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Induced Preferences - Welfare Economics - Freedom

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Induced Preferences - Welfare Economics - Freedom

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A Introduction. Normative Individualism: Why homo oeconomicus has survived for so long

Traditional Welfare Economics is built on the assumption of the fully rational economic agent, i.e. the assumption of "homo oeconomicus". This assumption also includes the hypothesis that preferences of homo oeconomicus are fixed once and for all. This homo oeconomicus assumption allowed economists to develop normative economics which was fully individualistic. *Normative individualism* thereby was possible. By this we mean the following: the measuring rod for the performance of an economic system is fully anchored in the preferences of individuals. There is no "collectivist" value judgement about the worth of particular goods involved. (Of course, distributional justice considerations always require some "collectivist" value judgement – even in traditional welfare economics).

If you – realistically – admit that preferences are influenced by the economic environment normative individualism faces a fundamental difficulty: the measuring rod of economic system performance no longer is independent of the object that it is supposed to measure. It is like a measuring rod that changes its length as a function of the length of the table it is supposed to measure. Such measuring rod no longer allows a straightforward measurement of the length of objects.

I believe that this difficulty is the reason for the tenacity with which economists have stuck to the assumption that preferences are fixed, are exogenously given. They did not see a way to maintain normative individualism, if they would give up the assumption of fixed preferences. One form this tenacity took was the Stigler-Becker (1977) paper: "De gustibus non est disputandum". There the authors present the hypothesis: every person has the same preferences – and, as a corollary, preferences are fixed, are exogenously given. They reject the traditional method of economists who explain observed differences in behaviour by differences in preferences. They say that this "explanation" really is no explanation at all, but a tautology. Stigler and Becker cling to the assumption of fully rational behaviour.

We should clarify one point at the very beginning. Many critics of the homo oeconomicus assumption depict homo oeconomicus as a complete egoist. But this has never been the opinion of mainstream economists who have used the homo oeconomicus model. Indeed many papers which assume preferences to be fixed do include altruistic or social preferences. The important logical point has been that preferences are exogenously given so that they can be used as a measuring rod of economic performance. Thus, in the following I use the term homo oeconomicus for the model in which people maximise their utility in a fully rational way and in which the utility function is exogenously given, be it fully egoistic or partly altruistic.

Here I want to present a theory which allows us to maintain normative individualism and yet to get rid of the unrealistic assumption of fixed

preferences. It builds on a hypothesis about the "laws of motion" of preferences, which I call adaptive preferences. To come back to the measuring rod analogy: if you would know the way in which the measuring rod changes its size as a function of the object to be measured it might still be a useful tool for measuring the length of objects.

Summarize the paper.

B Positive economics and preferences

Behavioural economics has shown that human behaviour is not consistent with a literal interpretation of the homo oeconomicus model. I believe that stable deviations from the model of full rationality are all consistent with my hypothesis of adaptive preferences. This will be the topic of other work to be written down as a sequel to this paper. In this paper I proceed with the hypothesis that the assumption of adaptive preferences is a realistic assumption. The reason for this sequence of argument is the following: the realism or otherwise of the hypothesis of adaptive preferences can only be appreciated if we better understand its meaning. We can draw certain consequences from the assumption of adaptive preferences which help us to understand whether the hypothesis is realistic or not.

Adaptive preferences are a "law of motion" of preferences. Before we can understand the concept of adaptive preferences we need to understand the concept of preferences. Why do economists talk of preferences? In my view this concept is intimately related to the idea of freedom of action. The concept of preferences is the mode by which normative economics introduces the idea of freedom or liberty into its theory of human interaction.

Positive economics does not really need the concept of preferences. Take the Stigler-Becker view of 1977: "de gustibus non est disputandum". Here the authors essentially argue that preferences are an empty concept. Concerning human behaviour preferences do not explain anything. They are used as an explanation only like as a stand-in, as a joker, where the researcher has not been able to explain observed human behaviour. A "true" explanation of the causes of some observed behaviour does not refer to the person's preferences. To say that person A prefers chocolate ice cream over vanilla ice cream does not add anything to the observation that, if given the choice between chocolate ice cream and vanilla ice cream person A will choose chocolate ice cream. Thus referring to the preferences as the cause for an observed behaviour is not a causal

explanation of such behaviour. Thus, if positive economics aims at explaining human behaviour it can dispose of the concept of preferences.

Preferences are an important concept in another research programme. It is the research programme asking the following question: how does a society of free individuals work? And how can it be improved? It is the research programme of normative economics. This research programme is important – and one can do this kind of research even without having finished the research programme of positive economics. Indeed, it is the research programme of traditional welfare economics. Obviously there exist interdependencies between the research programme of positive economics and the research programme of normative economics.

C Normative Economics, Freedom and Preferences

To understand the importance of the concept of preferences in normative economics we have to discuss the concept of freedom or liberty as it is implicitly used in normative economics. There we understand liberty to be a situation in which an agent has the choice between different alternatives; moreover her/his choice is justified and legitimate in society simply due the fact that it is her/his choice. The degree to which the agent has a freedom of choice, i.e. the degree to which the agent is free rises as her/his choice alternatives rise. Greater freedom, intuitively speaking, is greater choice.

One very simple example of freedom of choice is an election for public office in which the voter has the choice among different candidates. No matter what his or her reasons are for his or her voting decision, the ballot is valid and counts. Freedom of choice exists, if the reasons and causes for the particular choice decision are irrelevant for the legitimacy of that decision. Thus, in a sense, it is the very emancipation from the causal chain leading up to the decision, which characterises the concept of liberty.

The set-up of free elections in a democracy can be seen as a model for the general institutional set-up of a society of free people. Ballots are cast in a voting box to provide secrecy of voting. The secrecy of voting is the device by which it is guaranteed that the vote can be cast without any pressure from other citizens. Thereby modern democracies come close to the ideal that individual

voting decisions are legitimate irrespective of the causal chain that lead up to the individual's decision. In a similar way - in a free society and within the available choice set of the individual - other decisions by individuals ought to be shielded against legitimizing or de-legitimizing pressures from others and from the government, irrespective of the causal chain that leads up to the particular decision. We then need a kind imaginary "voting box" or "decision box" for the citizens allowing them to do what they want without interference by others.

No doubt, this "decision box" is a close relative of the privacy rules which are part of the institutional set-up of a free society. But there is a conceptual difference. The set of privacy rules is one of several instruments which enable society to implement that "decision box". "Due process" in the legal system is another such instrument. A specific "bill of rights" of citizens is a further such instrument. Property protected by law, as John Locke and other social philosophers have pointed taught us long ago, is important to build up and enlarge that "decision box".

Seen from the point of view of the social philosopher interested in a theory of a free society, the "decision box" is a kind of filter concerning the facts and causal links he or she is allowed to use in this normative theory. This filter has taken a particular form in economics. It is the distinction between constraints and preferences which explain for him or for her the behaviour of the citizens of a free society.

The way the economist incorporates free decisions into his models is by means of the concept of preferences. For the purposes of his modeling the economist treats the agents as determined in their decisions, quasi like automata or machines whose behaviour can be predicted. This determinism is technically useful for the economist's goal of predicting the outcome of any given institutional set-up. Thus, the actual freedom of choice is transformed into a seemingly deterministic outcome by means of the concept of preferences. The behaviour of the agent is determined by two classes of factors: 1. the constraints (like, for example, the budget constraint), determining his/her choice set and 2. his/her preferences which determine the choice within his/her choice set. The first class of factors are the constraints of his/her freedom; the second class of factors are the expression of his/her freedom. Thus, given the preferences, the person is free and at the same time predictable for the on-looking researcher.

Normative individualism as an approach for economic theory then is the expression of the researcher's goal to understand the working of a society of free

persons and to recommend changes in the institutional set-up which raises the freedom of choice of the members of that society. Normative individualism thus tries to avoid impositions of values by the collective of individuals on each individual. It works observing the citizen only partially and hiding the rest of the causal explanation of their behavior behind a “veil of ignorance”, to borrow a phrase which has been introduced by social philosophers with a somewhat different meaning. (Rawls, Buchanan).

D The limits of homo oeconomicus for a theory of a free society

But, if the general norm behind normative individualism is to enhance individual freedom, we see that, in an ideal society, preferences of individuals play a quantitatively important role for the results of this human interaction. This is the opposite of the treatment of preferences in positive economics. There the degree to which one refers to preferences as an explanation of behaviour and thus of human interaction is a measure of our ignorance of the true causes of behaviour. The goal is to minimise the degree to which one relies on preferences as an explanation.

Is there a logical contradiction between the two research programmes? I do not think so. Two basically different concepts of the term "preferences" are involved. Preferences in positive economics are the unexplained remnant of a science that tries to explain as much as possible about human behaviour. Preferences in the research programme of normative individualism represent the realm of legitimate decisions of the individual, irrespective of their causes. It should then be perfectly possible to develop a theory that tries to explain the voting behaviour of citizens alongside with a normative theory of democracy that works with the assumption that ballots count - irrespective of the causes for any particular voting behaviour.

But the freer citizens are, the more is determined in a society by the choices taken by citizens (rather than the constraints), the more we need to acknowledge the fact that choices or preferences are influenced by the social environment of the citizens. It is then a strong desideratum for normative individualism to have a welfare economics that does not have to rely on the assumption of fixed preferences, i.e. a welfare economics that works even with endogenously determined, i.e. induced preferences.

In this paper I want to indicate the way one can do welfare economics when preferences are induced by the economic environment. The crucial assumption or hypothesis is "adaptive preferences".

Before entering this approach towards “induced preferences” it is useful to understand the concept of “constraints” in such a normative theory. As we use this term in everyday life we have a conception that there are possibilities of choosing freely among alternatives. The constraints then determine the choice set of alternatives among which the agent chooses. In the positive theory the “constraints” ideally fully determine the “choice”. The “constraints” then are the “causes” of any given action. To the extent that the causes are not yet fully known, explaining choice by “preferences” is not explaining them at all. “Constraints” in the normative approach are not necessarily the constraints that the agent subjectively would consider limiting his or her choice. They also are not the “constraints” which positive economics would call “causes”. Rather, “constraints” in the normative theory determine the realm of legitimate and thus free choice of the individual. Obviously, any society of free people needs to constrain individual behavior in the interest of the freedom of other people. The rights which are allocated to different citizens must be compatible with each other, must be “compossible”. (Steiner 1977). From there we must derive a set of constraints.

If we want to be quite radical concerning the distinction between the positive and the normative approach we could say: in the normative theory constraints are *exclusively* determined by the limits of the rights which are set by law in the interest of “compossibility”. Physical constraints within each private household can be accounted for by the (ordinal) utility function of the agent. If the agent is unable to jump two yards high we simply designate a “utility” of minus infinity ($-\infty$) to any consumption basket containing a two-yard jump of the agent. The issue of compossibility will be further discussed in section S below.

E Preference Systems and the Concept of Induced Preferences

We need to formalise the meaning of the terms “induced preferences” and “adaptive preferences”. The intuitive meaning of adaptive preferences is the following: individuals have a tendency to value their present position or situation higher relative to alternatives than they would, if their present position or situation were a different one. We also may call this preference conservatism:

a tendency of agents to stick to the place where they are. As I shall show in other papers, this is quite a universal characteristic of human behaviour. Here I now proceed to present a more formalised form of the hypothesis and some of its implications. In order to formally define adaptive preferences we first have to define "induced preferences".

Generally preferences of individuals are influenced by their own past and by other people, in particular by the choices other people make. So as not to overburden the reader with too many new concepts and their interrelations I limit myself in this paper to a particular case of induced preferences: preferences of a person are only influenced by her/his own past consumption. In other papers the case of inter-personal influences on preferences will be included. Here I only deal with intra-personal influences on preferences.

I denote any choice object by x or y z or A or B or C. For concreteness the reader may interpret any such object as an n-dimensional commodity basket where each component is non-negative. Preferences are then denoted by q. For concreteness the reader may interpret q as a point in some N-dimensional Euclidean space of preference characteristics. N may be larger or smaller than n. We do not impose any restriction on N, except that it is a natural number. But the theory is more general: the space of preference characteristics may even be infinitely dimensional or may not even be defined in terms of dimensionality. But it does need a well-defined topology so that concepts like "continuity" and "convergence" make sense.

