A Model of Austrian Economics

Hendrik Hagedorn

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Hendrik Hagedorn

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1. Introduction

Although Austrian economics has many fervent followers, its relative popularity within the science of economics is limited. Neoclassical economics, with its DSGE modeling,[1] is far more visible to not just the general public but also amongst those educating future economists. This single focus has not gone without debate and the discussion was renewed after the most recent financial crisis (Hicks, 1981; Solow, 2008; Caballero, 2010). Without doubt, limiting economic research to only one methodological standard prevents the scientific community from incorporating the insights of those fields of economics that have developed independent of this standard (Caballero, 2010). Therefore, some of the main themes that were elaborated by Austrian scholars, such as the theory of capital, the theory of entrepreneurship, and the theory of the money-driven business cycle, have not or only to a small extent be accommodated by neoclassical economics.

What inhibits mainstream economists from adopting these theories is, on the one hand, the absence of a general modeling approach for Austrian economics and, on the other hand, that the neoclassical approach is fundamentally unsuited to capture these insights. As demonstrated by Mirowski (1989), the concept of general equilibrium is not at all a natural approach to economic thinking. Rather is the equilibrium approach an attempt to transcribe the metaphors of 19^{th} century physics to economic phenomena. However, in order to obtain such a transcription it is necessary to make compromises between mathematical tractability and economic realism. And hence the equilibrium perspective easily becomes distorted. The "law of one price" is a case in point: it provides equilibrium models with the symmetry that is necessary to emulate a conservation principle of the physical sciences, but it is foreign to all economic processes. In fact, it is price dispersion and not price unity which allows markets to develop their coordinating function (Gintis, 2007).

On a similar note, the compliance with the general equilibrium framework led economists to make widespread use of the rational expectations framework, whose flaws have long been exposed (e.g. Davidson, 1983). Again, the symmetry between future states of the world and the expectation thereof does not represent economic insight, but is only postulated out of mathematical necessity. The dilemma of modern macroeconomics can thus be framed as follows: The need for mathematically tractable models has led to a general acceptance of premises that are highly unrealistic at best and have often provoked a serious deal of confusion.

This work provides a possible solution to this dilemma. It does so by developing a model that synthesizes elements of post-Keynesian economics and complexity economics

[1] DSGE is an abbreviation for dynamic stochastic general equilibrium. DSGE models are also used in new-Keynesian economics, but the term neoclassical is here used as to comprise both strands of literature.

with the central tenets of Austrian economics thereby portraying Austrian economics in a formal and coherent way. The model that is thus established is just as general as a DSGE model, but it is by all means more realistic and it treats macroeconomics from an entirely different perspective. At the same time, the proposed model provides a mathematically rigid framework under which the propositions of the Austrian school can be scrutinized.

The centerpiece of the Austrian school is the study of the *formal implications* of human action, a discipline that Austrians call *praxeology* (Mises, [1949] 2008, pp.1). Economics, according to this research paradigm, is only a subdiscipline of praxeology. This methodological perspective has many consequences. First, in Austrian economics, valuation not only originates from the human mind alone and is therefore subjective, but also are valuations only expressed through action. On the other hand, the things that human beings value are inherently heterogeneous. Thus, in essence, Austrian economics describes the world on the basis of a dynamic theory of subjective value and a theory of heterogeneous capital. Second, in Austrian economics all economic agents are treated as true economic actors and not as mere reactors to their environment, as is characteristic for the neoclassical school. The Austrian perspective thus implies that all economic analysis is based on the principle of cause and effect, which, as a corollary, implies the passage of time. Austrian economics therefore depicts the economy as a process, as opposed to the static interdependency of neoclassical economics.

Furthermore, what distinguishes Austrian economics from other schools of thought is its purely theoretic and essentialist character. Since only the formal implications of the fact that human beings act are described, Austrian economics is not concerned with the specific choices made by individuals or with the circumstances under which such choices arise. According to the Austrian understanding such inquiry belongs to different fields of science, namely psychology and history. Austrian economics confines itself to statements that are true for all actions made by human beings. These statements are true *a priori* like the statements of mathematics and logic and they are not subject to verification or falsification on the ground of experience and facts (Mises, [1949] 2008, pp.32). For instance, the law of diminishing marginal utility is logically implied in the concept of action (Mises, [1949] 2008, pp.119). Almost nothing in Austrian economics is assumed. Only basic premises like, e.g., capital being heterogeneous are taken as self-evidently true and are thus taken for granted (Rothbard, 1957). Hence, this approach assumes almost universal validity. The mechanisms underlying the proposed model are firmly rooted in this causal-realist and non-positivistic world view. This serves as the model's epistemological foundation. Also, Austrian economics is here understood in this narrow sense. Much of what runs under the heading of Austrian economics today is not directly implied by the logic of action, but rather by a logic of choice and equilibrium-like concepts (Gloria-Palermo, 1999). However, the idea of this model is to emphasize the essentialist character of the Austrian approach and to describe economic insights based on processes that are driven by human action alone.

