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review

Inferential reasoning in policy analysis: knowledge use under uncertainty and complexity

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Contemporary policy problems often involve calls for action in contexts marked by high levels of uncertainty and value-laden conflict. This poses a challenge to traditional approaches to policy analysis based on expectations of the availability of relatively uncontested norms and evidence and, often, more or less unlimited time. This article proposes a diagnostic approach to policy problems which combines multiple knowledge types (scientific, craft, practical, theoretical and intuitive) in an iterative inferential process of problem framing, analysis, deliberation and adaptation. This kind of inferential reasoning promotes rapid policy learning through better inference, data collection and use. Based on 'abduction', this approach allows analysts to work productively under knowledge, time and resource constraints by making provisional but transparent inferences which are then iteratively updated as new evidence emerges. Similar but less constrained than Bayesian approaches, such an orientation helps policy analysts arrive at actionable conclusions and recommendations faster and more accurately than traditional inductive or deductive methods.

Keywords abduction • inferential reasoning • knowledge integration • policy analysis • policy complexity • uncertainty

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Introduction: Policy analysis in complex and uncertain worlds

Policy problems are often characterized by volatility, uncertainty, complexity and ambiguity – sometimes referred to as 'VUCA' environments (Bennett and Lemoine, 2014a, 2014b) – which pose significant challenges for traditional policy analysis, which presupposes more clearly defined problems and the presence of knowledge

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adequate to address them. Approaches such as cost–benefit analysis or *ex ante* and *ex post* impact assessments presume the existence of epistemological and temporal environments that can allow problem identification and solution adoption to occur relatively quickly and with a high confidence of accuracy.

While conditions of uncertainty and ambiguity always challenge policy makers to some degree (Manski, 2011), heightened global turbulence and interconnectedness not only speed up the spread of problems and demands for their solution but also strain the capacity of traditional analytical approaches to provide adequate, rapid and actionable guidance to decision makers and policy formulators. Developing actionable evidence on the origins and corrective measures needed to deal with many problems from pandemics to homelessness and drug abuse can take years of research and can require lengthy control trials to gather evidence, while problems with uncertain definitions and solutions and conflicts over them can add to delay and undermine confidence in any conclusions reached.

Conventional approaches such as cost–benefit or effectiveness analysis, for example, assume levels of knowledge and certainty about future conditions such as discount rates and problem origins that turbulent environments rarely provide, and commonly presume an environment where the time to collect and digest information is not lacking and the speed of decision-making is not pressing. Such circumstances ultimately constrain the development of policy solutions through traditional techniques which fail to address the issue concerned, be it climate change, pandemics, tariffs or crypto, in a timely and satisfactory manner.

In other words, traditional epistemological challenges found in the policy sciences are exacerbated by the scope and intensity of many social, economic, health and other problems, and many existing methodologies and approaches are ill-suited to dealing with demands placed on governments for swift action and problem amelioration. Analytical approaches are needed that are better suited to such complexities, conflicts and uncertainties and are able to deal in a timely fashion not only with unknown parameters or 'uncertainties' but also fundamental disagreements and knowledge limits which further enhance 'ambiguity' in policy making and analysis (Rittel and Webber, 1973; Funtowicz and Ravetz, 1993; Levin et al, 2012; Cairney, 2019).

But what direction should efforts take to better reconcile analysis and environment? This is not immediately clear. While traditional, positivist, methodologies are problematic, critics of them have not developed alternate methodologies or approaches that can deal with many current problem environments. 'Post-positivists', for example, have long criticized conventional analytical methods but have done so due to them masking power dynamics and normative assumptions, not because of their ineffectiveness in complex epistemological environments. They do not directly engage with alternate analytical methods and have offered only vague calls for greater participation and consultation as alternative governance arrangements that might deal with what are often perceived as overly technocratic biases in existing tools and processes (Fischer, 2019).

As a result, there is growing interest in alternative and more practice-oriented approaches to policy inquiry and advice that are better suited to the volatile and rapidly changing nature of policy-making environments (Baines and Cunningham, 2013). But practitioners who have atheoretically adopted novel deliberative forums

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and techniques such as social media–based crowdsourcing and citizen juries to help gather input and legitimize administrative and political decisions, for example, have often found the effectiveness of these processes limited by access and cost barriers that introduce their own biases in who participates, and result in poor information generation, policy inputs and outputs (Parry et al, 2024; Agger and Egmose, 2025; Goovaerts et al, 2025).

This article contributes to the discussion of future directions in policy analysis by showing how classical typologies of knowledge types help outline the basis of an approach to analysing problems and fashioning solutions to them that is better suited to many contemporary environments than traditional techniques. The article proposes an *inferential*, diagnostic, approach to problem analysis or 'policy reasoning' that integrates diverse modes of reasoning into a complementary tool to traditional forms and methods of policy analysis.

This form of reasoning involves the synergistic combination of multiple knowledge types (scientific, craft, practical, theoretical and intuitive) in an iterative or 'abductive' process of problem framing, analysis, deliberation and adaptation that promotes policy learning and 'inference towards the best solution' (Lipton, 2004). These knowledge types, inferential reasoning processes and a learning orientation work together iteratively or *abductively* to better inform and guide policy analysis and decision-making in complex environments where traditional techniques fail altogether, or fail to arrive at timely results.