Definition: A preference system $\{x;q;\dot{q}\}$ is a system consisting of a commodity space containing commodity baskets x, consisting of a preference space containing preferences q, and of a rule $\dot{q}(x;q)$ describing the change through time of preferences as a function of the actually prevailing commodity basket x and the actually prevailing preferences q.

Any particular person is characterised by a preference system.

Definition: Induced Preferences. For any given preference system $\{x;q;\dot{q}\}$ preferences $\rho(x)$ are induced by basket x, if, for x constant through time, preferences q converge towards $\rho(x)$.

The function ρ is a mapping from commodity space into preference space indicating the inducement of preferences by actual consumption.

Concerning preference changes I investigate two different models, the "class-room model" and the “real world model”. The latter is a continuous time model.

1. The class room model. Here I denote a preference system by $[x;q;\dot{q}]$. The class room model is a discrete time model such that $q(t)=\rho(x(t-1))$. In words: preferences lag behind the basket by one period in the sense that they are the preferences induced by the basket of last period. Obviously the class-room model does not pretend to be a description of the real world preference dynamics. But the class-room model serves an important analytical purpose, as will be seen below.

2. The real world model. Here I denote a preference system by $\{x;q;\dot{q}\}$. But I use this notation also when I talk of a preference system without specifying whether it is of the class-room model type or the continuous time model type. In the real world time is a continuum. Thus, the real world model is a continuous time model. Here we do not distinguish discrete time periods, rather time is represented in the model by (a subset of) the continuum of the real numbers. The preference dynamics then may be given by the vector differential equation

$$\dot{q} \equiv \frac{dq}{dt} = f(x;q)$$

A specific form that the function $f(x;q)$ may take could be the linear vector differential equation

$$\dot{q} \equiv \frac{dq}{dt} = \alpha(\rho(x(t)) - q(t))$$

Here α is an NxN positive definite matrix and $\rho(x)$ are the preferences induced by basket x. If x remains constant through time preferences q converge towards $\rho(x)$. Occasionally, for purposes of illustration we replace the matrix α by a positive real number α (which of course is equivalent to the special case of an N times N matrix with that real number along the main diagonal and zeros outside the main diagonal). For the main results we need not specify the law of motion by this linear differential equation. It suffices that the preference space has a topology and that for this topology $q(t)$ converges to $\rho(x)$ for constant x.

F Adaptive Preferences Defined

Having defined induced preferences we now can define adaptive preferences. I use the following notation. If basket y is preferred over basket x under preferences q we write $y(>;q)x$. If basket y is indifferent to basket x under

preferences q we write $y(=;q)x$. If basket y is either preferred over x or indifferent to x under preferences q we write $y(\geq;q)x$.

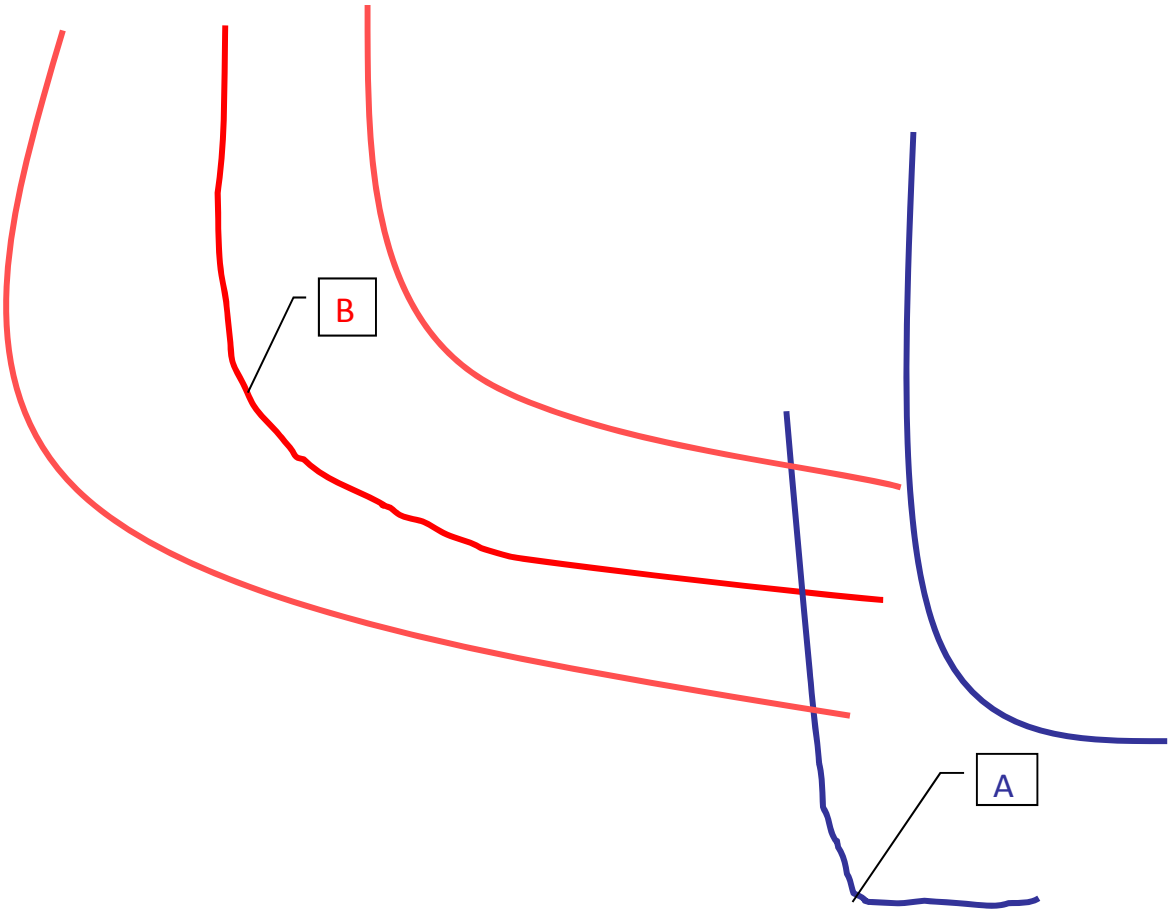
Definition of Adaptive Preferences: Assume that a preferences system is characterised by a well-defined mapping $\rho(x)$ of induced preferences. The preference system $\{x;q;\dot{q}\}$ exhibits adaptive preferences if the following holds: 1. For any two baskets x and y, if $y(>;\rho(x))x$ then $y(>;\rho(y))x$. 2. For any two baskets x and y, if $y(\geq;\rho(x))x$ then $y(\geq;\rho(y))x$. In words: Preferences are adaptive, if a basket y which is preferred over x with preferences induced by x, is, a fortiori, preferred over x with preferences induced by y.

Note that the traditional homo oeconomicus with fixed preferences is a special case of adaptive preferences. The latter thus are a true generalisation of fixed preferences. As Galileo already observed, zero speed of a body is a special case of a positive speed.

To see the connection between this definition of adaptive preferences and the intuitive meaning of preference conservatism think of $\rho(x)$ as the initial preferences inherited from the past. Consider now some change in the consumption from x to y which by preferences $\rho(x)$ is considered to be an improvement. Now keep y constant for a while. Then preferences converge towards $\rho(y)$. Preference conservatism would thus indicate that, given y was already preferred to x with preferences induced by x it would a fortiori be preferred to x with preferences induced by itself. Provided I prefer living in Paris over living in Berlin even though I actually live in Berlin I, a fortiori, prefer to live in Paris over living in Berlin once I have moved from Berlin to Paris.

G The comparability problem

If preferences depend on past consumption we may see a picture like this one



Preferences corresponding to past consumption A may be represented by the blue indifference curves. Preferences corresponding to past consumption B may be represented by the red indifference curves. As I have drawn the two sets of indifference curves they indicate the property of adaptive preferences. Given the choice between A and B the person chooses A, provided past consumption has been A; and the person chooses B, provided past consumption has been B. Is it then appropriate for economic policy to say: "stay put, wherever you are"? Certainly this would not correspond to the tradition of normative economics. It has always been reform-minded. Even though it generally did not advocate revolutionary changes, it did advocate changes in general arrangements in the hope to improve the welfare of people. After all, economics is a child of the age of enlightenment. Thus, improvement was considered to be possible. As we shall see, it is the very concept of improvement or progress which is closely linked to the concept of adaptive preferences.

In this particular case of the two baskets A and B we can ask the following two questions. First: Although a jump from A to B – given the blue indifference curves – is not an improvement and although a jump from B to A – given the red indifference curves - is not an improvement, is it perhaps possible to move gradually from one point, say A, to the other point, say B, by means of a number of smaller steps each of which is an improvement, thereby exploiting the fact that preferences change along-side during this longer journey? Second: And if that is a possibility, could it be that the reverse improvement journey from B to A is not possible? Could we then – in a certain sense – consider basket B to be superior to basket A? In the following I want to make this idea precise. And I will show that adaptive preferences do play a crucial role for a positive answer to these two questions.

H The Improvement Axiom

Here I introduce the concept of an improvement sequence (or, equivalently, an improving sequence). Basically it is a development of consumption baskets through time such that any change in the basket is considered to be an improvement or at least a change to which the person is indifferent relative to the status quo. Here, for ease of presentation I take the somewhat unrealistic case of discrete time steps with preferences corresponding to the basket of a time period before. It is the "class-room model". Let A, B, C,… K be a finite set of consumption baskets which have the following properties. For preferences induced by A the basket B is preferred over A; for preferences induced by B the basket C is preferred over B; and so on. Each basket is preferred over the preceding one with preferences induced by the preceding one. Such a sequence I call an improving sequence. If, in addition, the end- basket is different from the starting basket then the improving sequence of baskets is called an improvement path or an improving path.

I now introduce the Improvement Axiom. People are aware that their preferences may change as their consumption basket changes. They must deal with this in their decisions. They may not know the details of the change in their preferences, but they do know that a change in their consumption basket changes their preferences. I then assume the following: given the choice between an improvement sequence and a stationary consumption path, both starting with the same basket and the same preferences, people prefer the improvement sequence, provided they expect that any improvement sequence is an improvement path. This is the Improvement Axiom. Although generally

people do not know precisely how their preferences will change under new consumption circumstances they do accept an improvement if it is offered to them. And they do assume that they will do the same in the future after further improvement is offered to them and after their preferences then have changed due to the first improvement.

I consider the Improvement Axiom to be a rather weak assumption. Everyday life tells us that by and large people behave in accordance with this Improvement Axiom. People want improvement even if they are aware that their wants will change with this improvement.

The Improvement Axiom is the single point where I introduce something like an evaluative comparison of different preferences, albeit only a quite local one. This is in contrast to approaches by other economists like Becker or Sen, who talk about meta-preferences, i.e. about preferences over different preferences. In a sense what this meta-preference approach does is to return the theory back to the paradigm of fixed preferences. Indeed, the assumption of the meta-preference approach is that meta-preferences are fixed, are exogenously given. This then again leads to decisions of the individual which can be predicted as if preferences themselves were exogenously given.

I Adaptive Preferences and Non-Circularity of Improvement Sequences

At the core of my theory lies the equivalence of adaptive preferences and of the non-circularity of improvement sequences. This equivalence enables me to generalise welfare economics from the traditional case of fixed preferences to the case of induced preferences, provided the "law of motion" of preferences is characterized by adaptive preferences. Moreover this equivalence also gives additional "sociobiological" cause for the empirical hypothesis that preferences are adaptive.

This equivalence is not self-evident. To show equivalence requires some substantial mathematical effort. Moreover, it is easily seen that we need further assumptions about the structure of preferences to show this equivalence. Indeed, here is a very simple example which contradicts this equivalence. Consider the following preference system. It is of the "class-room" type. The space of commodity baskets consists of the three baskets A, B, and C. We assume the following table of preferences

$B(>;\rho(A))A$	$A(>;\rho(A))C$	$B(>;\rho(A))C$
$C(>;\rho(B))B$	$B(>;\rho(B))A$	$C>;\rho(B))A$
$A(>;\rho(C))C$	$C(>;\rho(C))B$	$A(>;\rho(C))B$

As we compare the entries within a given row (each row representing one of the three different induced preferences) we see that given preferences are "rational", i.e. consistent. Thus, for example, with preferences induced by A (top row) B is preferred over A and A is preferred over C, and also B is preferred over C, which shows consistency. Also, as we compare the first column with the second column we see that preferences are adaptive. Yet we can construct a circular improvement sequence: A, B, C, A.

J General Assumptions on Preferences

Thus, we introduce the following assumptions about preferences in general.

