Biodiversity-related Risks and the Financial System: Evidence from Mexico

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February 17, 2025

Abstract

This article assesses the potential impacts of biodiversity-related risks on the financial system. To do so, we used data for Mexico, one of the most biodiverse countries in the world. More specifically, we link industry-specific dependencies and impacts on the environment to socioeconomic and financial data. This allows us to evaluate the exposure of output, employment, and the national credit portfolio to high and very high dependencies on ecosystem services and environmental impacts. Additionally, we simulate the potential impacts of physical (water supply) and transition (conservation policies) risk scenarios on the financial system. The main results indicate that 48-66% of total output, 33-70% of total jobs, and 28-53% of total loans are potentially at risk as they exhibit high or very high dependencies on ecosystem services and environmental impacts. Based on the two illustrative scenarios, we find that the credit portfolio exposition to water-related events cannot be seen directly, but rather it is transferred through the economy's supply chains, as 80% of the national credit portfolio is found allocated to industries behaving as net importers of embedded water. Furthermore, an expansion of protected conservation areas would lead to an exposure of $1.1-$8.8 billion USD of output, 4.5-65.5 thousand jobs, along with $291-702 million USD of credits. The article offers an exploration on methodologies and datasets that could be used, replicated and expanded to better understand the economic and financial implications of the complex dependencies on ecosystem services and the diversity of the economy's environmental impacts.

Keywords— Biodiversity, Ecosystem Services, Physical Risk, Transition Risk, Input-Output Economics, Financial System
JEL classification— Q51, Q57

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1 Introduction

It is now widely recognised that climate change would pose significant challenges to the financial system, and therefore central banks have already increased their efforts to enhance the system's resilience. More recently, institutions such as the Network for Greening the Financial System (NGFS) have acknowledged that other environmental issues may also impact the economy and the financial system (NGFS, 2022). In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) caught the attention of humanity, pointing out that the biosphere, along with the services it provides, i.e., ecosystem services (ES), has experienced a high level of deterioration (IPBES, 2019). Within this context, Hadji-Lazaro et al. (2024) argue that biodiversity loss is nowadays perceived as one of the main sources of financial risk, and therefore central banks should understand banks' dependencies and impacts on biodiversity. In line with this idea, the new global biodiversity framework, proposed by the Convention on Biological Diversity (CBD), encourages banks to consider dependencies and impacts on ES in their risk management mechanisms.

As some authors have pointed out, biodiversity-related risks may arise from two sources. *Physical* sources of risk refers to what extent economic activities depend on the degradation of ES, for example, water provision for irrigated agricultural lands, pollination, or flood protection. *Transition* sources of risk are those related to the mismatch between optimization behaviour of firms and policies that aim to reach a nature-positive economy, for example, setting up new protected areas for conservation or prohibiting activities with large negative impacts on nature. This means that banks are directly and indirectly linked to ES because they invest -through loans- in economic activities that largely rely on a healthy nature, e.g. agriculture or forestry, or lead to biodiversity losses, e.g. mining or electricity generation based on fossil fuels. Thus, poor quality or negative changes in ES would rise the probability of defaults, decrease asset values, and therefore, put greater values at risk.

In recent years, some authors have assessed to what extent biodiversity-related risks would impact the financial system in both developed (Van Toor et al., 2020; Hadji-Lazaro et al., 2024) and developing countries (Hadji-Lazaro et al., 2023; WB and BNM, 2022). Broadly speaking, previous studies encountered that a significant share of banks' loans portfolio highly depends on at least one ES or it is exposed to a transition risk because such resources were allocated to economic activities with harmful impacts on biodiversity. For example, in Europe (Kedward et al., 2021), France (Svartzman et al., 2021), Brazil (Calice et al., 2021), and Malaysia (WB and BNM, 2022), 40%, 42%, 46%, and 54% of the loan portfolios are linked to economic activities that show a high or very high dependence to ES. In terms of financing harmful activities, 15-38%, 70%, and 87% of the credit portfolio are at risk in Brazil, Europe, and Malaysia, respectively. This highlights the importance of providing additional evidence about the potential impacts of biodiversity-related risks on the financial system.

To further advance this strand of literature, the contribution of this paper is twofold. First, we combine dependency-impact ratings from ENCORE, input-output matrices, microdata drawn from economic censuses, and GIS data, and use our methodological framework to examine to what extent countrywide physical and transition scenarios would impact the financial system. Second, it provides the first assessment for Mexico in which both financial and socioeconomic variables are considered. Mexico is an exceptional case study because it is one of the most biodiverse countries in the world, and both the Bank of Mexico (BM) and the National Institute of Statistics and Geography (INEGI by its acronym in Spanish) regularly record and publish firm and industry-level[1] spatially disaggregated data.

