

The first two columns in this table replicate the results in Foster (1995, Table 2) for the Fall 1988 data. The coefficients on own and village borrowing indicate that there is evidence of credit market segmentation for landless households, and within each village there is additional variation in the cost of borrowing across landless households. However, there is no evidence of either market segmentation by village or variation in the cost of borrowing within the village for landed households.

The second pair of columns use the same maximum likelihood procedure and same conditioning variables to test the same Euler equation for the 1992 data. Interestingly enough, the results show that there is no evidence of market segmentation or differences in the cost of borrowing across households and villages, neither for landed nor for landless households. None of the estimates are significantly different from zero at conventional

Table 2
Maximum likelihood estimates of linear approximation to Euler equation for landless and land-owning households (Dependent variable: Change in standardized weight)

	Fall 1988[a]		Fall 1992	
	Landed	Landless	Landed	Landless
ΔDiarrhoeal disease[b] (prop)	−1.696	−2.336	−1.332	−1.636
	(2.524)	(2.783)	(2.616)	(2.880)
ΔLog rice price ($\times 10^{-1}$)	−0.648	−1.588	−0.232	−0.822
	(1.204)	(3.136)	(1.901)	(1.932)
ΔRice price growth ($\times 10^{-3}$)	1.194	0.533	1.223	0.717
	(2.702)	(1.050)	(3.111)	(2.718)
Interval between rounds (days)	0.042	0.194	0.101	0.088
	(0.490)	(2.619)	(0.823)	(0.41)
First round age (months)	0.004	0.011	0.004	0.009
	(0.426)	(2.710)	(0.701)	(1.019)
Male	−0.579	0.409	−0.428	−0.017
	(0.822)	(0.569)	(0.922)	(0.408)
Borrowing ($\times 10^3$ Tk)	0.485	−1.418	0.172	−0.021
	(0.121)	(2.455)	(0.667)	(0.961)
Average borrowing in village	−2.173	4.864	−1.823	−1.412
	(0.814)	(1.730)	(1.032)	(0.832)
Variance of average borrowing	0.042		0.020	
	(1.964)		(2.341)	
Residual covariance *P*-value[c]	0.303		0.292	
Goodness of fit *P*-value	0.253		0.312	

Notes: ML estimates for landless and landed households are estimated jointly for each year; *t*-ratios (in parentheses) computed from robust covariance matrix (see Foster, 1995).

[a] These estimates replicate those in Foster (1995, Table 2).

[b] Endogenous variable, instrumented using diarrhoeal disease.

[c] Likelihood ratio test for covariance of residual growth net of borrowing variables.

levels. These results are consistent with the idea that existing micro-credit mechanisms were specially vulnerable to the conditions created by the flood in 1988 but largely well-functioning in the more normal circumstances of 1992. In this sense, this situation represents a valuable opportunity for evaluating whether risk aversion appears to be endogenously related to market arrangements. This situation allows us to compare the implications that different market arrangements for different households may have for their risk aversion parameters. We can also compare the estimates for the same economy across different degrees of market completeness (Fall 1988 and Fall 1992).

In what follows we are interested in estimating the coefficient of relative risk aversion γ for landed and landless households during the Fall 1988 and Fall 1992 periods. We follow the methodology in Vissing-Jørgensen (2001) and Attanasio and Weber (1989). It is well known that if the return on assets and next period consumption are jointly normally distributed conditional on information known in this period, and utility is of the Epstein–Zin form or the CRRA form, then the elasticity of intertemporal substitution σ can be estimated consistently using standard GMM methods as:

$$\sigma = \frac{\mathrm{d}E_t(\ln(c_{t+1}/c_t))}{\mathrm{d}E_t(\ln(1+r_t))}.$$

In the CRRA case $\gamma = 1/\sigma$. An advantage of the Epstein–Zin case is that intertemporal substitution and risk aversion are distinguished from each other, while still retaining the desirable property of inducing time-consistent preferences (see Kreps and Porteus, 1978). Attanasio and Weber (1989) derive the log-linearized Euler equation in this case. They show how it is still possible to identify unambiguously σ as the elasticity of intertemporal substitution. The coefficient γ, however, is not easily identifiable, although we can still make inferences on its sign and size and, what is more important in our case, test for different sizes across household groups.

