Impacts of real options analysis on EU co-financing policy: the case of Ponta Delgada Port in the Azores

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Abstract

Under the EU's cohesion policy, investments with negative net present value but critical for the economic and social cohesion and development of a region can be co-funded. Ponta Delgada Port is the most important maritime infrastructure in the Autonomous Region of the Azores, struggling to keep pace with its growing activity, due to its limited capacity and inefficient equipment. Investment to expand its capacity was sketched. The traditional discounted cash flow method showed that the investment should not be deployed, nevertheless its positives induced effects in the economy as a whole and economic value creation. The framework used by the EU to figure co-funding rates does not incorporate the flexibility factor. This paper uses real options analysis to assess the investment and its impact on the EU co-financing policy. The results support the hypothesis that real options analysis can result in substantially different co-funding rates compared to the traditional discounted cash flow method used by the EU.

Keywords: Ponta Delgada Port; real options analysis; co-financing policy; flexibility; funding gap.

1 Introduction

Nowadays, the global market prevails with countless commercial trades across borders and freight transport. Physical infrastructures play an increasingly important role in the economic development of each region or country. This importance is even more critical in a region like the Azores, formed by nine islands and multiple maritime infrastructures. To keep pace with the global market and be linked to the main routes of maritime transport, the public company that manages the commercial ports in the Azores is performing several restructuring investments for its ports. Seaports construction or expansion usually claim very high investment expenditures, do not create value according to traditional discounted cash flows method (net present value (NPV) is negative and almost with the same value of the investment costs) and face several sources of uncertainty, including the competitiveness of the local economy.

Being the Azores one of the poorest regions of the EU and according to the cohesion policy, those investments with positive economic value are eligible for co-funding, reducing substantially the investment expenditures supported by local authorities. In financial terms, EU co-funding turns the NPV less negative on the local authorities' perspective. According to the Portuguese regulation, for projects with investment higher than 25 million euros, the investment needs to be assessed by a cost-benefit analysis, that assesses the investment from a financial and economic perspective. To be eligible for co-funding, projects need to have negative Financial Net Present Value (FNPV), both in the investment perspective and in the investor perspective, and positive Economic Net Present Value (ENPV) (European Commission, 2014). The amount of EU's aid will depend on the potential of the project to generate net cash flows that can fund the project itself. The framework used by the EU to assess the financial and economic value of the investment is a traditional discounted cash flow method. In this way, the investment is assessed as ”now or never”, with no value coming from the flexibility to delay the investment until uncertainty clarifies. Flexibility value can be captured using real options analysis (ROA). In this context, it is important to clear up the implications that arise for project financing if ROA is used instead of a traditional discounted cash flow method. Ponta Delgada Port case gives us this possibility.

In the Azores, the commercial port of Ponta Delgada, located in São Miguel island, is the main entrance and exit of goods traded with the external market and the Portuguese mainland, as well as the distributor hub for the rest of the Azorean islands. The tourism sector trend in the Azores in recent years and imported goods consumption growth requires more competitive support facilities and better responsive. Laying on that trend, local authorities, through the Portos dos Açores, S. A., the public company responsible for managing all ports in the Azores, foreseen the need to invest in an expansion of the commercial port of Ponta Delgada, which is in line with the majority Azorean economic entities and experts.

This research shows the case study of the commercial port of Ponta Delgada in line with Martins, Marques, Cruz, and Fonseca (2017), which aimed to associate the flexibility concept through an expansion option to the investment planning of the Ferrol Spanish port. Also used as support Smit (2003) and Pimentel, Couto, and Oliveira's (2018) models, based on airport and railways investments. To take advantage of future growth opportunities, it will be assumed that the demand for the Ponta Delgada Port is exogenous and evolves as a binomial process.

The main data was retrieved from the cost-benefit analysis developed for the Ponta Delgada Port expansion (Fundo de Maneio, 2017), approved by an expert commission for applications to the EU funds. Additionally, it will be used to compare the results with a flexible scenario given in this paper. We assess the investment using ROA and compare it with the traditional discounted cash flow method, foreseeing the implications in the EU co-funding policy. For that, the assessment was done according to three perspectives: investment perspective, investor perspective (considering the financial aid from EU) and economic perspective. Our hypothesis is that, with ROA, co-funding rates are lower than the ones laying upon traditional discounted cash flow method.

Apart from the introduction, the literature review will disclose the pros and cons of ROA and how suitable it was in real case studies, particularly in transport facilities. Then, the non-flexible scenario of Ponta Delgada Port expansion is presented, as well as its main results. Methodology, results, and discussion follow. For last, the main conclusions are addressed along with our research contributions, main limitations and further research.

2 Literature Review

ROA arises to solve the limitations of traditional evaluation methods. Traditional methods, like the discounted cash flow method, focus on the selection of a discount rate suitable for the risk of the project. Nonetheless, management flexibility is ignored and investment decisions are seen as a “now or never” type. In this way, expected cash flows’ present value is considered as a passive method, better suitable in fewer investment scenarios. It shows limited applicability in uncertainty conditions (Couto, Crispim, Lopes, Pimentel, & Sousa, 2013). Dzyuma (2012) lists types of investments where traditional evaluation methods do not fit. For those, ROA makes sense.