Assumption I: Continuity: Preferences are continuous, i.e. If $y(>;q)x$ then there exist neighbourhoods $N_1(x)$, $N_2(y)$, N_3(q) such that for $w \in N_1(x)$, $z \in N_2(y)$, $r \in N_3(q)$ we have $z(>;r)w$.

A precise definition of Assumption I is in the Mathematical Appendix: "neibourhoods" (i.e. "open sets") have to be understood in terms of the relative topology for the subspace of R^n containing those dimensions i with $y_i > 0$.

Assumption II: Non-satiation: Preferences are defined over (a subset of) non-negative commodity baskets in the n-dimensional Euclidean space R^n, which we call $R^n +$. Let x and y be two baskets in $R^n +$. For each component i such that $x_i > 0$ we have $y_i > x_i$. Then for all preferences q we have $y(>;q)x$.

Assumption III: Regularity: First let $n = 2$. For any given $\bar{x}$ any two different preferences $q^1$and q^2 let $I(\bar{x};q^1)$ be the indifference curve passing through $\bar{x}$ with preferences q^1 and let $I(\bar{x};q^2)$ be the indifference curve passing through $\bar{x}$ with preferences q^2. Then for the intersection of the two indifference curves $\hat{I}(\bar{x};q^1;q^2) \equiv I(\bar{x};q^1) \cap I(\bar{x};q^2)$ we either have $\hat{I}(\bar{x};q^1;q^2) = I(\bar{x};q^1) = I(\bar{x};q^2)$ or $\hat{I}(\bar{x};q^1;q^2) \equiv I(\bar{x};q^1) \cap I(\bar{x};q^2) = \{\bar{x}\}$. In words: if the two indifference curves passing through a given basket $\bar{x}$ and corresponding to two different preferences are not identical then they only overlap in $\bar{x}$. For $n > 2$ the regularity defined for $n = 2$ applies to any two-dimensional subspace of baskets. Moreover a certain

"triangle inequality assumption of adaptive preferences" is assumed to hold which will be discussed below in section L.

One consequence of adaptive preferences under the three assumptions just introduced can be easily seen. Take the class room model. Take the case $n = 2$. Take two indifference curves passing through x. Indifference curve 1 corresponds to preferences $\rho(x)$. Indifference curve 2 corresponds to preferences (y) . Here we assume that y lies to the "south-east" of . Assume $y(=;\rho(x))x$. We then can infer from adaptive preferences that indifference curve 2 passes below (or at most through) y, because $y(\geq;\rho(y)y$. Thus indifference curve 2 has a steeper slope than indifference curve 1. This means that with a given budget constraint $p_1x_1 + p_2x_2 = 1$ demand for good 1 is higher, if preferences $\rho(y)$ prevail than if preferences $\rho(x)$ prevail. Thus, if in the class room model past consumption has been y then today´s demand for good 1 is higher than if past consumption has been x. But with y as past consumption, past consumption of good 1 has been higher than with x as past consumption. We then observe that there is an inter-temporal complementarity in the demand for any given good. This then is an important characteristic of adaptive preferences and can be used for empirical tests of the hypothesis of adaptive preferences. The substantial empirical literature on demand systems for consumers corroborates the hypothesis of this inter-temporal complementarity of demand, which is also known as the hypothesis of habit formation.

Draw figure

K Theorem 1 for the Class Room Model and $n = 2$

In the following I give different versions of two Theorems. Theorem 1 says that adaptive preferences imply non-circularity of improvement sequences. Theorem 2 shows that non-circularity of improvement sequences leads to an exogenous "homo oeconomicus"-like quasi-preference structure which, as a corollary, implies adaptive preferences.

I now proceed to show the first version of Theorem 1.

Theorem 1A: Assume the three Assumptions I, II and III (continuity, non-satiation and regularity). Assume further the class room model and assume $n = 2$. Then adaptive preferences imply non-circularity of improvement sequences.

The Proof is in section 2 of the Mathematical Appendix. It takes some effort to prove this proposition. What we actually do is to derive a somewhat "global" result from a somewhat "local" assumption. Improvement sequences can be of any length, as long as they have a finite number of steps. Thus, they can lead to baskets which are far away from the starting point and then, one might think, may come back on quite different routes from the ones they have taken moving away. Why should they be non-circular? Thus, the proposition that all improvement sequences are non-circular is a rather "global" proposition. On the other hand the characteristic of adaptive preferences only needs two baskets to be defined. In this sense it is a much more "local" characteristic.

There are of course many examples in science where "local" characteristics lead to global properties. Newton´s mechanics of planetary motion is of course a well- known case. But to prove his theory (as far as I know, even to convince himself of its truth) he had to invent differential calculus and had to integrate a differential equation. So it should not be a surprise that our Theorem 1A requires some effort.

But, to support our intuition, I can show here a very simple proof, if in addition I assume that preferences can be understood to be equivalent so some cardinal utility function. We then can write down a cardinal utility function $U(x;q)$. I now assume that for any given basket x cardinal utility $U(x;\rho(x)) \geq U(x;q)$ for any preferences q. Thus, for a given basket x, utility is highest, if preferences prevail which are induced by x. This assumption is in the spirit of adaptive preferences: for a given basket people are happiest, once they have accommodated themselves to their situation. Happiness research, by the way, shows that this is a realistic assumption. Of course, this inequality concerning cardinal utility is consistent with the purely ordinal concept of adaptive preferences: for, if $y\big(>;\rho(x)\big)x$ then $U(y;\rho(y)) \geq U\big(y;\rho(x)\big) > U(x;\rho(x)) \geq U(x;\rho(y))$ and thus $y\big(>;\rho(y)\big)x$.

In the class room model consider now an improving sequence $\{x^0, x^1, x^2, \ldots . x^T\}$. We then have $U\big(x^0;\rho(x^0)\big) < U\big(x^1;\rho(x^0)\big) \leq U\big(x^1;\rho(x^1)\big) < U(x^2;\rho(x^1)) \leq U(x^2;\rho(x^2)) <\ldots\ldots\ldots<U(x^T;\rho(x^{T-1})) \leq U(x^T;\rho(x^T))$, in short: $U\big(x^0;\rho(x^0)\big) < U(x^T;\rho(x^T))$. This shows $x^T \neq x^0$ and thus, non-circularity of improvement sequences. Note that for this "cardinal utility case" I did not have to assume that $n = 2$.

L Theorem 1 for the Class Room Model and $n \geq 2$

I now generalise Theorem 1 to the case of any number of distinct commodities. For this I have to make a regularity assumption which applies to any dimension n of the commodity space.

Assumption IIIe ("e" for "extended") of extended regularity: The regularity assumption III for $n = 2$ applies to any two-dimensional subspace of R^n defined (together with the origin 0) by any two linearly independent non-negative baskets x and y. Moreover the following "triangle inequality assumption of adaptive preferences" holds: Slightly simplified (a precise definition is in section 3 of the Mathematical Appendix) it says the following: Consider any three baskets x, y, z such that they form an improving sequence i.e. $y\big(>; \rho(x)\big)x$ and $\big(>; \rho(y)\big)y$. Then there exists some $\hat{y}$ which is a weighted average of x and z such that $x; \hat{y}; z$ also form an improving sequence.

The "triangle inequality assumption of adaptive preferences" is in the spirit of our intuition about adaptive preferences. They are the expression of a certain preference conservatism. Thus, if, by an improving sequence, one can reach a basket z from a basket x via an intermediate step y then it should be possible to find an intermediate step which is "more similar" to x and z than is y. The "detour" via y should not be necessary, since it involves more change altogether than does $\hat{y}$; and preference conservatism means resistance to change.

We then can prove

Theorem 1B: Assume the three Assumptions I, II and IIIe (continuity, non-satiation and extended regularity). Assume further the class room model and assume $n \geq 2$. Then adaptive preferences imply non-circularity of improvement sequences.

The proof in section 3 of the Mathematical Appendix is rather lengthy. Here I describe its main idea. I start with any given improving sequence $\{x^0, x^1, x^2, \ldots . x^T\}$ in $R^n +$. I then pick that basket x^{t*} in the sequence which is farthest away (by Euclidean distance) from a two-dimensional subspace $R^2(x^0; x^T)$ containing 0, x^0, and x^T . I replace this x^{t*} by some z^{t*} which is in the two-dimensional subspace $R^2(x^{t*-1}; x^{t*+1})$ and is a weighted average of x^{t*-1} and x^{t*+1} such that the sequence remains an improving sequence. This is always possible due to the "triangle inequality of adaptive preferences". Thereby we have a new improving sequence such that its average distance from

$R^2(x^0; x^T)$ has been reduced. We continue with this procedure. The thereby constructed sequence of improving sequences converges to some limit sequence. This limit sequence, due to continuity, is again an improving sequence. It then can be shown that this limit sequence is contained in $R^2(x^0; x^T)$, again by some rather complicated argument which makes heavy use of the continuity assumption. The proof that the limit sequence has the desired properties only can be done by first working with weakly improving sequences. From there we then can show a corresponding result for strictly improving sequences. The fact that the limit sequence lies in $R^2(x^0; x^T)$ and is an improving sequence makes it possible to apply Theorem 1A. Thereby we show that the improving sequence $\{x^0, x^1, x^2, \ldots . x^T\}$ is non-circular.

The Assumptions I,II, IIIe are sufficient conditions for deriving non-circularity from adaptive preferences. I have other sufficient conditions for this result which I do not present in this paper. The question arises whether there is a chance to derive Theorem 1 from substantially weaker conditions. The answer is "no" in one respect: what I basically have done is to use assumptions which give me the result that any improving sequence can be replaced by an improving sequence contained in a two-dimensional subspace $R^2(x^0; x^T)$. But, due to Theorem 2, to be discussed below, I know that any preference system with only non-circular improving sequences has the property that each improving sequence can be replaced by an improving sequence contained in the two-dimensional subspace $R^2(x^0; x^T)$.

M Converse Theorem (Theorem 2): Non-Circularity of Improving Sequences Implies the Existence of a "Homo Oeconomicus"-Like Quasi-Preference Structure and Thereby Implies Adaptive Preferences

An essential building block for welfare economics under adaptive preferences is the fact that non-circularity of improving sequences allows us to find "quasi-preferences" $V(x)$ which are exogenous. The function $V(x)$ does not depend on past consumption. These "quasi-preferences" are an indicator for answering the question, whether some basket y can be reached from some other basket x by means of an improving sequence or not. I therefore also call it an "indicator function" for the existence of improving sequences: If and only if $V(y) > V(x)$ is there an improving sequence from x to y.

The ordinal indicator function or "quasi-utility function" $V(x)$ formally then looks like an ordinal exogenously given utility function, even though its precise

economic meaning is different. But it also has one property in common with the homo oeconomicus model which makes it so important for welfare economics: it links up with the person´s demand behaviour. Here it is "long run demand", by which I mean the demand function which provides the limit demand as a function a budget that remains constant over time. It is not the demand function for given preferences q which we may call the "short run demand function". Rather it is the demand function which encompasses the change in preferences induced by the budget constraint. In the tradition of revealed preference theory we are then able to read preferences from demand behaviour; only these are the fixed "quasi-preferences" $V(x)$ rather than the endogenously determined actual preferences.

For $n > 2$ I need an assumption to enable me to prove Theorem 2 by means of the Samuelson-Houthakker revealed preference theorem. For $n = 2$ I can show a more general theorem, which is crucial to demonstrate one of the main differences between traditional welfare economics and welfare economics of adaptive preferences. In this paper I deal with the case $n \geq 2$.

Here I need the assumption that "long run demand" for any given budget constraint converges to a unique point. Throughout I assume the budget to be unity (I therefore ignore issues related to money illusion, but I will discuss this topic in a paper yet to be written). Demand then is restricted to the inequality $px \leq 1$.Here $p \geq 0$ is the prevailing price vector. For given preferences q we then have a demand function $x = h(p; q)$. Keeping prices constant through time we may get convergence of demand. It must have the following property

$$x = h\big(p; \rho(x)\big) = H(p)$$

For any given budget p the demand basket must converge to a particular basket x which has the property that it is the "short run demand" under the preferences induced by itself. The basic assumption we make (and which in a later paper I relax for another Theorem 2 for the case $n = 2$) is that the convergence point fulfilling the equation $x = h(p; \rho(x))$ is unique for any given p and is independent of the initial preferences $q(0)$ prevailing at time 0. Thus, we assume that there exists a "long run demand function" $H(p)$.