The concrete modeling approach taken in the following is agent-based and accounting-based. That is, all economic activity in the model results from the decentralized actions

of agents. These agents exchange goods and services against money on virtual markets and each of them has a balance sheet that reflects his financial and economic situation. Implicitly, the agents serve as an interface between two economic domains. On the one hand, they pursue certain pre-defined goals and thus represent behavioral aspects of the model while, on the other hand, they apply standard accounting rules in order to keep track of their economic situation and thus embody a calculative element within the model. On the basis of these calculations any result that the model produces can be examined via its effect on the system of national accounts. Moreover, the application of an economy-wide accounting scheme means that all markets in which the agents interact are fully interdependent. Yet, this interdependency is not achieved by imposing synchronicity, as the equations of motion that govern DSGE models do, but rather emerges from within.

The agent-based character of this model thus makes it possible to conduct macroeconomic research while only specifying microeconomic behavior and, moreover, to reconcile the modeling of complex systems with the praxeological research program. This also means that the model does exhibit genuine microfoundations, but these must not be confounded with the microfoundations of neoclassical economics. Since all agents in this model operate under knowledge constraints and uncertainty and since all their actions are bound in historic time the notion of the *homo oeconomicus*, which is germane to neoclassical economics, cannot be sustained in the present context. Rather, the agents in this model represent a notion of the *homo agens* (cf. Mises, [1949] 2008, p.14). That is, the agents in this model use means to attain certain ends and they are boundedly rational in their actions. These actions alone constitute economic activity.

With this approach the proposed model fills a gap that has long been observed in the economic literature, namely to combine Austrian economics with the techniques of agent-based modeling (e.g. Lavoie et al., 1990; Gloria-Palermo et al., 2002; Koppl, 2006; Vaughn, 1999; Nell, 2010; Gloria-Palermo, 2013). Yet, while many authors point to the compatibility of the Austrian theory with the modeling of complex systems, this task has rarely been taken on, up to this date. To the author's knowledge, the systems that have been developed so far do not assume the general character that would make them comparable to DSGE models. Yet, as will be argued in this thesis, it is possible to develop a disequilibrium model of that kind.

The setup of this model is explained in the following Chapter. Chapters 3 through 5 specify the behavior of the agents and Chapter 6 describes the functioning of the model. The results are subsequently presented in Chapter 7 and they are discussed in Chapters 8 and 9.

2. The setup of the model

2.1. A monetary market economy

All economic activity in the model is borne by decentralized actions of agents. These agents are categorized as households, firms, and banks each assuming the following economic functions. The households buy and consume goods, make investments, and provide labor to firms. The firms, on the other hand, hire labor and purchase capital goods in order to produce and sell goods. The banks, finally, act as the financial intermediaries between households and firms. That is, they manage transactions between non-bank agents, they offer saving contracts to households and loan contracts to firms, and they facilitate purchases of equity (Figure 2.1).

All these activities are modeled as market phenomena. That is, each type of good or service that exists in this model is traded in a separate market. Markets come into existence whenever agents offer a product or a service for sale. Thus, every market consists of a list of offers, each of which specifies the quantity offered by an individual offerer and the respective asked price. In each market the total quantity supplied is thus determined by the sum of the individual quantities. Formally, such a market can be described with the help of a diagram that measures offered quantity on the abscissa and unit price on the ordinate. In such a diagram every offer constitutes a horizontal supply-curve of a given length. By sorting these offers in ascending price order while cumulating over their quantity it is possible to construct an upward sloping supply curve (Figure 2.2). Such a supply curve, however, is not to be confounded with a Marshallian supply curve. It does not describe the hypothetical total supply given a hypothetical equilibrium price, but rather the price spectrum at which the marketable quantity is available. Thus, there is price dispersion in every market. In what follows the median of the prices of a given market is called the price level of that market.

Transactions occur in case agents on the demand side of a market respond to the offers in that market. In all transactions only one unit of a good is traded. In order to buy a unit of a good each potential buyer consults a fixed number of randomly selected offers and chooses the one with the lowest price. Subsequently, each potential customer evaluates whether a purchase of the chosen good would improve his economic situation. In the case of the households this evaluation is made on the basis of individual preference while in the case of firms and banks it is based on profitability. The result of this assessment is in any case the formation of a reservation price. If, according to this reservation price, it is rational for an agent to buy a unit of the selected offer he pays the required sum to the offering agent and receives the good in exchange. Otherwise, he declines the offer. All market transactions are thus two-sided affairs in which money and a good change

