Studies on the Effects of Mine Closures in Canada

CLARA LÉA DALLAIRE-FORTIER

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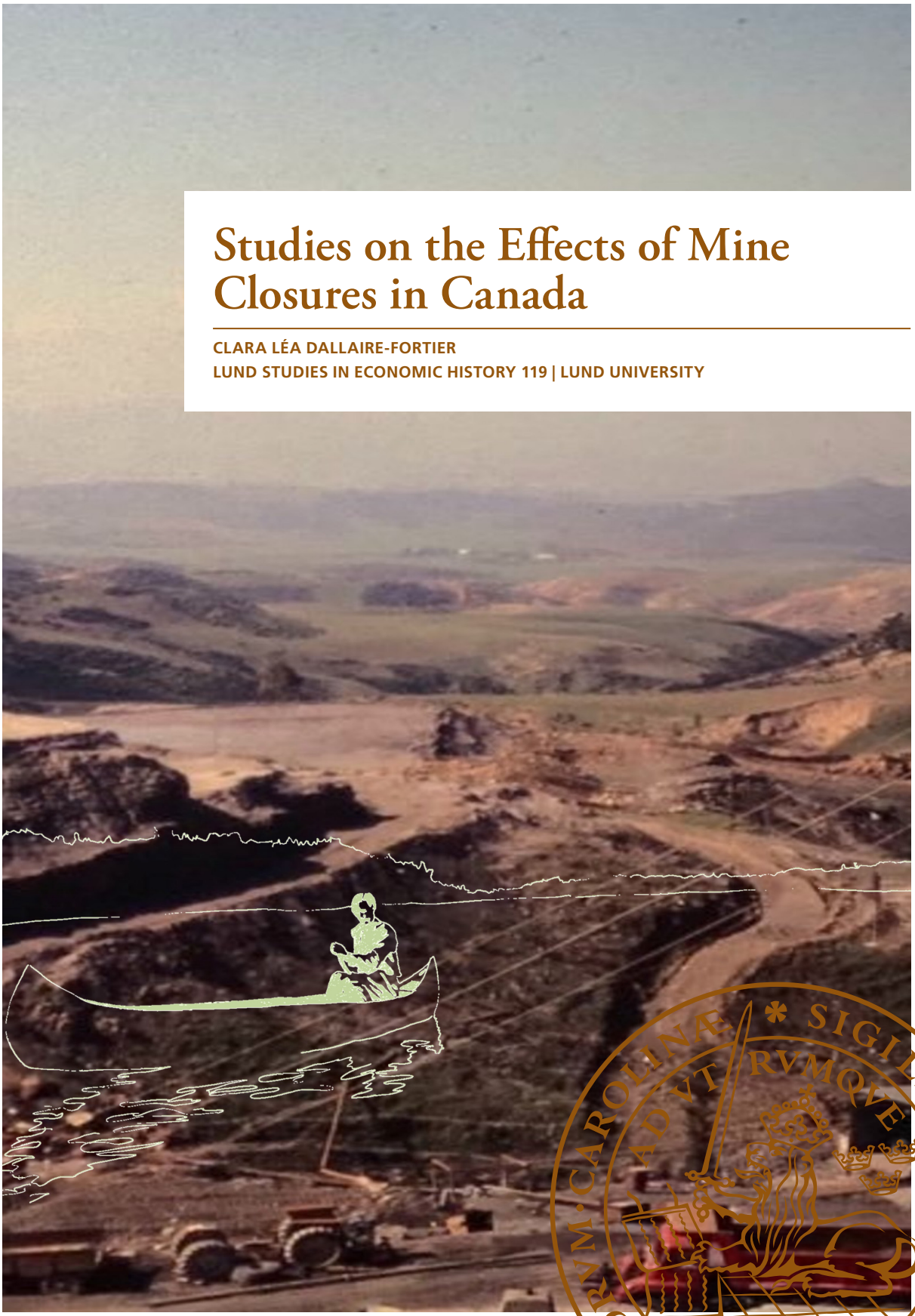

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Clara Léa Dallaire-Fortier

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DOCTORAL DISSERTATION

Doctoral dissertation for the degree of Doctor of Philosophy (PhD) at the School of Economics and Management at Lund University to be publicly defended on 27th of May at 10.15 in EC3:211, Department of Economic History, Tycho Brahes väg 1, 223 63 Lund, Sweden

Faculty opponent
Professor Gavin Bridge

Organization: LUND UNIVERSITY

Document name: Doctoral Thesis **Date of issue:** 27 May 2025

Author: Clara Léa Dallaire-Fortier **Sponsoring organization:** Department of Economic History

Title and subtitle: Studies on the Effects of Mine Closures in Canada

Abstract:

This dissertation explores the socioeconomic impacts of mine closures in Canada, focusing on the vulnerabilities that arise within local economies and the political economy implications of industrial changes. Through a combination of historical, quantitative, and qualitative analyses, the research provides a comprehensive understanding of the effects of mine closures on employment, municipal finances, and community livelihood.

The studies provide key foundations to the analysis of mining in Canada. First, I trace back the history of the mining in the country by presenting four regimes to comprehend industrial changes and continuities since 1859. This is the first longitudinal analysis made of the industry at the Canadian level. Second, I construct a novel database of mining activities from 1950 to 2023, which both offers an essential base for the rest of the dissertation and can be used by other researchers.

The dissertation then estimates the dynamic effects of a closure and draws a multifaceted understanding of community livelihoods in resource-dependent regions. The findings reveal that the repercussions of mine closures extend beyond immediate job losses at the mine. I uncover the large spillover into employments in other industries and the constraints on fiscal capacities of mining municipalities in the long run. I demonstrate the persistence of the effects on local labour markets and the significant challenges in maintaining essential services following mine closures.

Overall, this dissertation contributes valuable insights for policymakers, stakeholders, and scholars interested in the sustainable development of mining communities and the economic history of regional structural transformation. With respect to necessary transition toward sustainable economies, I underscore the importance of linkages and economic structures to mitigate the adverse effects of mine closures and the need to be critical to the sustainable mining discourse given the history of the industry in Canada.

Key words: Mining Industry, Structural Change, Regional Economy, Canada,

Language: English **Number of pages**: 202

ISBN: 978-91-989642-2-6 (print)

978-91-989642-3-3 (pdf)

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Printed in Sweden by Media-Tryck, Lund University

Lund 2025

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MADE IN SWEDEN

For Isabel,

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Abstract

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Abstrakt

Denna avhandling undersöker de socioekonomiska effekterna av gruvnedläggningar i Kanada, med särskilt fokus på sårbarheter som uppstår inom lokala ekonomier samt politiska och ekonomiska konsekvenser av industriella förändringar. Genom en kombination av historiska, kvantitativa och kvalitativa analyser möjliggör forskningen en omfattande förståelse för effekterna av gruvnedläggningar på sysselsättning, kommunala finanser och samhällens återhämtningsförmåga.

Studierna utgör ett betydande fundament för analysen av gruvdrift i Kanada. För det första tar jag fram en historisk exposé över gruvdriften i Kanada, där fyra regimer presenteras för att belysa såväl förändring som beständighet inom industrin sedan 1859. Detta är den första longitudinella analysen av gruvindustrin på nationell nivå. För det andra skapar jag en ny databas över gruvverksamhet från 1950 till 2023, vilken utgör en central grund för resten av avhandlingen och kan användas av andra forskare.

Avhandlingen skattar sedan de dynamiska effekterna av en nedläggning och lägger grunden för en mångfacetterad förståelse av samhällens försörjningsmöjligheter i resursberoende regioner. Resultaten avslöjar att återverkningarna av gruvnedläggningar sträcker sig längre än till omedelbara arbetsförluster vid gruvorna i fråga. Jag synliggör betydelsen av spridning till sysselsättning i andra branscher och begränsningar för gruvkommunernas långsiktiga skattekapacitet. Jag påvisar bestående effekter på de lokala arbetsmarknaderna och svårigheter för upprätthållande av väsentliga sociala tjänster efter en gruvnedläggning.

Sammanfattningsvis bidrar denna avhandling med värdefulla insikter för beslutsfattare, intressenter och forskare som är involverade i hållbar utveckling i gruvsamhällen och den ekonomiska historien om regional strukturomvandling. Utifrån en nödvändig övergång till hållbara ekonomier, understryker jag vikten av sammankopplingar och ekonomiska strukturer för att mildra negativa effekter av gruvstängningar och behovet av en kritisk granskning av diskursen om hållbar gruvdrift, med tanke på industrins historia i Kanada.

Résumé

Cette thèse doctorale explore les impacts socio-économiques des fermetures de mines au Canada, en se concentrant sur la vulnérabilité des économies locales et sur l'implication d'économie politique des changements industriels. De par une combinaison d'analyses historiques quantitatives et qualitatives, cette recherche vise à comprendre les effets des fermetures de mines sur l'emploi, les finances municipales et la résilience des communautés.

La thèse repose sur deux piliers fondamentaux pour analyser l'exploitation minière au Canada. Premièrement, je retrace l'histoire de l'exploitation minière dans le pays en identifiant quatre régimes illustrant les mutations et les continuités industrielles depuis 1859. Cette analyse constitue la première étude longitudinale de l'industrie minière au niveau national. Deuxièmement, j'offre une nouvelle base de données qui collige des informations sur les activités minières de 1950 à 2023. Il s'agit d'une ressource importante pour les chercheur.se.s et constitue une pierre d'assise pour le reste de la thèse.

J'évalue ensuite les effets dynamiques des fermetures de mines pour comprendre, dans toute leur complexité, les moyens de subsistance des communautés dans les régions dépendantes des ressources. Les résultats indiquent que les répercussions des fermetures de mines vont au-delà des pertes d'emplois, en affectant les emplois dans d'autres industries et contraignant, à long terme, les capacités fiscales des municipalités minières. La thèse démontre ainsi la persistance des effets sur les emplois locaux et les défis importants liés au maintien des services essentiels après la fermeture des mines.

Cette thèse apporte des informations clés pour les décideur.se.s politiques, les acteur.trice.s locaux et les universitaires intéressé.e.s par le développement durable des communautés minières et l'histoire économique des changements structurelles régionaux. En ce qui concerne la transition vers des économies soutenables, je souligne l'importance des structures économiques et industrielles pour aborder les effets négatifs des fermetures de mines. Finalement, à la lumière de l'histoire de l'industrie au Canada, je mets de l'avant la nécessité d'une réflexion critique sur le discours concernant l'exploitation minière durable.

Acknowledgement

The cover of this dissertation recalls the story of previous generations of my family, whose life revolved around the mining industry. The silhouette on the canoe is my great-grandfather, Hervé Dallaire, who took part in the Abitibi gold rush of the 1920s and 1930s. The family was unlucky with prospection and speculation and my grandfather, Raymond Dallaire, was born at mining camp during this period of economic hardship. Defying the odds, he later would become a mining engineer and professor. The first time I presented my work on the history of Canadian mining was in Bologna in September 2022. Their lives and legacies gave textures to my analysis. That very night, my grandfather Raymond passed away. He had been suffering from dementia, and I never could share my research with him. The background image is a photography he took during a contract in Burkina Faso. While mining certainly echoes my personal family tree, the economic history of mining bears greater implications: those of international market and industrial ties illustrated through the Canadian presence in Africa or the disappearance of natural landscape and the canoeing routes taken by Hervé. In this dissertation and in memory of them, I hope to paint an accurate multidimensional portrait of the mining industry and explore its implication to build a more sustainable world.

I would like to express my gratitude to my colleagues at the Department of Economic History, starting with my supervisors Tobias Karlsson and Kerstin Enflo. I received valuable insights and thoughtful comments from Josef Taalbi, Alexandra Lopez Cermeno, Prince Young Aboagye, Johanne Arnfred, Linda Stihl, Tancredi Buscemi, and Ben Chatterton. It was a delight to explore the intellectual history of the discipline of Economic History alongside with the great minds of Neelambar Hatti, Benny Carlson, and Jonas Ljungberg. I also had the pleasure to teach and collaborate with Linn Ternsjö, Martin Andersson, Cristina Chaminade, and Jonas Kreutzer, as well as the brilliants Lotta Takala-Greenish at UWE Bristol and Mathieu Perron-Dufour at Université du Québec en Outaouais. I was happy to live this experience with my cohort; Markus, Louise, Dominic and Nick, I enjoyed being by your side through covid, lunch breaks and weeks of writing. Moreover, I want to send special thanks to Anneli Nilsson Ahlm who made my experience at the department particularly beautiful.

Experts on the topic of natural resources have gifted me with cardinal insights. Many thanks to Marion Provencher and her colleagues from the International Institute for Sustainable Development, to Emily Tucker, Sandrine Levasseur, and Donald Wright from Natural Resources Canada, and to Andreas Dugstad Sanders from the Norwegian University of Science and Technology. I wish to acknowledge Roger Hayter from Simon Fraser University and David Leadbeater from Laurentian University for their comments and their work. Many thanks also to Julia Eder and

Robert Guttmann who took on the challenge of helping me applying the Regulation Theory to the mining industry.

I am grateful to the incredible scholars who welcomed me during visiting stays in Lausanne in the spring 2023 and in London in the winter 2024. Special thanks to the ecological economists at the University of Lausanne: Julia Steinberger, Elker Pirgmaier, and Lorenz Tilmann Keyßer, your energy is contagious. The visiting period at London School of Economics as a fellow at the Cañada-Blanch Centre was memorable; special thanks to Andres Rodriguez Pose and Beatriz Jambrina Canseco for your recommendations. The intellectual ferment of the city was introduced to me thanks to Chandni Dwarkasing, Kate Bayliss, Adrien Plomteux, Emma Obermair, Elena Butti, and Marco Ranaldi. Warm thanks also to the economists and friends at Roma Tre for your kindness during my visits; Salvatore Morelli, Rama Dasi Mariani, Jenan AlShowaikh, Oleksandra Sokolenko, and J. Christopher Proctor.