The main findings indicate that 48-66%, 47-53%, and 45-52% of output, jobs, and credit portfolio, respectively, highly depend on at least one ES and that, for the same variables, 49-66%, 33-70%, and 28-53% are at risk because the corresponding economic activities harm the environment somehow. Turning now to the physical and transition scenarios, the results are as follows. Given the importance of water-related ecosystem services across Mexico's economic structure, the paper assesses the economy's exposition to the physical risk linked to physical data on water use. About 76% of water withdrawals in Mexico are for agricultural activities, which then behave as main exporters of water embedded in their deliveries to the rest of the economy, followed by power generation in thermoelectric plants. Notwithstanding, their relevance to water use, agricultural activities only represent 2.6$ of the credit allocation in the country. In contrast, 80% of national credit is allocated to manufacturing and services, which are net importers of embedded water. This implies that the exposition of the credit portfolio to water-related events cannot be seen directly, but rather it is transferred through the economy's supply chains. For the transition risk scenario, we use one of the Mexico's commitments in the Kunming-Montreal Global Biodiversity Framework: *Goal 2.1: Ensure that at least 30% of terrestrial degraded ecosystem areas are subject to effective restoration.* Assuming that harmful activities would be prohibited in these areas, \$1,141-\$8,829 and \$290-\$702 million USD of output and credit values would be at risk, along with 4,480-65,472 jobs.[2]

The remainder of this paper is as follows. In section 2, we present a brief overview of the existing literature in terms of key findings, methodological approaches, geographical coverage, data availability, and key limitations. Section 3 describes our empirical strategy and data. Section 4 presents the results and their implications in terms of advancements with respect to previous studies, their replicability in other contexts, and policy making in Mexico. Section 5 concludes.

2 Literature review

Recently, one can encounter empirical assessments of either nature or biodiversity-related risks in this strand of literature. These valuations have been conducted in the Netherlands, France, Brazil, Malaysia, Mexico, and Europe. Such studies closely followed the methodological approach introduced by Van Toor et al. (2020). Generally speaking, we can summarize the methodological steps as follows. First, key financial or economic indicators should be disaggregated and classified

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[1] Along the article, we use the term 'industry' to refer to the 4-digit NAICS codes, that is, to the industry group.

[2] The pairs of values show results for direct and indirect linkages.

on a industry level based on the Global Industry Classification Standard (GICS). Second, using the ENCORE web-based tool, which provides industry-specific dependencies from and impacts on ecosystem services, researches link financial or economic indicators to dependency and impact rates by industry. Third, based on ENCORE's ratings, which vary from very low to very high, and a given threshold, one can identify the value of financial or economic values at risk. In some articles, the authors present a case study to illustrate how particular physical and transition risks would be materialised into the financial system (see for example Hadji-Lazaro et al. (2023)).

Van Toor et al. (2020) points out that Dutch financial institutions have provided EUR 510 billion to companies that highly depend on at least one ES, EUR 193 billion to firms that are involved in conflicts related to damages to ES, negative impacts on biodiversity, or deforestation, and that - given the expansion of protected areas - EUR 28 billion of their funds are exposed to this transition policy. In France, Svartzman et al. (2021) and Hadji-Lazaro et al. (2024) encounter that 42% of debt securities directly depend on at least one ES, however, if the analysis considers indirect effects through the supply chain, 100% of securities depend at least slightly on services provided by the ecosystem. For South Africa, Hadji-Lazaro et al. (2023) estimate that 50% of national output depends on at least two ES and that 70% final demand, 59% profits, 46% wages, 40% employment, 52% taxes, and 83% net exports are linked to industries with a high dependency on ES.

Also looking at the impacts of biodiversity loss, Calice et al. (2021) find that 46% of Brazilian banks' loan portfolio belongs to non-financial entities that highly depend on at least one ES, if there is a collapse in ES output losses would likely translate into an increase of 9% in non-performing loans, if the government prohibits economic activities in protected areas, or potentially protected in the future, 15%-38% of their credit portfolio would be at risk. For commercial Malaysian banks, WB and BNM (2022) indicate that 54% of their loans portfolio is in the hands of firms that strongly depend on ES while, at the same time 87% of the portfolio is exposed to transition risks as these resources were allocated to industries with a strong negative impact on ES.

Martinez-Jaramillo et al. (2023) argue that for Mexican banks an important share of their credit portfolios holds a strong degree of dependency and impact on ES, that is, such portfolios are highly exposed to physical and transition risks. Analysing corporate bond purchase operations of the European Central Bank, Kedward et al. (2021) discover that 40% of the portfolio highly depends on ES while 70% of the portfolio is now invested in activities potentially causing biodiversity loss, e.g., real estate, infrastructure, mining and manufacturing. Using a different approach, in terms of units of analysis, Mundaca and Heintze (2024) estimate that USD $335.22 billion, or 27%, of equity investment made by the 10 largest European banks highly depends on ES, being the UBS Group AG and the Deutsche Bank AG the most exposed banks. Overall, empirical studies agree that both physical and transition risks would likely pose significant challenges for financial institutions worldwide.

Since the pioneering study by Van Toor et al. (2020) there have been important methodological advancements. For example, Hadji-Lazaro et al. (2023) include i) an identification of key sectors using direct dependencies and impacts, ii) an estimation of indirect impacts through the value chain - upstream and downstream -, and iii) socioeconomic variables in their analysis. Another relevant improvement corresponds to the introduction of the spatially-explicit assessment of financial risks as has been done by Hadji-Lazaro et al. (2023) and Martinez-Jaramillo et al. (2023). Despite its advancements, the method still suffers from some deficiencies. Recently, Mundaca and Heintze (2024) identify the following methodological and data limitations. First, impacts and dependencies on ES are subject to the specific location of assets, credits, or firms and their supply chains, and this has not been fully incorporated into the analyses. Second, previous studies typically use ENCORE data to obtain dependency and impact ratings, notwithstanding, such information is based on a business process level and different approaches should be utilised to obtain industry level scores. Third, derived from the previous caveat, ENCORE assumes that firms within the same industry are homogeneous, i.e., same scores for these entities. Some authors coincide that there exist important limitations in terms of data availability and its temporal and spatial aggregation.