What are the properties of the long run demand function? Under which conditions does it satisfy Houthakker´s strong axiom of revealed preference and thus can be seen as the expression of an underlying utility function? The answer is given by

Theorem 2A: In the class room model under Assumption I (continuity) and Assumption II (non-satiation) assume further that all improving sequences are non-circular and that there exists a long run demand function $x = h\big(p; \rho(x)\big) = H(p)$ which is independent of initial preferences $q(0)$. Then the long run demand function satisfies the strong axiom of revealed preference. Thus there exists a quasi-utility function $V(x)$ underlying the long run demand function. Moreover this underlying quasi-utility function is continuous and has the following property: If and only if $V(y) > V(x)$ there exists an improving sequence starting at x and ending at y.

The Proof is in the Mathematical Appendix. The main idea of the proof is the reference to the Samuelson-Houthakker Theorem of revealed preference. This works by means the following

Revealed Preference Lemma of Induced Preferences: If in a sequence of baskets $\{x^0, x^1, \ldots . . x^T\}$ each basket (except x^0) is revealed preferred to its preceding basket under the long run demand function then there exists an improving sequence from x^0 to x^T.

The proof is in the Mathematical Appendix.

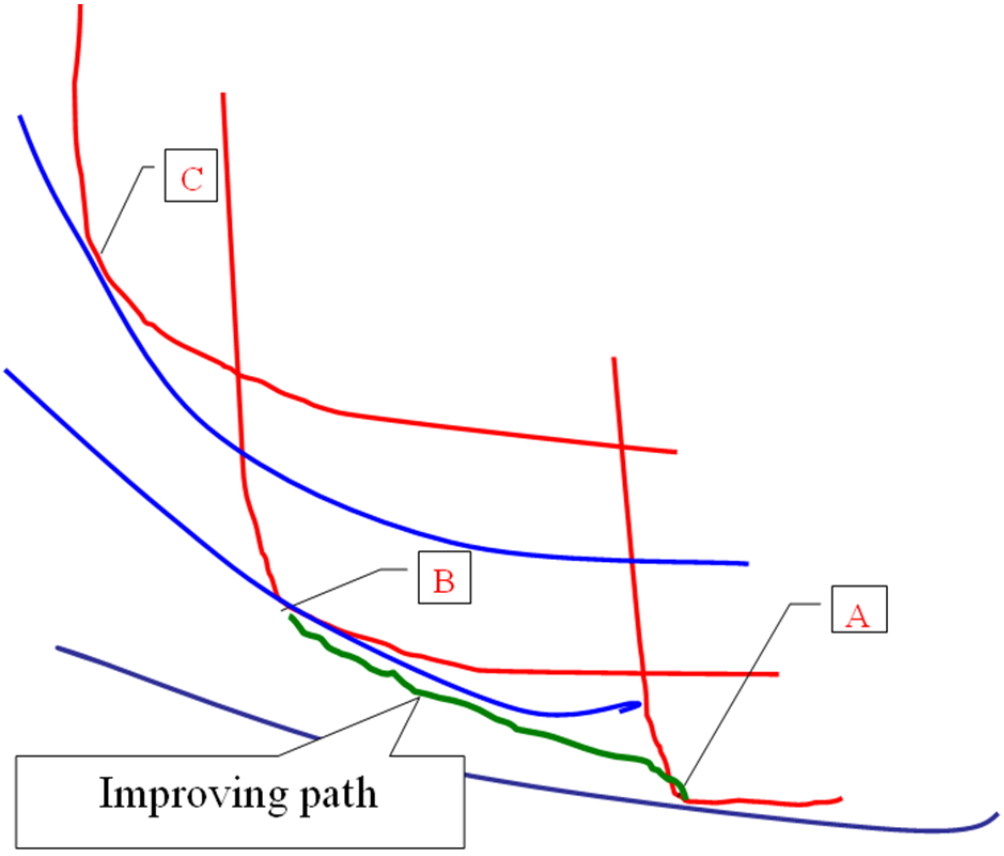
Thus, since, by assumption, all improving sequences are non-circular, all revealed preference sequences are non-circular under the long run demand function. Therefore the strong axiom of revealed preference is fulfilled for $x = H(p)$ and we have an ordinal utility function $V(x)$ which corresponds to the long run demand function $H(p)$. Moreover, it also follows from the Samuelson-Houthakker Theorem: if and only if $V(y) > V(x)$ there exists a finite revealed preference sequence under $H(p)$ starting at x and ending at y. Then, again by the Revealed Preference Lemma of Induced Preferences, there exists an improving sequence from x to y. On the other hand, it is then obvious that for $V(y) < V(x)$ there exists no improving sequence going from x to y: for otherwise we could construct an improving sequence which starts at x, touches y and comes back to x, thereby violating the assumption that improving sequences are non-circular. Using continuity arguments, it can also be shown that $V(y) = V(x)$ makes it impossible to construct an improving sequence from x to y.

There is a Corollary to Theorem 2A:

Adaptive Preference Corollary: Under the assumptions of Theorem 2A preferences are adaptive.

Sketch of Proof: Consider $y(>;\rho(x))x$. Then, obviously, y can be reached from x by an improving path of length $T = 1$. Thus, by Theorem 2A, $V(y) > V(x)$. But we then also must have $y(\geq;\rho(y))x$. For, otherwise we would have $x(>;\rho(y))y$ and thus $\{x, y, x\}$ would be an improving sequence, contrary to non-circularity. For continuity reasons $y(=;\rho(y))x$ also can be excluded. It remains $y(>;\rho(y))x$. QED.

In the graph below I depict Theorem 2A and its Corollary. I draw three single indifference curves corresponding to preferences induced by baskets A, B, resp. C and going through A, B, resp. C. They are in red. Then I draw a system of indifference curves, in blue, which depict the "quasi-preferences" $V(x)$. Because B is on a blue indifference curve above the one through A Theorem 2A tells us that there exists an improving sequence from A to B.



Moreover the Corollary shows up in the graph by the fact that the red indifference curves of induced preferences corresponding to a basket is above the blue indifference curve through the same point.

Theorem 2A also has immediate implications for price elasticity. As we know, price elasticity of demand is higher when indifference curves have less curvature. Thus, the price elasticity of demand of the long run demand function - corresponding to the blue indifference curves -is higher than the price elasticity of demand for those given preferences which are induced by the basket under investigation. A change in the budget constraint generates a change in tastes so that the total or long run effect on demand is larger than the immediate effect holding the initial preferences constant. Preference change thus is like a reaction amplifier. Induced preference changes thereby help the person to adapt to changes in the social or natural environment. This is a further reason why I have chosen the name "adaptive preferences" for the main hypothesis of my theory. As we shall see in a sequel to this paper this then also helps us to understand the "sociobiological" foundations of the empirical validity of the hypothesis.

N Equivalence Theorem 1 for the Class Room Model

After having presented a first version of Theorem 2 I can show an additional version of Theorem 1. This is Theorem 1C. It sheds additional light on the – as yet not fully known - set of sufficient conditions for Theorem 1 type theorems.

I introduce the following name: A preference system $\{x; q; \dot{q}\}$ may have the property of "two-dimensional mappings of improving sequences". By this I mean: if $\{x^0, x^1, \dots x^T\}$ is an improving sequence in R^n a two-dimensional mapping of $\{x^0, x^1, \dots x^T\}$ is an improving sequence $\{x^0, z^1, z^2, \dots . . z^S, x^T\}$ such that all $z^t \in R^2(x^0, x^T)$ where $R^2(x^0, x^T)$ is a two-dimensional subspace containing x^0 and x^T. S , the number of in-between steps in $R^2(x^0, x^T)$, need not coincide with the number of in-between steps of the original improving sequence.

Theorem 1C: Assume the Class Room Model. Assumptions I (continuity) and II (non-satiation) hold. Assume further the existence of a long run demand function $x = h\big(p; \rho(x)\big) = H(p)$. Assume adaptive preferences.

Part A: For a given preference system $[x; q; \dot{q}]$ assume that every improvement sequence has a "two-dimensional mapping". Then every improvement sequence is non-circular.

Part B: Assume that every improvement sequence of a given preference system $[x; q; \dot{q}]$ is non-circular. Then every improvement sequence of that preference system has a "two-dimensional mapping"

The proof of Part A is the same as part of the proof of Theorem 1B. There we show non-circularity of improvement sequences by first deriving the existence of a two-dimensional mapping for each improvement sequence, and then using Theorem 1A to derive non-circularity.

For the proof of Part B I use Theorem 2A which yields a quasi-utility function $V(x)$ as an indicator function for the existence of improvement sequences. But then we can restrict the function $V(x)$ to the subspace $R^2(x^0, x^T)$ where it serves the same indicator function for the existence of improving sequences. Thus $V(x^T) > V(x^0)$ also indicates the existence of an improving sequence in $R^2(x^0, x^T)$. (A proof that $V(x)$ serves the same indicator function in the subspace as in the full space is in the Mathematical Appendix).

Theorem 1C tells us that by investigating sufficient conditions for the derivation of non-circularity of improvement sequences from adaptive preferences we can concentrate on the existence of two-dimensional mappings of improving sequences.

O The "Real World Model" ("Continuous Time Model"): Theorem 2

I now define and discuss improvement sequences in a model of continuous time. I call it the "real world model", because it mirrors the real world much more closely than does the class room model. The preference dynamics then may be given by the vector differential equation

$$\dot{q} \equiv \frac{dq}{dt} = f(x; q)$$

We assume that $f(x; q)$ has all the properties required to make the differential equation integrable. In its linear form the vector differential equation reads

$$\dot{q} \equiv \frac{dq}{dt} = \alpha(\rho(x(t)) - q(t))$$

Here α is an NxN positive definite matrix and $\rho(x)$ are the preferences induced by basket x. If x remains constant through time preferences q converge towards $\rho(x)$. I also assume for the case $\dot{q} = f(x; q)$ that, for constant x preferences q converge towards some well-defined induced preferences $\rho(x)$.

Before I continue I want to point out to the reader that in section Q below I discuss a simple example of the continuous time model with two goods and computable parameters for the elasticity of substitution and the influence of past consumption on present preferences. Looking at the example of section Q may help the reader understand what is going on in the more general model.

For the following it is useful to introduce an ordinal utility function representing the preferences involved in the analysis. Thus $U(x;q)$ is a function continuous in x which represents the preferences q. Because preferences are continuous we know that such $U(x;q)$ exists. Moreover, as before, we assume that preferences are also continuous in preference space. We then also can assume $U(x;q)$ to be continuous with respect to q in the topology assumed to exist in preference space.

We now look at a path through time of the consumption basket $x(t)$. According to the differential equation above, for any given initial preferences $q(0)$ we have a movement of preferences $q(t)$ which of course depends on $x(t)$. We introduce the following definition:

Definition: For a given movement $x(t)$ a point in time t is an improvement point, if for $q(t)$ there exists $\varepsilon > 0$ such that for $t - \Delta t > t - \varepsilon$ and $\Delta t > 0$ we have $U\big(x(t-\Delta t); q(t)\big) < U(x(\mathrm{t});q(t))$. A point in time t is a weakly improving point, if for $q(t)$ there exists $\varepsilon > 0$ such that for $t - \Delta t > t - \varepsilon$ and $\Delta t > 0$ we have $U\big(x(t-\Delta t); q(t)\big) \leq U(x(\mathrm{t});q(t))$.

Consider now a movement of x through time from time zero to some time T. We restrict ourselves to movements $x(t), 0 \leq t \leq T$, such that $x(t)$ is piecewise differentiable with K "jump points" with K≥ 0 a finite integer. Let $J = \{t_1, t_2, \ldots . t_K\}$ be the set of jump points. We then assume that $x(t_i)$ is the limit point of $x(t)$ as $t > t_i$ approaches t_i from above. With this restriction we consider any path $x(t)$. Due to this restriction of piecewise differentiability (and hence piecewise continuity) and for a given $q(0)$ preferences $q(t)$ are well defined by means of the integrable differential equation $\dot{q} = f(x;q)$.

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We then can describe the path by $\{x(t); q(0); T\}$.

Definition: A path $\{x(t); q(0); T\}$ is a weakly improving sequence, if $q(0) = \rho(x(0))$ and every $t \in (0, T]$ is a weakly improving point for $0 \leq t \leq T$.

