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# An Oifig Buiséid Pharlaiminteach Parliamentary Budget Office **Uncertainty Challenges in Budgetary Costing Analysis**

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## Séanadh

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# 1 Overview

Costings produced by the Parliamentary Budget Office (PBO) are estimations of the financial effect of proposals for policy on the Budget. While the PBO will strive to produce the best possible estimate of the budget impact of a policy, all costing estimates are subject to some elements of uncertainty. This means that it is likely that the estimated cost will differ from the actual outcome once the policy proposal is implemented. The level of uncertainty will differ due to factors such as simplifying assumptions, data quality, methodology, the variability/stability of the costing base, and the size of the policy change.

## 2 Introduction

As part of its functions, the Parliamentary Budget Office provides parliamentarians with an independent and impartial costing service to evaluate the fiscal impact of new tax or spending policies. Estimating costs is a recognised and well-established means to assess the financial impact of policy proposals on the Budget. It is also a keystone of ensuring accountability within the limits of scarce budgetary resources. When the costs of policy proposals are clearly laid out, greater fiscal transparency and better accountability follow.

However, all costings are produced with uncertainty inherent in the analysis. This paper explores this issue and highlights challenges arising from the uncertainty in budgetary costing studies. Costing policy proposals is a predictive analysis estimating how much a policy would cost in the future. Therefore, there will always be uncertainty about how close a costing estimate will be to the actual figure. This paper explains how different sources of uncertainty can affect the confidence we can have in the policy costing produced. We also identify how uncertainty issues can be addressed during a costing analysis.

In brief, there are two main sources of uncertainty that can make a costing estimate deviate from the final realised cost of a policy:

- Assumptions (e.g., assumptions on behavioural responses to a policy); and
- Availability, quality and variability/stability of the data used as an input.

The next section defines what is meant by uncertainty and how it affects the approach and outcome of a costing analysis. Section 3 outlines the main factors determining uncertainty arising from assumptions. Section 4 refers to data-related uncertainty in detail. Section 5 discusses how to address uncertainty in costing analysis. The final section summarises and concludes.

### 3 Defining uncertainty in Budgetary costings

**On request, the PBO will prepare costings of policy proposals for Members of the Houses of the Oireachtas.**<sup>1</sup> However, the analysis will be constrained by a number of factors related to uncertainty. The analysis subject to uncertainty essentially means that an actual cost will turn out different from the estimate. The confidence we have in a costing estimate diminishes the greater uncertainty is involved in the costing process. Although it is common for policy makers to refer to a single costing figure, if a costing estimate inherently contains uncertainty, it is essential to understand the implications of the uncertainty in costing analysis. This is because a single costing figure is a composite/aggregated indicator. The process to produce it entails summing various uncertain possibilities to reach a single “bottom line.” Thus, the sensitivity of costing analysis to uncertainty must be explored and understood.

### 4 Uncertainty due to assumptions made

**Costing analysis is, by definition, of predictive nature.** Therefore, not all aspects of the analysis can be based on data (as we cannot know the future in advance), and assumptions are necessary to make with respect to:

- The context where the policy will be implemented (e.g., the future macroeconomic environment);
- The behavioural responses of the target population of the policy (e.g., whether they will behave as the policy has originally intended); and
- The behavioural responses of the population other than the target population (e.g., whether they will be affected indirectly by the policy through a “spillover” effect).

The assumption usually made on context is either the continuity of the status quo - social, economic, and political environment, or a change in such an environment that is reasonable to estimate by a standard economic projection model. In other words, it is assumed that there will be no “shock” or drastic change such as a financial crisis or a war. The assumption usually made on behavioural responses is that no behavioural change takes place. A less stringent but more analytically demanding assumption is that people change their behaviour to the extent that it maximises the benefit they can obtain from the proposed policy.

**A justification for an assumption can be made, based on logical reasoning, expert judgement, and/or extrapolation from available data.** The credibility of assumptions should be checked by peer review and/or backed up by relevant previous research. Yet, sometimes, less reasonable assumptions may be required as a solution under practical constraints. This is because assumptions can limit the range of potential input values which otherwise would be too complicated.

<sup>1</sup> Please see the PBO's Policy Costing Service Guidelines available on [our website](#).