The contribution of this paper to the literature is as follows. First, we aim to advance the methodological approach to identify how physical and transition risks can affect the financial system through the real economy. More specifically, we take advantage of input-output matrices, firm-level geocoded data drawn from economic censuses, and GIS tools to simulate the potential impacts of environmental degradation and nature conservation policies on the financial system. Second, rather than using local changes in Es or local transition policies, we use countrywide representative data. Third, this article also provides the first assessment for Mexico, one of the most biodiverse countries in the world, in which socioeconomic variables are also taken into account.

3 Method and data

To identify the impacts of biodiversity-related risks on the financial system, we proceed as follows. First, in most cases widely used datasets report dependencies and pressures on ES using the International Standard Industrial Classification (ISIC) for specific ratings. However, country-level data may not use the same classification for its economic activities; therefore, researchers should deal with any misalignment that arise from using a different industrial classification. Second, using input-output matrices, one can identify industry-specific direct and indirect dependencies and pressures over nature. Lets assume we have the following model for an economy consisting of n production industries:

$$x_i = \Sigma_j a_{ij} x_j + y_i \tag{1}$$

where x_i is total output in industry i, a_{ij} represents the demand for inputs from industry i to produce a unit of output in industry j, x_j is total output of industry j, and y_i is final demand. Equation (1) can be re-written in matrix form as follows:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \tag{2}$$

where $\mathbf{A}$, known as the *matrix of technical coefficients*, is of dimension n x n and contains all the coefficients a_{ij} capturing the direct industrial interdependencies given current technology. The economic model in (1) and (2) can be solved as follows:

$$(\mathbf{I} - \mathbf{A})\mathbf{x} = \mathbf{y} \tag{3}$$

or,

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{L}\mathbf{y} \tag{4}$$

where **L**, known as the *Leontief inverse*, is also of dimension n x n and organizes total requirements l_{ij}, each describing the total output from industry i that is needed to satisfy one unit of final demand of industry j, including for the intermediate demand of required inputs. Therefore, equation (4) tells us the volume of output from each industry that is needed to satisfy both the intermediate and the total demand of the economy, where matrices A and L identify the direct and indirect interdependencies between industries, respectively.

Assume now the existence of two additional matrices **D** and **P** organising scores of direct dependencies on ES and of direct environmental pressures, respectively, for all industries in the economy. Let m be the number of relevant ES and q be the number of relevant environmental pressures, such that matrices **D** and **P** have dimensions m x n and q x n, respectively. To obtain the indirect dependencies of industries to ES we multiply the following:

$$\Omega = \mathbf{DL} \tag{5}$$

The matrix Ω has dimension m x n and each entry ω_{mn} contains the indirect dependency score of industry's n supply chain to the ES m. Similarly, to obtain the indirect scores of environmental pressures by the industries in the economy we compute:

$$\Phi = \mathbf{PL} \tag{6}$$

The matrix Φ has dimension q x n and each entry ϕ_{qn} contains the indirect score of industry's n supply chain to the environmental pressure q. Third, the identification of key industries is based on a comparison for both the total backward and forward linkages of an industry, which are built with the following procedure (Miller and Blair, 2022). From the Leontief matrix **L**, we first compute the total backward linkage of industry j, $BL(t)_j$, as:

$$BL(t)_j = \Sigma_{i=1}^{n} l_{ij} \tag{7}$$

Note that each $BL(t)_j$ sums the output needed from all the industries in the economy to satisfy one unit of industry's j final demand, and in that sense is helpful to identify industry's j supply chain. We can organize the total backward linkages for all industries in a row vector:

$$\mathbf{b}(t) = \mathbf{i'L} \tag{8}$$

where a prime denotes transposition. In order to facilitate inter-industry comparisons, we follow the standard practice to normalize linkages by utilizing Rasmussen's measure of dispersion power (Miller and Blair, 2022). In this procedure, the total backward linkage for each industry is presented as a proportion of the average linkage in the economy, such that industries with linkages above (below) average exhibit indices greater (lesser) than one:

$$\bar{\mathbf{b}}(t) = \frac{n\mathbf{i'L}}{\mathbf{i'Li}} \tag{9}$$

We follow a similar procedure to construct total forward linkages as a measure of the participation of each industry in the supply chains of the rest of the economic system. Again, from the Leontief matrix $\mathbf{L}$ we define the total forward linkage of industry i as:

$$FL(t)_i = \Sigma_{j=1}^{n} l_{ij} \tag{10}$$

$FL(t)_i$ measures the output that industry i needs to generate in order to simultaneously satisfy one unit of final demand for each industry in the economy, and in that sense is helpful to identify industry's i participation in all the supply chains in the economy. Again, we organize the total forward linkages for all industries in a column vector:

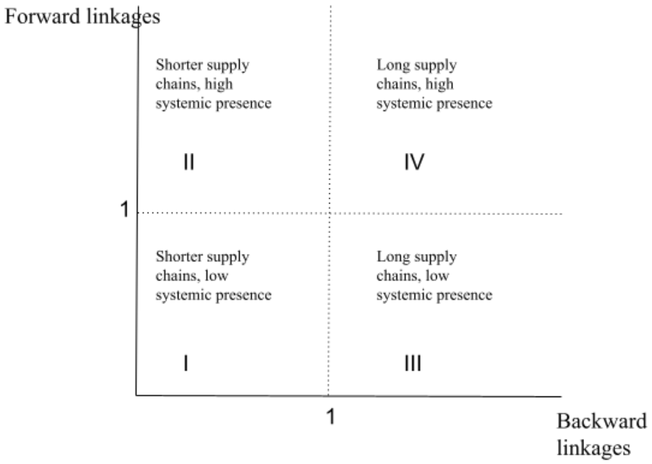
$$\mathbf{f}(t) = \mathbf{Li} \tag{11}$$

Similar to total backward linkages, we normalize using Rasmussen's measure of sensitivity of dispersion (Miller and Blair, 2022), now implying that industries with forward linkages above (below) the economy's average exhibit indices greater (lesser) than one:

$$\bar{\mathbf{f}}(t) = \frac{n\mathbf{Li}}{\mathbf{i'Li}} \tag{12}$$

Finally, for each industry we combine the normalized backward and forward linkages to assess its importance in the economic system using the criteria of Figure 1. Industries with below average backward linkages (quadrants I and II) are relatively independent from intermediate supply, exhibiting shorter supply chains from the rest of the economy. Industries with above average backward linkages (quadrants III and IV) are relatively more dependent on intermediate supply, with larger supply chains from the rest of the economy.

Figure 1: Quadrants for key sectors



Similarly, industries with below average forward linkages (quadrants I and III) do not have a strong systemic presence in terms of their participation in other industries' supply chain, whereas industries with above average forward linkages (quadrants II and IV) do participate more in other industries' supply chain than the average industry in the economy. Therefore, key industries are defined as those in quadrant IV, they have larger supply chains in the rest of the economy while participating more frequently in the supply chains of other industries. These measures for backward and forward linkages are crucial for the analysis as they help us to identify vulnerabilities along the supply chain given their dependencies on ES or their impacts on the environment, which can then be transferred to the financial system.

The assessment of exposition to physical risk is performed with a standard computation of the environmentally-extended input-output model (Miller and Blair, 2022). In our case, the extended model includes a vector containing coefficients indicating the volume of water required in each industry to generate one unit of output. That is,

$$\mathbf{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_N \end{bmatrix} = \begin{bmatrix} \frac{W_1}{x_1} \\ \vdots \\ \frac{W_N}{x_N} \end{bmatrix} \tag{13}$$

where W_i is the total volume of water directly consumed by industry i. Then, the water consumed in the Mexican economy can be computed simply as follows:

$$W_Q = \mathbf{w}^T\mathbf{x} = \mathbf{w}^T\mathbf{L}\mathbf{y} \tag{14}$$

where a T denotes transposition. Finally, to obtain the matrix of inter-industry flows of embedded water we compute:

$$\mathbf{W} = \hat{\mathbf{W}}\mathbf{L}\hat{\mathbf{Y}} \tag{15}$$

where $\hat{\mathbf{W}}$ and $\hat{\mathbf{Y}}$ are matrices organizing vectors $\mathbf{w}$ and $\mathbf{y}$, respectively, in their principal diagonal.

Complementing this identification of key industries, we use an alternative criterion derived from network analysis (more on PageRank). Similar to Hadji-Lazaro et al. (2023), we also account for socioeconomic variables by including output and employment in the analysis. We also use the industry-specific share of credit portfolio from commercial banks to examine the exposure of the financial system to changes in nature. Fourth, we define two scenarios for physical and transition risks and develop a spatially-explicit assessment of the potential impacts of biodiversity-related risks on the financial system. This last step requires the use of geocoded firm-level and other GIS data.

Following the methodological approach, we link dependency and impact ratings to socioeconomic data in Mexico. We use the updated version of the ENCORE dataset (ENCORE, 2024), which reports dependencies from 25 ES and impacts on 13 nature-related items of 271 industries[3], to assign dependency and pressure scores to socioeconomic data reported for 263 industries in Mexico.[4] We use the equivalence table in INEGI (2018a) to match ISIC to NAICS codes where possible.[5] In those cases where there was no a clear link, we performed a one-by-one association between industries to assign the closest economic activity to the corresponding industry.

INEGI (2018b) publishes the 2018 input-output matrix, reporting linkages between 263 industries. Since we have the correspondence between the ISIC and NAICS codes, it is straightforward to assign dependency and impact ratings to the input-output matrix and to other socioeconomic variables such as total output, employment, and loan portfolio. For socioeconomic variables in the analysis, we use the National Account System, 2019 Economic Census (INEGI, 2019), and 2022 Agricultural Census (INEGI, 2023). Apart from reporting socioeconomic variables, both censuses record the location of 4.8 million firms and 4.6 million farms. Having the location of economic units is crucial as one can develop spatial assessments of the potential impacts of biodiversity-related risks not only in the economy but also in the financial system. **The industry-specific loan portfolio was provided by BM (2024).**

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[3] ENCORE uses ISIC codes to categorized economic activities.