Definition: A path $\{x(t); q(0); T\}$ is an improving sequence, if it is a weakly improving sequence and if $T = t_K$ is a jump point with $U\big(x(T); q(T)\big) > \lim_{t \to T} U(x(t); q(T))$

Concerning this definition of improving sequences note the following: 1. A stationary path $x(t) = \bar{x}$ is a weakly improving path. 2. Note that the definition of improvement points only involve utility comparisons with identical preferences. Thus, we are in a purely ordinal environment. For the utility function $U(x(t); q(t))$ at time t (if $x(t)$ is differentiable at t) we note that $\frac{\partial U}{\partial x}\dot{x} > 0$ if t is an improving point. If $x(t)$ is the result of utility maximization against a budget constraint we know that $\frac{\partial U}{\partial x} = \lambda p$ for some $\lambda > 0$. Thus $p\dot{x} > 0$ which means we see a rise in real income. We therefore can understand a weakly improving sequence as a path in which any change in real income is always upwards and never downwards. 3. A weakly improving sequence which has strictly improving jump points or time intervals with strictly improving real income improvements could reasonably be seen as an improving sequence in the strict sense. For mathematical reasons I have defined an improving sequence somewhat more strictly: by requiring a strictly positive utility jump at the very end. Proofs of the theorems are then much easier. But I do not think this to be a big problem, because the final jump in real income can be arbitrarily small, as long as it is positive. For any basket y which can be reached from an initial basket x by means of an "improving sequence", reasonably defined, we can find $\hat{y}$ arbitrarily close to y such that $\hat{y}$ can be reached by a sequence which I define as a strictly improving sequence.

We now use the results from the class room model for deriving results for the "real world" model. We first introduce the following

Definition: For a given preference system $\{x; q; \dot{q}\}$ in continuous time we define the corresponding class room preference system $[x; q; \dot{q}]$ as that class room model which exhibits the same induced preferences mapping $\rho(x)$.

We then show the following

Correspondence Lemma: Assume all improvement sequences of a "real world" preference system $\{x; q; \dot{q}\}$ are non-circular. Assume that there is a long run demand function $x = h\big(p; \rho(x)\big) = H(p)$ for the corresponding class room model. For any basket x^0 let $A(x^0)$ be the set of baskets which can be reached from x^0 by means of an improvement sequence in the "real world" model. For any basket x^0 let $\hat{A}(x^0)$ be the set of baskets which can be reached from x^0 by means of an improvement sequence in the corresponding class room model. Then $A(x^0) = \hat{A}(x^0)$.

The proof is in the Mathematical Appendix

Theorem 2B: Assume the "real world model" with a given preference system $\{x, q, \dot{q}\}$. We then assume further: 1.Preferences are continuous. 2. There exists a long run demand function $x = h\big(p; \rho(x)\big) = H(p)$ 3. Improvement sequences are non-circular. Proposition: Then there exists a continuous quasi-utility function $V(x)$ with the following properties: If and only if $V(x^1) > V(x^0)$ there exists an improving sequence beginning at x^0 and ending in finite time at x^1.

Proof: Note first that the long run demand function is the same as the one for the corresponding class room model, since it only depends on the mapping $\rho(x)$. Then, by the Correspondence Lemma, the quasi-utility function $V(x)$ derived for the class room model from Theorem 2A is also an indicator function for the sets $A(x^0)$. QED.

Corollary: In the "real world" model, if there exists a long run demand function $x = h\big(p; \rho(x)\big) = H(p)$ and if all improvement sequences are non-circular then preferences are adaptive. Proof: Due to the Correspondence Lemma, we can apply the corresponding Corollary of the class room model. QED.

For the "real world model" we have inverted the sequence in which we prove Theorems 1 and 2. In the class room model we first have obtained sufficient conditions for Theorem 1: adaptive preferences imply non-circularity of improving sequences. Then, together with the assumption that there exists a long run demand function $x = H(p)$ and the assumption that improving sequences are non-circular we obtain the "exogenous" quasi utility function $V(x)$ as an indicator function for the existence of improvement sequences. This is Theorem 2, which has the corollary that preferences are adaptive. We then use Theorem 2 for the class room model to derive the corresponding Theorem 2 for the "real

world model". The next task is to derive a Theorem 1 for the "real world model".

P Theorem 1 for the "Real World Model" : From Adaptive Preferences to Non-Circularity of Improving Sequences

For the "real world model" I have so far not succeeded to show that sufficient conditions for non-circularity of improving sequences are the same as in the class room model. The Correspondence Lemma only tells us that if all improving sequences are non-circular then the quasi- utility function $V(x)$ serves the same indicator function for improving sequences in the real world model and in the class room model. But with the additional assumption of "smoothly adaptive preferences" we can show that sufficient conditions for non-circularity of improving sequences in the class room model also imply non-circularity of improving sequences in the "real world model". And the assumption of smoothly adaptive preferences is highly plausible. Indeed, as will be seen, it covers an important special case of the "law of motion" of preferences.

I first define "smoothly adaptive preferences" for a cardinal utility function. Then I show that we can define a utility function which looks like a cardinal utility function but which has a completely ordinal meaning.

Definition: In the "real world model", for a given preference system $\{x; q; \dot{q}\}$ assume that there exists an indicator function $V(x)$ for the corresponding class room model for the existence of improving sequences. Thus, in the corresponding class room model improving sequences are non-circular. Assume the existence of a cardinal utility function $U(x; q)$ with the following properties: $1. U(x; q) \leq V(x)$ for all q; 2. $U\big(x; \rho(x)\big) = V(x)$; 3. $\frac{\partial U}{\partial q}\dot{q} = \frac{\partial U}{\partial q} f(x; q) \geq 0.$ Then we say that preferences are smoothly adaptive.

I explain the economic meaning of smoothly adaptive preferences: As before in section K consider U to be some kind of "happiness" index. Then, for a given basket x, the person´s well- being is highest with preferences which are induced by x, i.e. with preferences $\rho(x)$. This then leads to equation 2. and inequality 1. in the definition of smoothly adaptive preferences. Condition 3. then only adds that, what prevails globally (for constant x preferences converge to those which maximise utility), also prevails locally: the time derivative of utility for constant x is non-negative.

We then can show

Theorem 1D: For a "real world model" preference system $\{x; q; \dot{q}\}$ assume that in the corresponding class room model improvement sequences are non-circular and that there exists an indicator function $V(x)$ for improving sequences of the class room model. Assume for the "real world" model that preferences are smoothly adaptive. Then improving sequences are non-circular in the "real world" model.

Proof: By the definition of an improving sequence we have $\frac{\partial U}{\partial x}\dot{x} \geq 0$ wherever $x(t)$ is differentiable. Where there is a jump point utility jumps upward. Because of smoothly adaptive preferences we thus have $\dot{U} = \frac{\partial U}{\partial x}\dot{x} + \frac{\partial U}{\partial q}\dot{q} \geq 0$ wherever there is differentiability and thus U is a non-decreasing function of time. Moreover, at time T utility makes an upward jump, because we look at an improving sequence. Thus $U\big(x(T); q(T)\big) > U(x(0); \rho\big(x(0)\big) = V(x(0))$. On the other hand $V(x(T)) \geq U(x(T); q(T))$ and thus $V\big(x(T)\big) > V(x(0))$ which implies $x(T) \neq x(0)$ and so proves non-circularity. QED

Theorem 1D is of particular interest, because we can transform purely ordinal preferences into an "as if cardinal" expression and thereby apply Theorem 1D to them. Smoothly adaptive preferences then also are basically an outcome of a regularity assumption quite similar to the extended regularity assumption in the class room model.

To show this we introduce the following ordinal utility function. Assume we have from the class room model an indicator function $V(x)$. For any x and q consider the indifference hyper-surface $I(x; q)$ of baskets z which are indifferent to x, given preferences q. Thus, in a formula, $I(x; q) = \{z: z(=; q)x\}$. We then define $U(x; q) = \min_{z \in I(x;q)}\{V(z)\}$. In words: the "utility" of x, given preferences q, is the smallest value of $V(z)$ reachable within the indifference hyper-surface containing x. We assume that such minimum always exists. First we have to show that this is a utility function which represents the preferences for any given q. Let $(>; q)x$. Then we know that $I(y; q)$ lies above$I(x; q)$. Therefore we also have $U(y; q) = \min_{z \in I(y;q)}\{V(z)\} > \min_{z \in I(x;q)}\{V(z)\} = U(x; q)$. This proves that $U(x; q)$ is a utility function representing preferences q.

Obviously, since $x \in I(x;q)$ we know that $U(x;q) \leq V(x)$. On the other hand, due to Theorem 2B and its Corollary we know that for $z \in I(x;\rho(x))$ we have $V(z) \geq V(x)$, and therefore $U\big(x;\rho(x)\big) = V(x)$. Thus, for given x, "utility" is maximised across preferences q at the point $\rho(x)$. So the conditions 1. and 2. of smooth adaptiveness are fulfilled. Condition 3 reads $\frac{\partial U}{\partial q} f(x;q) \geq 0$. In the Mathematical Appendix we show the following: If $f(x;q) = \alpha(\rho(x) - q)$ is a linear mapping within the subspace (in preference space) of preferences that are induced by some basket z then condition 3 follows from the extended regularity assumption which we use in Theorem 1B to show non-circularity of improvement sequences.

We then see that smoothly adaptive preferences are the equivalent in the real world model of the regularity conditions which we use to show that adaptive preferences imply non-circularity of improving sequences in the class room model. We only have to impose a linearity condition on the time derivative of preferences, i. e. on the "law of motion" of preferences in the real world model, i.e. in the continuous time model. In this sense then the theory is free from any proper cardinal utility assumption. It is a theory of purely ordinal preferences. This is important to keep in mind – due to the close logical connexion between revealed preference theory and the theory of freedom.

On the other hand, "cardinal" utility is a nice heuristic to intuitively understand why the theorems work. We have seen this for the class room model in section K above. And we see it in the quite simple and intuitive proof of Theorem 1D above.

Q A Simple Example With Two Goods

Assume the ordinal utility function of a person to be

$U = \frac{1}{1-\gamma} g {x_1}^{1-\gamma} + \frac{1}{1-\gamma}(1-g){x_2}^{1-\gamma}$. Here x_1 and x_2 are the two quantities of the two goods consumed, $0 < g < 1$ is a weight parameter of the two goods, and $\gamma > 1$ is a substitution parameter of the two goods. $1/\gamma$ is the elasticity of substitution. The latter then is smaller than unity. Given the prices of the two goods the ratio $z = \frac{x_1}{x_2}$ in which the goods are consumed can be computed to be

$z = \frac{g}{1-g} p^{-\frac{1}{\gamma}}$ with $p = \frac{p_1}{p_2}$ the price ratio of the two goods. Now I introduce the influence of past consumption on present tastes. In this simple model I can assume that the weight factor $\frac{g}{1-g}$ is influenced by an exponentially weighted average w of the past values of z. We may write $\frac{g}{1-g} = bw^{\mu}$, where $b > 0$ is a constant weight parameter of the two goods and μ is a parameter, which indicates the strength of the influence of past consumption on present tastes. We assume $0 \leq \mu < 1$. The case $\mu = 0$ is the case of fixed preferences. The assumption $\mu < 1$ is related to the property of adaptiveness of tastes. So the demand function now reads $z = bw^{\mu} p^{-\frac{1}{\gamma}}$.

The preference characteristic w is modeled as an exponentially weighted average of former levels of z. We then get the linear differential equation $\dot{w} = \alpha(z - w)$. Here the real number $\alpha > 0$ is a speed parameter for the adaptation of tastes to any given consumption basket proportion z. The solution of the differential equation then is

$$w(t) = e^{-\alpha t}(w(0) + \alpha \int_0^t e^{\alpha \tau} z(\tau) d\tau)$$

There is a long run demand function, if prices remain constant. We can compute it by solving the differential equation keeping p constant and by looking at the limit as time goes to infinity, or by observing that constant prices in the long run will lead to a situation of constant quantities, hence a constant level of z, which again implies that the weighted average of past consumption converges to the actual level of consumption. Thus a stationary level of z and w will be characterised by $w = z$. Using this equation for the computation of the long run value of z by means of the demand function yields the equation

$$z = bw^{\mu}p^{-\frac{1}{\gamma}} = bz^{\mu}p^{-\frac{1}{\gamma}} \text{ from which follows } z = (b^{\frac{1}{1-\mu}})(p^{-\frac{1}{\gamma(1-\mu)}})$$

The long run demand function thus is of a similar kind as the short run demand function; but the elasticity of substitution $\frac{1}{\gamma(1-\mu)}$ is higher than in the short run case. Thus, for example, if the short run elasticity of substitution is one half (corresponding to $\gamma = 2$) and the influence parameter μ of past consumption is also one half, then the long run elasticity of substitution is equal to 1, which corresponds to a logarithmic utility function. As is known from traditional utility theory the long run demand function of this specific form has the property that there exists a utility function which would generate the long run demand function. For $\gamma(1-\mu) \neq 1$ it can be written as

$$V(x) = \frac{1}{1-\gamma(1-\mu)}\left[\beta {x_1}^{1-\gamma(1-\mu)} + (1-\beta){x_2}^{1-\gamma(1-\mu)}\right]$$

where $\beta = \frac{b^{\frac{1}{1-\mu}}}{1+b^{\frac{1}{1-\mu}}}$

For $\gamma(1-\mu) = 1$ it can be written as $V(x) = {x_1}^{\beta}{x_1}^{1-\beta}$

It can be shown that there exists an improving path from x to y if $V(y) > V(x)$.

