1. Introduction

1.1 BACKGROUND

For several decades, a considerable amount of research has been devoted to issues surrounding the use and design of the national accounts. One of the basic ideas behind this research has been to provide a coherent framework for measuring national well-being. This idea is closely related to the concept of social accounting. According to The New Palgrave Dictionary of Economics, ‘social accounting’ refers to ‘the body of data that portrays a nation’s economic activity in terms of output produced and incomes created, the stocks of capital goods and other inputs required, and the financial pathways and instruments used’. In accordance with this definition, as well as with a broader perspective that includes many nations in a global economy, a welfare economic theory of social accounting has been developed. This book addresses the theory of social accounting, with particular emphasis on valuation problems facing imperfectly competitive market economies.

One of the basic issues in the theory of social accounting is the idea of associating a comprehensive measure of net national product (NNP) with the welfare of a dynamic economy. It is easy to argue that this idea has practical appeal. If it were possible to measure welfare solely by means of a static and (in principle) observable indicator, welfare comparisons would become manageable in practice. Meanwhile, it is quite clear that the conventional NNP does not constitute such an indicator. The only type of consumption included in the conventional NNP refers to goods and services, whereas the concept of net investment is limited to physical capital. A comprehensive concept of consumption should reflect consumer preferences, and not be restricted to conventional goods and services; it would also be likely to include other ‘utilities’ such as leisure and environmental quality. Similarly, a comprehensive measure of net investments should include all capital formation undertaken by society and not merely changes in the stock of physical capital. Other stocks of importance for production and/or utility are natural resource stocks, stocks which represent or have an impact on environmental quality and the stock of human capital. The net changes in these stocks, measured over a period of time, should also qualify as capital formation, since they are an integrated part of the ‘investment policy’ undertaken by society. Such extensions of NNP, which are motivated by the objective of measuring welfare, are commonly referred to as...
Welfare measurement in imperfect markets

‘national product related welfare measures’, ‘comprehensive NNP’ or ‘green NNP’. In what follows, we use these concepts synonymously.

The preliminaries give rise to an important question: is there a rigorous welfare economic foundation for welfare measures based on a comprehensive concept of NNP, or does it simply serve as an approximation to more complicated exact welfare measures? Indeed, one of the most important contributions to the theory of social accounting involves providing an exact welfare measure based on an extension of the conventional NNP. However, there are also arguments against the idea of trying to measure welfare by comprehensive, or green, NNP. First, additional complications are associated with measuring the welfare contributions of technological change and market imperfections. It is well known that the welfare contribution of technological change is not always recoverable from market data. Similarly, in a ‘distorted’ market economy, prices might not reflect social opportunity costs and, in certain situations, markets might even be missing. Here, the concept of distorted market economies should be interpreted in a broad sense, so as to include both ‘traditional’ market imperfections and distortions associated with policy implementation. Second, measures related to NNP do not in general reveal how consumption possibilities are distributed across individuals, households or generations. The argument is that the information that is relevant for measuring welfare is not captured by an aggregate such as green NNP. Third, many environmental (and possibly other) aspects of economic behavior are not measurable in a complete way on a national basis. An example is transboundary environmental problems, where environmental damage caused by a particular country affects the welfare of individuals in other countries. If all welfare effects of economic behavior are not appropriately measured on a national basis, the resulting national green NNP is likely to be a biased welfare indicator. We return to these arguments below.

Welfare measurement can also refer to the welfare changes associated with policy projects and/or other parametric changes in the economic system. This is closely related to the principles of cost–benefit analysis in dynamic economies. It should be emphasized that although projects may be small or temporary, they are likely to have intertemporal consequences. Therefore, the study of cost–benefit analysis in dynamic economies might generate insights that are not easily gained in static models. Part of this book concerns cost–benefit analysis of environmental policy with particular focus on environmentally motivated taxes.

The above perspective gives rise to several pertinent questions:

1. What are the conditions under which green NNP, as we have come to know it from the literature, constitutes a welfare measure?
2. How does technological change contribute to welfare measures?
3. What does an appropriate welfare measure actually look like in an imperfect market economy with, for example, uninternalized external effects or imperfect competition?

4. Are market imperfections empirically relevant in the context of social accounting, or is it possible to neglect them in empirical applications without too much loss of information?

5. How are welfare measures affected by policy objectives, such as distributional concern, and/or restrictions on the set of available policy instruments due to, for example, the necessity of raising revenues through distortionary taxes?