[4] INEGI uses the North American Industrial Classification System to report industry-specific data.

[5] The equivalence table can be found here.

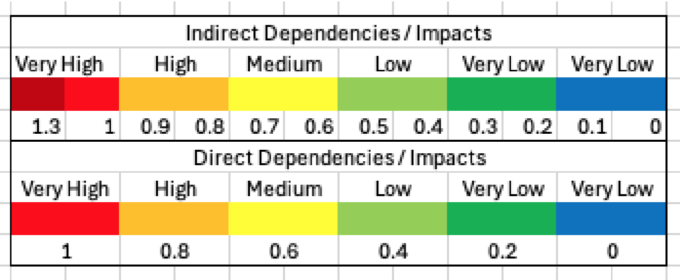
4 Results

4.1 Economy-wide dependencies and impacts

The assessment of dependencies of industries on ES is done using two main sources of information. First, the direct dependency matrix **D** resulting from the correspondence between the ENCORE database and the North American Industrial Classification System (NAICS), consisting of 25 rows (one for each ecosystem service) and 263 columns (one for each industry under the NAICS). Second, the matrix for indirect dependencies $\mathbf{\Omega}$ resulting of pre-multiplying **D** to the Leontief matrix **L**, resulting in matrix $\mathbf{\Phi}$, which is also a matrix of 25 rows (one for each ecosystem service) and 263 columns (one for each economic sector under NAICS, see previous section).

Recall that the Leontief matrix contains information about the supply chain of each industry m as measured by the output of all industries in the economy needed to produce one unit of good m for final demand. Recall further that these industry interdependencies are measured by taking into account infinite feedback loops. That is, each supply chain m is composed of both the industrial output of the inputs that are directly needed for good m, and the industrial output that is also needed to produce those inputs, and so on. The ratings for direct dependencies in the ENCORE database are categorical (i.e., 0, 0.2, 0.4, 0.6, 0.8, and 1), while the indirect dependencies resulting from matrix multiplication yield a continuum. We follow the next colour code to maintain consistency between the two.

Figure 2: Colour codes for direct and indirect dependencies and impacts

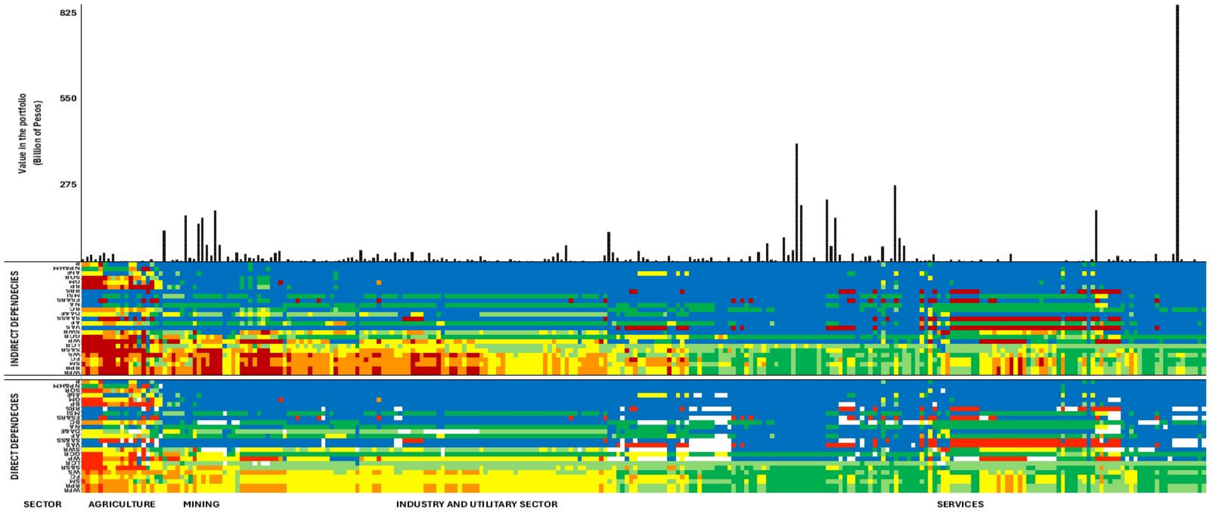


Indirect Dependencies / Impacts											
Very High		High		Medium		Low		Very Low		Very Low	
🟥	🟥	🟧	🟧	🟨	🟨	🟩	🟩	🟩	🟩	🟦	🟦
1.3	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0

Direct Dependencies / Impacts					
Very High	High	Medium	Low	Very Low	Very Low
🟥	🟧	🟨	🟩	🟩	🟦
1	0.8	0.6	0.4	0.2	0

Figure 3 provides an economy-wide comparison between indirect and direct dependencies on ES. High and very high direct dependencies located in certain industries are 'transferred' to other industries in the indirect dependencies due to their participation in their supply chains. For example, agricultural sectors exhibit high direct dependencies on water, on soil services and on climate regulation, while the direct dependencies to these services by the food industry is rather weak. However, in the indirect heat map, the food industry increases its dependency on these services due to agriculture's high participation in their supply chains.