Family and friends made this research possible. I am particularly grateful to my mother; Isabel Fortier who pave the way a little farther to allow women to access a wider horizon. Many thanks to my sisters whose perseverance and creativity inspire me. Thank you, dad, for your support and for sharing your mining genealogy. Thank you, Giacomo and Selma for giving a meaning to all this. Thank you the Rellas for accompanying me through this journey. I want to close this by sending a hug to Christie, Madi and Barbara; your artistic and caring minds make academia a warmer place.

Introduction

> The Ajo plant was closed, and town of Ajo may as well have rolled up its sidewalks. Although there was plenty of other commerce in that small town, and life would go on, there was a pall over the town. The grand old Gadsden Hotel with its marble columns and tiffany glass – built in 1927, when the copper boom still promised the world to Arizona – had never felt emptier: a ghost of good fortune that time forgot. Dust accumulates quickly in the desert.
>
> Barbara Kingsolver in *Holding the Line*

Topic and Aim

For industry towns, there is nothing more poignant than closure. Yet, in global capitalism, there is nothing more normalised than shifts in capital investment. Here, the normal coexists with life-changing events and the vulnerability of displacement. Observing the wave of plant and mine closures in the 1970s, Bluestone and Harrison (1982, p. 105) describe a speed of disinvestment that is not socially manageable, given the velocity and scale of its impact. The structural transformation during the 1970s and 1980s brought such stories to the fore across countries and cultures. These stories are often labelled as *deindustrialisation,* a term that denotes a phenomenon in which capital mobility leads to the closure of industrial plants (Jackson, 2020). What is fascinating - or at the very least, what motivated this research – is that booms and busts are intrinsic to the mining industry. Unlike the structural changes of the 1980s, this industry operates with dramatic and frequent instances of closures caused by the exhaustion of resources, relocation of production, competition and, to a large extent, by fluctuations in mineral prices.

In the context of the environmental crisis, the question of industrial closures takes on a new dimension. Climate experts have called for an industrial restructuring involving a shift from fossil- and resource-intensive economies toward sustainable economies. This will have implications for workers in specific industries and will lead to plant and mine closures. The estimated impact on labour and regional economies is significant. The International Labour Organization predicts the loss of 6 million brown jobs and the creation of 24 million green jobs worldwide by 2030 (ILO, 2017). Sampling 50 countries, Pai *et al.* (2021) estimate a decline from 12.6

to 3.1 million brown jobs (coal, oil, and gas) to mitigate the effect of climate change and remain below the 2°C target. The job losses primarily concern the closure of coal mines, but many other jobs are also expected to experience booms and busts in other types of mining. Indeed, we already observe a rising demand for critical minerals – notably lithium, copper, nickel, and cobalt – in order to develop greener energy infrastructures. The magnitude of the impact calls for a *Just Transition* or the holistic accounting for the effects of the structural changes on communities and workers at the frontline of the industrial restructuring (ILO, 2015).

Through the analysis of mine closure events in Canada, this dissertation interrogates the implications and underlying complexities of sustainable transition. The focus on downturns in the Canadian mining industry leaves out other dimensions of the transition, such as diverse social costs, the petroleum industry, and stranded financial assets. However, the selected focus has the advantage of drawing a clear and detailed portrait of mine closures. What better case than an industry intrinsically defined by boom and bust cycles to reflect on the implications of the upcoming structural change?

I focus on the case of Canada due to its extensive history of mining, dating back to the 19th century, which encompasses a diverse array of mining practices and socioeconomic impacts. Canada's selection is further justified by the international significance of its extractive industries, underscored by its role in setting regulatory standards and conducting mining projects across continents. Moreover, the substantial economic contribution of mining to the Canadian economy and the country's dependence on natural resources are rare among developed countries. Lastly, the large number of mining operations and companies, along with the extensive availability of statistical data, provides a robust and pragmatic foundation for comprehensive analysis.

The overarching objective of my dissertation is to understand *how* and *why* Canadian mining communities are vulnerable after mines closures. Listed below is a description of how the articles of the dissertation address the objective.

1. I start the investigation by tracing and introducing a historical overview of the economic history of the Canadian mining industry since its first expansion in 1859. The first article is a historical analysis of the industry based on the definition of a *regime* from the Regulation School (Boyer, 1987). I lay the foundation for the analysis of continuity and change in the industry. This analysis serves as the framework for the rest of the thesis.
2. To assess the effects of mine closures on local economies, the analysis relies on the new database, *MinCan* (1950-2023). In the second paper, I describe the construction of the database. Its creation addresses data scarcity and opens the door for not only to the additional work presented in the dissertation (Articles 3 and 4) but also to future research. The database is available as open access in the database journal of Nature, *Scientific Data*.

3. The third article is a quantitative investigation of the labour force in mining towns (1987-2020). I am interested in the dynamic shock induced by the closure of a mine on direct, indirect and induced employment. I use local projections panel regressions to describe how the shock impacts the three categories of employment in the 10-year period that follows the mine closure.
4. The fourth article is concerned with the local fiscal capacity of mining towns (2001-2022). Together with Giacomo Rella, we investigate how the closure affects the municipal budget of municipalities and thus the provision of services to the local population. We use both advanced econometric methods and semi-structured interviews to uncover the multiple factors that affect municipal finance.

With the overarching research objective, I wish to acquire a critical understanding of the fiscal, employment, and other economic vulnerabilities that emerge following the closure of mines and to further assess the structures of resource-dependent economies and welfare systems. In the longer term and with these new insights, this research informs sustainable transition policies that consider frontline communities in the shift toward a more sustainable economic model. This dissertation is only the first step in this research agenda.

Research Questions

Overarching Research Question

As mentioned, the dissertation explores the implications and spread mechanisms of mine closures in Canada. The impact of a closure goes beyond the job losses at the mine. Impacts cannot be simply assessed; they need to be contextualised. A mine closure impacts a variety of local economic components. It creates a contagion throughout the local labour market and leads to declines in wages and consumption. The impacts also range from distorting the path of regional development to shrinking public finance and slowing down the life of the mining municipalities. Underlying these impacts and contagion mechanisms, there are major implications of people's livelihood and political decisions. The resulting overarching research question is *How and why are Canadian mining communities vulnerable after closures?*

Article-Specific Research Questions

Each article focuses on a specific dimension of assessing the contagion effects, contextualising the closures, and evaluating the political economy implications.

The first article focuses on the historical contextualisation of the mining industry in Canada. It addresses the question of *How have institutional forms shaped continuity and change in the development of the Canadian mining industry*?

The second article provides the base for the assessment of the impact by offering a new database with mine-level information. The database provides an overview on *Where are mines located, what is produced, who are the main mining companies, when mines open and close and how production change over time?*

The third article measures the contagion of the closures on different segments of the local labour market. The research question is *How persistent are the direct, indirect, and induced effects on employment following a mine closure and what is the strength of these effects?*

The fourth article explores the impact of mine closures on the fiscal capacity of municipalities in Northern Ontario. The research question is *To what extent, and in which ways, do mine closures affect the capacity of local governments to provide goods and services?*

Scope of the Dissertation

From the first to the last article, the research progressively narrows its historical and geographic scope (Figure 1). Starting with the whole country, I scale down the analysis to Northern Ontario in the last article. Similarly, I initiate the discussion with the start of the industry covering more than 150 years (1859 to the present) and progressively focus the research on the last two decades.

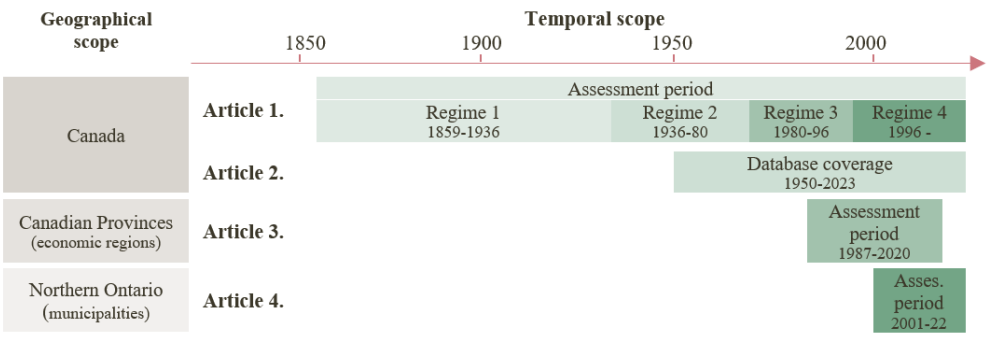

Figure 1. Temporal and geographical scope of the articles.

One particularity of the research is that I do not restrict the analysis to the level of single mine closures. The largest share of the literature on mine closures - in Canada and globally - focuses on case studies. This is illustrated in the work of the two excellence centres in mine closure research: the MinErAL network hosted by Laval University, Canada and the Sustainable Minerals Institute at the University of Queensland, Australia. Their publications focus on a single mine closure or the comparison of a few cases. This includes the rich cases of Schefferville in Quebec (Rodon *et al.,* 2022), Giant Mine in the Northwest Territories (Sandlos and Keeling, 2016; Beckett, 2021; O'Reilly, 2015; Gamble, 2020), Century Mine in Queensland (Eringham *et al.*, 2013), Gold Ridge mining project in the Solomon Islands (Owen and Weldegiorgis, 2011), and Free State Goldfields in South Africa (Marais, 2013; Nel and Binns, 2002; Nel *et al.,* 2003; Seidman, 1993). Other studies focus on comparing institutions or practices; for instance, country comparisons (Neil and Bradbury, 1992), legislative frameworks (Swart, 2003; Vivoda *et al.,* 2019), or reports or closure plans from three to twelve companies (Monosky and Keeling, 2021, Kabir *et al.*, 2015; McAllister *et al.*, 2014). The literature on mine closure is also rich on theoretical discussions and best practices reviews (notably Bainton and Holcombe, 2018; Stacey *et al.,* 2010; *Manero et al.*, 2020; Ackerman *et al.*, 2018; Beckett *et al.*, 2020).

Case study and theoretical analysis allow an in-depth exploration of the impacts and an assessment of the specific dynamics at play. I consciously focus on a larger empirical investigation of the impacts of mining. However, generalisable conclusions at the level of Canada should be used cautiously since the phenomenon of mine closure is heterogeneous. Variations emerge from diverse mine sizes, regional industrial diversification, the type of commodity, the location of the mines, *etc*.

The large sample approach I adopt is useful to inform macro policies and trends, but my econometric results might not hold for individual mining communities. The selected scope allows me to identify patterns across cases diverging from town- or mine-specific results. With the new database, I provide a new resource and make the analysis with a larger sample accessible to other researchers. In the last two articles, I illustrate how the large sample of mine closure cases opens the door for advanced econometric methods and qualitative analysis, in which mechanisms and patterns can be identified.

List of Articles

I. Shaped by Boom-and-Bust: A History of the Canadian Mining Industry, 1859 to 2020.

Dallaire-Fortier, C. (2024).
New Political Economy: 1-18.
https://doi.org/10.1080/13563467.2024.2373053

II. A comprehensive historical and geolocalized database of mining activities in Canada.

Dallaire-Fortier, C. (2024).
Scientific Data, 11 (307).
https://doi.org/10.1038/s41597-024-03116-3

III. Unemployment ripple: The impact of mine closures in Canada, 1987 to 2020.

Dallaire-Fortier, C. (2024).
Resources Policy, 92, 104901.
https://doi.org/10.1016/j.resourpol.2024.104901

IV. A Balancing Act? Local Fiscal Resilience After Mine Closures.

Dallaire-Fortier, C. and Rella, G.
Unpublished Manuscript

I am the only author of the first three articles; I confirm sole responsibility. The contribution of Article 4 is shared with Dr. Giacomo Rella from Université du Québec à Montréal, who is responsible for: *Conceptualisation, Data Curation, Investigation, Formal analysis, Validation, Writing, and Visualisation*. I am responsible for: *Conceptualisation, Data Collection, Methodology, Investigation, Formal analysis, Writing, Visualisation*.

Overview of the Dissertation

Table 1. Core components of each article.

	Article title	Research question	Data source	Analytical strategy	
				Methodology	Objective
Article 1	Shaped by Boom-and-Bust: A History of the Canadian Mining Industry, 1842 to 2020	How have institutional forms shaped continuity and change in the development of the Canadian mining industry?	Historical quantitative and qualitative data and secondary literature	Application of the Regulation Theory at the industry level	Understand the political economy of Canadian mining over the long run
Article 2	Principal Producing Mines of Canada: Introducing a Novel Mine-Level Database	[This paper is a database description.]	Archival maps and supplementary historical sources	Archival work and database harmonisation	Address an information gap and create an open access database
Article 3	Unemployment Ripple: The Impact of Mine Closures in Canada, 1987 to 2020	How persistent are the direct, indirect, and induced effects on employment following a mine closure and what is the strength of these effects?	*MinCan* and *Labour Force Survey*	Local projections fixed-effect model	Estimate local employment shock after mine closures and propose a new methodology
Article 4	A Balancing Act? Local Fiscal Resilience After Mine Closures (with Giacomo Rella)	To what extent and in which ways, do mine closures affect the capacity of local governments to provide goods and services?	*MinCan, Financial Information Return* for Ontario, and interviews with municipal actors	Mixed-Method: Local projections difference-in-differences and semi-structure interviews	Investigate local fiscal capacities and impacts on service provision after mine closures

Contribution and Limitations

The contributions and limitations[1] of this dissertation are evaluated in light of its primary objectives. Two principal aims were previously identified: first, to elucidate *how* and *why* mining communities are vulnerable after closures, and second, to contribute to the broader conversation on sustainability transition.

