

# TABLA DE CONTENIDO

<b>Chapter 1.</b> Introduction	1
<b>Chapter 2.</b> Brief review of some necessary previous models: the single-line model, the parametric city and the basic lines structures	5
2.1 The single-line single-period model	5
2.2 Parametric description of the urban area	6
2.3 The strategic line structures	7
2.4 Main results	8
<b>Chapter 3.</b> The role of heuristics in designing lines structures	11
3.1 Description and application of the heuristics	11
3.1.1 Dubois <i>et al</i> (1979) – DBL	11
3.1.2 Ceder and Wilson (1986) – CW	13
3.1.3 Borndörfer <i>et al</i> (2007) – BOR	14
3.1.4 Cenek (2010) – CEN	15
3.2 Results and analysis	15
3.2.1 Main results	16
3.2.2 Global indicators	18
3.2.3 Analysis of operators' and users' costs	19
3.2.4 Role of the transfer penalty	20
3.3 Main conclusions	21
<b>Chapter 4.</b> The technical dimensions behind scale economies induced by transit lines structures design.	22
4.1 Introduction: scale economies in public transport	22
4.2. The impact of the discrete nature of lines structure choice on <i>DSE</i>	24
4.3. Introducing directness	26
4.3.1 The concept	26
4.3.2 An illustrative model	27
4.4 Analysis over the parametric city	29
4.5 Some results on subsidies and fares	33
4.6 Main conclusions	35
<b>Chapter 5.</b> Introducing lines density in the strategic design of transit networks	37
5.1 Lines density: the parallel lines model revisited	37
5.2 Lines density in the parametric city	41
5.2.1 Lines density as a new design variable	41
5.2.2 Results	43
5.3 Main conclusions	47
<b>Chapter 6.</b> Two periods optimization over a single line	49
6.1 Formulation of the model	49
6.2 Buses full at the peak	50
6.2.1 Comparing optimal and single period frequencies	50
6.2.2 Crossed effects between periods	52

6.2.3 Summary of this case and comparison with previous approaches	52
6.2.4 Numerical analysis	54
6.3 Buses full at the off-peak	57
6.4 Main conclusions	61
<b>Chapter 7. Systems that allow for two fleets</b>	<b>63</b>
7.1 Joint optimization allowing for two fleets	63
7.2. One or two fleets? Comparison of the models	67
7.3 Main conclusions	69
<b>Chapter 8. Second-best strategies</b>	<b>70</b>
8.1 Optimizing one line with fixed capacities	70
8.2 Optimization of one period and adaption of the other	71
8.3 Comparison between the two alternatives	72
8.4 Main conclusions	73
<b>Chapter 8. Synthesis and conclusions</b>	<b>74</b>
<b>Bibliography</b>	<b>79</b>
<b>Appendix</b>	<b>85</b>
Appendix A: Numeric values of the parameters	85
Appendix B: Some details on the application of each heuristic to the city model	85
Appendix C: Analysis of line structures over the isosceles-city	89