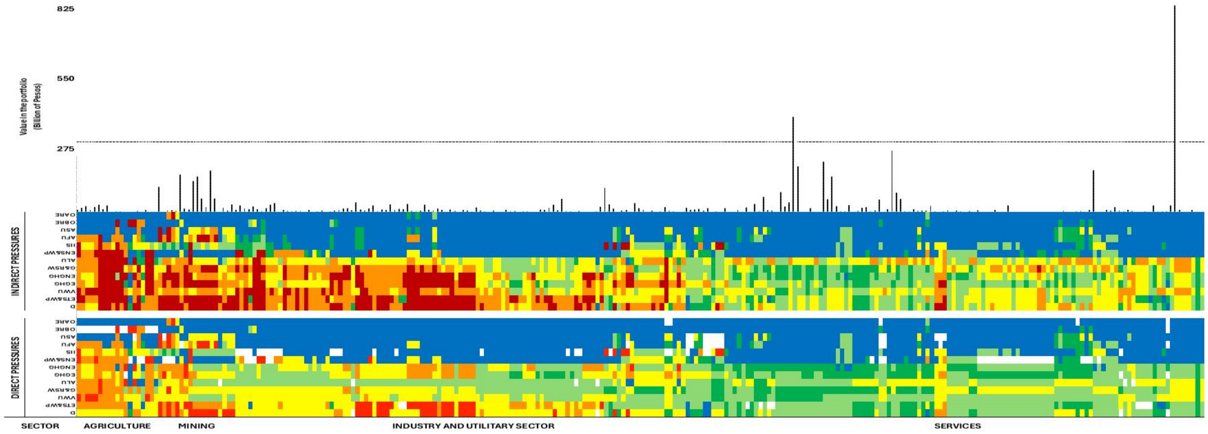
Figure 3: Direct and indirect dependencies linked to credit portfolio



Indirect dependencies for industrial and manufacturing sectors appear high due to the transfer of high direct dependencies in their supply chain, especially so for water, biomass services, genetic material, regulation of soil quality and pollination for the food industry, the light wood industry, petroleum derivatives, and various chemical industries. Health services exhibit a high dependency on water, while visual, spiritual, artistic, and symbolic amenity services are important for education, health and some social services.

Similarly, once the correspondence between the industrial classification codes is established, the ENCORE database is also used to identify the pressures generated by the 263 industries in 13 categories of environmental impact in matrix **P**. The pressures levels in the direct database are also categorical (very high (1), high (0.8), medium (0.6), low (0.4) and very low (0.2)), while the scores for indirect pressures resulting from matrix multiplication are in a continuum. We use the colour code of Figure 2 to identify them. Figure 4 illustrates the direct impact of each of the branches on each of the environmental pressures. As can be seen, services are the industries with the lowest impact on all variables, with low and very low impact on disturbances (e.g. noise, light), emissions of toxic soil, water pollutants, volume of water use, generation and release of solid waste, area of land use, emissions of GHGs and of other air pollutants, emissions of soil nutrients and water pollutants. In contrast, mining and the steel industry exhibit high and very high impact levels for disturbances (e.g. noise, light), emissions of toxic soil and water pollutants.

Figure 4: Direct and indirect pressures linked to credit portfolio



Following a procedure similar to the analysis of dependencies, matrix **P** is used to estimate indirect impacts through the supply chains of each industry by multiplying it to the Leontief inverse **L**. In general, accounting for indirect impacts that occur in each industry's supply chain increases its impact score (see Figure 4. Livestock activities, for example, stand out when compared to direct impacts with the highest scores for GHG emissions and for various pollutants due to its supply chain. A similar behaviour is observed in mining, construction, energy and urban water, while GHGs emissions and those of other atmospheric pollutants have medium direct importance, when considering supply chains the importance increases substantially.

Figure 4 also shows the indirect impacts for manufacturing and services. There is also an increase in the importance of impacts when considering the indirect effects of the supply chains for each industry with respect to direct impacts. The highest impact ratings are observed for various disturbances, emissions of toxic pollutants, and GHGs emissions by the light industry (wood and paper), the petroleum derivatives and the chemical industry. The food industry also shows important indicators for these impacts, although it adds the use of water and land and the emission of water and land pollutants. Services show less impact importance due to their supply chains, although waste collection services stand out (for disturbances and emissions of GHGs and other toxic pollutants) or some care and health services (for generation of solid waste).

Table 1 summarizes these results and links with socioeconomic (production and employment) and financial (sectoral credit) variables. As seen, a large number of industries exhibit high or very high direct scores to at least one ES (146), representing 47% of gross output and employment, and 46% of the economy-wide credit portfolio. These numbers increase when considering the cascade effects through each industry's supply chains, as now 189 industries have high or very high indirect dependencies to at least one ES, representing 66% of gross output, Table 1 summarizes these results and links with socioeconomic (production and employment) and financial (credit) variables. As seen, a large number of industries exhibit high or very high direct scores to at least one ES (146), representing 47% of gross output and employment, and 46% of the economy-wide credit portfolio. These numbers increase when considering the cascade effects through each industry's supply chains, as now 189 industries have high or very high indirect dependencies to at least one ES, representing 66% of gross output, Table 1 summarizes these results and links with socioeconomic (production and employment) and financial (credit) variables. As seen, a large number of industries exhibit high or very high direct scores to at least one ES (146), representing 47% of gross output and employment, and 46% of the economy-wide credit portfolio. These numbers increase when considering the cascade effects through each industry's supply chains, as now 189 industries have high or very high indirect dependencies to at least one ES, representing 66% of gross output, 53% of employment and 52% of the credit portfolio.