Vis-à-vis the first aim, the dissertation contributes to a comprehensive definition of the phenomenon of mine closure. The definition is inclusive of the ripple effect on labour and municipal finance and the complex dependence of the resource regions on the fate of the industry. To effectively understand the phenomena, it is paramount to address the critical issue of data availability. This concern extends beyond Canadian borders, as approximately half of the world's mining areas remain undocumented (Maus and Werner, 2024). *MinCan* is the first open access database to propose an exhaustive, free, and reliable compilation of the principal mines in Canada. The development of *MinCan* was labour-intensive, thereby constraining my ability to explore more than two facets of the mine closure phenomenon. After developing a historical overview of the industry (Article 1) and building the database (Article 2), I provide new insights into the reasons and mechanisms by which local labour market (Article 3) and municipal finance and services (Article 4) are vulnerable to mine closures. These dimensions, rarely explored in the literature, clarify the cumulative downward effect on local mining economy that emerges after the shock.

While these are sizable contributions, the achievement of the first aim is constrained by the databases to which *MinCan* is matched (regional databases on labour and municipal budgets). Here, the scale (local and regional) is prioritised over historical scope. As such, the dissertation is limited to the modern period: the last 30 years in Article 3 and 20 in Article 4. It would have been interesting to cover the period of the 1980s during which Canadian mining employment shrunk two-fold and large mining towns closed *e.g.,* Elliot Lake in Ontario. This shorter time perspective also limits the statistical significance of the results of the econometric models.

Moreover, a fundamental element of the Canadian political economy of natural resources is lacking: the Indigenous question. Indigenous groups are living on sites of mineral extraction; while they are both resisting and working for mining companies, they are also more likely to be vulnerable to the cyclicality of resource development (Keeling, 2010). Their attachment to the land and traditional activities root many Indigenous individuals to the mining region in a way culturally distinct from that of Canadian settlers. With the statistics available at the local and regional

[1] Further limitations are presented in the Methods section.

levels, it was unfortunately not possible to explore the uneven impact (Laforce *et al.*, 2009) or racial discrimination (Bullard, 1993) in the size and persistence of the impact of mine closures. While the models were tested with variables such as a dummy for Indigenous population, the results were inconclusive. Other research questions, methods or datasets would be needed to investigate the impacts of mine closures on Indigenous communities.

Regarding the second aim, the results of the articles contrast preconceived ideas on the sustainable transition. To be specific, the first article critically looks at the sustainable mining discourse, the second article provides data for further research about the impacts of the mining industry, the third article unpacks the myth around the positive net cost of brown to green jobs (see below), and the fourth article examines the resilience of mining municipalities. While each paper contributes to the sustainability conversation, they are indirect contributions as none of the work is targeted toward a field journal.

The first article provides insights to critically examine the sustainable mining discourse. I identify how the sustainable mining discourse emerges from the need for companies to re-legitimise their operations after the decline in mining employment in the 1980s. This discourse consists of multi-stakeholder agreement, impact assessment, and sustainable objectives that together provide mining companies with the "social licence to operate". In the 2000s, it allowed companies to benefit from the upswing in mineral price. Yet, I show how the benefits of the industry have throughout its history been highly skewed toward foreign companies and financial stakeholders rather than local communities and workers. For instance, even with the recent upswing in prices, the labour share (the part of mining income allocated to wages) shrunk. The article encourages us to think about sustainable mining through the lens of labour, ownership and regional development. These lenses add nuances to the contemporary corporate responsibility narrative.

The second article offers a database to collectively engage in assessing the (un)sustainable impacts of mining. Given the rise of critical minerals, the database can work as a resource to shed light on the impacts of the mining industry. The database can be used to provide evidence to improve the future of the environment, regional development and Indigenous communities.

For its part, the third article addresses an important myth in the transition from green to brown jobs and provides a new methodology to measure the effect of job spillover. The persistent myth regards the positive net cost of sustainability transition: the number of green jobs created is larger than the number of brown jobs destroyed. I measure the full employment cost by looking at the ripple effect on different industries. I walk in the footsteps of other researchers (Black *et al.,* 2005) who measured that, when it comes to coal mining, the impact of boom-and-bust is asymmetric *i.e.,* more jobs are lost in times of bust than jobs gained in times of boom. Moreover, brown and green jobs are not located in the same region, and I

show how the fragile resource-dependent structure of mining economies makes such cost-benefit accounting overly simplistic.

The fourth article explores a gap in the literature on fiscal municipal resilience following a shock. While the sustainability discussion addresses municipal resilience, it primarily focuses on resilience to environmental disasters (Lis and Nickel, 2010; Phaup and Kirschner, 2010). It does not address the role of municipal finance in relation to purposeful industrial transformation. Yet, the nature of an industrial shock is quite distinct from an environmental one, and the sustainability transition is and will be a purposeful industrial change generating plant closures and openings to meet environmental objectives. Our investigation into Northern Ontario's resource dependence provides insights into how and why municipalities are vulnerable to industrial downscaling. We argue that these impacts are likely to intensify over time, further isolating municipalities by weakening their ability to deliver services and sustain liveability. Addressing this challenge requires a reconfiguration of the fiscal structure, one in which access to capital and the capacity to maintain infrastructures are no longer tied to resource cycles. Such a shift is essential to opening up a broader horizon of possibilities for mining regions, where hopes are tied to the prospect of future upswings.

Economic History Context

The development of the Canadian economy is tied to the expansion of its resource frontier. This fact holds from the time of colonisation and its characteristic fur trade to the contemporary society and its petro-dependence. Canada, while being a developed and influential economy notably part of the G7, is typified by its high share of the natural resource sector (OECD, 2023). The rich work of economic historians such as the classic author Harold Innis (1894-1952) outlines how different staples or resources influenced the historical path and explains the current economic state and institutions. According to Innis' *longue durée* analysis (1956), Canada shifted from a state of resource dependency to another.

This dependency implies that boom-and-busts in resource economies have led to migration from one resource-rich province to another and to localised economic de-vitalisation. For instance, Quebecois recount the relocation of families facing poverty in the mid-20th century toward logging camps in Northern Ontario. It is also illustrated by stories from Newfoundlanders who, after the collapse of cod fishery in the early 1990s, sought employment in Alberta where oil boomed in the mid-1990s. Livelihoods of many Canadians families and regions are shaped by the resource sector.

Innis' staple theory holds and describes the contemporary economy of Canada. The only exception in the national development timeline was a short period of industrial diversification in the late 20th century that temporarily interrupted this pattern of resource dependency, notably with the automotive industry. Yet, we observe a renewed dependency since the oil boom in Alberta and the North American Free Trade Agreement in 1993, which designates Canada as a resource exporter. This is labeled as the re-primarisation of the Canadian economy (Stanford, 2008). This rise of the primary sector was predominantly driven by the Albertan oil boom, but Chinese development increased the demand for minerals from Canada in the 2000s. Illustrating this renewed dependence, Figure 2 shows the decline of manufacturing activities and its substitution for the primary sector as a share of the provincial and territorial economies.

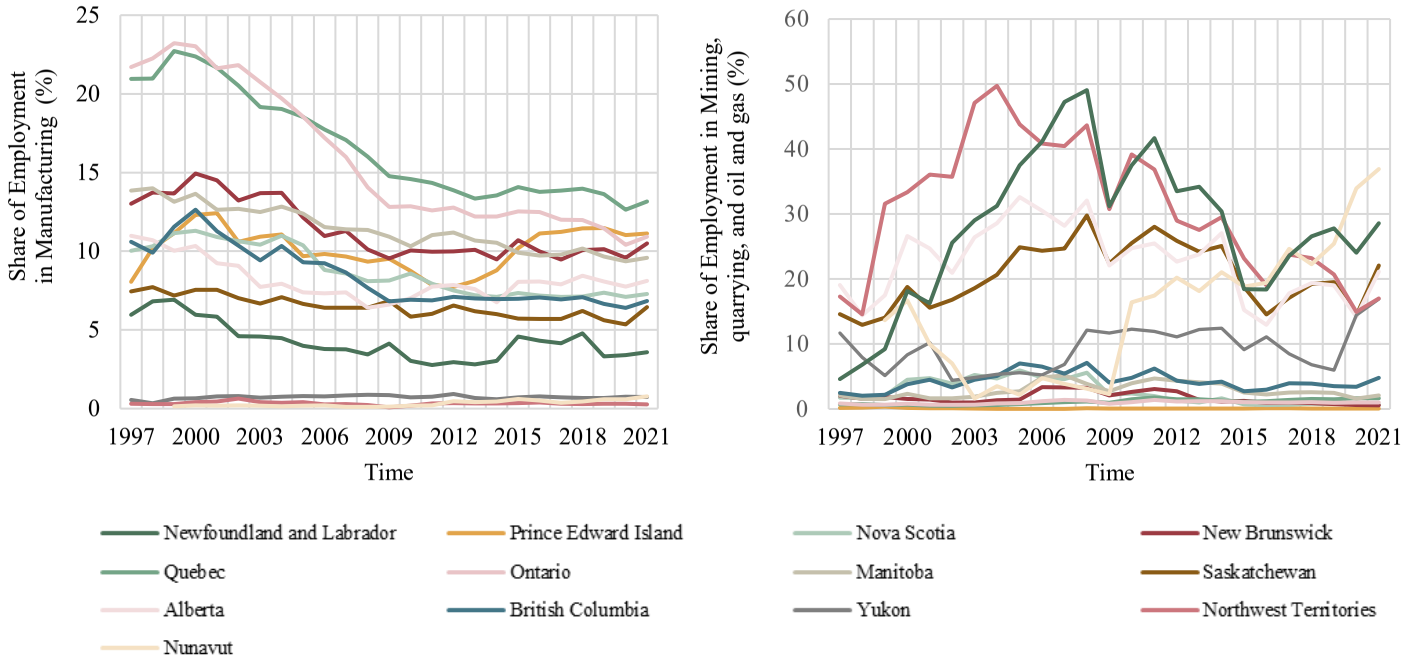

Figure 2. Industrial composition of Canadian provinces and territories, 1997 to 2021.
Source: Statistics Canada (2022)

Moved by new technologies for mineral exploration and extraction, the resource frontier reached more isolated regions. As a result, most Canadian provinces and territories (Figure 3) have partaken in mineral production. Alberta is known for its coal mining, Saskatchewan for potash and uranium, and Manitoba for lithium. Ontario, British Columbia, and Quebec are the main national producers with a wide diversity of minerals including gold, copper, nickel, and zinc. The territories, located in the north of the country, export precious minerals like diamond and gold. The border between Quebec and Labrador has been disputed notably due to its rich iron-ore deposits. Some regions are historical mining regions. This is the case of the territory at the northern border of Quebec and Ontario, which is still described as a resource region. Many towns in British Columbia and Yukon still exhibit architectural features from gold rushes that occurred in the second half of the 19th century.

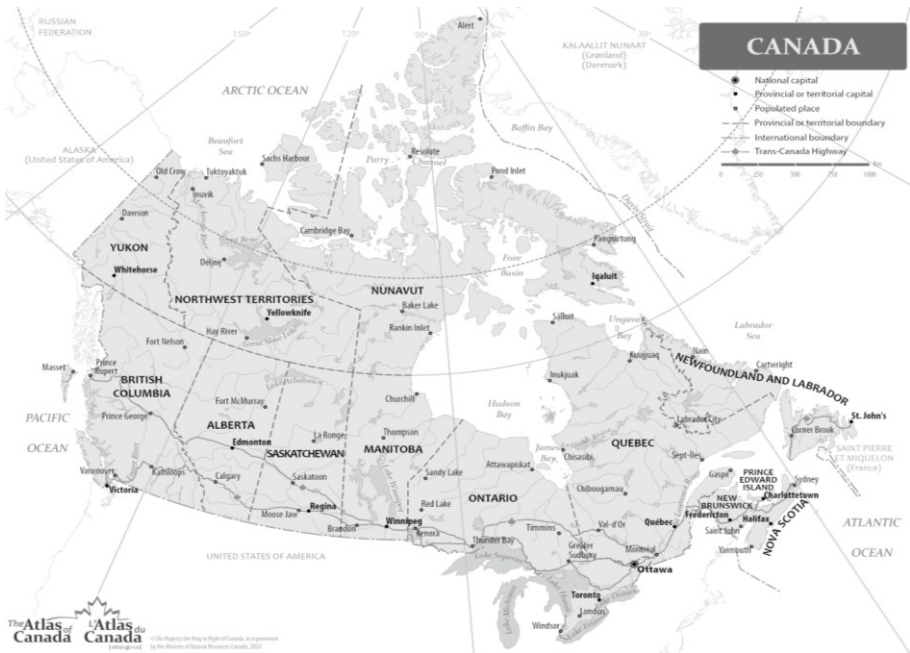

Figure 3. Maps of Canadian provinces and territories.
Source: Minister of Natural Resources Canada (2024).

The export-oriented nature of the Canadian mining sector has been a historical feature with foreign companies owning a large share of the production, and the value-added transformation of the commodities taking place outside the country (Watkins, 1963). To fully grasp the economic history of mining, we must account for these spatial disconnects that often isolate resource towns from decision-making

processes. Ownership and value-added activities are also often located outside Canadian borders and financial interests are concentrated in centres such as the Toronto Stock Exchange, rather than in the mineral-rich regions.

Mining towns are vulnerable to changes in commodity prices, notably due to the lack of diversification in their economy (Watkins, 1963; Gunton, 2003). The price of commodities is determined by strong exogenous factors including industrial development, economic crises, resource depletion, substitution, technology, and competition (Stuermer, 2014; Hayter and Patchell, 2017). Figure 4 shows the change in the price of the main minerals produced in Canada and the general commodity price index for all metals and minerals over the long run. It illustrates the highly cyclical nature of mineral prices.

