EVALUATING FLEXIBILITY IN AIRPORT CAPACITY-ENHANCING TECHNOLOGY INVESTMENTS

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Abstract

This paper illustrates the use of Real Options Analysis to capture and value the flexibility of airport capacity-enhancing technology investments. In particular, it demonstrates and emphasizes the importance of accounting for managerial flexibility when considering such investments. This work also investigates, through a change in traffic demand at a modeled airport, the different factors that have an impact on the strategic value of airport technology portfolios.

1 Motivation

Changes in aircraft types, technologies, airspace users, and the liberalization and privatization of airlines have strongly impacted airports. The industry's sensitivity to these changes, along with their dramatic consequences on airports' viability and profitability, has consequences on how investments and risk are perceived. For instance, investment decisions that may carry little risk at one time, may be considered highly risky as the future unfolds [8]. One way to mitigate risk is to provide decision-makers with the capability to contemplate alternative strategies as some degree of uncertainty gets resolved, and to adapt their investment strategy when necessary. Real Options Analysis (ROA) is a well-recognized method to integrate, capture and value the flexibility embedded in projects and has been applied in the past to address many airport expansion projects, such as the building of a new runway or expansion of a terminal building [11, 10, 12, 6]. The work presented in this paper considers the sequential acquisition of capacity-enhancing technologies as a means to support airport growth and viability. However, while previous studies have applied ROA to address airport expansion projects, few have considered sequential investment options. Indeed, most of the studies use real options to evaluate "go or no-go" decisions based on a one-time investment on a single project. The need to address interdependencies between projects and the acquisition of highly dependent technologies in particular has been discussed by many [1, 2, 3] but has not been implemented, from a real options perspective, at the airport airside level.

The present paper first briefly introduces ROA. It then presents the proof-of-concept developed to further illustrate the value of embedding flexibility in the definition of airport technology portfolios. Finally it presents key results and summarizes the conclusions of this work.

2 Basics of real options analysis

Real options has its quantitative roots in financial options. In financial options, an option represents "the right, without an associated symmetric obligation, to buy (if a *call*), or sell (if a *put*) a specified asset (e.g., common stock) by paying a prespecified price (the exercise or strike price) on or before a specified date (the expiration or maturity date)" [18]. Hence, an option is defined with respect to the five following variables [7, 9]:

- The stock price or underlying asset price: the net present value of the potential investment if the investment was happening today [7]
- The exercise price or strike price: the price at which the option owner can buy (*call* option) or sell (*put* option) the underlying asset [5]
- The expiration date or maturity date: the last day in which the option may be exercised. In particular an American option is an option that can be exercised at or anytime before maturity, as opposed to a European option, which is an option that can only be exercised at maturity [18]
- The risk-free interest rate: "the rate of interest the market is willing to pay on an asset whose payoffs are completely predictable" [7]
- The volatility or variance of returns on stock: it "measures how hard it will be to predict the underlying asset's price into the future" [7]

In the case of a call option, a buyer of an option has the right to buy some stock (underlying asset) from the seller of the option for a certain price defined as the strike price X. He can do it at maturity (the expiration date) in the case of a European option, or anytime before or at maturity for an American option. To have this right, the buyer pays a call premium. The value of an option, or payoff function P, is, in the case of a call option (buy), the difference between the stock price S and the strike price X (Equation 1). The payoff function for a European call option is represented in Figure 1.

$$\mathrm{P} = \begin{cases} S - X \text{ if and only if } S > X \\ 0 \text{ if and only if } S <= X \end{cases} \tag{1}$$

Hence, as long as the stock price S is less than the strike price X, the payoff remains 0 and the buyer has no reason to exercise his option. The option is said to be out-of-the-money. In other words, if the stock price S remains below the strike price X until the expiration date, the owner of the option endures a loss corresponding to the call premium. In the case where the stock price S goes above the strike price X, the owner of the call option can buy the stock for X and then sell it for S. The payoff would then correspond to S-X. The option is said to be in-the-money. However, the owner of the option only starts making a net profit when the payoff is more than the premium paid for the option.

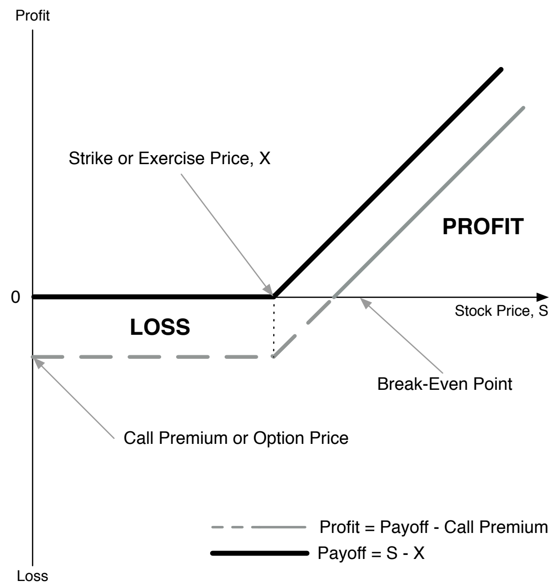

Fig. 1 Profit and payoff at expiration for a call option.