The preference system of this simple example can be described in terms of the parameters. The utility function $U = \frac{1}{1-\gamma} g {x_1}^{1-\gamma} + \frac{1}{1-\gamma}(1-g){x_2}^{1-\gamma}$ has the two parameters γ and g. Thus, in this case, the dimension N of the preference space is equal to 2. This presupposes that we already have specified the functional form of the ordinal utility function as being one of the constant elasticity of substitution type. The two parameters then specify the value of the elasticity of substitution $(1/\gamma)$ and the weights of the two goods (g and $1-g$). Note that for the restrictions $\gamma > 1$ and $0 < g < 1$ the utility function is continuous in the parameters γ and g. This continuity corresponds to our Assumption I in the general case.

The function $q = \rho(x)$ of induced preferences from commodity space to preference space in this case can be computed from the convergence point of the preference parameters if we keep the consumption basket x constant through time. First, we note that the elasticity of substitution for given preferences

remains the same at $1/\gamma$. But the weights of the two goods are influenced by past consumption. From the equation $\frac{g}{1-g} = bw^{\mu}$ indicating the influence of past consumption and the convergence condition $w = z$ we then obtain $\frac{g}{1-g} = bz^{\mu}$ or $= \frac{bz^{\mu}}{1+bz^{\mu}}$. For $q = (\gamma, g)$ the mapping $q = \rho(x)$ is specified by γ, i.e. a constant; and $g = \frac{b(\frac{x_1}{x_2})^{\mu}}{1+b(\frac{x_1}{x_2})^{\mu}}$. Thus, although there are only two preference parameters for the characterization of the preferences themselves there are two additional truly exogenous parameters b and μ which characterise the "induced preference mapping" $\rho(x)$. Then there is the speed parameterα. Altogether we have four truly exogenous parameters of the preference system: γ, b, μ and α. One exogenous parameter enters the utility function U directly. Two parameters determine the "induced preference mapping" to fix the induced weights of the two goods in the utility function. And there is a speed parameter, which determines the convergence speed.

We also can show that this example exhibits smoothly adaptive preferences.

R Inter-Temporal Complementarity

In this section I mainly use verbal argument rather than mathematical tools. The aim is to enable the reader to get a better understanding of the meaning of the theory. The concept of adaptive preferences is an inter-temporal concept. We define "induced preferences" in terms of a convergence in time of preferences towards a certain point in "preference space". This convergence process takes time – and thus the very concept of adaptive preferences which builds on "induced preferences" involves preference changes through time. In the class room model this convergence process is very fast: it takes just one unit period to be completed. The class room model thus predicts the following: assume adaptive preferences. Then, for a given the budget constraint today, demand for good i is higher today, if it was higher in the last period. We have discussed this result in section J. We may write this in a formula. In the class room model with the budget constraint $py = 1$ let $y = f(p; x)$ be the demand basket of today as a function of today´s price vector and of the basket x consumed in the preceding period. Demand then is determined by preferences $\rho(x)$ because we are in the class room model. If the demand function is differentiable we obtain $\frac{\partial y_i}{\partial x_i} \geq 0$.

In traditional economics we know many reasons for inter-temporal complementarity of consumption. If we want to understand the connection between inter-temporal complementarity and adaptiveness of preferences we have to discuss well known processes which are elicited by economics to explain observed inter-temporal complementarity. We then find out to which extent they are consistent with the hypothesis of adaptive preferences.

There are processes which to a certain degree result in the opposite of inter-temporal complementarity. They also will be discussed. The first one is an example

1. The appetite-saturation cycle. Before we eat a meal we are hungry, after the meal we are saturated, as food is concerned. Then gradually we get hungry again. This cycle, which we share with almost all animals, comes about because our body uses energy continually, but opportunities for the intake of energy by nourishment are not available continually. For survival the body just needs storage possibilities of energy. Our tastes then are geared to this fact. The hunger instinct signals the need for replenishment of the energy stock in our body and lets us intensify our search for food and our urge to eat.

   We thus observe an inter-temporal substitutability in terms of food intake. A higher level of food consumption a short while ago induces lower demand for food now. But economists know that this observation does not contradict the traditional assumption of fixed preferences. We simply have to take the average of food consumption over a period, like a day, which is long enough to include a full cycle of appetite and saturation. Between two neighbouring periods of such length the demand for food is no longer a close substitute.

   Apart from purely physiological appetite-saturation cycles there are such food related cycles due to “taste” rather than simply hunger. A person who has one meal a day with meat or fish may want to alternate between the two. Thus, after he/she has consumed meat for a few days in a row, he/she will have a preference for fish today and vice versa. People have a preference for variety and thereby exhibit a certain degree of inter-temporal substitutability of any given kind of food: for given prices today a lower price of meat yesterday may induce a lower demand for meat

today. Or to put it this way: meat yesterday and fish today are complements, whereas meat yesterday and meat today are substitutes.

But, as we know, a preference for variety is not a contradiction to the hypothesis of fixed preferences. One way to see this is to take consumption in unit periods which are sufficiently extended to encompass demand cycles due to this preference for variety.

If the taste for variety is not a contradiction to the assumption of fixed preferences it also cannot be seen as a contradiction to the hypothesis of adaptive preferences. For, as discussed above in section F, fixed preferences are a special case of adaptive preferences.

Concerning food, adaptive preferences then show up in the phenomenon that for unit periods long enough to accommodate the preference for variety we see an inter-temporal complementarity of demand for any given kind of food. People in Argentina get used to a food mix with a substantial share of meat. Vegetarians do not eat meat at all. Children don´t like to drink alcoholic beverages – and adults who never have consumed alcohol tend to dislike the taste of an alcoholic beverage. But a person who – for whatever reason – did drink alcohol as an adolescent tends to like alcoholic beverages as an adult: habit formation. It did take the Prussian kings quite some effort to induce or force their subjects to consume potatoes. But, once this was achieved, Prussian subjects, given their choice, preferred potatoes over other forms of caloric intake.

The appetite-saturation cycles applies to many other goods beyond food. There is a universal taste for variety. Alfred Marshall already understood it very well that this was not in contradiction to what I call adaptive preferences. Concerning the “law of diminishing marginal utility” he writes in his Principles of Economics: “The marginal utility of a thing to anyone diminishes with every increase in the amount of it he already has. – There is however an implicit condition in this law which should be made clear. It is that we do not suppose time to be allowed for any alteration in the character or tastes of the man himself. It is therefore no exception to the law that the more good music a man hears, the stronger is his taste for it likely to become; that avarice and ambition are often insatiable; or the that the virtue of cleanliness and the vice of drunkenness

alike grow on what they feed upon. For in such cases our observations range over some period of time; and the man is not the same at the beginning as at the end of it. If we take a man as he is, without allowing time for any change in his character, the marginal utility of thing to him diminishes steadily with every increase in the supply of it." Marshall (1920).

As we can see, Marshall was interested in the law of diminishing marginal utility and wanted to show that, what I call adaptive preferences, do not interfere with this law. I am interested in the hypothesis of adaptive preferences and thus I show that the taste for variety (which corresponds in ordinal terms to the - cardinal - law of diminishing marginal utility) does not contradict the hypothesis of adaptive preferences.

2. Random or periodic changes in consumption constraints. When it rains our consumption basket is different from the one we consume when there is sunshine. Our consumption basket in winter is different from the one we demand in summer. This is, of course, no contradiction to the hypothesis of fixed preferences. What changes through time is the set of baskets we can consume. For the case of fixed preferences all this is well understood. Given that fixed preferences are a special case of adaptive preferences weather or season dependent consumption baskets are also no contradiction to the general hypothesis of adaptive preferences.

   Moreover, it is interesting to observe the following: Assume there are two states of the world: rain (R) and sunshine (S). We argue in the "class room model". We keep the price vector the same across the two states of nature R and S. We designate by y the budget available in state R. We designate by z the budget available in state S. For simplicity of presentation we call $[R; y]$ and $[S; z]$ a "basket", thereby ignoring the fact that with a given state R (or S) and a given budget y (or z) it takes time that the actual commodity basket converges to some basket corresponding to the preferences induced by that basket. For simplicity of presentation I further assume that for this given price vector preferences induced by $[y; R]$ are the same for different levels of y and, similarly, preferences induced by $[z; S]$ are the same for different levels of z. Thus, for induced preferences we can write $\rho(R)$ and (S) . But keep in mind that induced preferences

may depend on the price vector, which we keep constant for our little example.

Assume now that the two states of nature occur at random. Assume that in period Zero the state R prevails and the person has a consumption budget of y_0. We want to construct an improving path. Thus, if in period 1 R prevails the available budget must satisfy the inequality $y_1 > y_0$. If in period 1 S prevails income must be above $\hat{z}(y_0)$ where the function $\hat{z}(y)$ is defined by$[\hat{z}; S](=; \rho(R))[y; R]$. Thus $z_1 > \hat{z}(y_0)$. Symmetrically let $\hat{y}(z)$ be defined by $[\hat{y}; R](=; \rho(S))[z; S]$. Assume now that the state of period 2 is again R. For an improving path we then have the condition $y_2 > \hat{y}(z_1) > \hat{y}(\hat{z}(y_0))$.

Assume now that we have adaptive preferences. This implies that $[\hat{z}(y_0); S](\geq; \rho(S))[y_0; R]$. Since, on the other hand $[y_2; R](>; \rho(S))[\hat{z}(y_0); S]$ we see that $y_2 > y_0$. Let $y^*(y_0)$ be the infimum value for a budget in period 2 such that it is compatible with an improving sequence, provided that the state of nature is R in periods 0,1 and 2. Obviously we have $y^*(y_0) = y_0$. Let $y^{**}(y_0)$ be the infimum value for a budget in period 2 such that it is compatible with an improving sequence, provided the states of nature are R in period 0, S in period 1, and R in period 2. Then, due to the inequality $y_2 > y_0$ derived above for this sequence of states we can infer $y^{**}(y_0) \geq y_0$ and thus $y^{**}(y_0) \geq y^*(y_0)$. The symmetric result can be derived, if we start with state of nature S.

The important point is that changing states of nature do not violate the proposition of Theorem 1B which says that adaptive preferences imply the non-circularity of improving sequences. On the contrary, if distinct states of nature really matter for the baskets which are being bought, and if in addition preferences are not fixed but adaptive in the narrower sense of the word which excludes fixed preferences then continuity and non-satiation and regularity assumptions imply that improving sequences are even "more non-circular" than in the case that states of nature remain the same or are irrelevant for the basket bought with a given budget. In our example, in that case we have$y^{**}(y_0) > y^*(y_0)$.

3. Inter-temporal allocation of consumption, i.e. saving and dissaving. The standard model of saving and dissaving assumes the existence of a life

utility function which is a weighted sum of period utilities. The problem then to be solved by the consumer is to maximize this life utility for a given inter-temporal budget constraint. In an economy in which consumers can rely on the existence of markets for all goods of interest to them they can postpone the decision which particular goods to buy in the future. Then the relevant parameters for an optimal saving decision today are the inter-temporal prices (interest rates) and the income flows which jointly form the inter-temporal budget constraint together with an appropriate price index of the goods available in the future.

In this model there exists no inter-temporal complementarity of demand for any given good. If the world were like this model and thus all consumption goods could be bought - without further transaction costs – at the time they are consumed then the computational effort to maximize the life utility would be insubstantial and thus one could realistically assume that it would be performed.