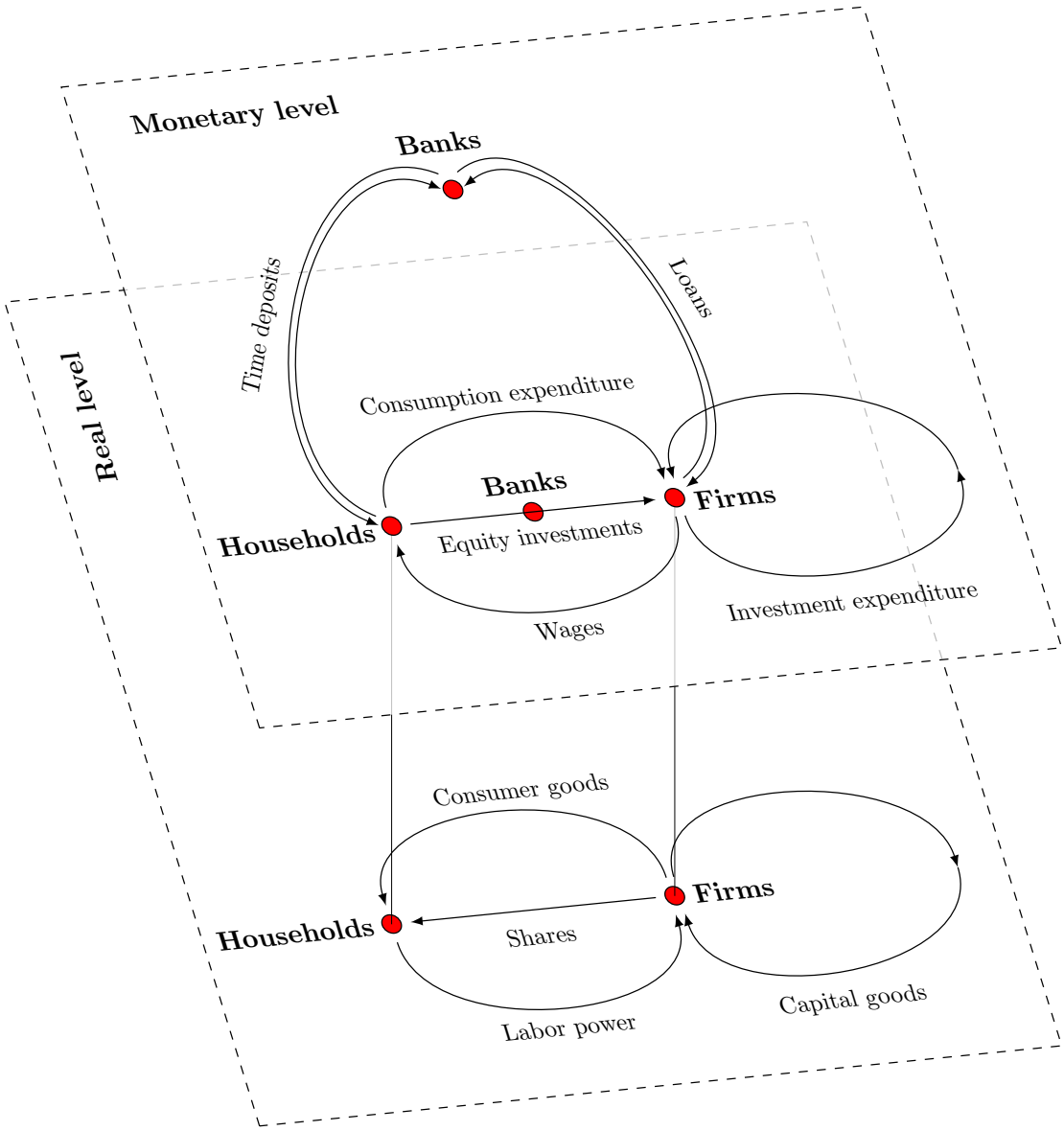

Figure 2.1.: In every market transaction a good is exchanged against money. The real level and the monetary level of the economy are thus complementary to each other. The figure illustrates the different market activities of the agents (dividend payments are not shown).

9. Further aspects

9.1. The character of this model

The model proposed in this work is rooted in the principles of accounting. On the one hand, the accounting system serves as structuring device. The fact money is conserved in transactions contains the model and it makes it intelligible from a macroeconomic perspective. In this regard the model is closely related to the flow-of-funds literature, which is mostly of post-Keynesian origin (Dawson, 1996; Godley and Lavoie, 2007). On the other hand, accounting principles apply in this model not only at the macroeconomic level, but also at the microeconomic level. The accounting practices motivate and guide the actions of agents and those actions find reflection in their balance sheets. The agent-based approach thus introduces microfoundations into a flow-of-funds model, a technique pioneered by Pascal Seppecher (2011).