Real options, as its name implies, applies financial options theory to physical or real assets [13]. Hence, instead of addressing financial assets or stocks and bonds, real options is concerned with estimating the value of flexibility of "real" projects in the face of uncertainty [13]. Because ROA is able to capture the uncertainty of future cash flows, it provides managers and decision-makers with a flexible path forward, allowing them to adapt their investment decisions as some uncertainty get resolved and new information becomes available [13]. Hence, one of the main advantages of real options analysis is that the value created by managerial flexibility and the ability to respond to future uncertainties is integrated into the valuation process [5]. In particular, the value of flexibility is captured by an expanded NPV (eNPV) criterion, which allows for the valuation of flexible projects [17]. This criterion, also called the total strategic value is defined in Equation 2, where the value of flexibility is calculated as the value of the real option. Another significant advantage of using ROA for this type of problem is that it supports the analysis and valuation of sequential and interdependent project investment decisions.

$$\text{eNPV} = \text{Passive NPV} + \text{Flexibility Value} \quad (2)$$

Many models and approaches exist to assess the value of an option. The model chosen for this work is the binomial model. While such model requires a certain number of steps to reach a good approximation, it offers the advantages of being transparent and easy to implement [13]. Also, because option values are calculated at every step in the binomial tree, the results obtained are easy to explain or validate [4]. Finally, binomial models are particularly well-suited to solve sequential compound options (options with multiple phases where the implementation of later phases depends on the success of preceding phases), as relevant to this paper.

3 Proof-of-concept

A real options framework is implemented to evaluate the strategic benefit of defining adaptable technology portfolios in the case of a change in requirements at airports. In particular, two airports are considered: one for which a significant technology equipage is already in place or planned, and for which there is not much room left for flexibility; and a second one that has not significantly committed to any technology portfolio. These two airports are actually the same airport, but with different levels of equipage. Hence, the "first" airport (referred to as *Airport #1*) is one with today's traffic and technologies, while the "second" airport (referred to as *Airport #2*) is the same regional airport but with the traffic and technologies of a few decades ago. Changes in requirements for both airports will come from a change in the aircraft mix as well as the number of aircraft arriving at the airport. In other words, both airports are submitted to the same traffic forecast in terms of percentage growth (or decrease) in small aircraft as well as in arriving aircraft.

The following sections (Sections 3.1 and 3.2) describe the different technology investment scenarios available to each airport, as well as the traffic scenarios under which both airports operate. These define the space within which ROA is implemented (Section 3.3). Then, Section 3.4 discusses the formulation of the technology portfolios used for this work. Finally, Section 3.6 introduces the implementation of Real Options Analysis to help assess the flexibility and strategic value of technology portfolios in the specific context of this work.

3.1 Formulation of investment scenarios

The investment window considered spans over 15 years. During these 15 years, airports can decide to invest, or not, at years 5 and 10. The flexibility in investment sequence is thus illustrated by the four following investment scenarios (Figure 2):

- Scenario #1: the airport does not invest in new technologies and thus carries its current equipage over the 15 years
- Scenario #2: the airport invests in a given technology portfolio at Year 5 only
- Scenario #3: the airport invests in a given technology portfolio at Year 10 only
- Scenario #4: the airport invests first in a given technology portfolio at Year 5 and later complements that initial technology portfolio with technologies available at Year 10 and earlier.

These scenarios illustrates the airport's investment flexibility. Hence, if the airport had envisioned to invest at both Year 5 and Year 10 (Scenario #4), it may deviate from that scenario

Table 1 Change in demand scenarios

Scenario	Variable descriptions	Ranges	Distribution
LOW	Annual traffic growth rate	1% to 3%	Uniform
	Annual change in % of small aircraft arriving	-3.5% to -1.5%	Uniform
HIGH	Annual traffic growth rate	2% to 4%	Uniform
	Annual change in % of small aircraft arriving	-6.5% to -3.5%	Uniform

and consider Scenarios #2 or #3 instead, in the case where demand does not materialize as expected. The same is also true in the opposite case. The formulation of this problem from a Real Options perspective offers the airport the possibility to alter investment strategies.

3.2 Formulation of traffic scenarios

Annual changes in traffic are modeled through the number of arrivals at the airport, as well as through the mix of aircraft (in this case the percentage of small aircraft) as illustrated for the traffic scenarios described in Table 1. This allows the decision maker to assess the value of the technology portfolios under different traffic conditions. The number of arriving aircraft for *Airport #1* represents the level of traffic currently experienced by the airport. The number of arriving aircraft for *Airport #2* represents the traffic experienced by the airport in 1990 in terms of air carrier and commuters/air taxi Landrum2002.