In other words, according to Trigeorgis and Reuer (2017), real options are seen as an “opportunity to acquire real assets through possibly favourable conditions”. In practice, as a result of its financial roots, a corporation expansion option is often seen as a call option, while an exit option behaves like a put option. Copeland and Antikarov (2003) bring some advantages of real options application to investments in real assets. Not only real options analysis frameworks deal with uncertainty arising the project value but they also contemplate the flexibility and real assets active management. In addition, the model shows a bigger similarity with the entrepreneurial reality as well as the flexibility value for each investment alternative is included in the results.

Being ROA a relatively recent concept, literature usually notes it as a limitation. Others are risk modulation, the use of imperfect approaches, the lack of market prices or liquidity, and the firms’ specific risk. In the face of that, the decisions based on this approach could not always converge to optimal decisions that theoretical models claims. ROA application should not be incompatible with other valuation methods, such as NPV. In most instances, the value for the scenario with no flexibility in operation and/or strategic adaptability is given by NPV (Trigeorgis & Reuer, 2017). The value from active management flexibility plus the NPV, become Net Present Value Expanded (NPV-E). In this way, as shows Couto et al. (2013), we have:

$$NPV_{expanded} = NPV_{static} + Option\ Value\ for\ Flexibility \quad (1)$$

Investment projects could incorporate one option, as well as several options, as Trigeorgis (1996) argues. However, to run ROA, several requirements must be met, which includes the existence of a suitable framework, uncertainty upon investment decision, the possibility to perform changes in the future, and a rational decision-maker seeking to exercise the option on its optimal time (Mun, 2002). As Kostrova, Britz, Djanibekov, and Finger (2016) identify, there are many methods to assess the real option value, including models with stochastic simulations, network models (binomial, trinomial, etc.), Monte-Carlo simulation, numerical methods with analytic solutions and partial differential equations, like the finite difference approach.

As pointed out by Chambers (2007), infrastructure investments face several sources of uncertainty: the investment expenditures (usually are underestimated), the expected traffic demand (that can be affected by several factors like the GDP growth), and operating revenues, among others.

Due to its suitability, ROA is being used to assess large infrastructure investments. Regarding high-speed railway transport, Pimentel, Azevedo-Pereira, and Couto (2012), Couto, Nunes, and Pimentel (2015) and Pimentel, Nunes, and Couto (2018) develop a ROA framework, in continuous time, in order to calculate the optimal time to deploy the investment in an uncertain environment. Azevedo-Pereira, Couto, and Nunes (2010; 2013) made developments regarding the optimal timing of relocation. Pimentel et al. (2018) extended Smit (2003) framework regarding investments in airport infrastructures.

Concerning port infrastructure investments, Taneja, Aartsenm, Annema, and van Schuylenburg (2010) did it for the Rotterdam port. They assume that to expand or renew a seaport, it is necessary to consider a long payback dilemma, apart from the required large investments in large scale facilities, along with a high level of uncertainty. This kind of projects faces uncertainty challenge, that requires different evaluation techniques in order to capture flexibility on the decision making, seize the advantages of some opportunities that may appear and immunize itself against certain risks. Additionally, Martins et al. (2017) intend to incorporate the flexibility in port planning, using a binomial network framework American-style call option to appraise Spanish Ferrol’s container terminal capacity expansion. In order to prove the framework consistency, Martins et al. (2017) performed a sensitivity analysis on critical variables and a Monte Carlo simulation on NPV upon base scenario and scenario with flexibility. Previously, Martins (2013) analysed the economic value resulting from the flexibility of the “new Lisbon Airport” investment, through an approach that considers the investment as a sequential option set.

Those are just a few examples of researches that used ROA to asses large infrastructure investment. Nonetheless, as far as we know, the literature on ROA only focuses on the investment project perspective, neglecting the impact of the financing structure to the investor's return. Some regions, like the Azores, can benefit from financial aid from the EU for projects that NPV is negative, but has high economic value. This financial aid depends on the net profitability of the investment project and intends to cover the funding gap between investment expenditures present value and net operating cash flows present value. All based on traditional discounted cash flow.

Literature shows that, usually, the investment project value is higher than is NPV (see equation (1)). In this way, our research aims to find if and how far the investment on Ponta Delgada Port was under-evaluated (according to EU method in use) and, consequently, benefiting from additional aid from the EU, in ROA point of view.

3 Case Study: Ponta Delgada Port

3.1 Base Scenario (Static NPV)

In order to evaluate the option to expand Ponta Delgada Port, the main info and parameters used in the cost-benefit analysis go as follows.

The construction works for this port include three main components: 1) reordering an access road to the port; 2) reinforcement of the pier, and 3) re-profiling pier 10. The third component is the one that will have more impact on operational performance since it will allow having a larger cargo storage and movement capacity, the possibility of simultaneous service three container ships of large dimensions (100 m to 120 m), as well as a larger area for the container parking (around 40% plus). At nominal prices, the total investment expenditures are around 43 million euros, for 8 years. Investment expenditures present value, at a 4% discount rate (European Commission, 2014), reach 35 million euros.