Table 1: Economy-wide financial exposure

	Sectors with high or very high scores	**Output value (Million USD)**	**Jobs (millions)**	**Credits (million USD)**
Direct dependencies	146	1,041,423	27.91	133,091
%	55.5%	47.8%	46.9%	45.5%
Indirect dependencies	189	1,432,482	31.65	150,590
%	71.9%	65.7%	53.2%	51.5%
Direct impacts	104	1,065,516	19.56	83,135
%	39.5%	48.9%	32.9%	28.4%
Indirect impacts	171	1,436,179	29.22	154,293
%	65.0%	65.9%	69.6%	52.8%

Source: own elaboration.

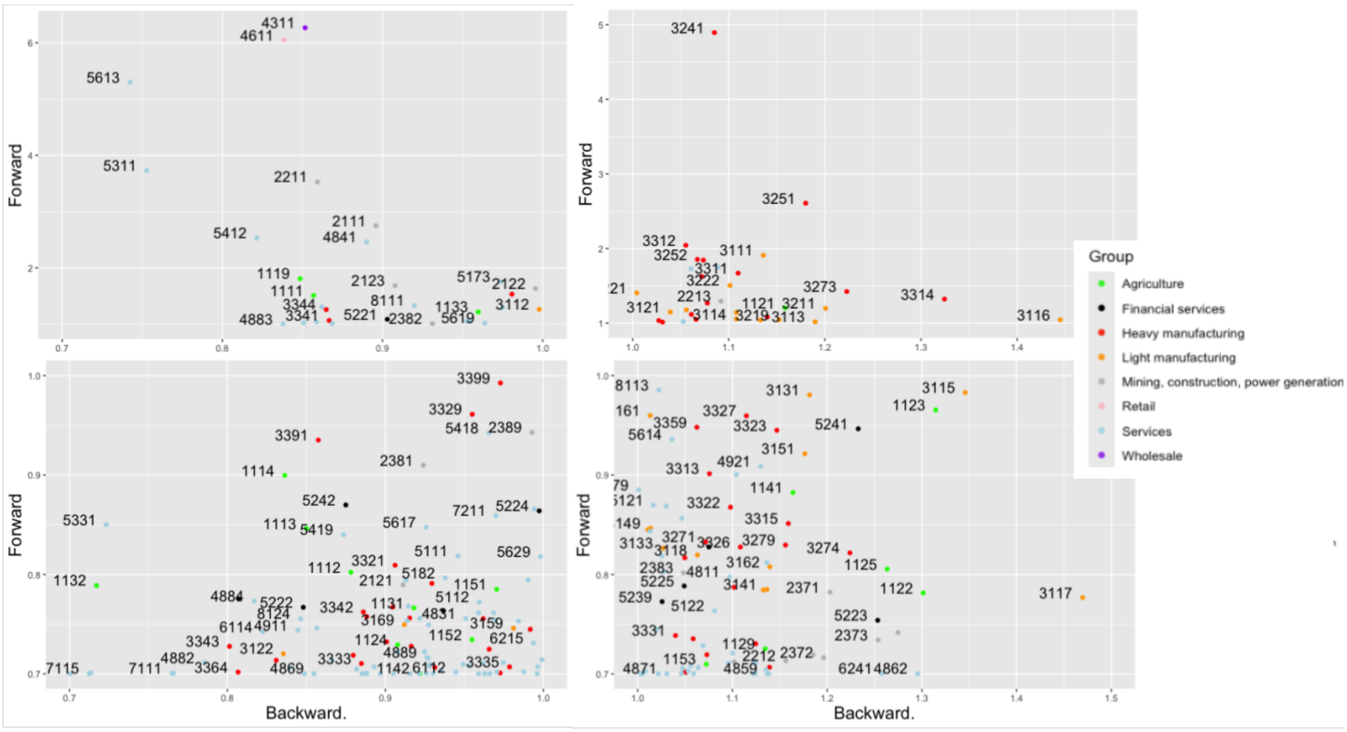
A similar behaviour is seen regarding pressures over several categories of environmental impacts. In total, 104 industries have high or very high direct scores of at least one of the impact categories, representing 49% of national output, 33% of employment and 28% of the national credit portfolio. However, by considering the indirect effects throughout industrial supply chains, we obtain 171 industries exhibiting high or very high scores to at least one impact category, representing 66% of gross output, 70% of jobs and 53% of the economy-wide credit portfolio.

4.2 Dependencies and impacts for key industries

Figure 5 organizes the 263 input-output industries of the Mexican economy using the criterion of Figure 1 to identify key industries, and shows the NAICS labels for some of them. The majority of industries locate in quadrants I (111 sectors) and III (90 sectors), while quadrants II and IV contain only 30 and 32 industries, respectively. Industries in quadrant I are relatively more isolated in the Mexican economy as they exhibit lower than average systemic participation (their forward linkage is less than one) and supply chains that are shorter average (their backward linkage is less than one). We see many industries in service activities (light blue), in heavy manufacturing (in red), and in agriculture (in green). Among those activities exhibiting the weakest linkages both backward and forward we find services from independent artists (7115), forest nurseries and greenhouses (1132), or rental of franchises and patents (5331).