3.3 Summary of potential scenarios of interest

The investment and traffic scenarios, along with the two types of airports considered, define the space within which real options analysis is implemented. This *scenario space* is further represented in a matrix of alternatives (Table 2). In particular, the scenario investigated in this paper is highlighted in grey.

3.4 Formulation of technology portfolios

Due to the number of scenarios and investment options considered (Figure 2), the formulation of technology portfolios represents a huge combinatorial problem. Indeed, considering only 4 candidate technologies for investment leads to the formulation of $\sum_{k=1}^{4} \frac{4!}{k!(4-k)!} = 15$ distinct potential technology portfolios. Consequently, a small subset of technologies is considered that are applicable to the airport under consideration. The technologies chosen to be part of the baseline or to be considered for future investment options are listed in Appendices in Tables 5 and 6, for *Airport #1* and *Airport #2*, respectively. Hence, the technologies considered for baseline and future investment options at airport #2 are the same as at airport #1, except that some technologies marked in the *Baseline* category in Table 5 belong to the *Future investment* category in Table 6. The following paragraphs discuss in more detail the formulation of technology portfolios for each of the scenarios identified above:

- Scenario #1: in this scenario, the airport does not invest in any technologies. Hence the technologies used are the ones marked in the *Baseline* category in Table 5.
- Scenario #2: the airport invests in a given technology portfolio at Year 5 only. In this scenario, the technologies that constitute each candidate portfolio have a deployment date less or equal to Year 5 (2010). Also, the portfolios created account for the relationships that may exist between technologies. Hence, if Technology B requires that Technology A be in place, then the portfolios formulated need to have both Technologies A and B. When generating technology portfolios, the algorithm developed verifies that Technology A is either

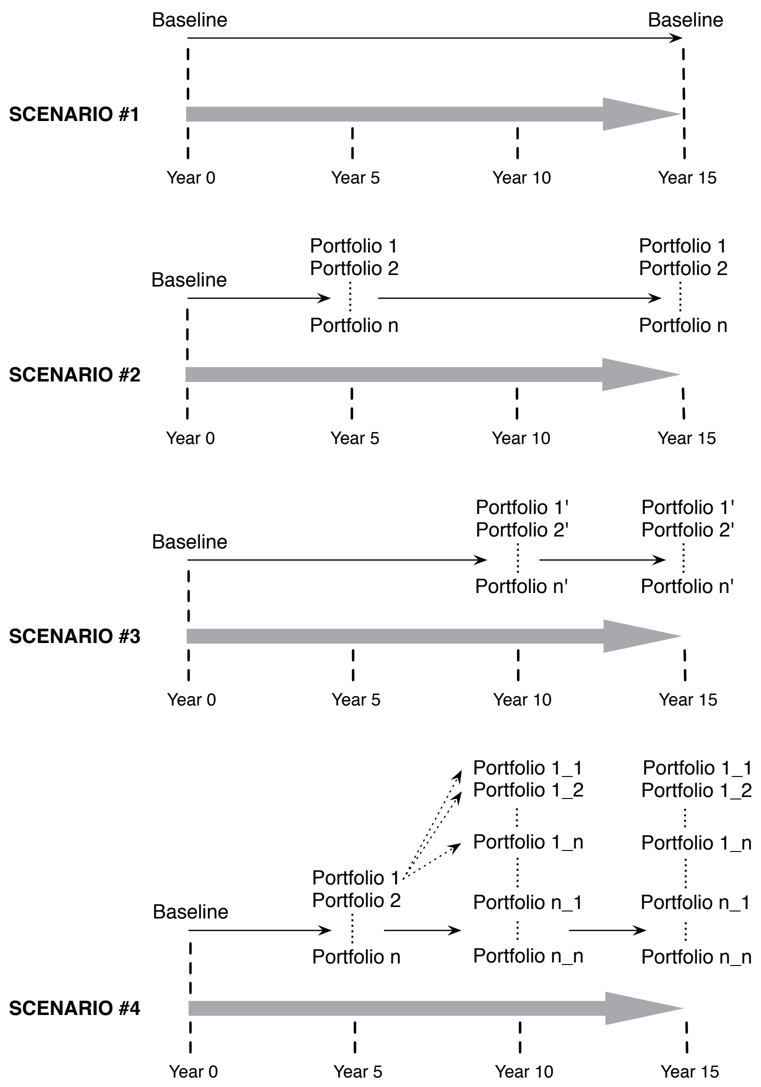

Fig. 2 Investment scenarios.

Table 2 Morphological matrix of scenarios of interest

Variable descriptions	Alternative #1	Alternative #2	Alternative #3	Alternative #4
Type of airport	Airport #1	Airport #2		
Investment scenario	Scenario #1	Scenario #2	Scenario #3	Scenario #4
Change in aircraft mix	LOW	HIGH		
Change in number of arriving aircraft	LOW	HIGH		

already in place (included in the baseline), or belongs to the list of new candidate technologies whose deployment date is less or equal to Year 5.