Once the investment gets done, Ponta Delgada Port revenues should grow 1.9% in the first year and 1.8% a year in each of the 2 following years. Across the investment period, revenues should grow 0.1% a year, similar to the no investment decision. In terms of operational running costs, beyond variable costs, the port will incur in maintenance costs (95 thousand euros in the first year, 205 thousand euros in the second year and 325 thousand euros in the following years) and in replacement cost for the new equipment (55 thousand euros 12 years later). The port will not need more employees. EU funding gap was set in 98.18% (the present value of net operating cash flows only covers 1.82% of the investment expenditures present value). Ponta Delgada Port investment project got 83.46% financial aid from the EU (85% co-funding rate multiplied by funding gap).

Evaluation outputs came in four perspectives: 1) investment perspective; 2) investor perspective (investment expenditures net from subsidy); 3) direct impacts on the economy, which considers the direct benefits and costs that are non-monetary (time travel savings, pollution, etc.); 4) induced impacts on the economy. The three first perspectives are mandatory to get EU aid, according to the European Commission (2014) guidance, grounded by the traditional discounted cash flow method. Regarding the last perspective, not mandatory, it considers the existence of a positive impact on regional GDP during the construction phase, as well as will increase the region's attractiveness as a tourist destination, which will increase revenues in the tourism sector in the following years. The framework used to assess this impact is similar to Glickman (1971) and Hall and Licari's (1974) small region econometric model, with data from Fortuna and Vieira (2007). The cost of capital for financial analyses is 4% and for economic analysis is 5%, as suggests European Commission (2014).

Table 1 illustrates the main results for Ponta Delgada Port expansion (Fundo de Maneio, 2017):

[Insert Table 1 here]

Even with financial aid from the EU, the project still presents a negative NPV. The economic value of the investment is positive, considering just the direct impacts or the induced impacts on the economy. Assessing the investment project value using ROA follows.

3.2 Real Options Analysis

ROA captures the value related to the uncertainty of an investment project due to the management capacity to choose the better pathway as time passes through. It minimizes the losses on unwanted scenarios and captures value on optimistic scenarios.

In this particular case, demand (measured in number of TEU - twenty-foot equivalent unit) is the only exogenous variable and it will follow a binomial process. As Figure 1 shows, demand in Ponta Delgada Port in the last 38 years faced high volatility and there is high uncertainty in the following years. Despite the relation between tourism sector growth and cargo handled in Ponta Delgada Port (the graphic shows port higher activity after the liberalization of the air space in the Azores in 2015), and the efforts to keep growing tourism activity in the Azores, the uncertainty in demand stays high. Additional to the reduced internal regional market, the Azores compete with other competitive destinations and there are accessibility difficulties related to the regional flag carrier airline and low-cost carriers (LCC). Additionally, as Couto, Pimentel and Ponte (2017) and Ponte, Couto, Pimentel and Oliveira (2018) argue Azores touristic destination is still an emergent market and it needs to consolidate its position across the world, making available better experiences and rising tourists average stay and expenditures (Ponte, Couto, Pimentel, Sousa, & Oliveira, 2019).

[Insert Figure 1 here]

The option to expand the port capacity can be one year delayed, in each period across time. In other words, we face an American-style call option in a capacity expansion problem as Martins et al. (2017), Smit (2003) and Pimentel et al. (2018), among others.

In order to compare ROA results with static NPV, we will set the same conditions and assumptions in the ROA framework, adding the option to delay the investment until the EU Multiannual Financial Program 2014-2020 deadline (late 2023).

The investment phase takes 8 years, being the base year (year 0) the last one. Uncertainty of the exogenous variable during the investment phase is neglected (future research should address this issue). Total investment expenditures present value (2014, investment phase begin) is 35,379,838 €, including equipment replacement expenditures 12 years later. Total investment expenditures future value (2020, investment phase end) is 44,757,668 €. Local authorities will support 16.46% (7,404,738 €) and can delay the investment decision until 2023 (which corresponds to time T).

The evaluation is done under an incremental approach (as did local authorities). Therefore, project operating cash flows (TCF_t) is given by the difference between the cash flows in the no expansion investment scenario and in the expansion investment scenario. Smit (2003) and Pimentel et al. (2018) start assessing the value of assets in place, i.e., port with no expansion investment. The value of assets in place comes from the port value on each node of the binomial tree without expanding its capacity. For that, it is necessary to draw, in the first place, the binomial tree for the exogenous variable (number of TEUs handled in Ponta Delgada Port) without capacity restrictions. According to Portos dos Açores, S.A. (2019), in Ponta Delgada Port were handled 74,179 TEU in 2018. Assuming that, during the investment period, demand will rise by 0.1%, the number of TEU in 2020 will be 74,327.

According to Cox, Ross, and Rubinstein (1979), the up (μ) and down (d) movement factors needed to run the binomial process for the exogenous variable is given by the following equations:

$$\mu = e^{\sigma\sqrt{(\Delta t)}} \tag{2}$$

$$d = \frac{1}{\mu} = e^{-\sigma\sqrt{(\Delta t)}} \tag{3}$$

The 6,85% volatility (σ) came from the normalized standard deviation historical volume of cargo handled in the Ponta Delgada Port (www.srea.azores.gov.pt), turning $\mu = 1{,}07$ and $d = 0{,}93$. Local authorities demand analysis in an optimistic scenario, expect 1.9 million tons of cargo handled in Ponta Delgada Port in 2023. Compared to 2018, it represents 6,5% growth, which is in line with the μ value.

With this data, it is possible to build the binomial process for the exogenous variable without capacity restrictions (Q_t), starting in 2020 with a value of 74,327 TEU and going ahead across time according to the up μ and down d movements.