The accounting-based character of the model is associated with the fact that money is modeled explicitly. This distinguishes this model from the models of mainstream economics where money is generally absent. Moreover, in making accounting principles the basis of individual decision making this model is a direct interpretation of Mises ([1949] 2008, pp.230) who asserts that monetary calculation is the only valid guiding principle under the system of division of labor. And furthermore, as explained by Hayek (1945), it is this principle, if applied by all acting parties, that guarantees that a market economy generates a resource allocation that is in congruence with the preferences of the consumers, despite the fact that the information about the entire economy is nowhere concentrated. This Hayekian mechanism is a direct feature of the model and it stands in opposition to the idea of a "social planner" that is germane to DSGE models.

Moreover, in making action the driving force of economic development this model replaces the synchronicity that characterizes DSGE models by a notion of causality and emergence. Markets are here not understood as anonymous entities whose workings depend on the mechanism of "tatônnement" that precludes an evolutionary perspective on the concept of time (cf. Mas-Collel et al., 1995, pp.620). Rather, they encompass certain related activities, all of which are subject to the principles of human action. Only where agents act do markets come into existence and only mutual agreements lead to transactions. Due to the limited knowledge of the agents such agreements never lead to a situation in which all markets clear. The steady states that this model produces are thus not equilibria in the neoclassical sense. One can say that the agents speculate against a hypothetical equilibrium and the system therefore tends toward it, but such a state is never reached as new events occur, thus upsetting the convergence process. Nonetheless, because of the consistent application of accounting principles all markets in

This model	The neoclassical growth model
"Human" action	Mechanics
Emergence	Synchronicity
Price dispersion	Price unity
Competition	Tatônnement
Historic time	Systematic time
Knightian uncertainty	Rational expectations
Limited information	Full information
Money	No money
Heterogeneous capital	Homogeneous capital
Profits and loss	Zero profits

Table 9.1.: Some differences between this model and the neoclassical growth model.

this modeled economy are interconnected and the model therefore exhibits the same full interdependency as DSGE models do. Furthermore, also in analogy with DSGE models, the steady states of this model are ultimately determined by preferences, technology, and institutions.

Thus, while being comparable on a general level, this model stands in sharp contrast to neoclassical and new-Keynesian economics.[1] A summary of the differences between the two model classes is presented in Table 9.1. The present model describes the economy as a process with incomplete markets, incomplete information, illiquidity, and bankruptcy. Physical capital is modeled as heterogeneous, complementary, and multi-specific. And all investments are irreversible since the model is defined in historic time. All of that is either assumed or assumed away in DSGE models, mostly out of mathematical necessity. The foundation of the present model is thus economic realism and its results emerge from these realistic premises.

Emergence means that the coherence of the model is not postulated, as in DSGE models, but rather unfolds. The present model therefore stands in the tradition of mathematical constructivism and at the same time opposes the mathematical formalism that characterizes neoclassical models.[2] That is, the mathematical method that is applied here justifies the existence of the concept of a steady state by construction, whereas neoclassical economics rests on the assertion that the non-existence of an equilibrium would violate certain axioms and, hence, its existence must be concluded (cf. Blaug, 2003).[3] As a consequence, neoclassical economics remains fully agnostic about the processes that lead to an equilibrium. These economic processes are simply outside the scope of the model and they are unrelated to the mathematical deductions by which the equilibrium

[1] A point of reference for the neoclassical growth model is (Romer, 2006, chs.1). New-Keynesian models, while sharing most of the methodological characteristics, are here not further considered.

[2] The term constructivism has a multiplicity of meanings. It is here used to subsume the mathematical stance that the consistency of a theory cannot in general be derived by deduction, but must be proven by its construction. For an introduction see Troelstra and Dalen (1988).

[3] The same is true for the specific values that are attained in these states.

solution is found. For these deductions are devoid of any economic content. The alternative paradigm, which is sometimes also labeled evolutionary economics, specifies the dynamics of the system only. The explanation of why something exists, or why a variable takes on the value it does, rests on a process account of how it becomes what it is. This is the approach taken in this model. Hence, the present model is not only more realistic than DSGE models, but it also covers aspects of reality that DSGE models remain silent about.