- Scenario #3: the airport invests in a given technology portfolio at Year 10 only. The logic used to formulate candidate technology portfolios is the same as for Scenario #2 except that the technologies included need to have a deployment date less or equal to Year 10 (2015)

- Scenario #4: the airport is presented with an investment option twice, the first time at Year 5 (2010) and the second time at Year 10 (2015). The formulation of technology portfolios at Year 5 follows the same logic and requirements as in Scenario #2. However, the formulation of technology portfolios at Year 10 (2015) is more complex as the candidate portfolios need to include the technologies acquired at Year 5 (2010)

3.5 Impact of the technologies on airport operations and performance

A modeling & simulation environment (Figure 3), previously presented in [15, 16], is used to model the impact of both technologies and changes in traffic on the performance (capacity, delay, costs and revenues) of the airport. In this environment, the annual demand growth rate experienced at the airport is translated into an increase in the average number of flights per day, and/or into a change in the mix of aircraft operating at the airport. The increase in the average number of flights in turn generates more revenues through landing fees. However, it also results in increased delays and congestion. When congestion reaches a given threshold, the airport is penalized by losing revenues. This loss in revenues is then used as an incentive for the airport to address the congestion issue. The decrease in resource adequacy can be remedied by deploying additional ground technologies. These technologies, by adding capacity and reducing delays, allow more aircraft to operate at lower congestions levels. This, in turn, translates into increased revenues for the airport. However, these technologies also come at a cost to the airport (maintenance, training, installation, and delivery costs). Eventually, this environment is used to evaluate the ability of various technology portfolios to address airport expansion needs. This assessment is carried out using the revenue, cost and airport performance information generated by this modeling and simulation environment. Hence the main outputs of interest are airport revenues, airport costs, average total delays, and airside and runway utilization ratios. Finally, each simulation run covers a period of 15 years, where a year is represented by one day of operation.

The impact of each of the technologies considered represents an improvement (in percentage) of the baseline for the airport considered. Hence, it is assumed that no technology contributes in degrading the system. In the case where the technology belongs to the baseline, its impact is assumed to be captured in the baseline values. The impact of each of the technology portfolios considered is modeled and computed as described in [16, 14].

3.6 Formulation of the real options framework

As discussed extensively in Section 2, ROA provides the framework necessary to value the flexibility embedded in projects in general, and sequential project investments, in particular. The real options in the context of this work is defined as follows:

- Underlying Asset, S: the present value of the free cash flow generated by deploying a given portfolio

- Exercise/Strike Price, X: the costs associated with the acquisition and installation of the technology portfolio under consideration. Cost/expenditure information for each of the technology considered is

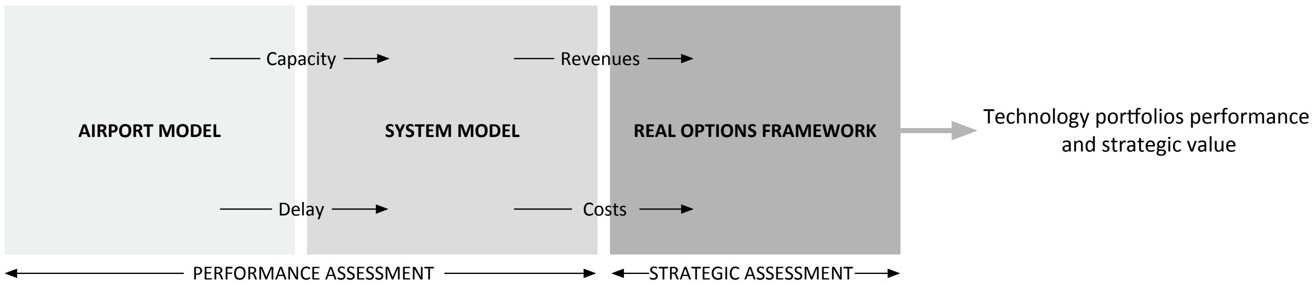

Fig. 3 Modeling and simulation environment.

based on data gathered from the literature, when available/applicable. Acquisition, installation and training costs are one-time costs, while maintenance costs are incurred on a yearly basis once the technology is in place. Airports #1 and #2 are also subjected to additional operating costs of M$4.0 and M$1.5 per year, respectively. These costs are assumed to remain constant throughout the study.