Such an approach to policy reasoning is often practised naively in government but can also be formalized as a method that can help analysts work productively under time and resource constraints. It does so largely by reducing initial evidence needs before informed action can be taken, encouraging reasonable but provisional inferences to be made from existing knowledge, which are then refined as action unfolds. At its core, this inferential reasoning process follows a straightforward logic: analysts draw on available facts, technical knowledge, theory and practical judgement to diagnose a problem and derive a plausible response. This provisional hypothesis is then tested through implementation, with results feeding back to update and refine both diagnosis and solution. The process iterates, with each cycle sharpening understanding and improving the fit between intervention and problem in a Bayesian-like prior updating procedure (Kaplan, 2019). This allows practitioners to arrive at workable policies faster than waiting for definitive causal evidence would permit, while building in mechanisms for learning and correction as new information emerges which can continuously update and refine policy efforts.

The article proceeds as follows. The next section reviews the challenges of contemporary and past policy analysis, highlighting the limitations of conventional technocratic and critical approaches in dealing with complex, uncertain and value-laden policy problems. We then introduce the policy reasoning framework, outlining its classical foundations and multidimensional logic. The subsequent section demonstrates how this kind of policy reasoning can be applied to the policy process, illustrating its iterative dynamics and adaptive potential. Two sections then discuss the methodological and practical implications of the framework, identifying specific techniques and skills for supporting the different modes of knowledge which contribute to policy reasoning. The concluding section summarizes the key arguments and points to directions for further research and experimentation.

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Uncertainty and the limits of conventional approaches to policy analysis

Dealing with societal change and the uncertainty it engenders about future states has always been and will ever remain the defining challenge of policy analysis (Manski, 2011). Although it has always been an issue, its severity increases with increasing complexity including the faster-moving dynamics of an increasingly interconnected, and conflict-riddled, world.

A distinction is useful here. 'Uncertainty' as Knight (1921) distinguished, has two forms. One covers fundamental risks when probability distributions affecting outcomes are unknown or unknowable; the other covers less serious situations where probabilities can be estimated and managed. This distinction has carried over into concerns about differentiating 'ambiguity' and 'uncertainty' (Matland, 1995) or 'deep' uncertainty from more normal kinds (Walker et al, 2010). While advances such as those in climate modelling and other fields may transform some previously ambiguous parameters into quantifiable risks, policy problems often involve uncertainties that resist probabilistic treatment, including unpredictable political responses, changed or emergent stakeholder coalitions, and implementation dynamics that confound forecasting.

Some of this is due to the increased complexity or 'enchainedness' of problems which commonly occurs over time and makes their dissection and analysis difficult, while some is due to gaps in knowledge or evidentiary 'unknowns', both of which may take a long time to fill through conventional research activities (Haag et al, 2025). But both these issues are made more problematic by any increases in the intensity and speed in which problems develop and spread, limiting greatly the time available for their study. That is, while policy makers must always grapple with a wide range of unknowns and unknowables they now commonly must also do so at an accelerated temporal pace that frustrates conventional approaches to policy analysis and administration (Howlett and Goetz, 2014; van Hulst and Visser, 2025). From climate change to pandemics to technological and political disruptions, current policy problems may be characterized by deep uncertainties about their causes or consequences, but in any configuration may not always provide a great deal of time in which to study problem causes or fashion evidence-based and tested policy solutions to inform practitioners and practice (Levin et al, 2012).

This was amply signified by the many flawed government responses to the rapid onset of the COVID-19 global pandemic, for example, which would probably have been less severe had the pandemic spread more slowly and allowed more time for study; but, of course, it did not (Capano, 2020; Tosun and Howlett, 2021). It is also true of government responses to US-driven tariff shocks in 2024-2025 and the side-effects of the rash military adventures of the same era.

These different kinds of policy uncertainty manifest themselves as problems for policy analysis in several distinct forms (Howlett and Migone, 2025). *Empirical uncertainty*, for example, arises from gaps in data and knowledge about policy problems. Climate change exemplifies this: uncertainties persist about warming rates, regional impacts, feedback loops, tipping points and the effectiveness of mitigation strategies (Hall, 2024). These uncertainties stem from natural system complexity, model limitations, the tension between long time-horizons and short action windows, and from the pure novelty of events. The multiple views held by different actors in an area

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like climate change also highlight the added difficulties caused by *political uncertainty* when powerful actors in society disagree strongly over problem causes, effects and solutions (Howlett and Migone, 2025).

Normative uncertainty is a third kind, which reflects disagreements about values and ethical principles guiding policy choices. Economic policy debates, for example, reveal tensions between growth and sustainability or the distribution of wealth; climate policy raises questions about fair distribution of costs across generations and moral obligations to ecosystems. Value conflicts – individual freedom versus social equity, competing stakeholder claims – pervade many policy arenas (Stone, 2012). These normative disputes, rooted in different world views and philosophical frameworks, resist technical resolution, though systematic frameworks for clarifying value goals can go some way towards rendering normative analysis more tractable (Daniels, 2007; Linquiti, 2024). When value conflicts intersect with political divisions and power struggles, however, reaching consensus on relevant facts, let alone solutions, becomes extremely difficult (Aagaard et al, 2024).

