

# Linear Programming Notes VII

## Sensitivity Analysis

### 1 Introduction

When you use a mathematical model to describe reality you must make approximations. The world is more complicated than the kinds of optimization problems that we are able to solve. Linearity assumptions usually are significant approximations. Another important approximation comes because you cannot be sure of the data that you put into the model. Your knowledge of the relevant technology may be imprecise, forcing you to approximate values in  $A$ ,  $b$ , or  $c$ . Moreover, information may change. **Sensitivity analysis** is a systematic study of how sensitive (duh) solutions are to (small) changes in the data. The basic idea is to be able to give answers to questions of the form:

1. If the objective function changes, how does the solution change?
2. If resources available change, how does the solution change?
3. If a constraint is added to the problem, how does the solution change?

One approach to these questions is to solve lots of linear programming problems. For example, if you think that the price of your primary output will be between \$100 and \$120 per unit, you can solve twenty different problems (one for each whole number between \$100 and \$120).<sup>1</sup> This method would work, but it is inelegant and (for large problems) would involve a large amount of computation time. (In fact, the computation time is cheap, and computing solutions to similar problems is a standard technique for studying sensitivity in practice.) The approach that I will describe in these notes takes full advantage of the structure of LP programming problems and their solution. It turns out that you can often figure out what happens in “nearby” linear programming problems just by thinking and by examining the information provided by the simplex algorithm. In this section, I will describe the sensitivity analysis information provided in Excel computations. I will also try to give an intuition for the results.

### 2 Intuition and Overview

Throughout these notes you should imagine that you must solve a linear programming problem, but then you want to see how the answer changes if the problem is changed. In every case, the results assume that **only one thing about the problem changes**. That is, in sensitivity analysis you evaluate what happens when only one parameter of the problem changes.

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<sup>1</sup>OK, there are really 21 problems, but who is counting?

# Linear Programming Notes Vii Sensitivity Analysis

**WJ Hussar**



## **Linear Programming Notes VII Sensitivity Analysis:**

**Technical Abstract Bulletin**, 1965 **Perturbations, Approximations and Sensitivity Analysis of Optimal Control Systems** A. L. Dontchev, 1983 Sm Intro Management Science I/M and Tests Pearson Higher Education & Professional Group, 1993-04

*Generalized Convexity and Generalized Monotonicity* Nicolas Hadjisavvas, Juan E. Martinez-Legaz, Jean-Paul Penot, 2012-12-06 Various generalizations of convex functions have been introduced in areas such as mathematical programming economics management science engineering stochastics and applied sciences for example Such functions preserve one or more properties of convex functions and give rise to models which are more adaptable to real world situations than convex models Similarly generalizations of monotone maps have been studied recently A growing literature of this interdisciplinary field has appeared and a large number of international meetings are entirely devoted or include clusters on generalized convexity and generalized monotonicity The present book contains a selection of refereed papers presented at the 6th International Symposium on Generalized Convexity Monotonicity and aims to review the latest developments in the field *Planning Stability in Material Requirements Planning Systems* Gerald Heisig, 2012-12-06 In logistics systems the issue of planning stability has attracted increased attention and interest in recent years This is mainly due to an increasing integration of planning systems both within and across companies in supply chain management The propagation of adjustments in planning systems first acquired wide attention when MRP systems were employed as standard planning tools for material coordination Within a rolling horizon framework the MRP application produced considerable planning instability which originates from uncertainties in the planner's exogenous environment as well as from endogenous sources This book presents an analytical investigation that gives deep insight into the influence of different kind of inventory control rules on the stability of material planning systems under stochastic demand in a rolling horizon environment

**Project Scheduling with Time Windows and Scarce Resources** Klaus Neumann, Christoph Schwindt, Jürgen Zimmermann, 2013-06-29 A project is a unique undertaking or endeavor to be accomplished that can be divided into individual subtasks or activities each of which requires time and scarce resources for its completion Also there is a desired objective to be attained for example minimization of project duration or of variation of resource utilization or maximization of net present value of the project Moreover there are given precedence relationships among activities prescribing the order in which activities must be carried out Project scheduling in its basic form consists of finding start times for all activities such that prescribed resource and precedence constraints are satisfied and an objective function is optimized Since the concept of a project can be interpreted quite broadly project scheduling problems arise in a great variety of practical situations These include construction work the development and introduction of new products service systems or software packages strategic long term planning in manufacturing and the service sector emergency planning and even the conducting of political campaigns Recently project scheduling has been successfully applied to production and operations management e.g. make to

order production in manufacturing and batch production in process industries Since the late 1950 s network based planning methods for project scheduling problems have been developed cf Elmaghraby 1977 and Moder et al

**An Economic Theory of Cities** Wei-Bin Zhang, 2012-12-06 Over more than two centuries the development of economic theory has created a wide array of different concepts theories and insights My recent books *Capital and Knowledge* Zhang 1999 and *A Theory of International Trade* Zhang 2000 show how separate economic theories such as the Marxian economics the Keynesian economics the general equilibrium theory the neoclassical growth theory and the neoclassical trade theory can be examined within a single theoretical framework This book is to further expand the framework proposed in the previous studies This book is a part of my economic theory with endogenous population capital knowledge preferences sexual division of labor and consumption institutions economic structures and exchange values over time and space Zhang 1996a As an extension of the *Capital and Knowledge* which is focused on the dynamics of national economies this book is to construct a theory of urban economies We are concerned with dynamic relations between division of labor division of consumption and determination of prices structure over space We examine dynamic interdependence between capital accumulation knowledge creation and utilization economic growth price structures and urban pattern formation under free competition The theory is constructed on the basis of a few concepts within a compact framework The comparative advantage of our theory is that in providing rich insights into complex of spatial economies it uses only a few concepts and simplified functional forms and accepts a few assumptions about behavior of consumers producers and institutional structures

**Lecture Notes in Pure and Applied Mathematics** ,1982 *Foundations of Control Engineering* ,1986 **The Measurement of Market Risk** Pierre-Yves Moix, 2001-07-03 The objective of this book is to set up an economic quantitative model for the assessment of financial market risk *The Measurement of Market Risk* reviews the probabilistic modelling of so called risk factors which represent the uncertainty of financial markets and discusses the issue of risk as the perception of uncertainty by individuals when faced with a decision problem Further the book discusses the pricing of financial instruments as a function of risk factors Emphasis is put on options because they exhibit a non linear exposure to the risk factors The core of the text is the assessment of risk for financial portfolios by way of estimating the portfolio probability distribution A new approach the Barycentric Discretisation with Piecewise Quadratic Approximation BDPQA which poses no assumptions on the risk factor distribution and accounts for the non linearity of the price functions is introduced

*The American Mathematical Monthly* ,1980 **Multiple Criteria Optimization** Ralph E. Steuer, 1989 *Parametric Optimization and Related Topics* Jürgen Guddat, 1987 *Optimality and Efficiency* D. J. White, 1982-12-22 An organized overview of recent developments in the field of optimality and efficiency Presents the concepts of optimal solutions and efficient solutions their interrelationships basic theorems and classes of problems where these concepts can be applied Includes extensive references for further study

**Bericht** Jyväskylä yliopisto. Matematiikan laitos, 1994 *Optimization with Data Perturbations II* Doug E. Ward, 2001

Progress in Operations Research ,1961      *Bulletin - Institute of Mathematical Statistics* Institute of Mathematical  
Statistics,1976      **U.S. Government Research and Development Reports** ,1966      *Bibliographie der*  
*Wirtschaftswissenschaften* ,1996

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