- Time to expiration of the option, T: the length of time the option is viable and may be exercised. The time to expiration is 5 years for Scenarios #2 and #4, and 10 years for Scenario #3. Also, this work uses a European option (an option that can only be used at maturity [18]) because this type of option presents similarities with the way investment decisions are made for this type of problem [11]

- Standard deviation of the value of the underlying risky asset, σ: it represents the riskiness of the asset. σ is defined as the standard deviation of the distribution of cash flows, expressed as Equation 3 [13]:

$$X = ln(\frac{\sum_{i=1}^{n} PVCF_i}{\sum_{i=0}^{n} PVCF_i}) \qquad (3)$$

where:
$PVCF_i$ is the present value of future cash flows at different time periods i
X is the forecast distribution

- Risk-free rate of interest over the life of the option, r_f: a value of 8 percent is assumed

As previously discussed, in the case of a call option, a buyer of an option has the right to buy the underlying asset from the seller of the option for a certain price. To have this right, the buyer pays a call premium. This call premium is represented, in the context of this research, by the amount of money that the airport pays for a feasibility study prior to any technology investment. The cost of this study is set to $150,000.

Finally, the expanded NPV (eNPV), as previously discussed, is obtained by Equation 4:

$$\text{eNPV} = \text{Value of Flexibility} + \text{Passive NPV} \qquad (4)$$

The value of managerial flexibility is calculated, using a binomial model, as the value of the real option and is sometimes referred to as "strategic value". By accounting for both the static NPV and the value of the option, the eNPV criterion (also called strategic NPV) captures the value of active decision making and future investment opportunities.

The following section discusses some of the key results obtained by applying ROA to the problem at hand.

4 Results and Discussion

This section presents results for both airport #1 (pre-existing equipage) and #2 (little pre-existing equipage) under the different investment scenarios subjected to a “HIGH” change in traffic mix, and a “HIGH” change in the number of arriving aircraft. Key results are discussed mainly from a strategic perspective.

Flexibility, in the context of this research, can be defined at two levels:

- At the system level, flexibility represents *the capability of a portfolio to evolve to respond to changes in requirements occurring after it has been acquired and/or deployed, and this, in a timely and cost-effective manner*.
- At the management level, flexibility represents *the capability to implement mid-course strategy corrections as the future unfolds and some of the uncertainty gets resolved*.

Managerial flexibility and its value are first discussed through the following example: an airport is considering increasing its capacity through the deployment of a set of technologies. Doing so would commit the stakeholders to pay some amount of money for a feasibility study at the beginning of the first year and to acquire a set of technologies at the end of the fifth year. Under traditional valuation methods, the technology portfolio with the highest positive NPV would be chosen (according to the NPV rule, portfolios with negative NPVs are disregarded). The issue with this approach is that commitment is based on the deterministic value of alternatives. However, as illustrated below, deterministic calculations of NPV can underestimate the value of a portfolio because it fails to capture the uncertainty of future cash flows.

Let’s consider Portfolio #5 (composed of technologies T_{29} and T_{30}) under Scenario #2 (one-time investment at Year 5) for *Airport #1*. The detail of its NPV calculation is provided in Table 3. A risk-free rate of 8% is assumed. Training costs for new technologies if any, and maintenance costs, are incurred on the sixth year. The NPV for Portfolio #5 being negative (-M$0.25), traditional valuation methods would disregard it, failing to recognize that there are other courses of action than the “now-or-never-proposition.” In reality, the stakeholders are faced with two alternatives. They can decide during the first year to pay some money for a feasibility study, and later (during the fifth year), decide whether or not to invest in new technologies. By doing so, they are buying the right, but not the obligation, to pursue a particular portfolio if the conditions are favorable. If it turns out that the demand has not materialized by the time a decision needs to be taken, they would only lose the money they put in the feasibility study, as opposed to loosing the money required to acquire, install and maintain new technologies that would prove unnecessary. Consequently, the opportunity to invest in a new technology portfolio can be seen as a call option with an expiration time of 5 years, a strike price X of M$1.5 (the sum of the acquisition and installation costs for that portfolio) and an underlying asset S equal to the discounted present value of the portfolio from year 5 to year 14 (M$1.268). The value of that option is M$0.370 (Table 4). Hence, in this instance, the value of the option outweighs the negative NPV.

The following sections discuss the impact that portfolio size (Section 4.1), investment timing (Section 4.2) and investment sequence (Section 4.3) have on the strategic value of the portfolios considered.

4.1 Impact of portfolio size

Figure 4 illustrates how both performance (represented here as the average total delay) and the value of flexibility evolve with the size of the portfolios (in terms of number of technologies included). As expected, performance increases as more technologies are deployed. This, however, happens to the detriment of the value of flexibility. Hence, as the number of technologies in a given portfolio increases, so does the strike price of the option considered, which in turn decreases the value of the option. Finally, Figure 4 helps identify portfolios with the highest strategic value among the ones that perform similarly.