The dichotomy between the two schools of mathematical philosophy and economic method finds a correspondence in economic epistemology (see Gloria-Palermo, 2013). As Mayer ([1932] 1994, pp.57) shows, there are in principle two different theoretical approaches to the explanation of prices. There are "causal-genetic" theories whose inquiry concerns the principles based on which prices are formed, which from there derive insights about real-world prices; and there are "functional theories" that describe the quantitative relationships between economic magnitudes in an imaginary state of equilibrium and thus seek to understand observed prices. Neoclassical economics is what has evolved out of the functional price theories and it therefore adopted the axiomatic approach of mathematical formalism. Consequently, the idea of neoclassical economics is to fully describe economic relations on the basis of the circumstances that specify the equilibrium conditions. Yet, this requires having a full account of these circumstances in the first place and, since this is impossible, neoclassical economics therefore takes recourse to the methods of statistics (Mayer, [1932] 1994, pp.64). This is also the explanation why the neoclassical school and positivism are so intimately related. The neoclassical way of proceeding stands in stark contrast with the view of Carl Menger, founder of the Austrian school, whose research approach is centered around the *understanding of the essence* of economic phenomena. In his *Untersuchungen* ([1883] 1963, p.43) he explains his approach as follows:

> The goal of scholarly research is not only the cognition, but also the understanding of phenomena. We have gained cognition of a phenomenon when we have attained a mental image of it. We understand it when we have recognized the reason for its existence and for its characteristic quality (the reason for its being and for its being like it is).

Menger therefore dismisses the method of Walras ([1874-1877] 1954) and others on epistemological grounds and instead espouses causal-genetic price theory. However, Gloria-Palermo (2013) argues that Menger did not in general reject the use of mathematical tools in economics, but only opposed the mathematics that was used by his contemporaries, which was functional mathematics. In fact, there is evidence in Menger's writings that he saw the possibility for mathematics to be helpful in elaborating his insights (Antonelli, 1953, p.272, quoted in Gloria-Palermo (2013)). It belongs to the merits of this work to revive this Mengerian stance and to show that the constructivist approach of evolutionary economics and the praxeological research program can actually be reconciled.

In the present context the difference between the two approaches to price theory, and thus the difference between neoclassical and Austrian economics, can be understood

when returning to the discussion of Chapter 8. In deriving his insights about interest-rate theory Kirzner ([1993] 2011, p.118) implicitly also distinguishes between formalism and essentialism. He writes:

> There is a phenomenon (the existence of interest income) which calls for explanation [...]. The required explanation need not necessarily invoke all those "forces" which may be relevant for the determination of the *particular* rate of interest prevailing in the market. It is true that a complete listing of all aspects of all the "rate-determining forces" would at the same time explain why the interest rate is other than zero. But to say that all these forces are responsible for the interest phenomenon would be highly misleading. [...] For Fisher [(1930)], it is quite clear, the "problem" of interest is simply to provide a full catalog of the rate-determining forces.[4]

Two aspects remain as a conclusion. One, at points like this is where the confusion of neoclassicism begins. In making non-essential aspects the building blocks of economic models neoclassical economists are prone to confuse particular solutions with general economic laws. And, two, the present model is able to disentangle the essential aspects of economic phenomena, as was demonstrated in Chapter 8.

9.2. Uncertainty and spontaneous order

All actions in this model are essentially speculative since the agents are uncertain about the state of the world. They do not have information about the future and only limited information about the present and past. In particular, the agents cannot quantify the probability of future events and are thus confronted with Knightian uncertainty (Knight, [1921] 1964, Ch.7). Therefore, the agents form expectations based on experiences, but they cannot be sure that the conditions under which these experiences arose will persist. As a consequence, there is the possibility for agents to incur losses.

In the context of the model, uncertainty poses a more fundamental problem to firms and banks than it does to households. The latter might obtain a lesser return on an investment or less satisfaction from a consumer good than expected, but such feelings are outside the scope of the model. For firms and banks, in contrast, uncertainty is the principle around which all their actions are centered. This concerns, in particular, the setting of prices. The pricing decision is the most important decision that firms and banks take in order to avoid bankruptcy. Moreover, they use the responses to their pricing as a guide to improve their market position. Yet, whether certain responses are due to a demand constellation or a competitive constellation and whether those responses will persist is undetectable for them. This is what keeps all markets in motion. The price dispersion in the markets of this model and the permanent change of their microeconomic structure are direct consequences of the fact that the agents are faced with uncertainty and knowledge constraints.[5]

[4] Emphasis added.

[5] Stigler (1961) reaches the same conclusion even though he uses an entirely different methodology.

The pricing rationale of firms and banks, as specified in this model, also motivates the sellers to withhold a certain quantity from the market. However, it is not the expectation of a higher price in the future or a similar motivation that constitutes this seller's demand, but rather a knowledge problem. The fact that inventories cushion demand fluctuations is only a side effect, yet the uncertainty about the optimal sales strategy induces the firms to keep inventories. The same is true for the holding of loanable funds by banks. Arguably, in an environment of uncertainty and strong knowledge constraints, the monitoring of inventories and loanable funds is also the only way for the agents to evaluate their market position, since no other information is available to them. Hence, the reaction functions spelled out in Chapters 4 and 5 are not founded in psychology, but rather in praxeology, given the assumption that the agents believe these reactions to be adequate.