[Insert Figure 2 here]

Nonetheless, with no expansion investment, the port cannot handle all TEU demand for the most optimistic scenarios. Recall that, with no expansion investment, demand in Ponta Delgada Port will only rise by 0.1% until 2023. At that time Ponta Delgada Port can handle 74,554 TEU maximum (Q_{max}). To evaluate the value of assets in place, a binomial process with capacity restrictions is required. For each node, restricted demand ($\mathring{Q}_t$) is:

$$\mathring{Q}_t = \min[Q_t; Q_{max}] \tag{4}$$

So, the binomial process for demand with no expansion investment is as follows:

[Insert Figure 3 here]

Operating cash flows in each node of the event tree with capacity restriction ($\mathring{TCF}_t$) is:

$$\mathring{TCF}_t = \mathring{Q}_t \cdot CF \tag{5}$$

Operating cash flow per TEU (CF) is 11.77 € and it was computed using Portos dos Açores, SA data. The binomial tree for operating cash flows, considering capacity restrictions, is as follows:

[Insert Figure 4 here]

Using the binomial tree and backward procedures, the value of assets in place is found. Port value at the end nodes of the event tree ($\mathring{V}_T$) is the sum of the operating cash flow of that year plus terminal value using perpetuity upon the annual operating free cash flow from assets in place and a constant risk-adjusted rate (k):

$$V_T^{\circ} = \frac{TCF_{T+1}^{\circ}}{k} + TCF_T^{\circ} \tag{6}$$

We will set $k = 4\%$, as recommended by the European Commission (2014). Returning to the current state, the port value in each node (V_t°) is computed using the risk-neutral probability (p), the expected present value in the up (V_{t+1}^{+}) and down (V_{t+1}^{-}) states and the expected operating free cash flows for year t (TCF_t°):

$$V_t^{\circ} = \frac{p.V_{t+1}^{+} + (1-p).V_{t+1}^{-}}{e^{R_f \Delta t}} + TCF_t^{\circ} \tag{7}$$

According to Couto et al. (2013), p comes from:

$$p = \frac{e^{R_f \delta t} - d}{\mu - d} \tag{8}$$

The risk-free rate (R_f) is the average of the Euro-AAA rated countries' yields, as suggested by Damodaran (2008). Between September 2018 and August 2019, the average risk-free rate is 0.850% according to KPMG AG (2019) data. With $p = 0.545$, the value of assets in place is 23.9 million euros.

[Insert Figure 5 here]

Regarding the decision to deploy the expansion investment, management has the option to, in each year, expand the capacity and capture the port incremental value or postpone the expansion investment, leaving the option open (Mun, 2002). The expansion investment value-added comes from incremental operating free cash flows present value of the additional capacity. To assess optimal decisions, it is necessary to compute incremental cash flows for each node, starting with expected demand after the expansion investment is deployed. Operating cash flows in each node of the event tree without capacity restriction (TCF_t) is given by:

$$TCF_t = Q_t \cdot CF \tag{9}$$

with CF assuming the same previous value, 11.77 €. Incremental cash flow (ΔTCF_t, which is all expansion investment operating cash flows) is the difference between the port's operating cash flows with expansion investment (TCF_t) and port's operating cash flows with no expansion investment (TCF_t°):

$$\Delta TCF_t = TCF_t - TCF_t^{\circ} \tag{10}$$

[Insert Figure 6 here]

Using backward procedures, the evaluation starts in the end nodes, where the project value in these node (V_T) is given by:

$$V_T = \frac{TCF_{T+1}}{k-g} + TCF_T - V_T^{\circ} \tag{11}$$

With expansion investment, the residual growth is 1%. In prior years, the investment project value in each node (V_t) is given by:

$$V_t = \frac{p.V_{t+1}^{+} + (1-p).V_{t+1}^{-}}{e^{R_f \Delta t}} + \Delta TCF_t \tag{12}$$

With all inputs known, the last tree can be drawn to compute the options values on each node of the binomial tree (C_t). This option value can be seen as a call option on the incremental cash flow. C_0 will be the option value at year zero.

In the end nodes, the decision is to invest and receive the value generated by the investment project onward net of investment expenditures ($V_T - I$), or not to invest and receive nothing:

$$C_T = \max[V_T - I; 0] \tag{13}$$

In the preceding years, the decision will be to invest and receive the value generated by the investment project onward net of investment expenditures ($V_t - I$), or to postpone the investment, leaving the option open (Mun, 2002):

$$C_t = \max[V_t - I, \frac{p \cdot C_{t+1}^{+} + (1-p) \cdot C_{t+1}^{-}}{e^{R_f \Delta t}}] \tag{14}$$

Next section came up with results, considering the option value in three perspectives:

1. Investment perspective, with total investment expenditures (I) of 44,757,668 €;
2. Investor perspective, with investment expenditures (I) of 7,404,738 €, corresponding to the ones that will be supported by local authorities; and
3. Economic perspective (only direct impacts): Using the same framework to assess the call option on the economic benefits net of economic costs, according to Fundo de Maneio (2017). The main differences on the inputs is that CF will correspond to the net economic benefits per TEU, the discount rate is 5% (European Commission, 2014) and investment cost is

41,603,195 € (using a 5% discount rate instead of 4% and other minor corrections suggested by European Commission (2014)).