Table 3 NPV calculation for Portfolio #5 Scenario #2 *Airport #1* (rounded values)

	Years														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Revenues ($M\$$)	4.38	4.55	4.73	4.89	5.15	5.43	5.57	5.75	5.99	6.17	6.01	5.48	5.20	5.15	5.10
Additional operating costs ($M\$$)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Acquisition costs ($M\$$)	-	-	-	-	1.50	-	-	-	-	-	-	-	-	-	-
Installation costs ($M\$$)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Annual maintenance costs ($M\$$)	0.91	0.91	0.91	0.91	0.91	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Training costs ($M\$$)	-	-	-	-	-	0.20	-	-	-	-	-	-	-	-	-
Total costs ($M\$$)	4.91	4.91	4.91	4.91	6.41	5.41	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21
PV ($M\$$)	-0.53	-0.33	-0.15	-0.01	-0.93	0.01	0.23	0.32	0.42	0.48	0.37	0.12	-0.00	-0.02	-0.04
Investment I_0 ($M\$$)	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NPV ($M\$$)	**-0.25**	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 Passive NPV, eNPV, and flexibility value for *Airport #1* Scenario #2 portfolios (round-up values)

Portfolios	S ($M\$$)	X ($M\$$)	**Passive NPV** ($M\$$)	**Value of Flexibility** ($M\$$)	**eNPV** ($M\$$)
P_1	1.711	1.000	0.766	1.045	1.811
P_2	2.149	1.461	1.070	1.183	2.253
P_3	1.964	0.500	1.506	1.629	3.135
P_4	1.511	2.461	-0.602	0.234	-0.368
P_5	1.268	1.500	-0.252	0.370	0.118
P_6	1.752	1.961	0.119	0.557	0.676
P_7	1.070	2.961	-1.617	0.032	-1.586

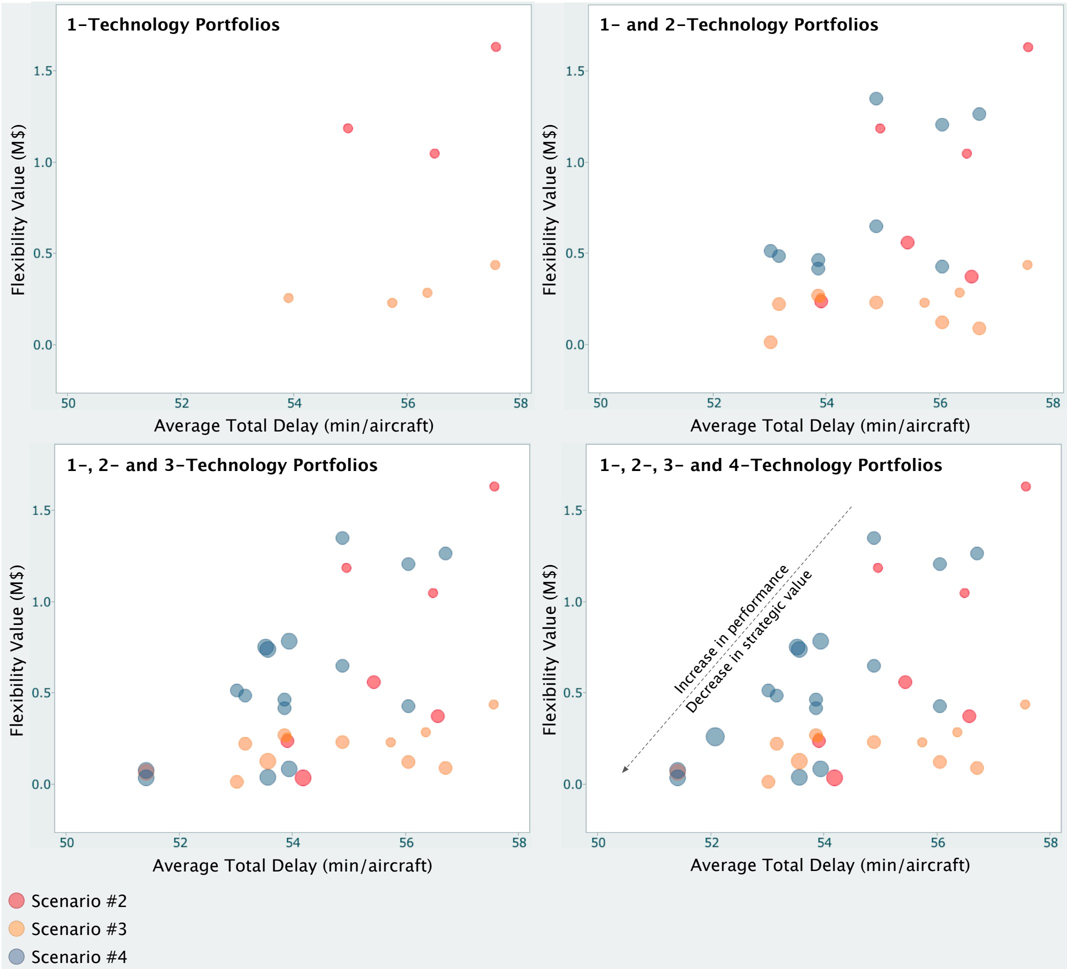

Fig. 4 Value of flexibility vs. delay responses for different portfolio sizes.