Thus, from a behavioral perspective the methodology developed above is fully in line with the Austrian account. Yet, on the other hand, in the Austrian literature such an approach is nowhere formulated. In fact, despite the causal-genetic view on price theory the formation of prices is mostly absent within this literature. Austrian writings emphasize that market prices are determined, within a certain margin, by the preferences of the acting parties. The concrete formation of prices or the specificities of a price system are however rarely brought up as an issue. Rothbard ([1962] 2009, p.363) even states that praxeology ends at the point where price determination begins. This contrasts with the post-Keynesian literature in which contract formation is a key principle of analysis (see Davidson, 2005). Following Simon (1959, 1976), the dominant approach in this field is to understand agents as being procedurally rational. That is, agents are interpreted and understood as having norms and targets through which they organize and plan their activities. These norms and targets pose thresholds to which the agents react and they can be adjusted if the market environment changes. If properly set, these algorithms then enable the agents to respond to market challenges. Such agents are thus inherently striving for profit maximization, but in contrast to the neoclassical paradigm this maximization remains implicit (see Cyert and March, 1963; Godley and Lavoie, 2007). The algorithms that are used in this work are built on exactly these post-Keynesian principles and the numerical simulations show that the suggested algorithms do in fact enable the agents to pursue their goals, at least to a certain extent, which is sufficient for the validity of the model.

The reason why Austrian economists usually consider the processes of price formation as outside the scope of economics is that human action, and hence the setting of prices, is, *per se*, unpredictable. The present model accommodates this unpredictability by stochastic modification. Most decisions by the agents are subject to such variations thus reflecting the indeterminateness of their free will. Notwithstanding, however, in all their actions the laws of human action apply. These laws are analytical truths, i.e. they are true *a priori* (Mises, [1949] 2008, pp.32). The model that is proposed here therefore has an "analytical core" that allows to translate the basic assumptions of Austrian economics into catallactic predictions. The patterns thus produced are independent of the specific choices of the individual agents, since unsuccessful strategies are eliminated

by bankruptcy and only those strategies that are compatible with the emergent market environment prevail. In other words, these patterns are instances of spontaneous order.[6] The model therefore provides a means to overcome the uncertainty that prevents Austrian analysts from making precise statements about certain aspects of the spontaneous order, e.g. the price system, or else, to overcome the disputes among Austrian economists about certain characteristics of such order (cf. Chapter 8). For, given the assumptions of the model and provided that there are no internal logical errors, the results of this model are necessarily true.

Finally, what are the assumptions that underlie this model? Rothbard (1957) enumerates four empirical premises that complement the analytical truths of Austrian economics.[7] These are the variety of resources, both natural and human; that leisure is a consumption good; that indirect exchanges are being made; and that firms (and banks) always aim at the maximization of their money profits (and have the ability to pursue this goal). Among those four, only the first two premises are indispensable, while the latter ones are made for ease of exposition. This model implements all of these premises except for the fact that here labor is considered to be homogeneous. The model could however be extended to incorporate this aspect as well. Beyond that the model makes assumptions about the nature of capital and it conveys a certain framing of supply and demand (Chapters 2.1 and 2.2). All these elements are, however, rooted in the essentialist understanding of the Austrian school. Implicitly, the model makes further assumptions by not including certain aspects of economic reality. The institutional setup is especially parsimonious and, certainly, the results of the model are influenced by the opportunities for action that are given to the agents. Therefore, for models of the present type it is vital that the modeler understands what is essential to the subject of inquiry. For the purposes of this work, however, the degree of specificity seems well taken.

9.3. On preferences

In general, preferences are a mental tool to organize the thoughts of economists. The preferences that are spelled out in this model, however, differ considerably from the preferences that are used in neoclassical economics (cf. Mas-Collel et al., 1995, pp.5). Within the neoclassical paradigm the preferences of an individual are understood as a value scale that exists independent of his actions and that determines these actions. These preferences are constant in time and they are fully known to the individual. Yet, such static preferences stand in contradiction with the reality of human action, as understood by Austrian economists. As Ludwig von Mises ([1949] 2008, p.95) states,

[6] Arguably, the term spontaneous order, when used by Hayek (1991) and other Austrian scholars, does bear a welfare implication. In the present context, however, no such claim is being made.

[7] Empirical, as here understood, means that, according to Rothbard, these premises are not analytical, i.e. they are not already contained in their definitions. It does not mean, however, that they are falsifiable. Moreover, note that Rothbard (1957) also considers the laws of praxeology as being empirical in this sense, but the analytical view is probably the adequate one (Oliva Córdoba, 2014).

> "[...] the scale of values or wants manifests itself only in the reality of action. These scales have no independent existence apart from the actual behavior of individuals."