**Some assumptions are made intentionally by the analyst, while others are latent and not recognised even by the analyst.** Often a deliberate recognition or choice is made in setting the value of the assumption. Sometimes, continuing or extending past assumptions may not always be appropriate. A policy that is “very new” will particularly increase the uncertainty. Assumptions can remain unrecognised because not all elements of costing analysis are under the analyst’s control, e.g., how data were collected and coded by a third party, what assumptions a standard analytical model makes inside the “black-box” algorithm, and how computations work within a specific machine. Keeping track of the number of assumptions (at least those known to the analyst) is important, as more assumptions means greater sensitivity of the estimate to uncertainty, *ceteris paribus*.

**Assumptions can bring uncertainty in costing estimates, because the realised future situation can turn out different from the assumed one.** The wider the range of assumption values used, the greater the level of uncertainty will be. A forecast for key economic variables – both near and long-term – will have a large bearing on the budgetary implications of a policy change. The macroeconomic environment might differ, and people might behave differently from what was assumed. However, it is not necessarily the case that a higher discrepancy between the realised future situation and the assumed one will lead to a bigger difference between the actual cost and the estimated one. It depends on what assumptions are unreflective of the future reality, by how much and to what extent.

For example, if the unemployment rate was higher than had been assumed in a costing analysis for an unemployment benefit, it would not necessarily guarantee greater uptake than estimated in the analysis, if, for example, there were more opportunities in, and easier access to, a neighbouring country’s job market than was assumed. In other words, the interaction between different assumptions makes it even harder to understand exactly how the divergence between those assumptions and what will actually happen in the future will affect the costing estimates.

**Table 1: The link between assumptions and uncertainty**

Type of Assumption	Purpose in costing analysis	Outcome for costing analysis	Impact on uncertainty
<b>Explicit (known)</b>	• Clarify the broader economic and fiscal context	• Simplifies the exercise	↓
	• Set boundaries for policy application	• Deals with known unknowns	↓
	• Fills the gaps in available information	• Ignores unknown unknowns	↑
	• Limits the possible behavioural response to a limited number of outcomes		
<b>Implicit (may not be obvious)</b>	• Relies on theory of logic and rational decision-making	• Simplifies the exercise	↓
	• Assumes all relevant information is clear and accessible	• May be hidden to the modeller	↑
	• Complex behavioural responses/non-standard objectives are not considered	• May be unavoidable	↓
	• Does not allow for 'change of mind' or tweaking of the policy in process	• Imposes rationality	↓
		• Decides that unknown dynamic effects are irrelevant	↓

Source: PBO

## 5 Uncertainty due to data issues

**The other issue that brings uncertainty is data.** Data-related uncertainty affects not only costing projections but also identifying the current baseline for a costing, so assumptions have to be made about the current situation. We identify two key issues.

**First, the degree of uncertainty changes depending on the availability of quality data.** When quality data are available for all aspects of a costing analysis,<sup>2</sup> there will be less uncertainty. As the availability of quality data decreases, the uncertainty increases. It follows that when the quality of data is poor (or data do not exist in the first place, which is the extreme case of poor data), additional assumptions are required to fill in this informational deficiency (“additional” in the sense that they must be made in addition to the assumptions necessary for future conditions).

**Poor quality of data can arise due to measurement errors, missing information,<sup>3</sup> outdated information, a small sample size, or unrepresentativeness of a sample regarding the target population of a policy.** When the evidence is of bad quality, the costing estimate produced will be subject to more uncertainty. To mitigate for poor quality data, a costing analysis will need to, for example, fill in missing information with additional assumptions, or try various plausible inputs for the same key parameter, to capture uncertainty.

**Second, greater variability of past data patterns increases the uncertainty of costing estimates.** This is the case even if the quality of data available is not an issue. If actual patterns in the past have been prone to volatile moves or are unstable, it will be uncertain which time point should be used as the current baseline of costing, and the projection of what will happen in future will also be more uncertain.

<sup>2</sup> This is of course except for the future conditions, where data do not exist by definition at the time of the analysis and assumptions are therefore necessary, as discussed in the previous section.

<sup>3</sup> Only a few years back, time lags for publishing spending reports and the preparation of official statistical reports in Ireland was considered to be among the longest in the OECD; and coverage of the accounts was considered to be particularly narrow (Downes and Nichol, 2016 in “Review of budget oversight by parliament: Ireland”, OECD Journal on Budgeting Volume 2016/1).