6. To what extent are global environmental problems important in the context of social accounting?

7. How should cost–benefit rules be derived in dynamic general equilibrium models?

8. How can deterministic results regarding social accounting and cost–benefit analysis be transformed into a stochastic environment?

The purpose of this book is to answer, or at least discuss, these issues.

1.2 IMPORTANT ISSUES AND BASIC RESULTS IN PREVIOUS RESEARCH

Welfare measurement has been a vital area of economics for a long time. References to previous studies will be given throughout the book. Here, we only briefly outline some of the fundamental results. Most of the early welfare measures were wealth-like concepts such as the present value of future utility or consumption; see, for example, Samuelson (1961). However, although such measures are accurate, they are not very useful from a practical point of view. This explains the quest to measure the present value of future utility by a more easily observed static indicator: green NNP serves this purpose. The welfare interpretation of green NNP comes originally from Martin Weitzman (1976), where green NNP is shown to be an exact indicator of welfare under certain conditions. More precisely, in a dynamic economy with a stationary technology and perfect competition, where the social objective is to maximize the present value of future utility, Weitzman was able to show that green NNP measured in utility terms is proportional to the optimal value function, defined as the maximized objective function. One important aspect of Weitzman’s result is, therefore, the interpretation of green NNP as a static equivalent to future utility. In technical terms, the result derived by Weitzman indicates that the current value Hamiltonian of the underlying optimal growth problem is proportional to the present value of future utility facing the representative consumer. The
current value Hamiltonian is, in turn, interpretable as green NNP in utility terms, since it measures the utility value of current consumption plus the utility value of the current net investments.

Although Weitzman himself did not mention the term ‘green NNP’, the concept of NNP in Weitzman’s paper may (and should) be interpreted in a broader sense than has become the convention in actual systems of national accounts. Weitzman discussed the concept of capital explicitly and argued that in addition to physical, man-made capital, ‘pools of exhaustible natural resources ought to qualify as capital, and so should stocks of knowledge resulting from learning or research activities’. This view of NNP has inspired much of the subsequent research on social accounting and welfare measurement, where different aspects of capital formation have been addressed.²

It should be emphasized that the welfare interpretation of the current value Hamiltonian of the underlying optimal growth problem is based on a set of assumptions which may be somewhat restrictive. Weitzman’s fundamental result was based on the assumptions of a stationary technology and perfect competition. The first assumption rules out disembodied technological change, whereas the second implies that green NNP welfare measures, as they are commonly defined in the literature, are fundamentally related to a first best resource allocation. If either of these two assumptions is relaxed, the welfare measure will contain unobservable forward looking terms (in addition to the current value Hamiltonian underlying the optimization problems facing consumers and firms), which cannot be estimated by using the observable set of shadow prices that supports the resource allocation. For obvious reasons, this makes it difficult to apply the theory of social accounting in practice.

We have analyzed welfare measurement problems under technological change and market imperfections in a series of papers, which will be discussed throughout the book. At a theoretical level, the main complication for welfare measurement associated with technological change and market imperfections is that the economic system becomes non-autonomously time dependent. In other words, time itself has a direct effect on utility and/or production in addition to its influence via the equilibrium variables and via the utility discount factor. If utility and/or production exhibit explicit time dependence, so does welfare, thereby implying that there is no simple relationship between the current value Hamiltonian and the optimal value function. Therefore, the exact welfare measure depends on the functioning of the economic system, suggesting that a distinction between perfect and imperfect market economies is imperative in the context of social accounting.

The step from theory to practical applications involves several noteworthy and challenging issues. One such problem that has to be considered is whether market imperfections are empirically relevant in the context of social accounting, or if they can be neglected in practical applications without too
much loss of information. This can be analyzed using numerical methods aimed at assessing the relationship between welfare contributions associated with various sources of market imperfections and the welfare contribution of the current value Hamiltonian. In the numerical simulations carried out by Aronsson et al. (1997), Aronsson et al. (2001) and Backlund (2000, 2003), the analyses focused on external effects. The results suggest that certain external effects may have only a minor impact on the welfare measures, whereas others may have a considerable influence. These results are useful not only from the point of view of testing the empirical relevance of the theory of social accounting; they are also useful in pointing out the direction in which to look for welfare significant information.