In real life things are more complicated. For example, many purchases come in the form of consumer durables. Relative to buying the services of the durables every period again transaction costs are substantially lower, if one buys these durables. This then generates an inter-temporal complementarity of demand for the services of the consumer durables. If the person has consumed the services of a vacuum cleaner in the preceding period it is much more likely that she will consume these services again in the present period than if she had not consumed the vacuum cleaner services in the last period.

This is well known in economics and does not contradict the hypothesis of fixed preferences. Here we can exemplify the difference between the traditional approach and our approach encompassing the hypothesis of adaptive preferences. Gary Becker, one of the authors of the Stigler-Becker paper quoted above in section B, has pioneered the household production approach, which has been very fruitful for many theoretical and practical topics in economics. In this household production approach one then can try to explain the inter-temporal complementarity of consumption in terms of transaction costs of market transactions. In my approach of adaptive preferences I simply state that consumer behavior is in line with the hypothesis of adaptive preferences, i.e. it exhibits inter-

temporal complementarity of consumption. I do not necessarily investigate the causes of this inter-temporal complementarity.

We may consider this to be a waste of knowledge about consumer behaviour. But in normative individualism, we stick to the proposition that within a certain realm a decision or choice of an agent is legitimate simply due to the fact that it the person´s choice. We look at the person purposefully with "a veil of ignorance", as was discussed above in section C. We do not have to find out why the person makes this choice rather than any other choice within his/her choice set. For specific purposes of economic policy it may be useful to find out some of the causes of any particular behavior. But for a general theory on the basis of normative individualism it may be sufficient to be able to corroborate the hypothesis of adaptive preferences.

Once we have accepted this point of view we then are also able to accept much more easily that – in their inter-temporal allocation decisions – people do not exactly maximize a life utility function which consists of a weighted sum of period utilities. One reason why they do not act in that way is the fact that in real life the corresponding optimization calculus is much too complex. Even with the enormous simplification of life by means of the institution of "money" and by means of the existence of a large array of reliably functioning markets there is a large gap between the real life situation and the above mentioned model of a maximisation of a life utility function. One reason for this is a kind of "self-destroying" tendency of the low transaction cost assumption behind this simple model: the easier it is to transact on goods markets in a money economy the more such goods markets come into being. They allow, as Adam Smith already knew, the social organization of the highly productive division of labour. Transaction costs – in terms of human time expenditure – are characterised by a "rebound effect": the lower the costs of transacting on any given market are the more such markets arise. Thereby, in sum, transaction costs may not decline at all for the persons benefitting from these markets. The complexity of life generated by the wealth producing division of labour then makes it implausible that people could pursue their optimization in such a simple way as the additive period utility model of maximizing a life utility function suggests.

Inter-temporal complementarity of demand for any given good then means that choice in the future is constrained by certain choices taken in the past. To the extent that these choice constraints are not imposed by society on the basis of "compossibility" considerations they may be seen as an expression of the preferences of the citizen. Due to the inter-temporal complementarity we then recognize them as an expression of adaptive preferences. But, apart from the "durables effect" discussed above, this inter-temporal complementarity may be due to simplification strategies of the person: in order not to have to make consumption decisions anew every morning for the day the person decides to arrange his things in such a way that certain earlier consumption decisions are also binding for consumption baskets consumed later.

Thus, apart from hardware durables (or, indeed, software durables in the literal sense of that word – in an age of personal computers) we will also encounter many "decision durables" to reduce the amount of effort needed to make decisions. Thus, the hypothesis of adaptive preferences is supported also by the phenomenon of "decision durables" as a device to simplify one´s life.

…. (location decision, migration, bounded rationality)

4. Information Acquisition as a Byproduct of Consumption.

Real life is characterized by incomplete information about the existence, the availability and the quality of goods and services. For decades the economics of incomplete information has been a thriving field of inquiry. It is obvious that under conditions of incomplete information markets do not show the same efficiency performance as under perfect information and perfect competition. The classic contributions by Stigler, Arrow, Akerlof, Stiglitz, Spence and others are known by every economist.

Economists also have thought about the consequences of the fact that consumers are aware of their imperfect knowledge concerning consumption goods. One particular point, the evolution of trademarks and reputation as an asset has been emphasized by Hayek (1946) long ago. He then emphasized that the build-up of a reputation for good quality was an answer to the problem of incomplete information and that this build-up

was a productive part of the competitive process and thus trademarks and brands should not be seen as an obstacle of competition.

Here I do not go into the details of the welfare analysis of actual and potential markets with incomplete customer information. I am interested in the relation of incomplete information to the hypothesis of adaptive preferences. First I point to the simple fact that one way information about products is gathered is by using them. Of those products which the consumer considers to be satisfactory the likelihood of repeat buys is very high.

Some people will buy a new product introduced by a supplier into the market; others are not among the pioneer customers. If the product is satisfactory to those who have obtained it early on they will be repeat buyers; and this then provides a positive correlation between the distributions of purchases of that product among people yesterday and today. This then is again the phenomenology of adaptive preferences.

Moreover, psychologically, this observed inter-temporal complementarity is supported by an effect which is well established empirically: avoidance of cognitive dissonance. Festinger 1957. Once a person has decided that the product was a good buy he or she will raise his or her liking of the product. The marketing literature agrees on this point – and, of course, it is also being exploited marketing practitioners in real life. Thus, even apart from the statistically observed inter-temporal complementarity, if you ask people about their subjective preference concerning a particular product, they will give answers which are proof of the hypothesis of adaptive preferences, here understood as an expression of preferences in interviews.

As I will discuss in more detail in a separate paper in the framework of inter-personal influences on preferences, the imitation of other people is a particular form of adaptive preferences. Imitation implies a similar positive feedback from actual consumption to preferences as we observe with adaptive preferences defined in this paper. But imitation of others is of course one of the main forces by which new products obtain rising sales. In this case we can speak of information acquisition as a byproduct of other people´s consumption.

We then see a strong support for inter-temporal complementarity of consumption from the information acquisition process going on as a by-product of consumption. This is in line with the hypothesis of adaptive preferences.

Incomplete information also stimulates search activities. Economics has investigated quite a few aspects of search. I only mention the work underlying the 2010 Nobel Prize for Peter Diamond, Dale Mortensen and Christopher Pissarides. Here I am interested in the relation of search activities to the hypothesis of adaptive preferences. Search is not without cost. And search costs limit the search activities. People may want to avoid search costs by putting a (subjective) premium on those goods they know by having consumed them. This then is exactly in line with the hypothesis of adaptive preferences.

5. Education and Schooling. Education and schooling are social activities organized by the grown-ups for their children. Children thereby acquire useful skills – one hopes – and, of course, thereby become –one hopes – better informed citizens than they otherwise would be. But parents also want to influence children´s attitudes and preferences. Without going into details here I simply state that the belief of most parents in the fruitfulness of education rests on an implicit assumption that adaptive preferences prevail among their children. Children imitate their parents. It is therefore generally accepted that parents´ own attitudes and behaviour are important for the success of education. But imitation is part of the hypothesis of adaptive preferences. Moreover, parents generally try to induce their child to perform activities of which they believe that they will make the child´s adult life a "better life", if they continue performing those activities. By inducing (forcing?) them to play the piano as children they expect thereby to influence children's tastes so they will like to play the piano when grown up. Obviously, this expectation rests on the implicit assumption of adaptive preferences. If preferences were "anti-adaptive" education, as our civilization knows it, would be inconceivable. If parents had to expect that inducing children to acquire the skill of playing the piano would induce them to dislike the piano when grown up, how could they expect to succeed in their wish that the children will play and like to play the piano when grown up? Those people who, as children did acquire

the skill, don´t like to use it. Those people who, as children, did not acquire the skill, would like to use it.

More generally: The human species, as a species whose individuals live and even survive on acquired skills, it would not exist with anti-adaptive preferences. The success of education and of training skills builds on adaptive preferences.

S Understanding the Framework for Freedom

As I already discussed in section D, a free society needs constraints of individual behaviour so as to make rights of individuals compatible, or, as Steiner called it, "compossible". There are, however, at least two different forms of "compossibility". One form we may call "strict compossibility"; the other form we may call "pragmatic compossibility". The idea is that within the realm of the individual rights the agent is free to act as he/she pleases.

Strict compossibility, as I define it, means that the architecture of individual rights is such that, in whichever way each agent makes use of his/her freedom, these actions do not interfere negatively with the freedom of the other citizens.

Pragmatic compossibility is a weaker form of compossibility. Its definition is somewhat more complicated. But, as I shall argue, it is the form of compossibility which reasonably can be asked for. Here, even before defining it precisely, I want to point out the following: since pragmatic compossibility is a much weaker requirement than is strict compossibility the rights which can be granted to the different citizens under pragmatic compossibility can be much broader than the rights which can be granted under strict compossibility. Indeed, under strict compossibility people would only have very few rights.

Take the use of cars with a given road infrastructure. If people who have a car can use it as they like very few people indeed could own the right to drive a car. This would be the case of strict compossibility. If the use of the roads for car drivers is subject to certain rules like obeying the commands of traffic lights, speed limits, prohibition to drive a car after having consumed alcohol etc. many more people can use a car. But even then there are certain negative externalities which one car driver imposes on other car drivers. If too many people drive at the same time there will be traffic jams. There may be accidents, even fatal accidents affecting people who have obeyed all traffic rules etc. The actual

driving rules, as experience shows, make it possible to grant driver licenses to a large number of people, thereby enhancing rights to act legitimately within one´s constraints defined by these rights. We then consider the actual rules of the road to be an example of “pragmatic compossibility”. And it is an example for the proposition that pragmatic compossibility generates much greater freedom of action for citizens than does strict compossibility. But it does so by accepting the fact that there *are* negative externalities suffered by any one driver from the other drivers.

Traditionally economics has made the distinction between physical and pecuniary externalities. The latter were considered immaterial concerning the goal of an efficient allocation of resources. The former were considered to be detrimental for an efficient allocation of resources. The theory was “pre-Coasian”. Markets in that model operated competitively and did not generate any transaction costs. Following Coase and taking account of transaction costs implies that we no longer can consider the existence of physical externalities to be necessarily an indicator of inefficiency. For many questions it is then also no longer necessary or adequate to draw this sharp distinction between physical and pecuniary externalities.

Before defining pragmatic compossibility I refer to the well-known paradigm of the Walras-Arrow-Debreu General Equilibrium and its property of pareto-optimality. We note that “rights” allocated to the agents in this model do not satisfy “strict compossibility”. Each agent has the “right” to buy and sell as many goods as he/she wants, provided the budget constraint is satisfied. But of those different budget-wise feasible consumption baskets of any given agent only a small subset - generally only one basket of those exhausting the budget – is “compossible” with the consumption baskets of the fellow- citizens. The general compossibility of the actions of the agents in the Walras-Arrow-Debreu world is only provided for those actions of the agents which they actually choose, given their constraints and given their preferences. Thus, already in the basic paradigm of traditional welfare economics the strict compossibility criterion is rejected.

To come to the definition of pragmatic compossibility I further observe the following property of the Walras-Arrow-Debreu general equilibrium and its associated allocation. An easy way to show this general property is to assume a pure exchange economy. For any given preferences the corresponding Walras general equilibrium is pareto-optimal. Assume now a set of preferences, called

"preferences 1". The corresponding Walras equilibrium may be called "equilibrium 1". Assume further for citizen A alternative preferences different from those he has in the "preferences 1" case. We then define a set of "preferences 2": here citizen A has those alternative preferences and all the other citizens have the same preferences as in "preferences 1". We then have a different Walras equilibrium, called "equilibrium 2". We compare the (ordinal) utilities in the two equilibria, i.e. we compare the "real incomes" of the citizens. Let p^1 be the price vector prevailing in equilibrium 1. Let p^2 be the price vector prevailing in equilibrium 2. Since in a Walras equilibrium equilibrium prices are only defined as relative prices we always can set the two equilibrium price vectors such the equation $p^1x = p^2x$ is fulfilled, where x is the total consumption vector of the economy, which is the same in the two equilibria.