**Table 2: Consideration of how the size of the policy change affects uncertainty**

Category	Hypothetical example	Type of uncertainty	Effect on Costing exercise
<b>Policy change introduced to new populations not previously affected</b>	New welfare scheme or tax	Existing data not recorded.  The rate at which people will qualify or make claims is imprecise or unknown.	The potential population must be assumed or based on a survey of those potentially affected. The costing will be sensitive to the changes in behaviour made to qualify. Application rates could be affected by communication campaign or 'inducements' to apply.
<b>Behavioural response not known for changes to existing policy</b>	Widening the scope of an existing policy or changing qualification criteria	The change significantly adds to the price of goods/services.  Some could maintain or increase their consumption (if a dependency has been established) i.e. price inelastic; an unknown proportion could substitute away to an alternative – price elastic.	Price elasticities are hard to estimate for different segments of the consumption base.  Price elasticity of products is typically estimated by looking at the impact of small increases in price. The impact of a large increase in price is less certain, particularly as income effects may also occur.
<b>Data may not exist for some changes</b>	Linking social welfare receipt to previous earnings or changes in means test criterion	Eligibility could be extended if new or existing eligibility criterion are radically altered.  Distributions of key variables may be unavailable or unreliable (if related to a different purpose)	Administrative data might not exist for populations previously ineligible. The costing needs to be based on imputed or extrapolated data
<b>Large policy change with significant transitional uncertainty</b>	Phased introduction of a new sales tax or social welfare scheme.	Transitional uncertainty occurs when details of the adjustments are partially applied or applied at a lower rate initially.	Uncertainty increases if the response occurs in stages or there are uncertainties according to the timing and scale of the revenues/expenditure generated.

Source: PBO derived from Australia PBO (2017) <sup>4</sup><sup>4</sup> Parliament of Australia Parliamentary Budget Office, Technical Note no. 01/2017. Available [here](#).

## 6 How to address uncertainty in costings

**It is important to identify and deal systematically with uncertainty in a costing analysis.** Statistical measures of the level of uncertainty in the modelling techniques used should be routinely calculated. It is also important to monitor past forecast errors as well as the uncertainty inherent in the current forecast. The PBO is committed to being transparent in relation to the factors that affect the reliability of the costings prepared.

**Sensitivity analysis is the main tool.** Alternative scenarios both for the economic situation and other inputs into the budget costings estimates will highlight the sensitivity of estimated costs to determining factors.<sup>5</sup> Sensitivity analysis can be streamlined by the statistical simulation technique called Monte Carlo analysis. In this way, credible/confidence intervals around a point estimate express the extent of the uncertainty as the variability of the costing estimates.

**Additionally, analysing the sources of errors is crucial.** Retrospectively, it is important to review how well past costing analyses have performed in light of realised data, and fine-tune existing models if necessary. Prospectively, possible errors in estimates can be identified, by examining what kind of errors all conceivable factors of uncertainty can bring to costing analysis.

**Statistical simulation techniques can facilitate more sophisticated policy and costing analysis when faced with missing data and data uncertainty.** Suzuki outlined a potential strategy to simulate synthetic micro data using statistical techniques.<sup>6</sup> Techniques based on Monte Carlo analysis, which repeats a simulation many times, allow us to derive a distribution of cost estimates. This helps capture the uncertainty around the estimate from which credible/confidence intervals are applied reflecting the uncertainty inherent in the modelling.

## 7 Summary and Conclusions

This paper has outlined the impact of uncertainty on budgetary and costing analysis. Uncertainty means the possibility that the actual outcome could turn out different from an estimate. We have discussed how assumptions made and the availability, quality, and variability of data are the main contributors to uncertainty in costing policy proposals. The PBO endeavours to be transparent with the assumptions and methodology used in our responses to costing requests.

<sup>5</sup> Standard statistical methods of sensitivity analysis widely used include assigning probabilities to data distributions, applying variable treatment patterns, scenarios of alternative resource utilisation and considering variable prices/tariffs.

<sup>6</sup> Suzuki, A. (2022), "Simulating Micro data for Policy and Costing Analysis", PBO Working Paper no. 1 of 2022. Available [here](#).



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