Finally, *interactive uncertainty* emerges from policy processes' enchainedness – whereby outcomes depend on multiple stakeholders' actions and responses occurring either simultaneously or in sequence. Climate policy effectiveness and economic trade and tariffs, for instance, rely not just on one country's choices but on responses from other nations, businesses and civil society. This complexity is compounded by interactive issues such as free-riding, cross-border leakages, rebound effects and cross-border spillovers, which all challenge traditional policy silos and analytical boundaries (Lewallen, 2022).

Conventional approaches to policy analysis are ill-suited to dealing with the last three uncertainties and struggle with the first. This is because they rely heavily on technical expertise manipulating agreed-upon sets of facts or evidence, typically using quantitative methods and rational decision-making models which can deal with only some kinds of uncertainties or help to better understand their sources and mitigate them. And techniques such as random-control trials or econometric analyses all require time and clean or agreed-upon data and are ill-equipped to handle the steep and multiple epistemic, political and other challenges that policy problems now commonly involve (Fischer, 2003; Levin et al, 2012; Lawrence et al, 2023).

Traditional approaches struggle to grapple with the difficult and contested nature of many policy issues, actors and evidence at the best of times, and fare poorly in more highly contested and time-constrained environments (Zittoun et al, 2021; Aagaard et al, 2024). Framing policy problems in purely technical terms, for example, obscures the value-laden and politically contested nature of policy choices, often presenting them as mere matters of objective calculation or optimization (Majone, 1989), glossing over some of the more fundamental normative or political issues they face. Attempts at depoliticization, for example, can fuel public distrust and backlash against policy elites and institutions, as seen in the current rise of populist movements and anti-science and anti-expert sentiments in many countries, exacerbating the problems themselves by complicating their analysis and potential resolution.

The effort to subject most policy issues to cost–benefit analysis, for example, exemplifies these limitations. It requires precise quantification of outcomes and valuations (Boardman, 2006; Hansson, 2007) while relying on opaque assumptions

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around the standard of costs (monetization), agreement on discount rates and other aspects open to manipulation or questionable judgement. Under conditions of deep uncertainty, such quantification becomes impossible or misleading (Vining and Boardman, 2007). Similar science-based approaches like risk assessments also may reduce some empirical uncertainties in stable situations but cannot resolve underlying value conflicts shaping how evidence is framed and interpreted or provide insight when risks are large, new or unknown (Maxim and van der Sluijs, 2011).

Even sophisticated tools like multi-criteria analysis, designed to systematize uncertainty and values in complex situations depend on subjective judgements open to contestation (Mayer et al, 2004; Saarikoski et al, 2016). Criteria selection and weighting remain politically fraught, privileging certain perspectives over others (Keeney, 1992), while the technical complexity involved in such techniques limits accessibility and democratic legitimacy (Leong et al, 2023).

Conversely, purely participatory approaches that reject technical analysis face different limitations (Hendriks, 2009). While emphasizing values and democratic deliberation, they often neglect empirical evidence and analytical rigour (Head, 2008; Howlett, 2020), risking a relativistic environment where any perspective may appear equally valid regardless of its factual basis (Paul and Haddad, 2019). Participatory methods also struggle with representation and quality of deliberation, as marginalized groups face participation barriers while powerful or better resourced interests dominate (Hendriks, 2006), and the technical nature of issues and process complexity often prevents meaningful lay citizen engagement (Gonçalves et al, 2024; Wauters et al, 2025). This dichotomy between technical and participatory analysis can, however, be overstated. As Linquiti (2024) and Ryan (2023) argue, normative analysis can be made more rigorous through deployment of systematic frameworks for clarifying value goals and integrating them with evidence. But the challenge may then lie less in choosing between facts and values than in developing approaches that suitably integrate both to the satisfaction of all parties.

To reiterate, both traditional positivist and post-positivist policy analyses may well remain appropriate in dealing with limited, 'tame' or well-bounded problems: those with clear parameters, stable contexts and proven solutions. However, a more subtle framework is necessary when, more commonly, problems exhibit characteristics that overwhelm these conventional approaches. Such 'wicked' characteristics include deep uncertainty, fundamental value conflicts, severe time constraints, novel situations lacking precedent, or repeated implementation failures despite technical soundness, all conditions that characterize many issues in the present age (Crowley and Head, 2017).

The kind of inferential reasoning advocated in this article is intended to help overcome these challenges and involves the integration of several elements. First, it requires a synergistic combination of different knowledge types, including what classical philosophers termed *episteme*, *techne*, *phronesis*, *sophia* and *nous* (Aristotle, 2011; Moss, 2024). Second, it employs an iterative process of problem framing, analysis, deliberation and adaptation, which 19th- and 20th-century philosophers of science termed *abduction*. Third, it requires the maintenance by analysts and decision makers of a pragmatic orientation towards supporting situated judgement and action emphasizing learning and the role of 'inference to the best explanation' (Lipton, 2004; Sanderson, 2009).