That is, for Austrian economists a value scale is only the description of a single decision. It describes the fact that in choosing between different options human beings have to compare certain things, which are, *per se*, not comparable. Therefore, acting men compare these things in terms of their capability to satisfy their needs (Mises, [1949] 2008, p.119). The comparison of different goods in terms of their serviceableness *is* the value scale. And only in the moment of an action does a value scale become definite. Moreover, the only thing that can be said about this scale is that the chosen option has been preferred to all others. The ranking among the other options remains obscure. With regard to their observability and their economic content value scales are thus only isolated preference relations.

Furthermore, it is generally true that no two actions of an individual can ever be synchronous (Mises, [1949] 2008, p.102). As a consequence, the value scales of an individual are permanently formed anew. From the Austrian perspective it is thus incorrect to assert that preferences or value scales are constant in time. No individual can ever have static preferences because the value scales that pertain to two different actions are ontologically different objects. This continuous creation of new value scales precludes a universal transitivity principle (cf. Mises, [1949] 2008, p.103) and it also precludes the notion of value scales being "complete", since it requires more than one action to achieve a set of goals.

The tenets of Austrian economics about preferences and action are thus fundamentally different from the corresponding neoclassical concept. Neoclassical consumer theory departs from the marginal rates of substitution between different consumption bundles and from there derives the utility functions. The law of diminishing marginal utility is thus absent from this theory and has been replaced by the assumption of convex preference sets. Arrow (1984, p.41) acknowledges this when stating that

> "[i]t may be doubted that this assumption [of a diminishing marginal rate of substitution] is really empirically verifiable, and in any case it is an assumption of a totally different logical order from that of utility maximization itself. The older discussions of diminishing marginal utility as arising from the satisfaction of more intense wants first make more sense, although they are bound up with the untenable notion of measurable utility. However, their fundamental point seems well taken."

Yet, it is exactly this measurability of utility that the Austrian paradigm avoids. Moreover, its logical order is as follows. Acting individuals constantly apply the logic of marginal utility in their actions and marginal rates of substitution are only a result thereof. In contrast, the neoclassical consumers, prior to any action, compare the *total* utility of all conceivable consumption bundles as derived from the marginal rates of substitution and then make their choices accordingly. If one accepts that human beings act on the margin, i.e. their valuations and actions are bound in time, then it follows

by necessity that neoclassical consumer theory is not a meaningful description of what it allegedly describes. The Austrian description of action, in contrast, is immune to criticisms of this sort.[8]

Would it be possible to translate the Austrian understanding of preferences into a utility-maximization framework as put forward in neoclassical consumer theory? The answer is clearly no. Under uncertainty an explicit maximization of utility is not possible because the necessary information for such maximization does not exist. Acting individuals cannot know the prices they will be confronted with in the next action, let alone what the market clearing price is. Hence, it is also not possible to make such prices the basis of consumer choice. In a world outside equilibrium, the boundary conditions of the neoclassical maximization problem are not well defined. Moreover, as goods are generally not infinitely divisible and since preferences are not necessarily constant, it is impossible to formulate Austrian preferences as a utility function.

The preferences in this model are essentially a dynamic interpretation of the Rothbardian ([1962] 2009) description of preferences. This dynamic elaboration makes it possible to replace the value scales of Rothbard by single preference relations.[9] The sequences of intended actions list the goods which are, in the course of time, preferred to all other goods (except money) and the reservation prices establish isolated preference relations between the considered goods and quantities of money. The consumer goods that are not chosen and the value scales that constitute the appearances of goods in the sequence of intended actions remain unknown. Valuation in this model thus remains truly subjective and exchange can be explained by different subjective valuations on the part of a buyer and a seller (Mises, [1949] 2008, pp.204).[10] Moreover, all exchanges in this model are speculative in the sense that their risk is not quantifiable. Yet, acting men never know beforehand whether actions really serve their needs, but they assume so and thus act (Mises, [1949] 2008, pp.105).

The preferences of the households in this model are furthermore not "rationalized". There is no psychologic element stating that it is advantageous to feel and act one way or another. All the more, however, these preferences are the expression of the consumers' wants. In being neither justified nor explained, they reflect their sovereignty. This also implies that the consistency of the model does not depend on the behavior of the consumers, no matter how this behavior is specified (cf. Holcombe, 2009).

The model must be interpreted in a way that the preferences of the households describe actions which are intended after planning. The process that precedes a decision, which includes an analysis of the personal situation and the formation of expectations, lies outside the scope of the model. The intended actions are only the *result* of such a

[8] There are several other shortcomings in the neoclassical theory, which are not treated here. For a detailed critique of neoclassical consumer theory see Selikoff (2011). Also see the debate between Caplan (1999), Hülsmann (1999), and Block (1999).