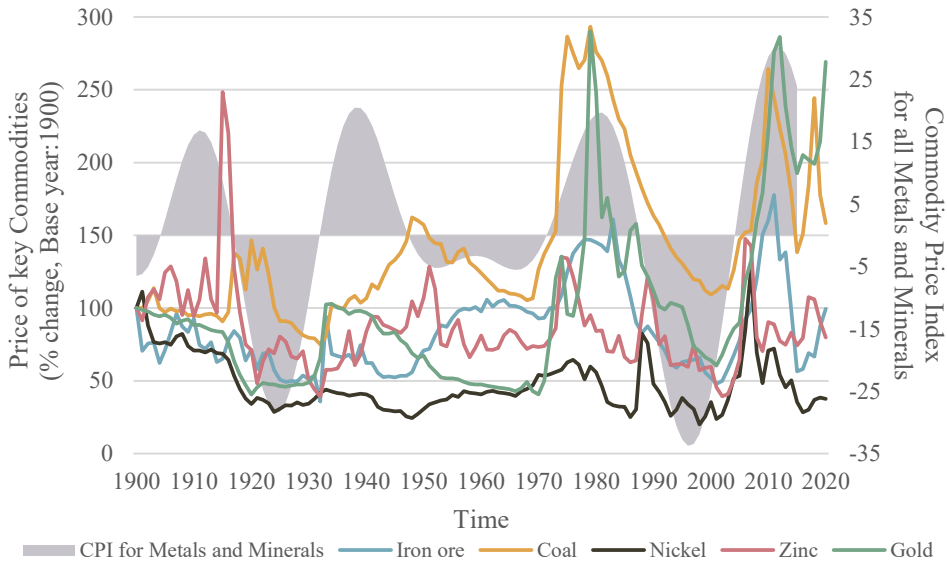

Figure 4. Fluctuation in commodity prices, 1900 to 2020.
Source: Macdonald (2017) for the CPI and Jacks (2019, 2021).
Note: The right axis corresponds to the change in prices for the main commodities produced in Canada (colorful lines) and the left axis is associated with the commodity price index (CPI) for all metals and minerals, which tracks general fluctuations in price over the long-run (grey).

Important price booms are associated with the Second World War in the 1940s and the extensive development of China in the 2000s both boosting demand for minerals. The financial crises in the 1930s and 1990s were accompanied with downward trends in mineral prices. Over the last century, the commodity cycle also indicates a slowdown in the 1950s and 1960s and a boom in the 1980s and 1910s.

Fluctuations in prices and localised resource exhaustion are accompanied by mine closures. Parker *et al.* (2018, p. 64) summarise it this way: a "tension between the de-territorialization tendencies of global financial markets and the localization

pressures associated with rapid resource extraction that vary across the boom–bust cycle". Table 2 shows the number of mine closures in each Canadian region for each decade from the 1950s onwards. The pattern echoes the price cycles with more closures in the 1960s, late 1980s and 1990s. In other words, the price of natural resources plays a critical role in production. Volatility in the price of natural resources affects on regional poverty over time (Lawrie *et al.*, 2011). The local consequences are significant with losses of employment and the ripple effect that this ensues on health, other industries, demographics, and fiscal capacity.

Table 2. Distribution of closures according to the great Canadian regions.

Decennia	West Coast	Prairie Provinces	Central Canada	Atlantic Provinces	Northern Territories	*Total*
1950s	11	11	43	6	6	*77*
1960s	21	17	82	16	7	*143*
1970s	20	16	61	15	5	*117*
1980s	33	16	60	19	11	*139*
1990s	30	20	67	13	8	*138*
2000s	10	14	38	13	8	*83*
2010-22	20	25	42	29	6	*122*
Total	*145*	*119*	*393*	*111*	*51*	*819*

Source: MinCan (2024).

Note: The greater Canadian regions include the following provinces and territories: West Coast is only British Columbia, Prairies Provinces includes Alberta, Saskatchewan and Manitoba, Central Canada is composed of Quebec and Ontario, Atlantic Provinces is composed of the remaining provinces located to the east coast of Canada, and Northern Territories comprises Yukon, Nunavut and Northwest territories.

The pattern of development of resource towns has changed throughout history. Between 1867 and 1920, mining towns were privately built by prospectors, speculators, and miners as in Cobalt, Ontario (Robinson, 1962). Between 1920 and 1939, the role of companies increased with holistic mining town planning and company ownership of most properties (Robinson, 1962). After 1945, comprehensively planned towns such as Kitimat, British Columbia, or Noranda, Quebec, developed and the provision of services became mainly public. More recently, mining sites have been characterised by fly-in-fly-out arrangements *i.e.,* workers alternate weeks between intensive work on-site while living in mining camps and returning to their homes and families, generally located far from the mine. These categories of mining towns are not sharply distinct; they have overlapped throughout history (Vallière, 2012).

Throughout the history of the mining industry, the State has played a prominent role. Its interventions include the provision of services to mining towns and mining companies, the cartography and reporting of mineral deposits, and the construction of infrastructure such as roads and railways (Vallière, 2012). One must note that we are dealing with a relatively recent national history, as the confederation of Canada occurred in 1867 and Newfoundland was only annexed in 1949. Provincial and federal governments promoted the exploration of resources, viewing extraction as

an opportunity to accumulate wealth. Canadian Prime Ministers from Diefenbaker (1957 – 1963) to Harper (2006 – 2015) formulated visions of the North as a pool of resources to be seized for economic gain. For instance, Diefenbaker based his 1957 election campaign on a Nordic vision and implemented the *Roads to Resources* program, a development project to build transport infrastructure to extract Nordic minerals (Isard, 2010). Harper described the resources of the North as a "national dream" and relaxed the legal system surrounding resource extraction in Canada, making the country a "legal haven of choice for the world's mining industries" (Deneault and Sacher, 2012). These visions come into direct conflict with other land uses traditional to Indigenous groups living in the mining regions.

Overall, political regimes shaping the management of natural resources in Canada have been characterised by strong public-private partnership. The only exception to this trend was the period of resource nationalism in the mid-20th century (Gendron and Sanders, 2019), concentrated on energy-generating natural resources such as hydropower (*e.g.,* Hydro-Quebec, NB Power, and Hydro-One) and petroleum (Petro-Canada, 1975 – 1991). However, national ownership was rarer in the mining sector. I only identify a few cases: Eldorado Resource (uranium, 1943 – 1988), Potash Corporation of Saskatchewan (1975 – 1989), and Saskatchewan Mineral Inc. (1947 – 1988). Vallière (2012) points to an opposite strategy in Quebec in the 1950s as the province promoted economic liberalism and financial interests in Toronto and the United States.

Article 1 expands this section and provides an in-depth analysis of the evolution of the industry since 1859. Four mining regimes are proposed to describe the changing nature of the industry and its effects on politics, labour, and finance, among other factors.

Theory and Previous Research

Approaching Mine Closures Historically

More than a century ago, in 1904, the renowned Swedish economic historian Eli Heckscher (1879 - 1952) formulated a research program for economic history. For Heckscher (1904), the discipline extends beyond being a sub-branch of economics that produces longitudinal analyses: economic history is not merely historical economics (Findlay *et al.,* 2006, p. 6). Heckscher (1904) envisions a combination of empirical, inductive research in which theories provide interpretation tools. Yet, theory must be contextualised to its historical contingency rather than treated as a set of universal laws.

A further argument in his program is the relevance of interdisciplinarity. Here history is positioned as equal to economics, and various methods are recognised as valid for investigating research questions. He himself had a background in political science (Findlay *et al.,* 2006). In this dissertation, geography, politics, regional studies, and rural sociology cannot be ignored. These fields host a rich literature on the topic of mine closures and offer key methodological contributions that inspire this dissertation. For instance, they emphasise the value of interviews and spatial analysis.

The recognition of interdisciplinarity and historical contingency has been carried forward by researchers in economic history and political economy. They contrast the large set of assumptions and abstractions from neoclassical economics with notions of equilibrium, universal laws, natural rates, and rational expectations. Nicholas Kaldor distanced himself from conventional equilibrium methodology (Setterfield, 1998). The French Annales School's concept of *longue durée* (Braudel, 1982) illustrates how historical structures are reconfigured over extended periods and how crises structure the analysis of economic change. Kondratieff (1935) interpreted the industrial evolution as a series of long waves initiated in the 1770s, 1820s, and 1880s (later additions include the 1940s and 1980s), each ending in crises. At the Department of Economic History in Lund, significant contributions in the same veins have been made since the 1970s through the structural cycles of Lennart Schön and Jonas Ljungberg (2016). At the core of these works is the recognition of the role of institutions, the search for underlying mechanisms to development, and an intellectual curiosity about processes of change within and across sectors.

In this dissertation, I engage with the idea of historical contingency and draw on interdisciplinary methods to analyse the phenomenon of mine closure. Like some of these authors, I adopt a critical realist and structuralist approach. In this section, I outline the two theoretical foundations of the dissertation. First, the Regulation Theory guides my understanding of the evolution of the mining industry in the *longue durée* (Article 1). Second, the concepts of industrial linkages and ripple effect form the basis for my analysis of the local labour market (Article 3). These two theoretical perspectives contribute meaningfully to the discussion of Canadian mining from both historical and empirical standpoints. As such, I hope to honour the disciplinary vision proposed by Heckscher (1904) and position this dissertation at the intersection of economic history and political economy.

The Regulation Theory: Longue Durée Analysis

The Regulation Theory is an economic school of thought concerned with historical changes. It emerged in France as part of Marxist political economy and analyses the dialectical developments of capitalism (Aglietta, 1982; de Bernis, 1983). It is also based on the Annales School and its emphasis on the economic context, their specificity in each society, and the corresponding structural crisis (Boyer and Saillard, 2002, p. 17). Moreover, the Regulation Theory developed in dialogue with post-Keynesian and institutionalist theories (Boyer 1986, 2004). It emerges from an explicit addition to Keynesian approaches, to add the role played by the State, international organisations, and social forces (Becker *et al.*, 2010, p. 241).

The theory expanded into multiple branches, which include the Social Structure of Accumulation from the United States (Gordon *et al.,* 1982; Kotz, 2003) and the Germanophone branch (for works in English, see Becker *et al.,* 2010; Eder, 2022). Recently, the concept of *regime* has been revived by scholars from Comparative Political Economy (refer to *growth regime* by Baccarro and Pontusson, 2016; Hope and Soskice, 2016; Hassel and Pallier, 2020) and post-Keynesian macroeconomists (Hein *et al.,* 2019; Kohler and Stockhammer, 2022). The use of the terms of *regulation, accumulation,* or *growth regime* should be associated to a comprehensive definition. Indeed, the Regulation Theory is not only concerned with the legal or regulatory framework; it is an economic theory that extends into to the political and social domains.

For the first article, I base my analysis on the work of French regulationists with a particular focus on Boyer's conceptualisation of the regime concept. This central concept is defined as a specific configuration of production conditions, technical progress, distribution of profit, and social composition of aggregate demand (Boyer, 2022, p. 70). The configuration brings stability to the social relations that make for the economic activities possible (Guttmann, 2020, p. 53). Crises are driven by the inherent contradictions of conflicting claims of various social groups. These

inherent contradictions within a capitalist economy can be stabilised over a limited period (Becker *et al.*, 2010; Hein *et al.*, 2014). Economic change is theorised through this stable and unstable nature of regimes.

Each regime is characterised by a configuration or hierarchy of institutional forms. There are five institutional forms according to Boyer and Saillard (2002): forms of competition, monetary regime, state interventions, wage relation, and international economic relations (see detailed definitions in Article 1). As a result, economic change is interlinked with historical, geographical, technological, and political circumstances.

To illustrate this framework, let's consider a country in which a group of industrialists are pivotal to international trade, and benefit from state support. A new industry in the country might be gaining large market power. The new industrialists begin to demand the same benefits received by the established industrial elite. This change in forms of competition (multipolar) creates instability: the demands from the new industry prompt a new regime configuration.

The regime concept is a relevant tool to describe historical periods and define the evolution of economic structures in a multi-faceted manner. First, it accounts for the relationship between actors (industry, workers, community and the state) and second, it orients the analysis toward different dimension of the political economy through the five institutional forms. These are the rationales for selecting this theoretical approach for the analysis of Article 1.

Ripple Effect and Linkages: Conceptualising Regional Downturn

I now turn to the analysis of industrial structures and their role in explaining regional downturns. This literature has been developed around the work of theoreticians like Myrdal (1957) and Hirschman (1977) and focuses on deindustrialisation in Western countries in the 1970s and 1980s. They indicate how linkages imply that industrial changes have repercussions on manifold aspects of social and economic life.

The classic work by Bluestone and Harrison defines deindustrialisation as "a widespread, systematic disinvestment in the nation's basic productive capacity" (1982, p. 6). Fluctuations in investment are key determinants of closures, openings, and relocations of plants (Bluestone and Harrison, 1982, p. 28). The loss of industrial activities induces "profound local economic and social disruption" (Sadler, 1992). Since sectors have different concentrations across space, regions face various velocities of deindustrialisation, levels of absorptive capacities, and positions in circuits of capital (Hudson, 2005). It cannot be assumed (as in neoclassical theory) that the mobility of capital leads to the mobility of labour. Indeed, it is observed that in cases of deindustrialisation, regional economies do not

adjust perfectly; worker mobility is insufficient to clear labour markets (Bluestone, 1984, p. 43).

The pace of transition and impact of deindustrialisation depend on the integration of the industry into production chains or, in other words, how connected the industry is to other sectors of the economy (*i.e.,* linkages) (Bluestone and Harrison, 1982, p. 72). The general spread impact of deindustrialisation is often referred to as a *ripple effect*, defined by the three types of industrial linkages. Two are production linkages: backward linkages associated with supplying inputs for production and forward linkages associated with processing outputs. Hirschman (1958, p. 100) relates backward linkages to "every non primary economic activity [that] will induce attempts to supply through domestic production the inputs needed in that activity" (Hirschman, 1958, p. 100). A forward linkage is understood as "every activity that does not by its nature cater exclusively to final demands, will induce attempts to utilise its outputs as inputs in some new activities" (Hirschman, 1958, p. 100).

For Hirschman (1958), a core issue with the development of a national economy based on natural resources is the movement of profit and raw material outside the country (by foreign companies) that fail to generate forward and backward linkages in the economy. The third linkage that defines the ripple effect is the consumption linkages associated with the demand for consumption goods by income earners to other producing industries (Hirschman, 1977). It is defined as "a measure of the inducement to invest in domestic industries producing consumer goods for factors in the export sector" (Watkins, 1963, p. 145). The decrease in local demand after a plant closure greatly affects the local economies by entailing job losses in the service sector.