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Policy reasoning: an inferential approach

As was argued earlier, addressing the varied challenges to traditional forms of policy analysis in the contemporary era requires an approach that transcends the limitations of the commonly deployed technocratic and normative participatory methods of policy analysis cited above.

This approach has certain requirements. First, it needs to acknowledge and accommodate the inherent uncertainties and complexities of policy problems rather than attempt to eliminate or ignore them, or be paralysed by them. It should also embrace a circumspect and pragmatic view of policy knowledge, recognizing the limits of prediction and control in complex dynamic environments (Cairney, 2012). Furthermore, it must engage constructively with diverse stakeholder values rather than impose false consensus or a depoliticized technocratic rationality onto policy deliberations. And it must help navigate the political realities and power dynamics of everyday policy processes rather than assume the conditions exist for unproblematic 'rational' decision-making (Brunner, 1991).

At the same time, policy analysis must maintain fidelity to factual accuracy and analytical rigour. While acknowledging the value-laden and context-dependent nature of policy knowledge, upholding standards of evidence, logic and critical scrutiny in policy deliberations remains crucial. But this must be done without requiring years or decades to reach definitive *ex-ante* conclusions to pressing problems (Nutley et al, 2007; Cartwright and Hardie, 2012).

To address these challenges, this article proposes a multidimensional inferential approach that recognizes the multifaceted nature of policy problems and levels of difficulty involved in gaining the knowledge required to resolve them. The framework draws upon the long-standing recognition that human endeavours of this kind involve five complementary knowledge types which come together to analyse and diagnose problems – factual knowledge, craft knowledge, practical wisdom, theoretical wisdom and intuitive reason – described in classical philosophy respectively as *episteme*, *techne*, *phronesis*, *sophia* and *nous* respectively (Tenbensel, 2006; Aristotle, 2011).

Integrating these diverse knowledge forms to guide action encounters a range of problems that have been extensively explored in some aspects of the existing policy literature, such as those related to environmental governance and resilience. Anderies et al's (2019) work on 'knowledge infrastructure systems', for instance, provides valuable insights into how these different kinds of knowledge interact in the analysis of complex socioecological systems. It offers guidance concerning how decision frameworks and stop-rules in each area help generate diagnostic understandings that inform actionable and implementable strategies.

This article builds on such foundations but generalizes these insights across multiple domains and issue areas.

Integrating different knowledge types

Policy making employs diverse forms of knowledge and reasoning to generate actionable recommendations, even in simple and uncomplicated or unconstrained policy environments.

Each of the five knowledge types we have set out plays a vital role in the processes of describing, understanding and transforming policy domains though their relative importance varies with context.

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As is well known, factual knowledge (*episteme*) is critical and relies on empirical observations to draw insights into any phenomenon's permanent and transitory aspects. Often used synonymously to define 'evidence', such knowledge constitutes systematized data or facts about problem conditions and impacts that can and should inform analysis of policy problems and potential solutions. However, epistemic knowledge on its own proves limited, particularly under conditions of uncertainty, complexity and value pluralism, when facts may not exist or may be contested, or may not exist at a high level of quality and accuracy.

Technical or instrumental expertise (*techne*), on the other hand, encompasses knowledge not of 'facts' per se, but of manipulable elements affecting a problem situation and knowledge about how to manipulate them. Essential for designing and implementing interventions, in the policy world this embodies the knowledge needed by government officials and administrators, for example, to deploy effective policy instruments and instrument mixes, or to design effective participatory or collaborative processes (Howlett, 2024). Yet *techne*, too, remains insufficient on its own for addressing elements of policy such as the value-laden and politically contested dimensions of complex policy problems outlined earlier.

In a third dimension, practical wisdom or *phronesis* is what enables decision makers and analysts to navigate the human relationships, moral values and political dynamics omnipresent in the policy realm. Situational awareness and value judgement allows policy makers to weigh competing values in specific contexts, and such knowledge is critical for effective policy design and for understanding and overcoming problems such as legitimation concerns or a lack of compliance with government wishes (Vickers, 1965; Flyvbjerg, 2001). Phronesis integrates empirical evidence and technical knowledge with normative considerations (Kristjánsson et al, 2021), allowing policy makers to balance stakeholder perspectives, navigate power relations and exercise contextual judgement (Majone, 1989; Sanderson, 2002). This form of knowledge, however, in itself remains partial and a- or pre-theoretical, limiting its scope and application to future-oriented decision-making.

Theoretical knowledge (*sophia*) is a fourth form of knowledge which helps integrate the other three. It does so by providing a conceptual understanding of the phenomenon under investigation through the creation and critique of formal models and theories that allow comparisons to be made and lessons to be learned from divergent practices, techniques and evidence. It shapes judgements about what facts to collect, which actions to examine and which instruments might prove effective (Hall, 1993; Hogan and Howlett, 2015). In policy contexts, this includes understanding how institutional landscapes, policy paradigms and social systems shape issues and timing, revealing structural constraints and opportunities for change and encapsulating or codifying them in various models and theories of decision-making and policy-making behaviour and actions from economic theory to psychological (Greenstein, 1973).