Table 3 presents the main parameters values for the Ponta Delgada Port expansion investment.

[Insert Table 2 here]

3.3 Results and Discussion

We aim to compare the ROA results with NPV supported in the traditional discounted cash flow method (Static NPV), foreseeing the implications that ROA may have in the EU co-funding policy.

From the investment perspective, static NPV is negative and the option value is 0 €. Flexibility does not add any value to the investment project. If the investment project were 100% financed by local authorities, the decision should be not to invest in the expansion, even if the expected demand rises to the most optimistic scenario in 2023. In any scenario, implementing the investment project will lead to value destruction. Despite the high economic value and a must for a region, those kinds of infrastructural investments are not attractive in a purely financial perspective, and as a consequence, no private entity sees interest in doing so. Financial aid will turn the investment project, at least, less financial unviable to local authorities, seeking a way to deploy it in order to promote the economic and social development of the Azores.

[Insert Figure 7 here]

[Insert Figure 8 here]

In fact, all those conclusions are coherent to the results from the cost-benefit analysis (Fundo de Maneio, 2017). Using a Monte Carlo simulation the probability to turn NPV positive is nearly 0%.

The financial aid local authorities will receive from the EU reduce substantially the investment expenditures to be supported locally. In the investor perspective, with 83.46% financial aid, the option value is positive (2.0 million euros), despite static NPV being negative.

[Insert Table 3 here]

This clarifies that flexibility can play a role in add value to investment projects. Ponta Delgada Port expansion should be postponed two years until demand reaches 85.241 TEU in 2022 or, at least, reaches 79.597 in 2023 (last year to deploy the investment). Since the incremental operating cash flows are positives, the call option value is coming mainly from the terminal value found in equation (6).

[Insert Figure 9 here]

[Insert Figure 10 here]

Once again, the results are in line with the cost-benefit analysis (Fundo de Maneio, 2017). If expected demand rises to the most optimistic scenario (6.5% growth rate for 3 years in a row), static NPV will be positive.

If EU financial aid goes up 85% of the investment expenditures (maximum rate), the investment project should be deployed in 2023 even with demand at a lower level (69.406 TEU) than in 2020 (74.327 TEU). The value for the investor comes from the residual growth after 2024, only possible if the investment decision gets done. Note that, even with the co-funding rate near to 100%, the decision would be to wait one year to resolve some uncertainty. To expansion investment be deployed in 2021, co-funding must reach 89.2% (not possible under the current rules) and expected demand must rise to the optimistic scenario.

As said before, to be eligible for UE co-funding, investment projects need to have negative FNPV, both in the investment and investor perspectives. Investment projects filling in the EU co-funding scheme cannot create any value for the investor. Considering that flexibility is a factor that adds incremental value to expansion investment in Ponta Delgada Port (it can be postponed until uncertainty resolves and optimal timing to invest is reached), co-funding rate should be 67.76% in order to not create any value for the investor (neglecting additional costs to fund the investment project, v.g. debt interest). The remaining investment expenditures to be supported by local authorities with this co-funding rate is not enough to revert the decision not to invest, even in the most optimistic scenario for demand in 2023 with no value for the call option. value. Regarding investor perspective static NPV, the EU co-funding rate would need to be 98.18% to turn it equal to 0 €, the same as the funding gap of the investment project. Note that Ponta Delgada Port expansion investment project gets approval with a negative NPV in the investor perspective, even having 83.46% EU co-funding. Negative NPV equals the remaining fund to be supported by local authorities (15%) plus the net operating cash flows present value.

[Insert Table 4 here]

For last, option value in economic perspective was calculated and, as expected, its value is very high (379.1 million euros). The value of assets in place from an economic perspective reached 1,423.6 million euros. These findings are in line with the cost-benefit analysis, assigning to the investment project, and to the port itself, high importance to economic and social Azores development. Nonetheless, the results in the economic perspective, are subject to discussion, since it depends on some assumptions and inputs that may deviate from the context of the Azores, or even Portugal. This perspective intends to monetize benefits and costs that are not financial and, in the Azores, data available on those are very scarce.

ROA can have impacts on the EU co-funding policy if this framework gets adopted to determine co-funding rates. It is highly probable that a high number of investment projects get lower EU co-funding rates since ROA adds more value to investment projects than traditional discounted cash flows method. The former uses the flexibility factor to mitigate risk. ROA tends to be more complex to run, with a high number of inputs. How it should be used to assess EU co-funding rates should benefit from deeper research. If data is not consistent, significant over or underestimated option values can be generated or it can result in different EU co-funding rates for similar projects in similar contexts. Additionally, investors really need to assess their options for their investment projects. Can it be delayed? Can it be abandoned? How should these options be assessed? All of these answers should be consistent for all countries, without neglecting the specifics of each one, as much as possible. This is a complex difficulty to overcome since ROA assumes that the investor will only decide to invest when the optimal time is reached. Copeland and Tufano (2004) refute the critic that ROA tends to over evaluate an option value, as long as decisions are made in its optimal time. Nonetheless, EU cohesion policy does not consider just a pure finance perspective of a single project. Impacts on the regional economy and social welfare need to be assessed too. Due to political, economic or other reasons, it may happen that an investment project must be deployed before its optimal time. Even a framework searching for the decision to invest in optimal time is useful to assess the consequences of doing it at any other moment.