In Article 3, I define the ripple effect as the combination of impacts connected by these three linkages. Similar to a domino chain, the mine closure spreads into other employment types locally: indirect and induced effects. The direct effect is defined as the impact of an industrial change on the workers directly linked to the industry where the change occurs. The indirect effect is associated with backward and forward linkages and refers to the change in employment in industries that provide inputs and process outputs for the mining sector. Examples from the mining sector include industries supplying inputs such as shaft constructors or water providers and industries handling the outputs like transporters of the minerals and manufacturers. Connected to consumption linkages, the induced effect is the impact on industries where the wages of workers are spent. The workers hired in industries with forward and backward linkages generate production through their expenditures in sectors like housing and food. Direct and indirect employment is positively related to sustaining the production of these local nontradable sectors. It is important to mention that many researchers flag the difficulty of fully measuring the induced impact (Pollin *et al.*, 2017; Bluestone and Harrison, 1982).

In previous research, scholars have calculated the ripple effect as a ratio. Marchand (2012) estimates that in Western Canada, ten energy extraction jobs created during a resource boom period generate three construction jobs, two retail jobs, and four and a half service jobs. Black *et al.* (2005) report a 4:1 ratio for the coal deindustrialisation in Appalachian communities, implying that when 100 coal jobs are destroyed an additional 25 indirect jobs are lost. In Article 3, I produce dynamic estimates, looking at the ratio over ten years.

Theories on Natural Resources

An abundance of resources is not always accompanied by good economic performance. This puzzle has given rise to in-depth academic examinations from which emerged the staple thesis (Innis, 1930; Watkins, 1958), the resource cycle model (Clapp, 1998), the resource curse (Krugman, 1987; Sachs and Warner, 1995), and the Dutch Disease (van Wijnbergen, 1984). These theories aim to make sense of the mixed evidence on the long-term impact of the resource industries: some countries are considered successful in their management of resource abundance, while other countries are not. All theories recognise the structuring role of natural resources on institutions.

Staple Thesis

The staple thesis (Innis, 1930, 1940; Watkins 1963, 1989; Drache 1982; Neil, 1972) lies at the heart of many analyses of the Canadian economy and of natural resource economies around the world. The thesis defines institutions and the natural resource economy as intertwined. It describes an over-specialisation in natural resource extraction and a systematic disinvestment from other domestic industries in Canada (Innis, 2001; Watkins, 1989). At the national level, it proposes phases of development:

1. *The frontier staple state:* The first phase sees the emergence of an economy based on the extraction of a certain resource.
2. *The expanding staple state:* The second phase ensues the first with a rapid expansion emerging from the extraction.
3. *The mature staple state:* The third phase entails maturity in which the growth rate slows down. This slowing down leads to disequilibrium, out of which the following phase emerges.
4. *The new-staple state:* The fourth phase represents a transition to a new form of resource activities (Howlett and Brownsey, 2007).

These phases are represented by cycles of transition toward new resources, described in a linear way with repeated patterns with specific growth rate, spatial configurations, and state intervention.

Additions to this theory suggest that staples (i.e., natural resources) can be used as a driver of economic diversification through its export base resulting in an alternative fourth state (Watkins, 1963, p. 144). Indeed, Hutton (2007) proposes a *post-staples state* as an alternative to the *new-staple*. This accounts for countries that diversified out of a staple-dependent economy and through transition processes where the material dependence is substituted with a new more sustainable sectoral composition of its economy, notably with the service or manufacturing sectors. It also leads to the marginalisation of resource abundant territories.

The literature debates the occurrence and linearity of the phases in Canada. It is said that the states/phases are not stable (Fournis and Fortin, 2015) nor linear since Canada faces a renewed dependence on resource extraction (Stanford, 2008). Indeed, after a period of industrial diversification with the notable automotive industry, the boom in the oil and gas sector at the turn of the century renewed the dependence on natural resources in Canada. This development has been problematised as the staple or carbon trap (Stanford, 2008; Fast, 2004; Haley, 2011; Pineault, 2018). It is also highlighted that the phases do not account for the complexity entailed by the diversity of trajectories among different types of resources (Dumarcher and Fournis, 2018).

Resource Cycle Model

The resource cycle model (Clapp, 1998) proposes to merge insights from the staple thesis with resource geography. It proposes to delve into the cyclical - even cyclonic (Keeling, 2010) - character of resource industries. Here, the decline stage and its spread effects are understood as central components of the evolution of these industries (Clapp, 1998). Three stages are defined with varying duration according to technology, demand and the resource itself. The first stage comprises the exploration and initial boom, the second stage is defined by profitable operation and high capital intensity and the third and last stage involves depletion of the resource and the abandonment of production (Clapp, 1998, p. 138).

The stages are determined by multiple drivers (*e.g.*, competition, technology, crises, policies, or lock-ins), which go beyond the simple price factor (Hayter and Edenhoffer, 2016, p. 2). These factors exercise pressure on the environment and cause depletion of the resource: the pattern of overexpansion and collapse “depends on the biology of the target species, the technology used to process the resource, and the institutions that allocate rights to the resource.” (Clapp, 1998, p.130) A problem highlighted by the model is that the logics of the market driven by competition, interest rates, and profit seeking behaviors are disconnected from the slow velocity

necessary for the regeneration of natural resource. Another critique from this model is the induced lack of industrial diversification and public policies necessary to go beyond the economic resource cycle (Clapp, 1998, p.132).

Resource Curse

The resource curse hypothesis formulated by Auty (1993) argues that natural resource abundance would reduce the competitiveness of sectors like agriculture and manufacturing and that this industrial underdevelopment leads to stagnation in the long run. Foundational works include Auty (1990), Gelb (1988), Sachs and Warner (1995), and Gylfason *et al.* (1999). It was largely developed around the case of the mining industry and is nowadays, also applied at the regional level (Fleming *et al.*, 2015).

The main factors to explain the different development pathways of resource-abundant countries are institutions and state capacity (Acemoglu *et al.*, 2004; Krugman, 1987; Boos and Holm-Muller, 2013; Sevil, 2017). A scenario of "resource blessing" is defined and identified with certain institutional settings *i.e.,* those with property rights, rule of law, and tax collection (van der Ploeg 2011). Australia, Canada, Scandinavia, and Botswana are cases of institutional setting leading to positive economic effects on general economic welfare (income level, employment and growth) (van der Ploeg, 2011). Describing the opposite scenario, Acemoglu *et al.* (2004) argue that higher resource rents make it easier for dictators to buy off political challengers. Mehlum, Moene, and Torvik (2006) talk about grabber-friendly institutions with the examples of Nigeria or Venezuela as opposed to producer-friendly institutions with the case of Norway.

Di John (2011, p. 180) argues that "The extent to which mineral and fuel abundance generate developmental outcomes depends largely on the nature of the state and politics as well as the structure of ownership in the export". Ownership structure here echoes evidence of corruption in many countries whereas the benefit of the resources is appropriated by a few and does not generate "trickle-down" with a sustained increase in levels of income, education, and industrial stimulus. The management of profit and the institutional settings relevant to sustainable resource management is the starting point for the final article of this dissertation. In Article 4, I explore together with Giacomo Rella, the fiscal infrastructures and their implications at the municipal level.

Dutch Disease

In dialogue with the other theories (staple thesis and resource curse), the Dutch Disease states that a boom in the natural resource sector raises exchange rates, constrains exports in other industries, and in turn, inhibits diversification (Gylfason,

2001a; Smith, 2015). While Canada is sometimes seen as a case of resource blessing, empirics support the presence of Dutch Disease in the country (Stanford 2009, Beine *et al.*, 2012). Beine *et al.* (2012) find evidence to support the Dutch Disease theory in the case of deindustrialisation in the Canadian economy, particularly between 2002 and 2007 – a period during which oil and mineral prices increased. Papyrakis and Raveh (2014) find that mineral-rich regions in Canada experienced higher inflation, and that labour has shifted away from non-primary tradable sectors, which led to manufacturing being crowded out.

Empirical Evidence

While earlier research concentrated at the national level, there has been a recent rise in within-country analysis on the impact of the natural resource sector. Evidence details how extraction results in negative local economic performance in the long term (Lockie *et al.*, 2009, Carrington and Pereira, 2011; Ivanova, 2014). Jacobsen and Parker (2016, p. 1122) find a negative relationship between the oil boom and bust in the United States and long-term employment and income effects: "after the bust, per capita incomes were lower in boom counties than we would predict them to be if the boom had never occurred." They find an income drop of 6%. In a longitudinal study on the oil sector in the southern United States, Michaels (2011) identifies that oil-abundant counties constrained the development of other sectors, resulting in a negative impact on population, employment, and local public goods.

In the short term, results are mixed. Some studies point to a positive income effect but a negative effect on unemployment and poverty for resource booms in general (Freudenburg, 1992, Mills, 1995; Stedman *et al.*, 2004; Höltge *et al.,* 2021) and for mining booms specifically (Elo and Beale, 1985; Williams and Nikijuluw, 2020; Perdue and Pavela, 2012; Oxley, 2014). However, Douglas and Walker (2017) also find a negative short-run effect on per capita income for Appalachian coal mining towns between 1970 and 2020.

Notwithstanding variations between natural resources, numerous studies indicate negative well-being outcomes, notably on poverty and community stability (qualitative analysis by Höltge *et al.*, 2021 and quantitative review by Freudenburg, 1992). When it comes to socioeconomic outcomes, evidence is generally negative after mining booms with increased occurrences of alcohol abuse (Bowes-Lyon *et al.*, 2009), sociocultural conflicts (Smith, 2015; Wood, 1986), as well as an increase in crime, divorce, and drug consumption (Lawrie *et al.,* 2011; Obeng-Odoom, 2014).

Further evidence on the effects of natural resource extraction is reported in Table 3.

Table 3. Summary of the literature on the effects of natural resource sector.

Sector	Article	Outcome variable	Direction of the effect	Scale	Period
Natural Resources	Atkinson and Hamilton, 2003	Genuine saving, investment & GDP/capita	-	National	1980 – 1995
	Auty, 1993	Long run: income per capita	+/-	National	1970 - 1990
	Bhattacharyya and Collier, 2014	Public capital stock	-	National	1970 - 2005
	Boos and Holm-Muller, 2013	Growth, genuine saving & physical/human capital	-	National	1970 - 2008
	Cockx and Francken, 2016	Education	-	National	1995 - 2009
	Fleming *et al.*, 2015	Resource curse	No evidence	Local (Australia, n=449)	2006, 2001 & 2016
	Freudenburg, 1992	Wellbeing & social pathologies	-	National (USA)	20th Century
	Gylfason, 2001b	Education	-	National (n=140)	1965 - 1998
	Gylfason and Zoega, 2006	GDP/capita & investment	-	National (n=85)	1965 - 1998
	James and Aadland, 2011	Growth & living standards	-	Local (USA, n=3092)	1980 – 1995 (2005)
	Mahdiani *et al.*, 2021	Wellbeing & social pathologies	-	Local (Canada, n=37)	2010s
	Paldam, 2013	Medium run: higher growth & Long run (50 years): lower growth	+/-	National	1970 - 1990
	Papyrakis and Gerlagh, 2007	Growth, investment, education & R&D expenditure	-	Sub-national (USA, n=49)	1986 - 2001
	Papyrakis and Raveh, 2014	Other sectors	-	Sub-national (Canada, n=12)	1984 - 2008
	Sachs and Warner, 2001	Growth & price	-	National	1970 - 1990
	Smith, 2015	Long run: capital stock, TFP, labour force & human capital	+/-	National	1950 - 2010
	Stijns, 2005	Growth	+/-	National	1970 - 1989

Oil & gas	Allcott and Keniston, 2018	Short run (at boom): employment	+	Local (USA)	1969-2011
	Caselli and Michaels, 2013	Income & spending (+), except for locals (-)	+/-	Local (Brazil, n=187)	1991-2000
	Jacobsen and Parker, 2016	Long run: employment & income	-	Local (USA, n=500)	1970 - 1990
	Michaels, 2011	Long run: other sectors, employment & public goods	-	Sub-national (USA)	1980-1990
Mining	Aroca and Atienza, 2011	Short run (at boom): Manufacturing employment	+	Sub-region (Chile)	1994-1999
	Bowes-Lyon *et al.*, 2009	Social systems & alcoholism	-	Local (Canada, n=2)	2000s
	Douglas and Walker, 2017	Long run: income & investment	-	Local (USA)	1970–2010
	Elo and Beale 1985	Poverty	-	Local (USA)	1980
	Glaeser *et al.*, 2015	Long run: growth & entrepreneurship	-	Sub-region (USA)	(1900): 1963-2000
	Lawrie *et al.*, 2011	Short to medium run: costs of living and housing(+), income (+/-), employment (+), welfare support (-) & equality (-)	+/-	Sub-national (Australia, n=3)	1990 - 2010
	Nord and Luloff, 1993	Income, poverty, education & job	+/-	Local (USA)	1980 & 1990
	Oxley, 2014	Poverty & employment	-	Local (USA, n=120)	2000-2010
	Perdue and Pavela, 2012	Poverty & employment	-	Local (USA, n=55)	1997-2009
	Williams and Nikijuluw, 2020	Income	+	Local (Australia)	2006, 2011 & 2016

Data

This section outlines the data used, constructed, and collected to conduct the research. I outline how I used a diverse range of quantitative and qualitative data to provide a holistic understanding of the mine closure phenomena and describe how I assembled *MinCan*, a high-quality database at the mine level.

Setting the Context with a Survey of Historical Data

The dissertation begins with an extensive exploration of data sources to unravel the economic history of the Canadian mining industry. Quantitative and qualitative as well as primary and secondary sources have been utilised. Figure 5 lists their sources.