This application of wisdom to anticipate and inform consideration of future states is made possible by *nous*, or reasoning itself, which allows the other four knowledge types to inform present-day decisions involving judgements of future conditions and circumstances. It is this knowledge of logic and reasoning that enables problem reframing, hypothesis generation and the envisioning of plausible alternative futures to take place at all (Aydede, 1998; Dunne and Raby, 2013; Corcilius et al, 2025). While sometimes translated as 'intuition', *nous* is better

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understood as the capacity for pattern recognition and diagnostic insight that precedes formal demonstration. This inferential ability allows policy makers to transcend established models and current fashion to imagine novel solutions in new future worlds (Colebatch and Castles, 2024). Inference from known data to future circumstances of this type drives policy making forward (Considine, 2012; Alexander et al, 2014) and what distinguishes *nous* as a form of knowledge is its primordial character, allowing the other knowledge forms to be drawn together into provisional but actionable conclusions. The importance of this kind of knowledge has been highlighted in design-for-policy practice, for example (Design Council, 2005), particularly in policy related 'living labs' and innovation units that intentionally seek to promote innovative and creative 'outside the box' thinking (Möck and Feindt, 2024; Bhatta et al, 2025).

As this brief summary shows, these five knowledge types are distinct and each requires a specific set of skills and training if they are to be applied with positive effect in policy making. Hence it is not surprising that policy schools for example, provide courses on empirical methods and data collection (*episteme*) and on policy instruments and administrative practices (*techne*), but also highlight case studies (*phronesis*) and economic, political and social theory (*sophia*). *Nous*, or policy reasoning, is often not addressed directly in specific courses but is a key component of course elements such as writing policy briefs projecting past behaviour into the future, envisioning possible solutions and recommending changes.

The approach proposed here, however, emphasizes the need to focus more clearly on how these skills are combined and deployed by analysts to infer from their knowledge of facts, values, practices and theories and accurately diagnose problems and propose solutions to them. Such reasoning processes, it is argued, should, and do, follow abductive principles, embracing continuous learning, experimentation and adaptation in dealing with evolving circumstances and unforeseen consequences. This kind of inferential reasoning, it is argued, is needed more than ever and should be taught in policy programmes and analytical training, and executed more systematically in policy-making practice. Doing so necessitates better articulating and supporting an iterative and evolutionary approach to policy design and practice, already practised in some quarters, where interventions are treated as hypotheses to be tested and refined through ongoing monitoring, feedback and adjustment.

A medical analogy illuminates the aims of the training. Physicians combine diagnostic facts, surgical skills, disease theories, understandings of human nature, and intuition to diagnose and treat illness, and must synthesize diverse kinds of knowledge to navigate uncertainty, value and knowledge conflicts in so doing (Geva-May, 2005, 2007). *Episteme* provides empirical evidence of symptoms: medical profiles for doctors, problem data for policy makers. *Techne* supplies operational skills: clinical and surgical techniques for physicians, policy instruments for analysts (Weimer, 1992, 1993). *Phronesis* enables judgements to be tailored to the specific circumstances of individual patients in medicine and of social behaviour in policy making. *Sophia* offers systemic understanding: healthcare frameworks and epidemiological theories for doctors, institutional practices and policy theories for policy makers. In both cases, *nous* allows practitioners to synthesize these elements, enabling intuitive diagnosis of ambiguous symptoms to proceed quickly in medicine and allowing creative problem-solving in policy.

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Abduction as diagnostic inference: making the implicit explicit

While the sources and origins of the first four knowledge forms cited are reasonably well established, the role of reasoning (*nous*) in policy contexts remains under-theorized and largely implicit. Yet, policy practitioners, like medical doctors, and engineers and mechanics, employ *nous* as they practise a form of inferential reasoning: generating hypotheses from incomplete information, testing provisional solutions, and updating their understanding based on the results of their interventions.

Importantly, in the policy world this inferential practice often proceeds without explicit recognition or systematic application. What is 'missing' is not the element of *nous* or the role of inference from available evidence, per se, but rather its *conscious articulation and integration* within a diagnostic analytical framework. By making this implicit reasoning process explicit, we can enhance its rigour, teach it more effectively, and apply it more consistently across diverse policy contexts.

The intuitive practice of generating and testing explanations, of course, has deep theoretical roots. Termed 'abductive' reasoning, this logic of discovery was developed in its modern form by Charles Peirce in the late 19th century. It describes a form of diagnostic activity that seeks to identify the most plausible explanation for a given set of existing observations (Peirce, 1931–58; Douven, 2021) and characterizes well how decision makers of all kinds progress from inferences based on their existing knowledge, of all types, to hypothesis testing and refinement and towards explanations of superior forecasting and analytical power. It emphasizes the merits of drawing reasonable inferences from limited information and updating them based on experience, a processes that can overcome serious limitations in both empirical evidence and theoretical considerations while relying on existing knowledge, intuition and judgement to guide decision-making and do so in a reasonably expedient way (Niiniluoto, 2024).