[9] One may argue that this is what Rothbard had in mind, but that he resorted to static value scales for ease of exposition (see Rothbard, [1962] 2009, footnote on p.239). Otherwise, Rothbard's description of preferences would be incompatible with the Misesian ([1949] 2008, pp.94) principles.

[10] Also firms apply a comparable rationale in their investment strategies, which illustrates the fact that not only is consumer choice driven by human action, but also decisions in the business sector.

process and therefore they need not be transitive. For it is implicitly possible that in the time between two purchases a household alters his desires and makes new purchasing plans.

In specifying the model the schedules of wants are known to the modeler. But this does not bear a contradiction at all. It only says something about the character of the model. The model describes the economic constellations that would occur if there were agents who act according to the given preferences. It is impossible to find out whether the population of an economy historically acted according to a given preference set. Consequently, models of this type cannot be calibrated. The objective of the present model is only to illustrate the mechanisms that are at work in an economy. It therefore belongs to the realm of positive economics.

A. List of Symbols

Symbol[1]	Description	Value
A	Book value of assets	
ac	Average costs	
ar	Average revenue	
b	A bank	
c	Number of consumer goods	
C	Consumption expenditure	
cap_l	Processing capacity of a worker	1
cap_k	Processing capacity of a machine	3
D	Book value of outstanding loans	
Div	Dividend payments	
E	Book value of equity	
E_0	Subscribed capital	
Es	Escrow money	
Ex	Expenditure	
f	A firm	
f^{min}	Expansion requirement (firm number)	8
GDP	Gross domestic product	
h	A household	
I	Investment expenditure (machines)	
in	Number of inventories	
In	Book value of inventories	
In^s	Book value of goods sold	
Inc	Income	
Int	Interest payments	
k	Number of machines	
K	Book value of machines	
l	Number of workers	
l_0^{min}	Minimal firm size (in workers)	2
l_0^{ext}	Extended minimal firm size (in workers)	8
L	New loans	
Lf	Loanable funds of banks	
M	Quantity of physical money	$5.5 \cdot 10^7$
M^0	Initial money holdings of agents	50,000
M^D	Money demand	
M^f	Sight deposits of firms	
M^h	Sight deposits of households	
N^b	Maximal number of banks	100
N^f	Maximal number of firms	200
N^h	Number of households	800

[1] If a variable refers to a certain agent this is indicated by a subscript. Subscripts are suppressed when no ambiguity arises. Variables that are either a subjective estimate of an agent or a target level are characterized by a hat, e.g. $\hat{y}$, the production target of firms.

NNI	Net national income	
I^{net}	Net investment	
o	Number of offered goods	
p	Price of a good	
p^{flex}	Flexibility of prices	1000
PPM	Purchasing power of money	
Q	Threshold for firm size determination	100
q^{min}	Expansion requirement (sales)	104
pr_l	Output per worker in regular firms	1
pr_m	Output per worker in type-A firms	1
pr_x	Output per processed intermediate good	3
Red	Redemption payments	
Rs	Reserves	
r_d	Interest rate on loans	
r_s	Interest rate on savings	
r^{flex}	Flexibility of interest rates	0.02
s	Number of goods sold	
sav	Savings rate	
t	Time period (index refers to value at end of period)	
t^*	Point in time within a time period	
T	Book value of time deposits	
T_0	Face value of time deposits / Price of equity share	10,000
u	Unit of production	
w	Wage of a worker	
W	Wage payments	
w^{flex}	Flexibility of wages	500
x	Number of intermediate goods	
X	Investment expenditure (intermediate goods)	
y	Production	
$\tilde{\alpha}$	Stochastic modifier, uniformly distributed	$\in (0, 1)$
β	Mark-up requirement (banks)	0.01
γ	Lending buffer	0.9
δ	Mark-up requirement (firms)	0.05
ϵ	Distance to mark-up requirement	0.01
η	Number of consulted of offers per market search	3
π	Return on equity	
Π	Profitability	
ρ	Time preference	
ρ_0	Minimal time preference	$1.6 \cdot 10^{-3}$
μ_k	Number of required machine parts per machine	5
ϕ	Expansion probability	0.15
τ	Duration of a contract or an investment	
τ_k	Longevity of fixed capital	6
τ_i	Time horizon for monitoring investments	6
τ_w	Time periods of uninterrupted employment	
τ_π	Time horizon for monitoring equity returns	12
τ_z	Time horizon for time deposits, uniformly distributed	$\in [1, 4]$
τ_1	Time periods to bankruptcy	2
τ_2	Time periods to bankruptcy	6
σ_1	Lower bound of target range of inventories	0.05
σ_2	Upper bound of target range of inventories	0.15
ζ_1	Preference parameter	400
ζ_2	Preference parameter	$2 \cdot 10^5$

ζ_3	Preference parameter	$1.5 \cdot 10^4$
ζ_4	Preference parameter	12

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