In Table 3, Panel A, we estimate the elasticity of intertemporal substitution for landed and landless households in the Fall 1988 and Fall 1992 periods. In Panel B, we evaluate whether there are statistically significant differences in the coefficient γ across the different households for both CRRA and Epstein–Zin preferences.[13]

The results are interesting. The estimates of σ in the Fall 1988 period are greater for landed households than for landed households, and greater for those with no or little borrowing than for those that borrowed the most. Recall that the evidence in Foster (1995) and in the previous table indicates that markets are segmented for landless households and that those households that ended up borrowing less or did not borrow at all faced greater costs of borrowing. The hypothesis of equality of risk aversion coefficients is always rejected except in the case of land-owning households versus households that were able to borrow a relatively large amount. In all other comparison the hypothesis is rejected both for CRRA and Kreps–Porteus preferences at the 5 percent level.

[13] Clearly, in the CRRA case the Wald tests are identical to testing for differences in σ across groups. In the Epstein–Zin case, the coefficient γ is a function not only of σ but also of the unobservable covariance of asset returns with the (unobservable) market portfolio. We use the bounds on this difference (denoted by z) reported by Attanasio and Weber (1989), and test for differences in γ across groups given z. The Wald tests are extremely similar given z's in this range, and even outside of this range, which is not too surprising given the relatively small range for z. The table reports the average value of the Wald statistic across z's.

Table 3
GMM estimation of log-linearized Euler equation and tests of equality of relative risk aversion γ

Panel A: Estimation of the elasticity of intertemporal substitution σ

	Fall 1988 Segmented markets		Fall 1992 No segmented markets	
	σ	(std. dev.)	σ	(std. dev.)
All households	0.880	(0.377)	0.503	(0.257)
Landed households	0.402	(0.130)	0.328	(0.152)
Landless households	0.979	(0.382)	0.517	(0.240)
Borrowing households[a]				
All	0.478	(0.222)	0.207	(0.097)
Top third layer	0.406	(0.147)	0.296	(0.102)
Bottom third layer	1.268	(0.437)	0.582	(0.209)
No borrowing	1.142	(0.421)	0.633	(0.311)

Panel B: Wald tests of equality of relative risk aversion parameter γ

	Fall 1988		Fall 1992	
	W	P-value	W	P-value
CRRApreferences$(\gamma = 1/\sigma)$				
Landed vs. landless	6.201	0.012***	1.428	0.232
Borrowing vs. no borrowing	7.117	0.007***	2.370	0.143*
Landed vs. borrowing top third layer	0.131	0.717	0.372	0.541
Top third vs. bottom third borrowing layers	5.150	0.023***	1.059	0.303
Kreps − Porteuspreferences				
Landed vs. landless	5.695	0.017***	1.115	0.290
Borrowing vs. no borrowing	7.249	0.007***	1.837	0.175
Landed vs. borrowing top third layer	0.298	0.585	0.128	0.720
Top third vs. bottom third borrowing layers	4.561	0.032***	0.862	0.353

Monthly dummies are included as explanatory variables and instruments. The instrument sets also include dummies for log(household size), lagged log real marginal rental price of weight, lagged log real riskless rate, and the variables known to the household at time t considered in Foster (1995); illness, assets, income, borrowing, prices, and price growth. ***, **, and * denotes null hypothesis rejected at the 5, 10, and 15 percent levels, respectively.

[a] Borrowing layers computed conditional on magnitude of the flood by controlling for the average level of borrowing in the village.