Recent cognitive science offers neurobiological and computational support for the omnipresence of such abductive processes and approaches in many fields of inquiry. The predictive processing framework put forward by Pezzulo et al (2024), for example, suggests that human cognition naturally operates through iterative hypothesis testing and updating in a very similar fashion to the abductive process described by Pierce. Unlike deductive and inductive methods (Reichertz, 2014), which attempt to derive certain knowledge solely from empirical or theoretical analysis alone, abductive reasoning involves generating and evaluating tentative hypotheses based on incomplete information, then learning from the results of actions taken accordingly, updating priors and presuppositions along the way (Lipton, 2004; Ramesh and Howlett, forthcoming).

A practical application of policy reasoning

In public policy, this inferential and abductive *nous* or creative diagnostic reasoning process allows policy makers to navigate complex problem spaces, generate innovative solutions, and adapt to changing circumstances in a relatively rapid fashion, without the need to await difficult-to-assemble facts and trial results (Ramesh and Howlett, forthcoming). This form of reasoning emphasizes hypothesis testing and trial-and-error learning through careful monitoring and evaluation of policy interventions, allowing tentative diagnoses to be refined towards more confident conclusions as policy making takes place (Toulmin, 1958).

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Experienced policy analysts *already* engage in this form of diagnostic reasoning daily. They observe patterns, generate explanatory hypotheses, test interventions and refine their understanding based on outcomes. Jones (2017), for example, has shown how these kinds of policy decision-making processes take place in contexts of bounded rationality where, as Vickers, has noted, decision makers deal with the realities of uncertainty and conflict by exercising experientially based judgement and inference (Vickers, 1963, 1964, 1965). They typically reject a quest for absolute certainty and instead acknowledge that all knowledge is fallible and subject to continuous revision in the face of emerging doubts and new facts although this is not often acknowledged in political or administrative policy discourse (Ansell and Boin, 2019).

To operationalize and justify this approach while avoiding lengthy and drawn out ad hoc empirical or collaborative research processes, practitioners typically draw on pragmatist principles. Rather than seeking optimization, under conditions of uncertainty such practices can allow incremental, trial-and-error decisions that can generate quick feedback, as long as irreversible commitments are not made while acquiring more information.

Analysis of this kind thus typically begins with a rapid assessment of the contextual parameters that shape analytical choices: time available, reversibility and stakes, degree of political and value contestation, and availability and quality of data. This establishes boundary conditions in which other forms of knowledge are deployed. Epistemic knowledge helps identify essential datasets or meta-analyses and note uncertainty bounds. Technical knowledge focuses on feasible instruments with understood operational parameters. *Phronesis* captures implementation constraints and distributional considerations through targeted engagement.

Proposed solutions then work through iterative abductive cycles: each cycle proceeds from hypothesis generation to testing against the existing evidence set and involves systematic updating as new evidence arrives. Iteration stops when additional analysis only changes the preferred option by a very small extent or when time expires.

Since many of these practices already exist and are practiced by policy makers, the objective of this article is thus not to introduce abduction and inference as completely foreign or novel concepts, but rather to argue the need to systematize the reasoning patterns that practitioners often already employ, providing a theoretical foundation and practical tools to make this kind of diagnostic policy reasoning more transparent, transferable and teachable. Whether practitioners who employ inferential reasoning more systematically ultimately produce better outcomes than those who do not remains an empirical question beyond this article's scope. But *prima facie* inferential reasoning draws upon all four other forms of knowledge and in synthesizing them allows timely informed judgements about problem causes and solutions to be made. It is this integrative capacity that enables creative problem-solving, providing a structured approach for generating and evaluating explanatory hypotheses in contested and time-constrained environments based on available evidence and theoretical considerations, which other approaches based on more inductive or deductive methods do not.

The structured yet flexible approach outlined here accommodates the realities of time, knowledge and other decision-making constraints in a way that more traditional techniques and processes promoted in policy schools and elsewhere do not. It enables rapid, transparent decision-making that navigates between premature closure and

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'paralysis by analysis', scaling effectively from urgent situations requiring rapid response to more deliberative processes where time may permit deeper inquiry (Veselý, 2020).

Inferential reasoning and the policy formulation process

When practised self-consciously, an abduction-informed inferential reasoning process can help policy makers address complex challenges through iterative refinement (Howlett and Rayner, 2013). By combining the five forms of knowledge – *episteme*, *techne*, *phronesis*, *sophia* and *nous* – policy makers can navigate uncertainty, value pluralism and political contestation, and be well positioned to generate creative solutions and adapt to evolving circumstances. While useful under normal conditions, this approach becomes particularly crucial under deeper uncertainty and time constraints.