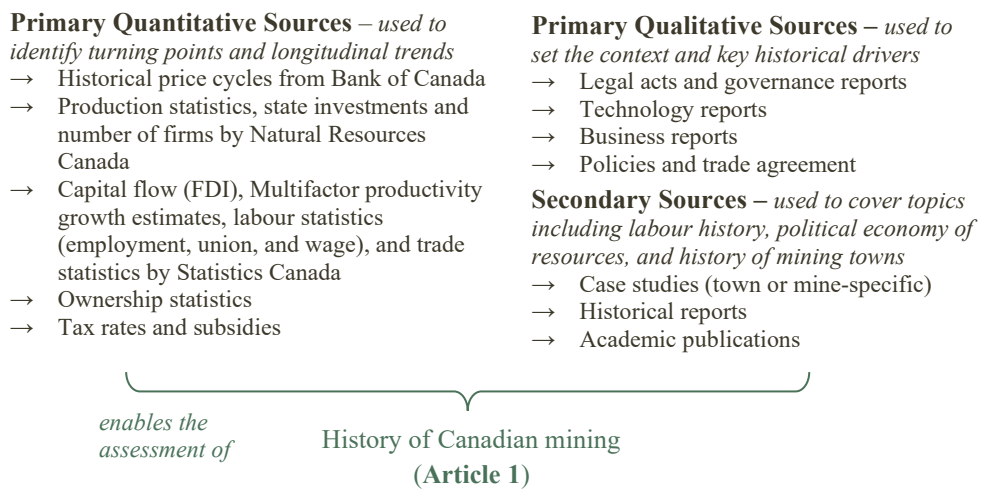

Figure 5. Data utilised in Article 1.

The dispersion and diversity of sources require extensive harmonisation of archival documentation to fill gaps and comprehend the multifaceted nature of the industry. Surveying historical data serves as the foundation for building a broad understanding of the topic at the micro, meso, and macro levels. Moreover, it is an

essential preliminary step to identify the direction and scope of the subsequent articles.

The data sources in Figure 5 are directly used to construct the first article, which provides an overview of the history of Canadian mining since 1859. In this article, quantitative and qualitative data are used both to measure variables that are fundamental to understand and identify regime changes. The procedure is detailed in the methods section, but it should be mentioned that qualitative and quantitative data contribute differently to the analysis. Quantitative data such as price cycles, international capital flow or ownership statistics are used to describe historical trends and their key turning points. I have selected longitudinal databases and often used different sources to cover the whole investigation period. Qualitative data and secondary sources are used to define the context and drivers of change. They uncovered a broad range of topics and components that form the plurality explaining the changes at play in the industry. For instance, technology and law are recognised drivers of change and policy briefs highlight the political tensions at play at different moments of Canadian history. Another example is how corporate reports are also used to account for the perspective of the companies and identify the rise of the sustainable mining and corporate responsibility narrative as early as the 1990s.

Constructing a Novel Database

A survey of historical data identified a gap: the absence of standardised historical information at the mine level. To understand the impact of mining, I constructed a large and unbiased repository of producing mines in Canada. The construction of this resource resulted in the creation of an open-access database called *MinCan* and a publication in the Nature journal for databases, *Scientific Data* (Article 2). Figure 6 details the sources used.

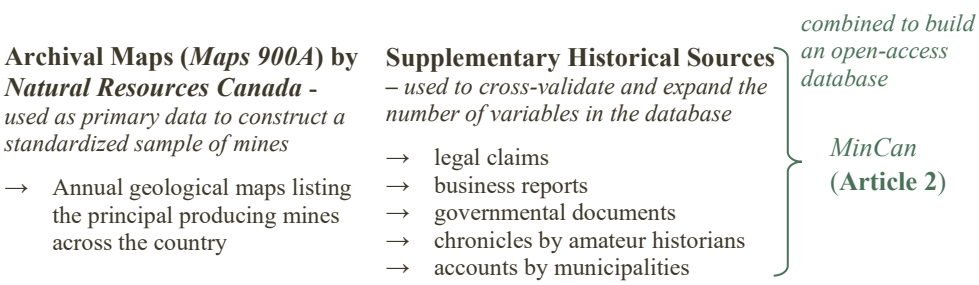

Figure 6. Data utilised in Article 2.

The database covers 947 mines and provides information on their location (latitude and longitude coordinates), company ownership, the principal commodities produced, and the years of operation (opening and closure dates). With these variables, the database provides a way to understand (i) the evolution of the geographical distribution of principal mines, (ii) waves of openings and closures and where they were concentrated, (iii) how the type of commodities extracted changed over time, and (iv) patterns in ownership (*e.g.* capital concentration). All this information opens new avenues for future research.

Constrained by when the archival maps were first issued, the database begins in 1950, yet some mine openings prior to that years are also included. It is the first open-access database to propose an exhaustive, free, and reliable compilation of the principal mines in Canada.

The database covers metals, nonmetals, metalloids, and coal, while oil and gas are excluded (Figure 7). The metallic mineral, the largest category, includes gold, silver, nickel, copper, iron, and lead while non-metallic includes limestone, diamond, gypsum, and salt.

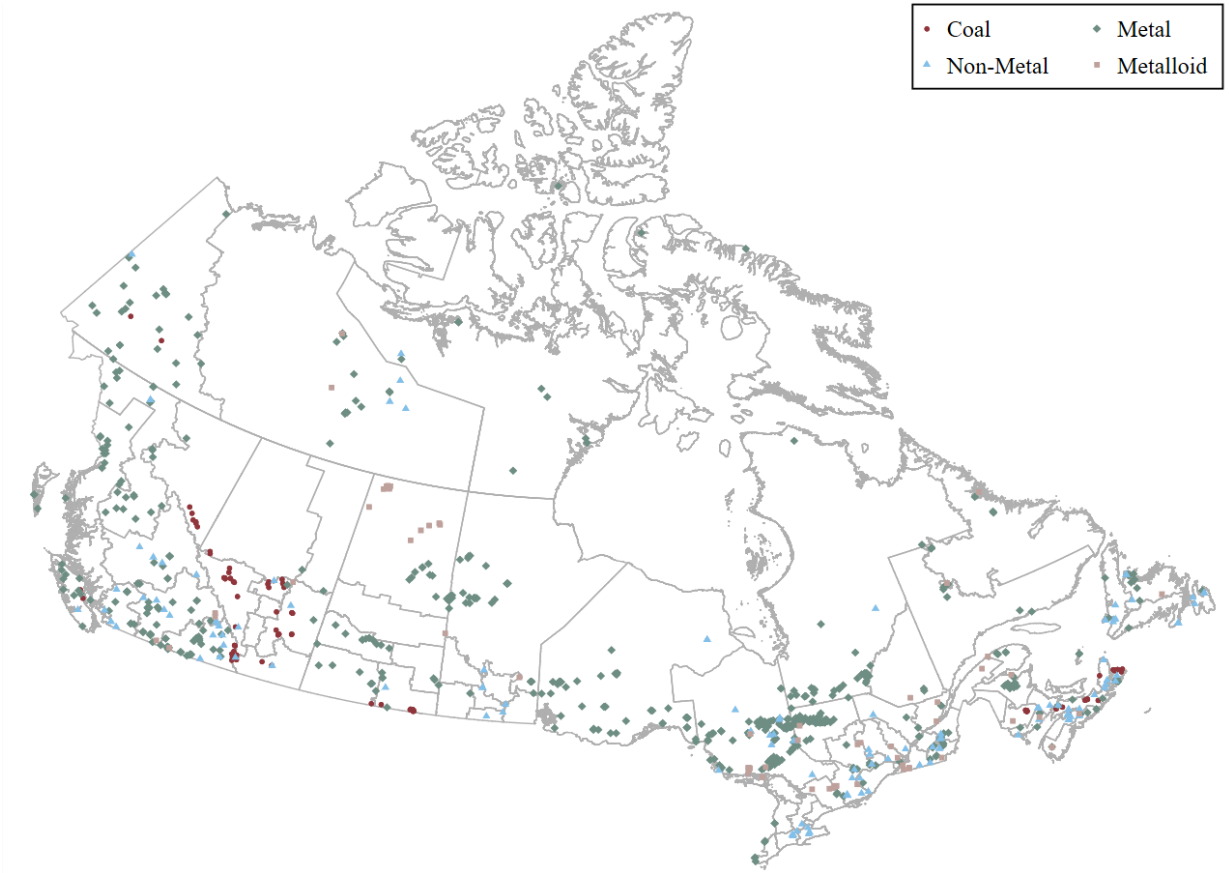

Figure 7. Mines covered by the *MinCan* database, 1950 to 2022.

Matching Datasets and Complementing with Qualitative Data

The construction of *MinCan* has been a necessary step to assess the impact of mine closures on different outcome variables used (see Figure 8) and the choice of variables plays a significant role on the assessment of the impact of mine closures (Mills, 1995). In Article 3, I go beyond mining employment and explore the broader local labour market. In Article 4, we explore fiscal capacity of municipalities and local public services, an understudied topic in the literature on mine closures.

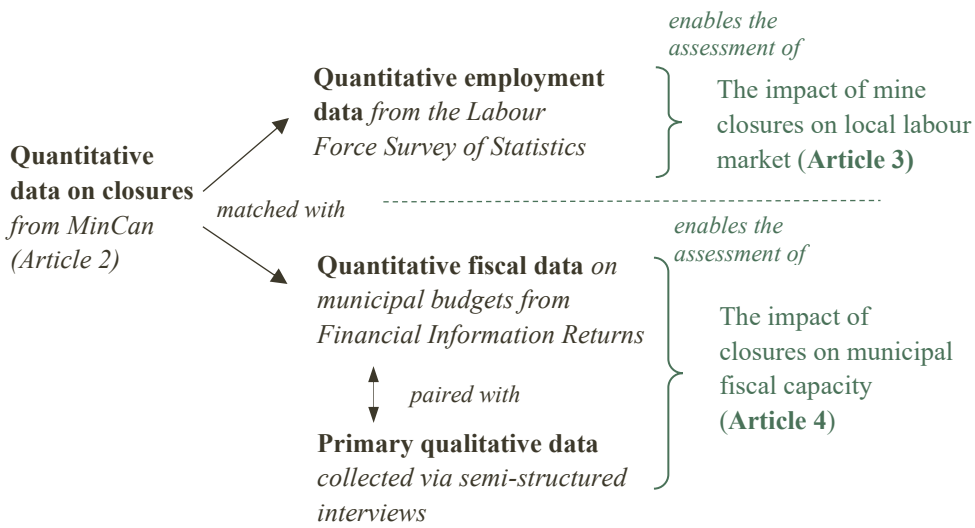

Figure 8. Data utilised in Articles 3 and 4, with matching and pairing procedures.

From *MinCan*, two variables have been used: the years of operation allow to precisely identify closure events and the longitude and latitude coordinates allow to match *MinCan* with geographic units in the other datasets. The rare granularity of *MinCan'*s geological coordinates at the decimal degree with precision of 6 digits or more, is a significant advantage. It allows for matching with databases at different geographical scales including municipalities, regions, electoral districts, labour market areas, commuting zones, and more.

In Article 3, I assess the impact of mine closures on local labour markets by matching *MinCan* with the *Labour Force Survey* by Statistics Canada. The *Labour Force Survey* is the main source of information on labour markets in Canada. It

includes information on employment status and other characteristics of the working-age population. Employment statuses are disaggregated by industries using the North American Industry Classification System (3-digits). The survey is used at the annual frequency and the economic region level. Economic region is the smallest geographical unit for industrial employment status and is the standard unit to analyse regional economies in Canada. This approach enables me to decompose the local labour market among different industries.

In Article 4, together with Giacomo Rella, we have assessed the impact of mine closures on municipal budgets by matching *MinCan* with the *Financial Information Return* from the government of Ontario. The database contains information for each fiscal year on assets, liabilities, revenues, and expenses. The data is used for the years between 2001 and 2022. The period is selected due to the stability of municipal borders and budget components' definition, allowing comparability. The period is also selected due to institutional stability with no significant changes in municipal laws nor change in accounting rules, which would induce spurious movements in municipal budget items that are not related to closure. The selected geographical area is Northern Ontario and the unit of analysis is municipalities. It is an interesting scope as municipalities are located in an historical mining region and are involved in the provision of a large range of public services relative to other regions in Canada.

To fully grasp the factors that determine the impact of mine closures on municipal fiscal capacity, quantitative data is complemented with the collection and analysis of qualitative data. Between August 2023 and May 2024, semi-structured interviews were conducted with municipal actors in the region of Northern Ontario. Interviewees are municipal stakeholders located in towns with a closure according to *MinCan*. The sample predominantly includes mayors and financial officers but also includes local journalists and representatives of Northern municipal associations. A total of 15 interviews (one per respondent) were conducted, each lasting approximatively one hour. Information was collected on the topics of municipal priorities, actions following the closure, institutional constraints, decision-making, and grants.

Methods

While taking a quantitative turn (Cioni *et al.,* 2020), the field of economic history allows researchers to employ a diverse range of sources and methods. As summarised in Figure 9, this dissertation builds on the complementarities of quantitative and qualitative approaches. I follow a pragmatic approach (McEvoy and Richards, 2006), where the choice of method is driven by the research question of each paper.