An entirely different picture is given by the evidence from the Fall 1992. First, the estimates of σ in Panel A are notably lower than the estimates in the Fall 1988 period for given household group, and somewhat more similar across groups. For CRRA preferences this readily suggests a greater degree of relative risk aversion in 1992.[14] Furthermore, the Wald tests indicate that it is not possible to reject the hypothesis of equality of risk

[14] The hypotheses of equality of elasticities of intertemporal substitution and risk aversion estimates over time (i.e. between the Fall 1988 and Fall 1992) given a land-owning status (landed or landless) are rejected for both CRRA and Epstein–Zin preferences. These results, which are available upon request, are consistent with the idea that risk aversion responds to the extent of market completeness, given that there is virtually no variation in land-owning status over time. The hypotheses are also rejected for given borrowing status and borrowing layer, although the status and layers of some households change over time.

aversion coefficients across household groups in any of the comparisons implemented, neither for CRRA nor for Epstein–Zin preferences in 1992.[15]

We take these results to be consistent with the main implication of the model that risk aversion is endogenous to the extent of markets, and that market completeness and greater aversion to risks tend to be complements when the formation of lower aversion to risk is costly. These micro-estimates of preference parameters indicate that in a situation of severe hardship and segmented markets estimates of the relative risk aversion coefficient are different for households facing different market arrangements. In an entirely different situation where there is no evidence of segmented credit markets and markets appear to be well-functioning, risk aversion estimates for the same population are significantly lower and not statistically different across households. In terms of our framework, the coefficients of relative risk aversion are different across different households facing different market arrangements in the Fall of 1998. When we compare the same population in a situation characterized, broadly speaking, by a greater degree of market completeness, risk aversion estimates are significantly lower (the proportion of $\bar{\rho}_1$-types increases and is likely at a corner ($\pi = 1$) since estimates of γ are statistically identical across households).

We do not claim that the framework we have developed is the only possible explanation for these variation in parameter estimates. Our only purpose in this subsection was to substantiate the theoretical framework by providing a suitable empirical application whose results are at least consistent with the implications of the model. Theories that deal with unobservables always find special difficulties in empirical analysis. Yet, there is a number of phenomena that are difficult to explain without explicitly allowing for time-varying preference parameters. Our objective was to incorporate into the theory a way to reflect endogenous interactions between preferences (the marginal rate of substitution schedule across states of nature) and the extent of markets. The empirical analysis is consistent with this idea.

4. Summary and concluding remarks

Over the last few years there has been increasing discussion in the social sciences about the endogeneity of tastes. It has also been recognized that economic theory has difficulties explaining a number of economic phenomena without acknowledging the importance of markets, public and private institutions, social values, and preference formation. However, formal and empirical work on the endogeneity of preferences has been scarce in economics and practically non-existent in other social sciences. Although much progress has been made in economics by taking preferences as constant and assuming that they are stable, many important matters cannot be explained without addressing the fundamental endogeneity of tastes.

The analysis in this paper seeks to help enlarge our understanding of human behavior by providing a tractable general equilibrium framework for the study of the endogenous

[15] The only possible exception is the comparison between borrowing and non-borrowing households. The hypothesis would be rejected at the relatively large 14.3 percent level.

formation of preferences and its implications. We have also discussed empirical applications and provided an empirical analysis whose results are consistent with the basic implications of the model. The endogeneity of preferences represents an important challenge to the social sciences and has far-reaching implications. The framework we have developed may help provide formal precision to different theories, clarify complex interactions, and form the basis for generating precise hypotheses in empirical applications. Appropriate empirical analysis is then necessary to validate the theory, interpret the data, and uncover the precise extent and implications of the endogeneity of preferences in different socioeconomic environments and applications. This indeed represents an important challenge to future developments.

Yet, successful social science theories must be based on a rigorous understanding of the mechanics underlying the endogenous relationship between preferences and the environment. The economic approach should help provide a significant step in the development of such an understanding. The main aim of our analysis in this paper is to contribute in this direction.

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