In terms of price vector p^2 let Δy_i be the change in real income of citizen i as the economy moves from equilibrium 1 to equilibrium 2. By this we mean the negative of the change in income citizen i would require to keep his utility constant. Let z^i be the initial endowment basket of citizen i. It is then clear that $\Delta y_i \geq (p^2 - p^1)z^i$. For, if Δy_i were equal to $(p^2 - p^1)z^i$ then, if citizen i would receive $-\Delta y_i$ as compensation for the change in prices then he/she could buy the old consumption basket he/she consumed in equilibrium 1. The inequality $\Delta y_i \geq (p^2 - p^1)z^i$ also applies to citizen A, if we apply his new preferences. Let $\Delta y = \sum_{i=1}^{m} \Delta y_i$ be the sum of real income changes for all citizens. We then obtain the inequality $\Delta y \geq \sum_{i=1}^{m}(p^2 - p^1)z^i = (p^2 - p^1)x$=0. Thus, applying "preferences 2" we see that the changeover from equilibrium 1 to equilibrium 2 raises real income of the economy in terms of prices prevailing in equilibrium 2.

But similarly we show that this result also obtains if we define real income changes in terms of prices prevailing in equilibrium 1. In deriving that result we simply have to replace the initial endowment by the consumption basket consumed in equilibrium 1. Obviously, it is then also possible to show that real income rises from equilibrium 1 to equilibrium 2 in terms of any price vector $p^\lambda = \lambda p^1 + (1 - \lambda)p^2$ which is a mixture of the price vectors of the two equilibria.

We then see that changes in demand of one agent due to his/her change in preferences raise real income in the economy. The potential loss in real income resulting for the other agents is smaller than the gain in real income of the agent whose preferences have changed.

Within the Arrow-Debreu framework of general equilibrium this result can be generalised to the case of production. Indeed this can be easily seen by the fact that we can consider producing firms in this model as additional consumers. We may see production as “negative consumption”. The shareholder of the producing firm who is an agent with an ordinal utility function then is an “extended” consumer with an “enriched” initial endowment where the “enrichment” consists of his proportional part of that firm. In a sense, we turn the idea of “household production” (of the positive economics approach developed by Becker) upside-down by looking at production as if it was (negative) consumption.

But the generalization can also be shown directly by working through the Arrow-Debreu calculus of consumption and production. A special case which is easily understood is the case of a single original factor of production which we may call labour. This then is the “labour theory of value” economy where final consumption goods bear prices in proportion to the direct and indirect labour content of their production. Here a change in tastes by any one consumer does not affect market prices of consumption goods. Only the quantities of the goods will change in accordance with the new preferences. People whose preferences have not changed are not affected by this change in demand. And the change in demand by the others raises their income relative to the equilibrium that prevailed before the change in tastes and demand took place.

For our aim to find a reasonable definition of “pragmatic compossibility” we now can conclude: in the paradigm of Walras equilibrium and pareto-optimality we find that changes in the behaviour of any given agent A within his/her realm of granted “rights” have an impact on other members of society that is more favourable than the negative of the gain for agent A from this change of behaviour. I then use this criterion as the general criterion of “pragmatic compossibility” of rights.

Definition: Rights of the citizens of a society are pragmatically compossible if a change of behaviour of any given citizen within the realm of his/her rights provides at least as great an advantage to this citizen as the negative of the byproduct of this change to his/her fellow citizens. – In other words: assume that rights are pragmatically compossible. Then a change in behaviour of a citizen due to his/her change of preferences generates, summed over all citizens, a net gain to society.

We thus do not require that any change in behaviour of a given person only has positive or at least non-negative effects on all other citizens. Negative effects on others of any change in behaviour remain compatible within a pragmatic regime of free people, but they only are justified within the realm of compossible rights if the benefits of this change of behaviour outweigh the costs.

Common sense tells us that pragmatic compossibility as just defined is more in line with the common meaning of freedom than would be the strict compossibility criterion. Any society, but in particular, a free society is characterized by lots of competitive situations. This holds not only in economic matters in the narrow sense of this word. It is a characteristic of everyday life. If John loves Mary and Robert loves Mary we would consider it Mary´s freedom to decide whether to live with John or with Robert or with neither. If she decides to live with Robert then John suffers a setback as compared to the situation where Mary had not yet made up her mind. This kind of "negative externality" in matters of personal live is unavoidable in a free society.

In economic matters economists and perhaps others consider it a good thing that suppliers compete with each other. Indeed, anti-trust law is here to promote this competition. Typically, and in contradiction to the model of perfect competition, suppliers sell at prices which are above marginal cost. They make substantial efforts to sell their wares (advertising, marketing, hiring a sales force etc.). If customer C has to make up his mind whether to buy from supplier A or from supplier B then we are in a typical situation where the freedom of the customer to decide which supplier to prefer will end up in disappointment by that supplier who was not chosen.

Whenever the freedom of choice of an agent involves the choice between different persons eager to be chosen then any given decision of the agent causes harm to those persons who were not chosen.

The distinction between actions that are within the boundaries of pragmatically compossible rights and actions that are not within these boundaries then is generally provided by the criterion of gain or loss to society at large. Thus, in contrast to economic competition, robbery is not within those boundaries. The gain obtained by the robber is not only compensated by the loss of the person being robbed, but overcompensated by the incremental costs of preventing being robbed, if robbery were legal.

It is obvious to the economist that this principle of pragmatic compossibility has a certain vicinity to the well-known efficiency criterion by Kaldor-Hicks-Scitovsky. They apply this criterion to government legislation or executive action. Here I apply the criterion of net gain in terms of real national income to derive a definition of pragmatic compossibility. As will be seen later this confluence of criteria helps us to develop a foundation of welfare economics within the framework of a market economy.

The important point concerning this concept of pragmatic compossibility is that society does not own a calculating machine which allows it to compute gains and losses of any kind of actions and thereby allows it to define rights which are compossible. The reason I call this compossibility criterion “pragmatic” is that it is only by experience, as society evolves, that law-makers obtain some reasonable judgment about the kind of arrangements that are compossible according to this criterion of net social gain from any change in a person´s behaviour.

It is this “pragmatic” point of evolving experience that leads me back to the main topic of adaptive preferences.

But before we get there I want to emphasize that a free society is characterized by many unalienable rights, be they in the form of legally adopted human rights, be they in the form of constitutionally protected rights like the USA “Bill of Rights” of the first ten Amendments, like the “Basic Rights” of the German Constitution. These rights mainly are meant as a protection of citizens against encroachments of their liberty by government. As such they are important constituents of a free society. Yet they may be seen as a limitation of the principle of pragmatic compossibility as defined here: a particular government action or law may violate one of these basic liberties and yet further total real income in this State. Such conflict between these basic rights and the principle of pragmatic compossibility can be interpreted differently.

Either we say: pragmatic compossibility is one limit of rights of individuals, but there are others like the basic constitutional rights, which further limit the interference of one person´s right to interfere with the affairs of other persons. Or we say: given the complexity of social life and the inability to reach unanimity about the probable effects of any action by government, basic rights are a safeguard against erroneous majority beliefs about the benefits and costs of any change in law instituted by government. Thus, these basic constitutional individual rights can be seen as being consistent with the principle of pragmatic

compossibility – considering the obvious difficulty of reaching consensus about the effects of any new legislation. Both interpretations have the effect that my theory definitely is not a plea to abolish constitutionally protected individual rights against encroachments of the government.

We may also consider constitutionally protected individual rights as a feature of a society which follows Karl Popper´s incrementalism, which he calls "piece-meal engineering". We do not have a consensus about a total picture of an ideal society. According to Popper, belief in such consensus would be "totalitarian" and thus would be the opposite of an "open society" or a free society. The way a free society runs its common affairs is by incremental steps away from the status quo, by piecemeal engineering. Such steps may turn out to be in error and may turn out to be opposite of improvement. Then society must have the opportunity to reverse such incremental steps. Open society is a society guided by the principle of reversibility. But then constitutionally protected individual rights are a safeguard against steps which in a profound sense violate the principle of reversibility.

Although "justice" is not a topic of this paper I want to add the following thought concerning the principle of pragmatic compossibility. Distributional justice has been introduced into formal theory, among others, by Atkinson. The Atkinson welfare function incorporates "society´s" (whatever that may mean) idea of the trade-off between average wealth and a more equal distribution of wealth. It looks like this $W = \sum_{i=1}^{m} U(y_i)$ where y_i is real income of person i and the function U reflects the trade-off between a higher average real income and its more equal distribution. A linear function U would correspond to society´s goal of maximizing average real income irrespective of its distribution. A concave function U would represent society´s concern about distribution. The stronger the "degree of concavity" the more important are distributional considerations relative to the absolute level of real income. There is, it appears, nothing which prevents us from defining the principle of pragmatic compossibility in terms of $U(y_i)$ rather than y_i as I have suggested above. (In a different paper I want to show why – again for pragmatic reasons – we still need the conventional criterion of Kaldor-Hicks-Scitovsky-efficiency improvement, even if we basically agree to pursue a policy according to the Atkinson Welfare function).

T Adaptive Preferences as a Precondition of Freedom in Society

Ours is not a world of Walras general equilibrium. It is quite complex and obviously difficult to analyse. We do not have a general equilibrium model of the world. We cannot in every detail predict what the results of certain private and public actions are. We cannot predict with certainty what the impact of some proposed legislation is.

But we do observe regularities in the social process. We do observe that the behaviour of people is characterised by a certain degree of constancy. In deciding politically what kind of laws to pass, what kind of public administration to organize we rely on our ability to extrapolate more or less stable patterns of behaviour which we have observed in the past.

As things change and as experience with the prevailing law becomes richer society or its politically elected majority will have a tendency to change the law so as to improve things. One of the drives to change the law is the hope that it is possible to enhance the "rights" of people without violating the principle of compossibility. In this permanent attempt to improve the rights of people one is guided by the observed behaviour of the citizens under the already prevailing law. Thus, it is factually observed behaviour of people which guides the evaluation of proposed legislation. Behaviour which would have been legitimate under present or past law but which was never or only rarely observed is unimportant for the evaluation of proposed new law.

Economists see the link between observed behaviour and preferences. It is the principle of revealed preference. So not only is observed behaviour important for the prediction of the effects of new legislation. Important is also the presumption that observed behaviour was preferred by citizens over other alternative behaviour which also would have been legitimate under prevailing law. Thus one can also use observed behaviour for answering the question: what is it that people want from the legislator?

I do not go into the details of the question: what do we really mean when we say we learn from observation and experience as regards human behaviour. Only a short remark: Extrapolating any observed behaviour into the future implicitly or explicitly requires the description of behaviour in terms of concepts and a language which allows to say which behaviour was "the same" as the one that was observed earlier under different circumstances. Thus, abstraction, "theory" are always involved in the extrapolation of observation. In an age of thriving

research in the different behavioural sciences it is definitely the case that expertise in these fields has a strong influence on legislation.

Also there are obviously differences of opinion about what the experience of the past tells us. Political controversy about the effects of actual and proposed laws is the normal picture of public life. Basic rights like freedom of speech serve the function for the public to get a "full picture" of facts and opinions on any proposed legislation. Other general principles and basic rights like equality before the law or procedural fairness in conducting any suits and procedures before judicial courts and administrative bodies also belong to any institutional set-up of a free society. All this has of course been extensively discussed in the literature.

The special point I want to make is the one about adaptive preferences. If the principle of pragmatic compossibility is the guideline for legislation in a free society and if it is experience of the past which guides predictions about the effect of any legislation then one implicitly assumes that preferences are adaptive. Indeed, if preferences of people were anti-adaptive then it would be very difficult to extrapolate their behaviour. In the passing of time preferences then would turn against whatever the agent had preferred to do in the past. Behaviour then would change all the time – and thus could not be well predicted. Also past preferences then would not be a good indicator of future preferences.

Like in the case of schooling and education the principle of pragmatic compossibility would not work and social life as well as legislation would be very difficult indeed. The historical fact that free, democratic societies have prospered and have shown superior performance over other kinds of societies is proof for me that preferences of people are adaptive and that thus their behaviour is reasonably well predictable.

Theorems 1 and 2, which we discussed in detail above, are an additional support for the hypothesis that pragmatic compossibility only can work if preferences are adaptive. Without adaptive preferences, Theorem 2 tells us, we might encounter improving sequences which are circular. We could not rely on our basic democratic belief that progress can be expected through time. Without such belief democratic politics would become quite difficult. On the other hand Theorem 1 tells us that the prevailing mode of incrementalism is on the right track. Small, consecutive improvements in science, the economy and legislation add up to improving sequences which are true improvements and not spurious.

All these implicit assumptions of our democratic system then can be seen as part and parcel of a world characterised by the prevalence of adaptive preferences.