4.2 Impact of investment timing

This section illustrates how both performance and strategic value change with the timing of the investment for *Airport #1*. In particular, Figure 5 shows that the best tradeoff between performance and strategic value is achieved under Scenario #4 (sequential investment). This is mainly due to the timing of this scenario which helps address congestion before it becomes critical but at a cost lower than that of a similar portfolio under Scenario #2 (one-time investment at Year 5). Also, this figure highlights the fact that the strategic value decreases when the investment occurs too far into the future (investment at Year 10 under Scenario #3), as there is not enough time left to alleviate congestion and recover from the cost of acquiring technologies.

4.3 Impact of investment sequence

Similar portfolios exist across the investment scenarios considered. As an example, one can decide to invest into both technologies T_{29} and T_3 at once:

- Invest in both technologies at Year 5 (Scenario #2: orange dot in both A & B squares in Figure 6)

- Invest in both technologies at Year 10 (Scenario #3: red dot in both both A & B squares in Figure 6)

or at two distinct points in time (Scenario #4):

- Invest in T_3 at Year 5 and in T_{29} at Year 10 (Scenario # 4: blue dot in square A in Figure 6)

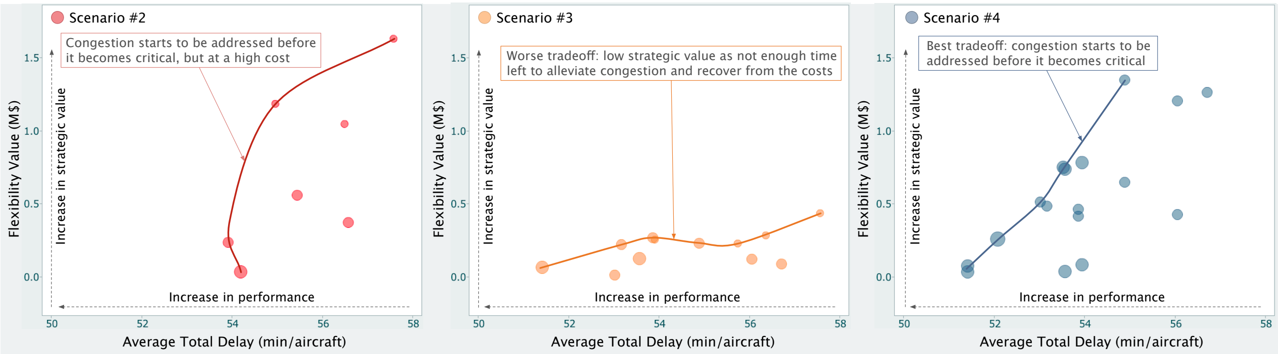

Fig. 5 Identification of a pareto front for each investment scenario under *Airport #1* (only portfolios for which all option values could be computed are represented).

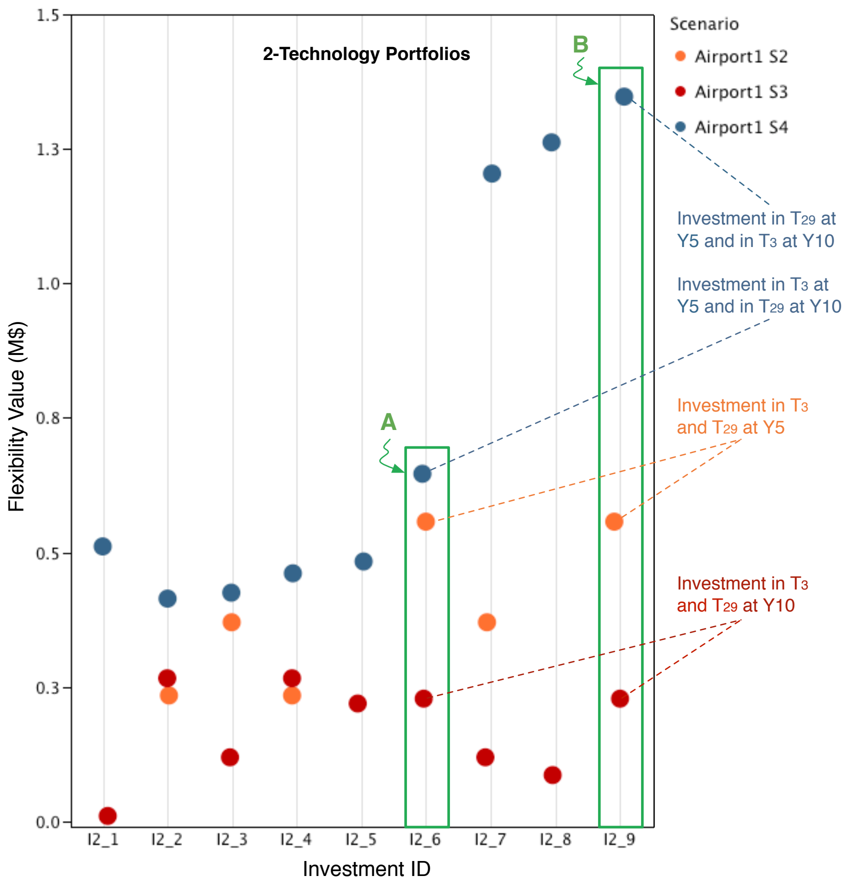

Fig. 6 Value of flexibility as a function of the investment sequence and the number of technologies included in *Airport #1* portfolios (only investment IDs for which all option values could be computed are represented).

