Contents

1 Acknowledgements I

2 Introduction and Preliminaries 1
   2.1 This Thesis 2
   2.2 Preliminary Remarks on Notation and Terminology 3
   2.3 Introduction to Game Theory 4
      2.3.1 Non-Cooperative Games 4
      2.3.2 Cooperative Games 18
   2.4 Summary of Notational Conventions 20
   2.5 Outline of the Thesis 21

3 On the Inefficiency of Standard Multi-Unit Auctions 27
   3.1 Background 29
   3.2 Contributions and Outline 31
   3.3 Definitions and Preliminaries 33
   3.4 The Price of Anarchy of Full Information Multi-Unit Auctions 35
      3.4.1 Uniform Pricing 35
      3.4.2 Discriminatory Pricing 36
   3.5 The Price of Anarchy for Incomplete Information Multi-Unit Auctions 39
      3.5.1 Proof Template for Mixed Bayes-Nash Price of Anarchy 40
      3.5.2 Key Lemma and Proofs of Theorem 45 and Theorem 46 43
      3.5.3 Lower Bounds 49
   3.6 Smoothness and its Implications 51
   3.7 Conclusions 56

4 The Strong Price of Anarchy of Linear Bottleneck Congestion Games 59
   4.1 Background 61
   4.2 Contributions and Outline 63
   4.3 Arbitrary Facilities 64
      4.3.1 General Player Weights 64
      4.3.2 Identical Players 68
   4.4 Identical Facilities 70

III