3.4 Adding More Uncertainty and Flexibility

In Ponta Delgada Port was assumed that investment can only be postponed 3 years, coinciding with the remaining period that a project can be executed under the EU Multiannual Financial Program 2014-2020. Indeed, as shown in the previous chapter, the fact the investment can be postponed until a better moment, even if for a small-time horizon, adds value to the option to expand the port. Nonetheless, as it is known in the literature regarding ROA, higher uncertainty and flexibility add, generally, more value to an option. In this way, two different scenarios were added: 1) investment can be postponed until 2027 (submission deadline to EU Multiannual Financial Program 2021-2027); 2) investment can be postponed until 2030 (deadline to execute investment projects under the forthcoming EU Multiannual Financing Program 2021-2027). We assume the EU co-funding base rate (84.36%) and the uncertainty of the exogenous variable will remain both the same as in the base scenario. Also no new capacity restrictions. Remaining inputs the same base scenario. The same framework with a larger time horizon increases the number of nodes and, consequently, the number of scenarios and decisions.

[Insert Figure 11 here]

Regarding the results, even if demand grows 7% for 10 years in a row, the decision is never to invest, considering the investment perspective. The option value remains worthing 0 €. In the investor and economic perspectives, option values are positives and even higher compared to the base scenario, confirming the positive effects of uncertainty on option values.

[Insert Table 5 here]

From the investor perspective, it is interesting to see that, with a co-funding rate of 83.46%, the decision to invest in the most favourable scenario should occur at 2023 when demand is 91,284 TEU, regardless of option time horizon (7 or 10 years). Even if demand stays, 10 years later, at the same level as in 2020, the decision should be to invest in 2030. With an 85% co-funding rate and a 10 years' time horizon, the investment should be deployed in 2022 if demand reaches the most favourable scenario (85,241 TEU). To investment be deployed in 2021 with a demand of 79,597 TEU, the co-funding rate needs to be 93.6% (not possible under the current rules).

[Insert Figure 12 here]

[Insert Figure 13 here]

If uncertainty has positive effects on option values, it will have negative effects on co-funding rates. As said before, investment projects filling in the EU co-funding scheme cannot create any value for the investor (option value must be 0 € in the investor perspective). For that, the co-funding rate should not be higher than 41.5% if the investment could be deployed up to 2027, or 16.6% if the investment could be deployed up to 2030. With higher uncertainty, the co-funding rate will lean towards 0%. When the co-funding rate is 0%, option value in the investment perspective will be positive, which means that the investment could create value on its own and does not need co-funding to low the investment costs, even if static NPV says otherwise.

[Insert Table 6 here]

Despite further research needed, on some topics not covered here, to better understand the impacts of ROA on the EU co-funding policy, it is an instrument to help rationalize the allocation of EU funds and to better develop the cohesion policy. Nonetheless, it may require better planning from the EU and all its members regarding infrastructural investments. To be effective, this analysis should be made prior to the Multiannual Financing Program, in order to analyse the options, decisions, evolution of exogenous variables and co-funding rates. For future research, besides the ones already revealed, the framework could be extended to incorporate a variable co-funding rate, in order to adjust it to the different scenarios under the same binomial tree.

4 Final Considerations

Considering the value that is given by flexibility and uncertainty on the valuation of infrastructural investments, this paper aims to validate the hypothesis that the use of ROA has impacts on the EU co-funding policy, especially in the determination of co-funding rates. In order to acknowledge these impacts, the case of Ponta Delgada Port, the most important maritime infrastructure in the Azores, was used, since it was a project that was co-funded by EU according to the rules of a cost-benefit analysis (European Commission, 2014; Fundo de Maneio, 2017). With a static NPV known, we use a binomial framework to assess the incremental value of an expansion investment project with the possibility to postpone the investment, according to the frameworks developed by Smit (2003), Martins et al. (2017) and Pimentel et al. (2018).

The results show that, in the investment perspective, the project does not create financial value, regardless of the time horizon of the framework. In fact, this is one of the requirements to get co-funding from the EU. From the investor perspective, the main impacts on the EU co-funding policy were found. Considering the co-funding rate that was approved, the expansion option value is positive. This means that, for the investor (the owner), there are some scenarios where the investment can create financial value since part of the investment is already covered by EU funds. With more flexibility and uncertainty, this value increases too. According to the EU rules, a project cannot create financial value for its owner and, therefore, co-funding rates may become overestimated.

Nonetheless, ROA incorporates a high number of inputs over a traditional discounted cash flow method. In order to ROA become the model to determine co-funding rates, limitations that came up along this paper should be addressed and uniformized for all EU members.

Besides the empirical application of ROA on the Ponta Delgada Port expansion, our paper aims to contribute to the literature regarding public policies, especially regarding the use and rationalization of public funds on infrastructural investments.