Another issue of relevance in the context of practical applications refers to the unit of measurement. Regardless of whether a first best resource allocation or an imperfect market economy is under consideration, the exact welfare measures are typically expressed in utility terms. The problem, of course, is that utility is not observable, so that practical applications of the theory of social accounting necessitate a transformation of the welfare measures into real terms. The traditional way of carrying out such a transformation is to linearize the current value Hamiltonian. The linearized current value Hamiltonian can typically be transformed into a measure of green NNP in real terms. However, an obvious disadvantage of the linearized current value Hamiltonian is that it only constitutes an approximation of the current value Hamiltonian. A welfare measure based on the linearized current value Hamiltonian is, therefore, only an approximation of the correct welfare measure, and the accuracy of the approximation depends on the functional form of the instantaneous utility function. Weitzman (2000, 2003) suggests a more rigorous welfare foundation for the linearized current value Hamiltonian. Weitzman’s idea is to normalize the instantaneous utility function such that the normalized utility function becomes commensurate with the money-metric value of consumption (broadly defined) at the time the measurement is conducted. Another approach to the ‘unit-of-measurement’ problem in a first best setting is to derive an exact welfare measure in real terms, which can be shown to consist of the sum of green NNP and the consumer surplus. This comes from developing the analysis carried out by Weitzman (2001), and implies that the consumer surplus represents the information lost by linearizing the Hamiltonian.

1.3 THE PLAN OF THE BOOK

The basic idea behind this book is to integrate the research on welfare measurement and social accounting briefly outlined above. In a previous book (Aronsson et al., 1997), we focused on external effects associated with environmental
Welfare measurement in imperfect markets
damage and analyzed their role in the context of social accounting. The present
book takes a broader perspective by considering a wider spectrum of resource
allocation problems in real world market economies.

In Chapter 2, we introduce a ‘benchmark model’ to be used and elaborated on
in later chapters. The benchmark model is a dynamic general equilibrium model
with stock pollution, originally developed by Brock (1977). It is an extension
of the traditional Ramsey growth model in that energy is added to the other
production factors (labor and capital). The use of energy releases emissions,
which give rise to a stock of pollution. Such a model is particularly convenient
from the point of view of ‘greening the national accounts’, since it recognizes
that the environment may serve as both a consumption good (by being part of
the instantaneous utility function) and as a capital good (by being part of the
capital concept). We start by considering the welfare measurement problem in
a first best resource allocation. We then examine uncontrolled and imperfectly
controlled market economies, and show how the welfare measures differ from
their counterparts in the first best. Another issue concerns the principles of
cost–benefit analysis in dynamic general equilibrium models. The chapter is,
to some extent, a recapitulation of some of the results from our earlier book
(Aronsson et al., 1997). They are, nevertheless, repeated here, since they serve
as a natural point of departure.

The ‘unit-of-measurement’ problem is dealt with in Chapter 3. By concentrat-
ing on the first best resource allocation, we derive a money-metrics analogue to
Weitzman’s (1976) welfare measure. More specifically, the analysis shows that
a generalized measure of the present value of future consumption is proportional
to the sum of green NNP in real terms and the real instantaneous consumer
surplus. We also derive cost–benefit rules in real terms, which are analogous
to the utility based cost–benefit rules in Chapter 2. The final part of the chapter
concerns the possibility of measuring changes in welfare by using changes in real
green NNP (an alternative view of green NNP discussed in the recent literature)
as well as provides an interpretation of the concept of ‘genuine saving’.

Pigouvian emission taxes might serve (at least) two purposes in the context
of a market economy: they bring the economy to the first best optimum,
and they are directly useful in social accounting by exactly measuring the
shadow price of additions to the stock of pollution in real terms. At the same
time, Pigouvian taxes are very difficult to implement in practice, since their
implementation would require information about future preferences. This is
the starting point of Chapter 4, where we analyze static approximations of
dynamic Pigouvian taxes. The information required to design these taxes is,
in principle, recoverable by using the willingness-to-pay method. The basic
idea is to arrive at a close approximation of the shadow price of pollution, in
which case the Hamiltonian may become a close approximation of the correct
welfare measure in an imperfectly controlled market economy. Two questions
are important here: (i) is a market economy controlled by the approximation of the Pigouvian tax welfare superior to the uncontrolled market economy, and (ii) is the approximation of the Pigouvian tax useful in social accounting in the same way as a correct Pigouvian tax would be in a perfectly controlled market economy? Both questions are addressed by using the model set out in Chapter 2. Numerical simulations supplement the theoretical analysis.