It should be noted, however, that knowledge is put to different purposes across the different stages of policy making, with specific knowledge types more prominent at different phases in this activity (Howlett et al, 2020). Problem definition and framing typical of agenda-setting, for example, typically begin with provisional frameworks and conceptual and theoretical models that highlight possible variables and relationships characterizing what makes a 'condition' a policy 'problem'. Epistemic and phronetic analyses subsequently deepen initial observations and identify empirical patterns and normative dimensions of specific policy-making contexts. Climate change policy, for example, evolves from framing the issue purely as a geophysical phenomenon to one encompassing global justice, economic transformation and societal resilience – a reframing continuously tested and refined through iterative stakeholder engagement and scientific evidence-gathering.

During policy formulation or design, technical knowledge guides the crafting of specific interventions and implementation plans, operating within *phronesis*'s assessments of political feasibility, behavioural considerations, and distributional or political impacts (Howlett et al, 2020; Howlett, 2024). While facts and evidence can support technical design through intervention modelling, and theoretical knowledge plays a key role in shaping overarching strategies, abductive reasoning remains essential for projecting present knowledge into future scenarios and potential or probable consequences.

Decision-making elevates practical judgement to the fore and emphasizes the importance of inference as decision makers forecast events, weigh trade-offs and negotiate conflicts, all while navigating towards an uncertain future. Inference can prove particularly valuable if deliberations stall, spurring creative problem reframing and novel solutions.

Following formulation and decision-making, implementation can also be seen to engage with different forms of knowledge as it relies heavily on technical knowledge to operationalize interventions, but also upon understanding human behavioural knowledge in order to identify compliance challenges and help adjust policies to emergent circumstances (Dupoux et al, 2025). Empirical knowledge, expertise and experience working with policy instruments and actors provides the knowledge needed to transform plans into operational procedures that link hypothesized relationships to practical reality. When participation in a new recycling programme falls short, for instance, implementers observing that missed pickups cluster in apartment buildings may imply that bin storage rather than resident motivation is the barrier,

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then test solutions accordingly. While empirical analysis of results remains important for evaluation (Varone et al, 2023), it is abductive reasoning or inference that enables a fundamental reimagining of problem definitions and solution strategies based on evaluative feedback.

By integrating diverse knowledge forms in this way, abductive or inference-based policy analysis helps mitigate the risks of myopic or partial perspectives dominating policy deliberations and leading to policy failure (Nair and Howlett, 2020). Its hallmark iterative learning process enables continuous readjustment of facts, opinions and knowledge as conditions evolve and new circumstances emerge (Pettrachin and Abdou, 2024).

Managing and promoting abduction: methodologies and techniques for enhancing inferential reasoning in policy practice

Various formal techniques already exist across various disciplines that can serve to further a more conscious or explicit use of diagnostic or inferential reasoning in policy analysis; their systematic application helps enhance policy analysis of this type.

Operationally, enhancing multidimensional inferential reasoning in the policy sphere requires analysts and their managers to strengthen at least one if not all of the five knowledge types and support iterative learning and adaptation. It must be implementable by policy teams, given moderate training, however. Several techniques exist and have been developed in fields such as operations research and future studies which can aid this aim.

Problem-structuring methods (PSMs) from soft operations research, for example, offer one way in which a more systematic conceptualization of ill-structured problems can be enhanced. Methods such as strategic options development and analysis (SODA) and soft systems methodology (SSM) help elicit stakeholder perspectives and map causal relationships, though they require skilled facilitation to manage power dynamics (Checkland and Scholes, 1990; Rosenhead, 1996; Eden and Ackermann, 2001; Pluchinotta et al, 2020). Complementing these approaches, foresight methods (including techniques such as horizon scanning, Delphi expert-elicitation techniques and scenario planning) can all help anticipate emerging developments and explore alternative futures (Linstone and Turoff, 2002; Könnölä et al, 2012; Amer et al, 2013).

Better understanding the policy landscape can also benefit from techniques that reveal otherwise hidden actor relationships and discursive framings. Policy network analysis and stakeholder mapping, for example, help to identify key actors, reveal power dynamics and assess political feasibility (Borgatti et al, 2009; Ingold, 2011; Fisher and Leifeld, 2019), while frame analysis examines how issues are discursively constructed and how different narratives shape policy implications (Schön and Rein, 1994; Béland and Cox, 2024).

Estimating likely policy consequences can also draw upon techniques such as impact assessments. And econometric techniques such as difference-in-differences, regression discontinuity and instrumental variables, if not used in isolation, can also help identify policy effects when data and time allow (Angrist and Pischke, 2009). Behavioural experiments can test responses to policy signals and promote more effective learning about compliance problems and other critical aspects of policy actor and public behaviour (Thaler and Sunstein, 2008). Participatory methods including

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citizen juries, deliberative polls and digital engagement platforms, again often less useful in isolation, can help inform judgements about political inferences (Fishkin, 2009; Aitamurto and Landemore, 2016).

Conclusion: Promoting better inference and diagnosis through abductive policy analysis

This article has identified an inferential form of policy reasoning that is already often practised naively in government as one that can help deal with the issues of volatility and uncertainty that characterize contemporary policy environments.