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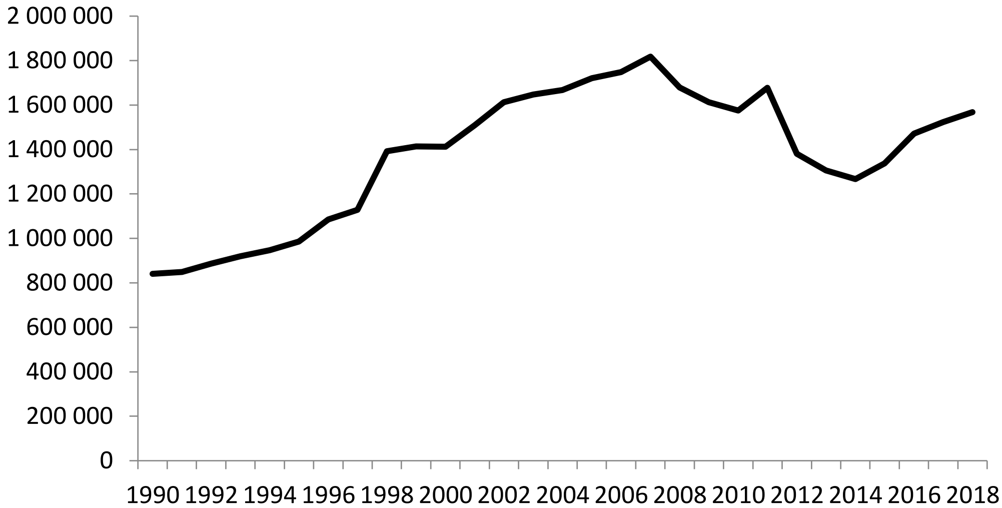
Figure 1 - Tons of cargo handled in Ponta Delgada Port (1980-2018)



Source: www.srea.azores.gov.pt

Figure 2 - Binomial process of the exogenous variable (3 years) without capacity restrictions (TEU).

			91.284
		85.241	
	79.597		**79.597**
74.327		**74.327**	
	69.406		**69.406**
		64.811	
			60.520
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 3 - Binomial process of the exogenous variable with capacity restrictions (TEU).

			74.551
		74.551	
	74.551		74.551
74.327		74.327	
	69.406		69.406
		64.811	
			60.520
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 4 - Operating cash flows with capacity restrictions (thousand euros)

			877
		877	
	877		**877**
875		**875**	
	817		**817**
		763	
			712
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 5 - Value of assets in place (thousand euros)

2020	2021	2022	2023
			22,811
		23,495	
	23,853		**22,811**
23,920		**22,785**	
	22,503		**21,237**
		20,648	
			18,518

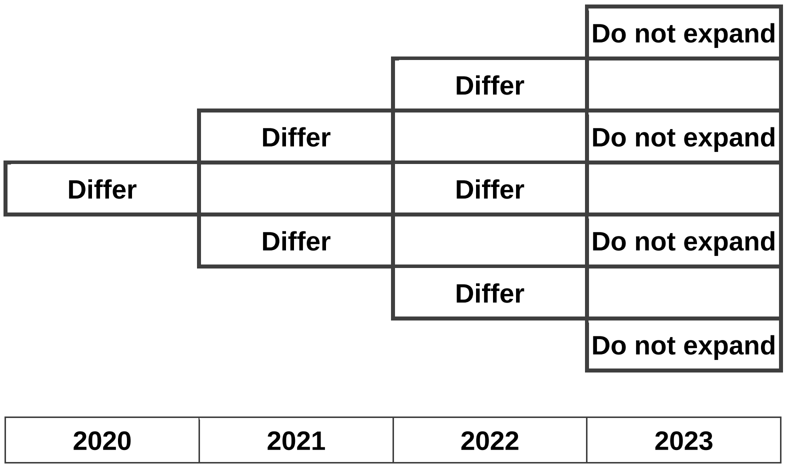
Source: Own elaboration

Figure 6 - Incremental cash flows (thousand euros)

			197
		126	
	59		**59**
0		**0**	
	0		**0**
		0	
			0
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 7 - Decision tree on investment perspective



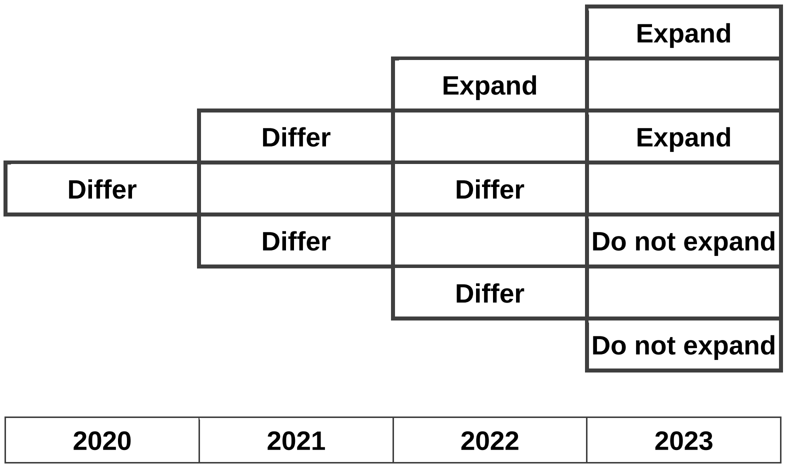
Source: Own elaboration

Figure 8 - Option value on investment perspective (thousand euros)

			0
		0	
	0		0
0		0	
	0		0
		0	
			0
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 9 - Decision tree on investor perspective



Source: Own elaboration

Figure 10 - Option value on investor perspective (thousand euros)

			7,026
		4,879	
	3,188		**2,258**
2,021		**1,220**	
	660		**0**
		0	
			0
2020	**2021**	**2022**	**2023**

Source: Own elaboration

Figure 11 - Binomial process of the exogenous variable for 10 years without capacity restrictions (TEU).