- Invest in T_{29} at Year 5 and in T_3 at Year 10 (Scenario # 4: blue dot in square B in Figure 6)

Figure 6 shows that, under the modeling and cost assumptions of this work, investing in two technologies sequentially is more valuable strategically than deploying them both at once. However, as illustrated, the sequence under which these investments take place matters significantly. Hence, while the sequence T_3, T_{29} results in a strategic value of M$0.646, the sequence T_{29}, T_3 provides a strategic value of M$1.346. When investing in only two technologies, this work shows that, under the assumptions formulated, investing in the cheapest technology first consistently results in higher strategic value (for *Airport #1*). When investing in 3 technologies, the same observation seems to hold true when the ratio of the costs of the first investment over the costs of the second investments remain below a certain value (for *Airport #1*).

Being able to quantify the impact that the size of the portfolios, the timing of the investments or the investment sequence have on the strategic value of investments is key. In particular, this work, by allowing the decision maker to concurrently investigate both the performance and value of flexibility, provides a better picture of the investment alternatives available.

5 Conclusion

The work presented in this paper considered the sequential acquisition of capacity-enhancing technologies as a means to support airport's growth and viability. Through the use of Real Options Analysis, this work has demonstrated the importance of accounting for managerial flexibility when considering such investments projects. In particular, it has illustrated that, by accounting for both the static NPV and the value of the option, the eNPV criterion provides a means to capture the value of active decision making and future investment opportunities. The quantitative assessment of the strategic value of embedding flexibility in the formulation of technology portfolios and investment options has shown that the difference in strategic value between investment scenarios depends on:

- The level of traffic at the airport: low traffic generates revenues that are too low to offset the cost of acquiring technologies
- The presence or not of congestion: congestion has an impact on revenues and thus on the ability of the airport to recover from technology acquisition costs
- The timing and sequence of the investment: late investments often come too late or are too costly to allow the airport to recover. Sequential investments help spread the cost over time while addressing congestion before it becomes critical
- The number of technologies to be acquired: the better the performance, the lower the value of flexibility. In other words, better performance comes at a cost, which corresponds to a decrease in the strategic value of the investment decision

By capturing the impact of technology portfolios on airport performance and by embedding flexibility in the formulation of investment scenarios, this work provides a more accurate picture of the alternatives available to the decision-maker, as well as the time and sequence under which he should exercise them.

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7 Copyright Statement

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9 Appendices

Table 5 Technologies considered for baseline and future investment options at airport #1

ID	Technology Name	Baseline	Future Investment
T_0	Multi-Sensor Data Processor (MSDP)	X	
T_1	Primary Surveillance Radar (PSR)	X	
T_3	Multilateration (MLAT)		X
T_4	Surface Movement Radar (SMR)	X	
T_5	Legacy Secondary Surveillance Radar (SSR)	X	
T_{10}	Human Machine Interface (HMI) related Technologies	X	
T_{11}	Ground/Ground Communication	X	
T_{21}	Switchable Center Line Lights and Stop Bars	X	
T_{27}	Instrument Landing System (ILS)	X	
T_{28}	Departure MANager (DMAN)		X
T_{29}	Surface MANager (SMAN)		X
T_{30}	Arrival MANager (AMAN)		X
T_{31}	Current Air/Ground Datalink Broadcast Technologies	X	
T_{32}	Current Air/Ground Datalink Point-to-point Technologies	X	

Table 6 Technologies considered for baseline and future investment options at airport #2

ID	Technology Name	Baseline	Future Investment
T_0	Multi-Sensor Data Processor (MSDP)	X	
T_1	Primary Surveillance Radar (PSR)	X	
T_3	Multilateration (MLAT)		X
T_4	Surface Movement Radar (SMR)	X	
T_5	Legacy Secondary Surveillance Radar (SSR)		X
T_{10}	Human Machine Interface (HMI) related Technologies	X	
T_{11}	Ground/Ground Communication	X	
T_{21}	Switchable Center Line Lights and Stop Bars		X
T_{27}	Instrument Landing System (ILS)	X	
T_{28}	Departure MANager (DMAN)		X
T_{29}	Surface MANager (SMAN)		X
T_{30}	Arrival MANager (AMAN)		X
T_{31}	Current Air/Ground Datalink Broadcast Technologies	X	
T_{32}	Current Air/Ground Datalink Point-to-point Technologies	X	