In Chapters 2–4, the first best resource allocation constitutes a natural reference case. This is so because the external effect associated with environmental damage constitutes the only imperfection in the market economy under consideration. As a consequence, if the government is able to design Pigouvian emission taxes, it is able to implement the first best resource allocation. In Chapter 5, we assume that the government finances a public good by means of distortionary taxes on labor income and capital income. It is well known that if the government is restricted to collecting tax revenues by means of distortionary taxes, the first best resource allocation will in general be unattainable. We show how green NNP in utility terms, derived in Chapters 2 and 4, might become an incorrect welfare measure in an economy with distortionary taxes. We also derive a second best analogue to green NNP in utility terms. Chapter 5 then turns to the welfare effects of policy reform. The motivation is that even if the government wants to combine revenue objectives and environmental goals, it may not be able to implement the second best resource allocation. We consider the welfare effect of a change in the tax mix, which is designed to include an increase in the emission tax. This extends the cost–benefit analyses carried out in Chapters 2 and 4 to an economy with preexisting tax distortions. It also complements some previous studies on environmental tax reform, carried out using static models.

Chapter 6 concerns welfare measurement when countries are confronted with transboundary environmental problems. We extend the benchmark model by introducing two distinct countries as well as allowing the pollution generated by emissions in each country to spill over into the other country. The purpose is to relate the properties of national and global welfare measures to the functioning of the economic system and, in particular, to whether or not there is international cooperation in order to correct for transboundary external effects. We compare a cooperative equilibrium, a non-cooperative Nash equilibrium and the equilibrium in an uncontrolled market economy from the point of view of welfare measurement. In addition, some aspects of the analysis carried out in Chapter 4 are extended here to a global economy by studying approximations of Pigouvian emission taxes.

Chapter 7 also deals with welfare measurement in a global economy by focusing on numerical applications. The first part of the chapter complements Chapter 6 by considering a numerical version of the model set out there. Using real world data as a basis, we also consider welfare measurement problems in a hypothetical ‘world economy’, where the world is divided into a rich and a
poor region. The interaction between regions refers to a transboundary external effect in production from greenhouse gases.

Chapter 8 concerns three emerging issues: welfare measurement in the context of (i) differential games, (ii) unemployment and (iii) distributional objectives. In Section 8.1, we address differential games, thus extending the analyses in Chapters 5 and 6 by considering some additional aspects of the welfare measurement problems implicit in Nash games of open-loop and feedback-loop forms as well as Stackelberg games. Section 8.2 deals with the implications of unemployment from the point of view of welfare measurement. This is topical not only as a technical extension of the analyses conducted in previous chapters; it is also relevant in light of the high (and possibly permanent) unemployment experienced in many countries. The implications of distributional objectives are analyzed in Section 8.3. The basic issue here is whether or not distributional objectives invalidate the welfare interpretation of the current value Hamiltonian.

In Chapter 9, we incorporate uncertainty into the study of social accounting and cost–benefit analysis. Welfare measurement under uncertainty in a dynamic model requires other mathematical tools than those used in preceding chapters, which motivates a brief introduction to stochastic control theory. This is accomplished in the context of a well known growth model introduced in its basic form by Merton (1975), where the growth rate of the labor force is stochastic from the social planner’s point of view. We then extend the analysis by introducing uncertainty into the benchmark model of Chapter 2, by assuming that the stock of pollution is also stochastic from the social planner’s point of view. This extension is motivated by the fact that the environmental consequences of economic behavior are often uncertain. The results explain the importance of the attitudes towards risk in the context of welfare measures. Moreover, the welfare measures and cost–benefit rules derived under perfect certainty are shown to be nested special cases in this more general model, which takes us back to the basic question of the potential inherent in augmenting NNP in order to obtain an exact welfare measure.

NOTES

1. To be more specific, the social objective commonly applied is ‘discounted utilitarianism’, which means that the objective is to maximize a discounted sum of instantaneous utilities using a constant discount rate.

2. See, for example, Hartwick (1990), Dasgupta and Mäler (1991) and Mäler (1991) for applications of this welfare analysis to economies where environmental and/or natural resources are important components of the economic system. The term ‘green NNP’ originates from applications of the theory of social accounting to such economies. See also Aronsson and Löfgren (1996), who consider welfare measurement in an economy with human capital.