										147,779
									137,687	
								128,571		128,571
							120,059		120,059	
						112,110		112,110		112,110
					104,688		104,688		104,688	
				97,757		97,757		97,757		97,757
			91,284		91,284		91,284		91,284	
		85,241		85,241		85,241		85,241		85.241
	79,597		79,597		79,597		79,597		79,597	
74,327		74,327		74,327		74,327		74,327		74,327
	69,406		69,406		69,406		69,406		69,406	
		64,811		64,811		64,811		64,811		64,811
			60,520		60,520		60,520		60,520	
				56,514		56,514		56,514		56,514
					52,772		52,772		52,772	
						49,278		49,278		49,278
							46,016		46,016	
								42,969		42,969
									40,124	
										37,468
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Source: Own elaboration

Figure 12 - Decision tree on investor perspective for a 7-years' time horizon

							Expand
						Expand	
					Expand		Expand
				Expand		Expand	
			Expand		Expand		Expand
		Differ		Expand		Expand	
	Differ		Differ		Differ		Expand
Differ		Differ		Differ		Differ	
	Differ		Differ		Differ		Do not expand
		Differ		Differ		Differ	
			Differ		Differ		Do not expand
				Differ		Differ	
					Differ		Do not expand
						Differ	
							Do not expand
2020	2021	2022	2023	2024	2025	2026	2027

Source: Own elaboration

Figure 13 - Decision tree on investor perspective for a 10-years' time horizon

										Expand
									Expand	
								Expand		Expand
							Expand		Expand	
						Expand		Expand		Expand
					Expand		Expand		Expand	
				Expand		Expand		Expand		Expand
			Expand		Expand		Expand		Expand	
		Differ		Differ		Expand		Expand		Expand
	Differ		Differ		Differ		Expand		Differ	
Differ		Differ		Differ		Differ		Differ		Expand
	Differ		Differ		Differ		Differ		Differ	
		Differ		Differ		Differ		Differ		Do not expand
			Differ		Differ		Differ		Differ	
				Differ		Differ		Differ		Do not expand
					Differ		Differ		Differ	
						Differ		Differ		Do not expand
							Differ		Differ	
								Differ		Do not expand
									Differ	
										Do not expand
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Source: Own elaboration

Table 1. Evaluation indicators of the investment in four perspectives

Indicator	Unit	Value
1) Investment perspective		
Net present value	€	-34,703,418.2
Internal rate of return	%	-17.38
Profitability ratio	abs	0.010
Payback period	years	n/d
Present payback period	years	n/d
2) Investor perspective (considering the financial aid from EU)		
Net present value	€	-5,254,783.5
Internal rate of return	%	-8.81
Profitability ratio	abs	0.060
Payback period	years	n/d
Present payback period	years	n/d
3) Economic perspective - Direct impacts		
Net present value	€	38,514,821.6
Economic rate of return	%	11.88
Cost-benefit ratio	abs	8.604
4) Economic perspective - Induced impacts		
Net present value	€	41,280,940.6
Economic rate of return	%	12.87
Cost-benefit ratio	abs	2.063
Payback period	years	15.00
Present payback period	years	16.45

Note: abs – absolute value

Source: Fundo de Maneio (2017)

Table 2 - Main parameters values for the Ponta Delgada Port expansion

Parameter	Investment perspective	Investor perspective	Economic perspective

I -	Investment costs	44,757,668 €	7,404,738 €	41,603,195 €
CF -	Operating cash flow per TEU	11.77 €		-
EB -	Net economic benefit per TEU	-		845.30 €
R_f -	Risk-free rate	0.850%		
p -	Risk-neutral probability	54.5%		
k -	Constant risk-adjusted rate	4%		5%
g -	Residual growth rate	1.0%		
μ -	Up movement factor	1.07		
d -	Down movement factor	0.93		

Source: Own elaboration

Table 3. Results of the model (million euros)

	Investment perspective	Investor perspective	Economic perspective
Static NPV of the project (according to CBA with DCF analysis) Year zero = 2014	-34.7	-5.3	38.5
Expansion value with real options analysis Year zero = 2020	0	2.0	379.1

CBA - Cost-Benefit Analysis
DCF - Discounted Cash Flow

Source: Own elaboration

Table 4. Co-funding rates with DCF and ROA

Approved rate	83.46%
Rate that turns static NPV = 0 (investor perspective)	98.18%
Rate that turns option value = 0 (investor perspective)	67.76%

Source: Own elaboration

Table 5. Results of the model with more uncertainty and flexibility (million euros)

	Investment perspective	**Investor perspective**	**Economic perspective**
Expansion value with real options analysis in a 7 years' time horizon	0.0	3.4	452.6
Expansion value with real options analysis in a 10 years' time horizon	0.0	4.3	504.2

CBA - Cost-Benefit Analysis
DCF - Discounted Cash Flow

Source: Own elaboration

Table 6. Co-funding rates with more uncertainty and flexibility

Rate that turns option value = 0 in a 7 years' time horizon (investor perspective)	41.53%
Rate that turns option value = 0 in a 10 years' time horizon (investor perspective)	16.56%

Source: Own elaboration