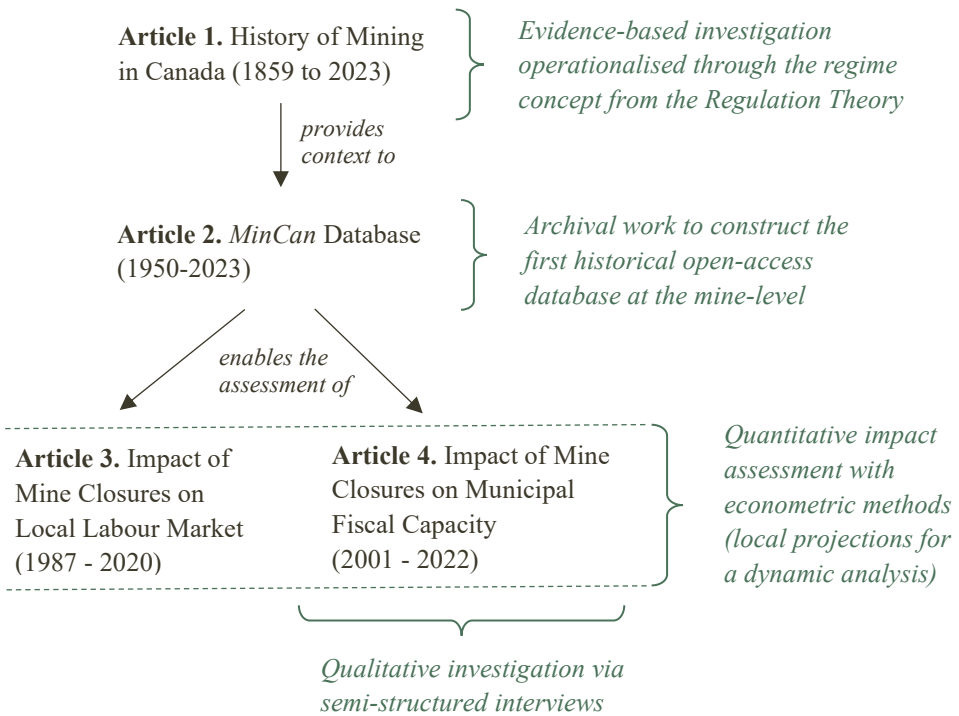

Figure 9. Schematic overview of the methods.

Application of the Regulation Theory at the Canadian Mining Industry

Article 1 investigates the history of mining in Canada through the lens of the Regulation Theory. To this end, I developed a four-step methodology to operationalise the regime concept from that theory.

1. Variable selection. The proposed methodology begins by identifying proxies for the institutional forms (see the definition in *Theory and Previous Research*). Starting with the broad theoretical framework I select proxies based on the theory, followed by a narrower selection of observable variables according to their relevance to mining.
2. Data collection. Data are collected without distinguishing between quantitative and qualitative, aiming to cover the entire timeframe from 1859 to 2023. Quantitative data are essential for providing a sense of scale to the changes at play and identifying trends, while qualitative data allow for exploring interactions between variables and understanding the mechanisms underlying changes in the industry.
3. Analysis. The collected data are then analysed to identify the evolving/enduring nature of the regimes, their drivers/stabilisers, and delineate the boundary dates of the regimes.
4. Validation. Finally, I cross-validate the conclusions by triangulating the data sources and conducting a thorough literature review on the Canadian natural resource sectors.

In sum, the first article rests on an evidence-based investigation of the Canadian mining industry, structured by the Regulation Theory. The four-step methodology has the advantage of transparently outlining the investigation process. This transparency is often absent in political economy analyses when the discussion section eclipses the methodological considerations.

Archival Work and Database Harmonisation

Article 2 reports on the construction of a new database for which I designed a two-step procedure to utilise archives and construct a representative sample of the main producing mines in Canada since 1950.

1. Extract and Compile. I constructed a sample of mines by extracting the names of the mines from geological maps (*Map 900A - Principal Mineral Areas, Producing Mines, and Oil and Gas Fields in Canada)*. The margin

texts (indicated in green in Figure 10) listing the principal mines were digitalised and extracted from the image file using the software ABBYY to text files (represented in Figure 10). Next, a spreadsheet inventory was constructed. In this inventory, rows represent an entry for a specific mine, and columns represent the different maps/years. For every year, "1" indicates that the mine is listed and "0" indicates that it is not.

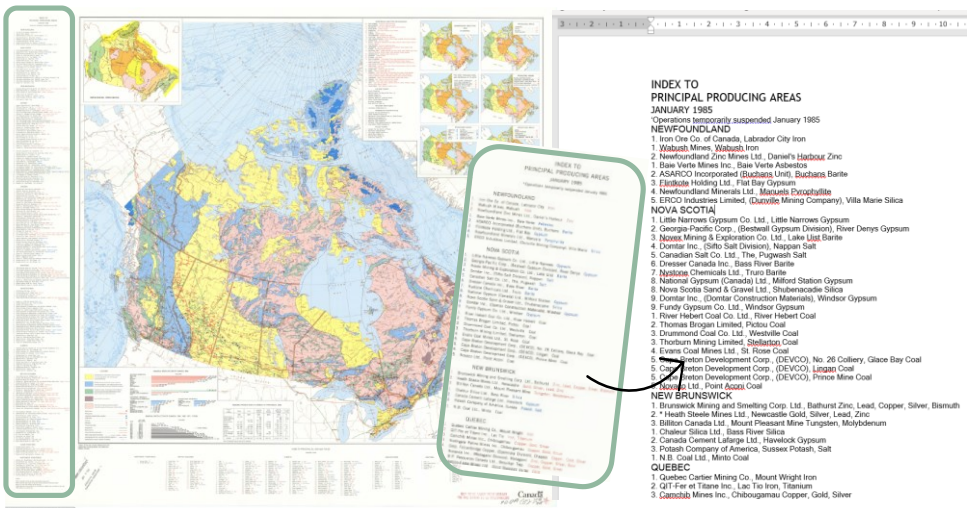

Figure 10. Information extracted from the margin of the archival maps.

2. Search and Verify. I searched for the core variables (location, mine ownership, name, and mineral types) for each mine in the sample using a range of supplementary sources. The supplementary sources were organised according to their scientific credibility into a hierarchy that is respected for each mine-specific search. Part of this extensive process involved collecting missing information. As single mines can be owned by different companies throughout the years, verifications are made to eliminate duplicates. A battery of technical validations followed.

Local Projections Fixed-Effect Model

For the subsequent articles, I employed a dynamic analysis, which implies examining how the effect of a mine closure evolves over the medium run. The econometric technique used is local projections (Jordà, 2005), which allows for obtaining an impulse response function — specifically, the dynamic response of an

outcome variable to a shock. The shock in this case is the closure of a mine. Distinct versions of this econometric model were applied in the two articles.

In Article 3, I used local projections fixed effect panel data models. The model was estimated using OLS with standard errors clustered at the economic region level. This model was used to estimate the dynamic response of employment levels to the mine closures, spanning from two years before the closure to ten years after.

The literature on industrial downturns primarily focuses on employment and output indicators to calculate the cost of the shock. It is argued that cyclical movements in employment tend to be more pronounced than in output and are better aligned with the true welfare costs for local communities (Martin *et al.*, 2015, p. 11). In the literature on local dependence on natural resources, employment indicators are widely recognised as effective ways to capture the relationship between economic fluctuation and well-being (Stedman *et al.* 2004). Supporting the use of employment-based indicators, Martin *et al.* (2015, p. 11) state:

> "it is a region's workforce that bears the brunt of adjustment in recessionary contractions: workers laid off during a recession may or may not be rehired when the demand for a region's production and services begins to recover, and of those who remain unemployed, some may have to move to other regions to finds a job, while those who cannot move may well end up as long-term unemployed, or even, drop out of the labour force."

This motivates my decision to focus on labour market, specifically on employment levels. For it, I decomposed the labour market in employment categories ($E_{i,t}$) in a specific economic region (i) at a given year (t). As shown in the following equation, the local labour market is decomposed into different employment categories (direct, indirect, induced, and residual) based on Hirschman's (1958) theory of industrial linkages:

$$E_{Total\ i,t} = E_{direct\ i,t} + E_{indirect\ i,t} + E_{induced\ i,t} + E_{residual\ i,t}$$

The econometric model estimated the effect on each employment category for the ten years following the closure. Results were presented visually to provide an intuitive understanding of the impact. These estimates were then used to calculate the ten-year average ratio of the number of indirect and induced jobs lost or gained for each mining job lost. This new method contributes to the literature in the following three ways:

1. the decomposition of the regional labour market enables a precise investigation of the impact,
2. the dynamic analysis assesses how the effect intensifies over the medium term, and

3. the use of the *MinCan* database allows for a precise identification of closure event, in contrast to the price change proxies currently used in the literature.

Nonetheless, while it is pertinent to identify *when* each labour category is likely to be affected by a closure, the method has limitation when it comes to causal explanations: *why* is there a delay, *how* do the effects spread from one industry to another, and *how* can these effects be mitigated?

Mixed-Method: Local Projections Difference-in-Differences and Semi-Structure Interviews

In Article 4 (co-authored with Giacomo Rella), we employed a mixed-method approach combining a local projections difference-in-difference model and qualitative data collection.

1. Local projections difference-in-differences model. The local projections difference-in-differences estimates capture the effects of a mine closure on each component of municipal revenues and expenses. The effect is measured from three years before the closure to seven years after. The treated group consists of municipalities in Northern Ontario that experienced a closure, while the control group includes municipalities in the same region that did not. This econometric method (Dube *et al.*, 2023) was newly developed to address the bias estimates in conventional difference-in-differences models. It is at the frontier of causal inference methods aimed at correcting biased estimates in canonical difference-in-differences models (Callaway and Sant'Anna, 2021; Sun and Abraham, 2021).

2. Interviews with stakeholders. After estimating the econometric results, we conducted semi-structured interviews with municipal actors. The topics covered in the interviews include changes in municipal budgets, decision-making, institutional structures, and political and social considerations. General municipal fiscal structures in Ontario (*e.g.,* intergovernmental transfers, responsibilities and obligations) and specific local realities (*e.g.,* lived experiences and municipal particularities) are also discussed.

The interviews allow us to go beyond the *what* to explore the *how* and *why*. Indeed, qualitative insights enable us to identify mechanisms that explain the size of the effects measured by the econometric model. The benefits of a mixed-method approach come at the cost of being more time-consuming compared to other

analytical strategies. We also encountered additional limitations. On the quantitative side, consistent data coverage for municipal statistics was limited to 22 years, which constrained us to a seven-year horizon in the model (*i.e.,* the length of time over which the effect of the closure was assessed). With the lag in response, it would have been valuable to cover 15 to 20 years after the closure. On the qualitative side, some respondents had reservations regarding the research purpose and investigations by foreign researchers. In fact, two municipalities declined our interview request. In most cases, apprehensions gradually diminished during the interviews, and trust was built between the respondents and the researcher. Nevertheless, an ideal scenario would have involved conducting the interviews in person within the municipalities. Although we were aware of this limitation, it was not possible due to unforeseen events.

Results

This section presents the results of the dissertation by summarising the four articles.

Article 1. Shaped by Boom-and-Bust: A History of the Canadian Mining Industry since 1859

Published in New Political Economy

This article provides the first periodisation of the Canadian mining industry, tracing its development since the beginning of large-scale production. Four regimes are identified to capture continuities and changes in the industry (Figure 11). These are defined using the regime concept from the Regulation Theory (Boyer, 1986). The use of the Regulation Theory is formalised through the introduction of a four-step methodology that combines quantitative and qualitative historical data collection to identify trends and turning points.

Regimes are periods of relative stability, intertwined by crises during which political economy variables are reconfigured. The description of mining regimes in Canada offers a general portrait of the conditions of production (technology, labour, and capital), international economic relations, state intervention, finance, and competition.

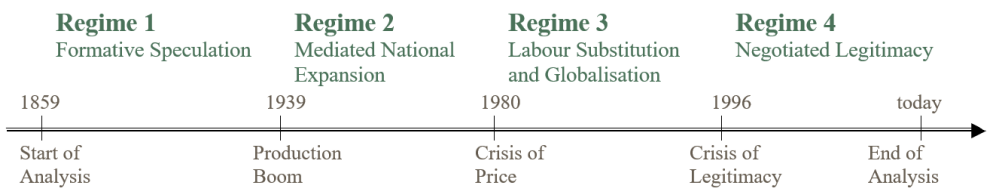

Figure 11. Timeline of the mining regimes in Canada, 1859 to 2023.

During the first regime, two core institutions are established: the *Free Mining Principle*, which gives primacy to mining companies and speculative laissez-faire. Their establishment is not inevitable but results from pressures, primarily from

American prospectors and speculators, and solidifies into a strong path dependency that favours mining companies over local actors, such as workers and Indigenous communities.

During the second regime, the mining industry expands due to rising demand and becomes a pillar of the Canadian national development plan. The state supports this expansion through infrastructure development, exploration services, and financial support. As the resource frontier grows, American companies profit from the boom. Yet, the consolidation of a national development strategy based on foreign capital raise criticism with progressive Canadian voices advocating for the nationalisation of production.

During the third regime, a decline in mineral prices induces a fundamental change in the configuration of the industry. The drop in price leads to a large capital outflow. Subsequently, companies adopt new technologies to reduce costs and increase profits. The burden of the price shock is borne by workers and local communities, as labour is substituted by technology and wages decline. The centrality of mining for Canadian development loses its legitimacy in light of shrinking of employment spillovers. Its legitimacy is further challenged by rising opposition from environmentalists and Indigenous actors.

During the last regime, an upswing in price compels the industry to redefine its legitimacy to operate and benefit from favourable market conditions. A sustainable mining discourse emerges, with impact assessments, corporate social responsibility, and multi-stakeholder agreements becoming normalised in extractive processes. In Canada, the boom coincides with the expansion of the oil and gas sector, positioning the country as a major resource exporter. In a context where the projects have been capital-intensive and risky, the government provides substantial financial support. In contrast to the sustainability narrative and state involvement, evidence indicates that the distribution of profits remains heavily skewed away from citizens and workers.

The first contribution of this article is methodological. I propose a four-step methodology to operationalise the Regulation Theory in the analysis of a specific industry. The five institutional forms (competition, monetary regime, state intervention, wage relations, and international economic relations) allow for a multi-faceted analysis. The heterodox approach, inspired by a plurality of schools of thought (Marxist, post-Keynesian, institutionalist, and Annales School), expands the range of economic factors relevant to the analysis of industrial dynamics. It moves beyond simplistic binaries of resource dependence/independence and blessing/curse.