We adopted the term *inferential reasoning* to describe this integrative diagnostic approach to policy analysis.The term follows Lipton's (2004) formulation of 'inference to the best explanation' and captures the diagnostic character of what philosophers of science have termed 'abductive reasoning' (Douven, 2021). Such inferential reasoning describes what many policy analysts and actors already do when generating and evaluating explanations under conditions of uncertainty although this is often not recognized adequately in policy research and instruction. Drawing on available evidence, they form provisional conclusions, develop programmes, implement them and then update their beliefs as new information emerges.

By reconceptualizing and updating for the present era classical and late 19th-century ideas about knowledge and its integration, this approach offers a coherent and comprehensive method and set of techniques to grapple with the multifaceted nature of many policy problems, and to do so in a more rapid and iterative way than many inductive or deductive qualitative and quantitative techniques currently taught in policy schools and promoted in policy circles. It helps analysts work productively under time and resource constraints by triaging evidence needs, making provisional but transparent inferences, and updating as learning occurs.

This kind of analysis can provide structured guidance in the many circumstances where standard methods stall or fail to produce timely and accurate results. Efforts to promote this kind of abductive reasoning in new and emerging areas where information is scarce and time short has already appeared in design-oriented and innovative policy thinking and administrative practices, including those promoted in policy labs and 'design for policy' work, and has begun to attract attention in policy schools, even if it has not yet penetrated very far into their pedagogy (Ramesh and Howlett, 2025; van Hulst and Visser, 2025). Here we systematize the elements and thinking about this approach and show how it can become a coherent, teachable approach to problem-solving suitable to complex and uncertain environments.

The approach we have set out can help to systematically integrate different forms of knowledge to better address contemporary policy challenges in a way that escapes more traditional approaches and techniques. By making explicit the diagnostic reasoning that experienced practitioners often employ intuitively, the article shows how classical knowledge typologies form a coherent analytical framework well-suited to effective policy making in turbulent policy environments.

The practical value of this approach emerges through its structured yet flexible response to very real-world constraints on the use of traditionally taught and desired techniques such as cost–benefit or impact analysis. Conventional analytical techniques presuppose accessible and agreed-upon facts and evidence and the presence of technocratic expertise and predictive capabilities which are often

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unavailable, especially in uncertain and volatile times. They also struggle with the heavily value-laden and politically contested and intensive nature of issues ranging from the continuing impacts of globalization to the emergence of artificial intelligence (AI) which affect the need for new policies and the reform of existing ones (Head and Alford, 2015).

Effective policy analysis, like medical diagnosis or other forms of professional judgement, requires the integration of multiple knowledge forms through an iterative inferential or 'abductive' process. While policy practitioners routinely engage in this form of reasoning without explicitly articulating or understanding its epistemological roots, the lack of explicit articulation has limited its systematic application, teaching and improvement. By providing a better theoretical grounding for understanding what analysts already do – observing patterns, generating explanatory hypotheses, testing interventions and refining understanding based on outcomes – the framework transforms tacit practice into transferable capability.

Long-term realization of the framework's potential, of course, will require sustained commitment across multiple dimensions. Investment in training must encompass not just individual methods but their integration – teaching analysts when and how to combine approaches based on contextual factors. Developing communities of practice that can support knowledge exchange and capability building across organizational boundaries is also needed. Creating policy labs or innovation units, for example, can provide protected environments for developing and refining abductive approaches. Reframing performance metrics to value learning and adaptation alongside traditional measures of analytical completeness can also create incentives for appropriate method selection and application.

Elements of the diverse methodological toolkit – from PSMs and foresight techniques to network analysis and participatory approaches, and eventually AI – are already often found to be in use, but they gain coherence through their incorporation into an abductive framework that better informs their use in specific circumstances. Each method strengthens a specific knowledge dimension, contributing to better iterative learning cycles.

The framework's utility, however, will no doubt evolve as analytical technologies advance. AI is already transforming policy analysis, with large language models increasingly generating policy documents and analyses (Bullock and Chen, 2024). The question is not whether to use AI tools, but how to preserve essential human judgement within automated workflows. Inferential reasoning offers principled guidance: while AI excels at processing empirical knowledge and identifying technical options, the contextual judgement of *phronesis* and creative inference of *nous* remain fundamentally human contributions. Organizations can design AI-augmented processes that leverage computational efficiency without sacrificing the situated wisdom essential for addressing value-laden policy challenges. Future research should explore how inferential reasoning can guide the development of decision-support systems that amplify rather than replace human policy judgement.

Academic research oriented towards testing various kinds of models and frameworks, however, often remains distanced from the situated realities and pragmatic concerns of policy makers (Yanow, 2014; Botterill and Fenna, 2019). Traditional policy analysis remains entirely appropriate for well-bounded problems with clear parameters, stable contexts and proven solutions. However, when, as is quite common, problems exhibit deeper uncertainty, fundamental value conflicts, severe time constraints, or repeated

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implementation failures, an inferential approach offers essential instruction in how to proceed.

By providing both theoretical grounding and operational guidance for navigating uncertainty and complexity, this approach equips policy analysts to transcend the limitations of conventional methods while maintaining fidelity to evidence and analytical rigour. The result is not perfect prediction or complete consensus, but rather better-reasoned decisions that improve over time, time that otherwise would have been spent on the analysis itself.

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