The second contribution is analytical. I provide the first longitudinal analysis of the mining industry in Canada. I show that, although the industry is largely shaped by boom-and-busts, the implications of price changes vary over time. In some periods, a price upswing is associated with economic spillovers, particularly benefiting

foreign interests. In contrast, the most recent regime demonstrates that a price upswing does not necessarily lead to the expansion of the labour force. This underscores the importance of context in economic history and illustrates how financial and political interventions have shaped the trajectory of Canada's mining industry — especially in terms of labour relations and the distribution of profits.

Article 2. A comprehensive historical and geolocalized database of mining activities in Canada

Published in *Scientific Data*

This article presents the database *MinCan*: *Past and Present Producing Mines of Canada, 1950-2022,* details its construction and data sources, and discusses its potential applications.

The database covers the principal mines operating in Canada from 1950 to 2022. It includes for a total of 947 mines. Information is provided at the mine level on location, company ownership, the commodities produced, and the years of operation (including multiple openings and closures). For several mines, additional information is provided on the causes of closure, the size of the labour force, Indigenous participation, and environmental pollution.

Formerly, data coverage of the Canadian mining industry has had severe limitations, notably due to uneven geographical coverage, confidentiality of governmental datasets, unreliability of sources, and a general scarcity of mine-level information. The method deployed to build the database follows a hierarchy of criteria-based credibility and standardisation. The sample is constructed according to the governmental classification of principal producing mines, which provides a credible sample with nationwide coverage. The sources are archival maps from *Natural Resources Canada,* from which the sample is extracted, and basic information is compiled into standardised mine entries. Following the construction of this sample, mine-specific searches were conducted to cover all variables and triangulate sources to improve the validity of the estimates. *MinCan* provides a systematic tracking of the historical sources used at the mine-level, which increases the credibility and transparency of this resource and allows other researchers to have direct access to further resources through the external web source provided.

The database is an open-access resource that aims to support other researchers and provide answers to questions relating to historical and contemporary questions around mining. Mines have vast effects: local economic shocks that "leave places behind", pollution, and destruction of Indigenous lands together with their intrinsic spiritual and cultural significance. Many questions remain open on the impacts of mining at the regional level from geographical, economic, and social perspectives

and new questions emerge with the growing importance of critical minerals. Addressing these questions is possible through database matching and case identification, as demonstrated in the subsequent articles.

Article 3. Unemployment ripple: The impact of mine closures in Canada, 1987 to 2020

Published in *Resources Policy*

This article provides an empirical assessment of how employment spillover evolves following the closure of a mine. The unit of analysis is economic regions in Canada between 1987 and 2020. The subnational level of analysis allows for a regional examination of the impact on the local labour market.

I investigate this impact over time by monitoring changes in the effects during the ten years that follow the closure and across different segments of the local labour market. More precisely, I look at three subgroups: workers in the mining industry (direct effect), workers in related industries (indirect effect), and workers in demand-linked sectors (induced effect) (Figure 12). The article investigates the persistence of the direct, indirect, and induced effects on employment after a mine closure and the size of these effects.

The interconnections between these segments of the labour force are theorised through industrial linkages, and the contagion of the effect is referred to as the employment ripple. Figure 12 illustrates how they are related.

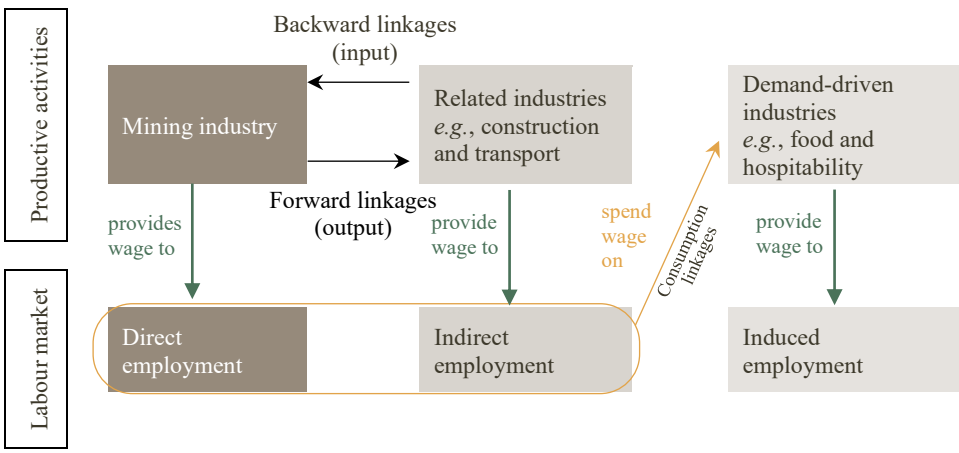

Figure 12. The employment ripple effect for mine closures.

I introduce a novel method to estimate dynamic job multipliers. The method combines the strengths of the input-output strategy (Leontief, 1936) and Moretti's local multipliers (2010). Their combination also addresses the respective weaknesses of these empirical strategies by providing a better compartmentalisation of the labour market and an assessment based on empirical evidence after the shock. I complement these strategies by providing a dynamic analysis using local projections fixed-effects panel model, an econometric strategy that traces the evolution of the employment effect over time (Jordà, 2005).

The findings reveal a substantial ripple effect: I estimate a ratio of 1:4:6. For each direct mining job lost, an average of four indirect jobs and six induced jobs are lost during the ten years following the closure. The dynamic effect on direct employment (mine workers) indicates a strong, immediate, and persistent decrease. For indirect employment (workers in mine-related industries), the effect is delayed by about five years, after which the closure is associated with a 2 to 5% decline. It is likely due to a decrease in demand and the saturation of the local economy, as these workers have similar skill profiles. For induced employment (workers in consumption-linked industries), while overall negative, fluctuations are observed over the ten years following the closure.

This article addresses a significant gap, as the analysis of industrial shutdowns has not sufficiently examined the medium-term effect or the implications for distinct segments of the labour force. Existing research does not adequately account for the dynamic effects in the medium term or their contagion amongst different types of local employment.

Two key implications are uncovered. First, the shock generated by a mine closure affects a large number of workers in non-mining industries. Governments that wish to design policies to address industrial shutdowns or structural changes must account for these other workers. Second, the effect varies over time, demonstrating the relevance of analysing the ten years following the closures (dynamic effect). Hence, research measuring the impact of local industrial shocks must integrate the medium-term changes into their assessment of the phenomenon.

Article 4. A Balancing Act? Local Fiscal Resilience After Mine Closures

Co-authored with Giacomo Rella

This article investigates the impacts of mine closures on municipal fiscal capacity between 2001 and 2022. We focus on municipalities located in Northern Ontario, a historically mining-dependent region in Canada characterised by mono-industrial towns and relative geographic isolation. These municipalities bear extensive

responsibilities for service provision, making them particularly vulnerable to economic shocks. The study explores how mine closures affect municipal budget components and, subsequently, the delivery of local services and overall community liveability.

The analysis derives from a mixed-method approach, combining dynamic econometric analysis based on municipal budget data and semi-structured interviews with municipal actors. The econometric model is a local projections difference-in-differences model tracking the effect of mine closures on budget components for seven years. This innovative research design provides both estimates of the effects on municipal budgets and essential insights to comprehend the underlying mechanisms that explain the direction of change.

At the aggregate level, findings reveal a decline of revenues and a relative stability of expenses, indicating a tension between the need for service provision and the municipality's fiscal capacity. Looking more in-depth, we identify an important change in the composition of revenues and expenses following a mine closure. On the side of revenues, the sources shift away from upper-level government grants toward local sources of revenues like services fees. This implies a reallocation of the fiscal burden onto local populations. On the side of expenses, while funding for recreation declines, environmental and transportation services are preserved. These changes signal a narrowing of municipal roles, from broader community well-being toward infrastructure maintenance.

The impact of the closure appears gradually, with numerous impacts felt in the medium to long run and intensifying over time. For instance, social insurance programs like pension and unemployment benefits help to mitigate the decline in local demand and property taxes.

A core result concerns infrastructure investment. While municipalities maintain their operating costs, large investments, such as basic infrastructure repairs, are not made. Interviewees in mining communities highlighted that such investments were previously borne by the mining companies. This implies that in these Northern communities, the public-private relationship is defined by a dependency that the closure of a mine illuminates.

Situated within the broader context of the climate crisis and the expected volatility of mineral markets, this article highlights the structural vulnerability of mono-industrial towns. It calls for a rethinking of the municipal fiscal structure in Northern Ontario, where the provision of services and the maintenance of infrastructure are heavily dependent on mineral extraction. Decoupling public service provision from private extractive activities is a necessary condition for achieving a just and resilient transition.

Concluding Discussion

The findings of this dissertation underscore the intricate and multifaceted impacts of mine closures on Canadian communities. By leveraging historical, quantitative, and qualitative analyses, the research highlights the vulnerabilities that arise in local economies when mines cease operations. Contributing to the academic discussion on mine closure, two new dimensions are added: the employment ripple in Canadian economic regions and the fiscal impacts on municipalities and their residents. I also lay the groundwork for future research with a political economy history of mining in Canada and a new database.

The historical perspective from the first article reveals that the industry's boom-and-bust cycles have long shaped local mining economies. Given the high dependence on natural resource sectors, these cycles bring about periods of significant economic hardship. Hardship at the micro level refers to the closure of a specific mine and the shock generated for that mining town. Hardship also occurs sporadically and at a macro scale, as seen in the 1980s when mining employment halved in Canada. The newly constructed database, *MinCan*, covering mining activities from 1950 to 2022, provides a comprehensive foundation for analysing these trends and their effects at the local level (Article 2).

Quantitative analysis using local projections panel regression methods sheds light on the persistence of impacts and the importance of time lags. The analysis illustrates how mine closures trigger structural changes at the local level. For the local labour market (Article 3), closures produce significant ripple effects, notably causing a decline in employment across related industries five years after the initial event. For municipal finance (Article 4), closures induce a reconfiguration of municipal priorities. Municipalities struggle to maintain key infrastructures while also experiencing cuts in basic social and recreational services that are central to community liveability. These findings are crucial for understanding the depth and duration of economic shocks in mining communities, as well as the nature of their resilience.

The results obtained from this analysis of Canada are unique in many ways. They must be situated within the timeline of four regimes proposed in Article 1. Indeed, empirical evidence obtained from the econometric analysis is specific to the contemporary period and its historical characteristics. It should be associated with an industry that is technology-intensive and heavily reliant on government

subsidies. It must also be said that nowadays, labour plays a smaller role in mineral production compared to previous periods. It is also important to stress that the housing boom experienced in the last decades is likely to obscure the impact of mine closure on property prices. Nonetheless, the case of Canada is also enlightening. If a country with a long history of mining continues to experience large impacts during periods of industrial slowdown, it highlights the urgent need to rethink the policies and distribution of risks associated with the industry.

Given the necessary transition toward more sustainable economies, we can expect a rise in demand for critical minerals, followed by a bust after their extraction, as well as a decline in demand for coal and other resources. These changes are necessary to achieving the dual objective of the sustainability transition: building green energy infrastructure (which relies on critical minerals like cobalt and lithium) and reducing resource use (especially fossil fuels). The case of Canada and its dependency on the natural resource sector offers valuable insights for mining regions around the world. All are affected by spillover effects on labour (Article 3) and local finance (Article 4), and are embedded within complex political economy structures (Article 1). My findings and the new methodologies I propose underscore the importance of considering the dynamic and widespread consequences of mine closures. This dissertation highlights the necessity for strategic planning and policy interventions that address the medium- and long-term impacts to support affected communities.

By focusing on Canada, a country with a long history of mineral boom-and-bust cycles, I aimed to understand the extent to which actions have been taken and mitigation measures have been implemented. Although sustainability discourse in the mining sector has existed since the late 1990s, few safety nets are in place, and mining regions continue to rely on the next boom to provide employment and fund local services and infrastructure. As such, while this dissertation focuses on providing empirical evidence on the effects of mine closures, it also offers valuable insights for policymakers, stakeholders, and scholars interested in the sustainable structural transition of resource-dependent economies.

Aware of the limitations inherent in what four articles can cover, I hope the *MinCan* database will be used by other researchers to address fundamental questions regarding the socioeconomic impacts of the industry - especially on Indigenous groups present in the mining regions – as well as the environmental impacts of the extraction, the historical evolution of mineral-rich economies, the concentration of mining ownership over time, and the prospective boom-and-busts that will emerge from the sustainability transition within Canadian borders.

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Studies on the Effects of Mine Closures in Canada

What do we know about the impacts of mine closures? How do closures generate ripple effects on regional well-being, municipal finances, and local workers across different industries? Can this knowledge help us plan for a more just transition away from resource-based economies? This dissertation examines the effects of downturns in the mining sector in Canada by mobilising a range of theoretical frameworks and methodological approaches. The papers (1) draw a historical portrait of the industry, (2) build a novel and comprehensive database on industrial activities at the mine level, (3) measure the dynamic effects on Canadian regional labour markets, and (4) analyse the impacts of closures on municipal finances in Northern Ontario and their capacity to provide local services.

Evidence demonstrates that mine closures have wide-ranging implications. They generate significant spillovers across industries and impact workers for years after the closure. In addition, closures harm local liveability by constraining municipal capacity to provide social and recreational services. This dissertation highlights the deeply embedded relationship of dependence between mining communities and the industry, as well as the structural conditions that sustain it. Recognizing and addressing these structures of dependence is essential for enabling a just transition toward more sustainable economies in Canada and other resource-dependent regions globally

Clara Dallaire-Fortier is a political economist interested in structural change, sustainability, and livelihoods. As a teacher and scholar, she employs quantitative and qualitative methods and draws from a plurality of schools of thought. Advocating for curricula that prepare students to face key societal challenges, Clara creates open-access teaching materials that explore real-world examples through diverse historical and plural perspectives.

Printed by Media-Tryck, Lund 2025 NORDIC SWAN ECOLABEL 3041 0903

LUND UNIVERSITY

Department of Economic History
School of Economics and Management

Lund Studies in Economic History 119
ISBN 978-91-989642-2-6
ISSN 1400-4860