Sectors in quadrant III generate output requiring supply chains more complex than in the average but that is not widely demanded as an input by other industries. Here we find agricultural activities like fishing (1141), aquaculture (1125), and production of pig and poultry (1122 and 1123); some light and heavy manufacturing, like processing of fish products (3117), dairy products (3115), textiles (3131 and 3141), some metallic products (3323 and 3327); and several services, like passenger transport by land (4859), gas transport through pipes (4862), repair and maintenance of agricultural machinery (8113), or services from social workers (6241).

Figure 5: Key industries in the Mexican economy



Quadrants II and IV are less populated than the former quadrants, indicating the lower number of activities that can have a high systemic presence. Industries in quadrant II have supply chains shorter than the average, but generate output highly demanded as inputs by the rest of the economy. Within primary and extractive activities we find crop production (1111 and 1119), forestry (1133), oil extraction (2111), mining (2122 and 2123) and power generation (2211). Not many manufacturing industries locate in this quadrant, but we see grain milling (3112) and the production of electronic components (3344) and of computers (3341). Standing out in the service sector we see commerce, both wholesale and retail (4311 and 4611, respectively), employment services (5613), rental of real estate (5311), cargo transport (4841), accounting (5412), and commercial banking (5221).

Industries in quadrant IV stand out as having supply chains that are relatively longer than the average and produce output that is more demanded economy-wide as an input than in the average. Both criteria qualify them as "key industries," implying that disruptions in their operation have the potential of affecting a large number of industries in the economy, both because they produce inputs widely used by these key industries, or because they very frequently demand inputs from them.

Only 32 industries qualify as key, and the majority of them (28) involve several manufacturing activities, including the food processing industry (six sectors from 3111 through 3121), some light industries like textiles (3132), paper and wood (3211, 3219, 3221 and 3222), and heavy manufacturing, notably oil derivatives (3241), but also the chemical (3251) and the plastics industries (3261), the production of metals, iron, glass, and concrete (15 industries from 3241 through 3314). Livestock for bovine production (1121) and the water industry (2213) also appear as key industries in the Mexican economy, while key services include storage (4931), corporations (5511) and business support (5611).

Table 2 shows the general picture for these key industries in terms of their dependence on ES and the pressures for several categories of environmental impact. Sixteen of these industries have high or very high direct dependencies on at least one ES. When considering the cascade effects throughout their supply chains, the number of key industries with high or very high indirect dependencies to ES rises to 27. Examination of Figure 6 shows that dependencies generally differ between agricultural industries (in this case, bovine production, 1121), manufacturing, both light and heavy (2123 through 3314), and service industries (4931, 5511 and 5611).

The supply chain for bovine production exhibits high and very high dependence to the largest number of services, including all related to water, climate regulation (local and global), waste remediation, biomass provisioning, regulation of soil quality, and cultural services like spiritual, symbolic and scientific services. Supply chains for manufacturing activities show high and very high dependencies for water-related services, especially for the water sector itself (2123), the food processing industry (3113 through 3119), the paper industry (3222 and 3231), the chemical industry (3253 through 3255) and the metal and glass industries (3272 through 3314).

Table 2: Economic and financial exposure in key industries

	Sectors with high or very high scores	**Output value (Million USD)**	**Jobs (millions)**	**Credits (million USD)**
Direct dependencies	16	215,809	1.77	14,795
%	6.1%	9.9%	3.0%	5.1%
Indirect dependencies	27	309,037	2.52	18,455
%	10.3%	14.2%	4.2%	6.3%
Direct impacts	18	256,197	1.77	14,403
%	6.8%	11.8%	3.0%	4.9%
Indirect impacts	31	341,898	2.89	27,030
%	11.8%	15.7%	6.9%	9.2%

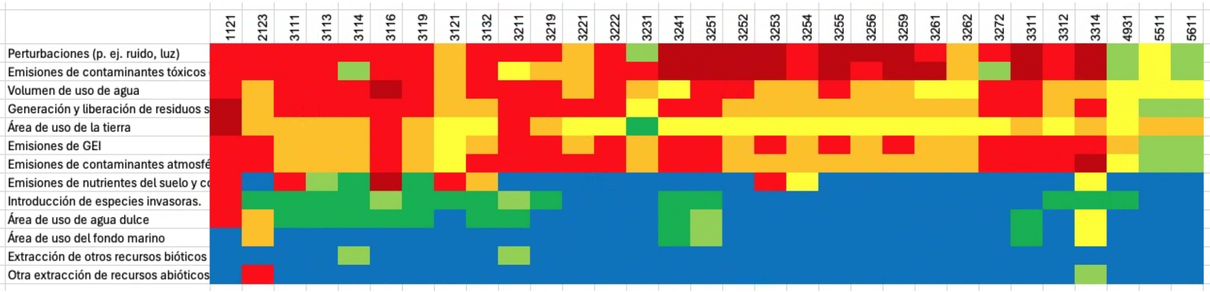
Source: own elaboration.

Manufacturing dependencies on other regulating and cultural services are generally less strong, although some of them appear as particularly important, like waste remediation for the food industry and for heavy manufacturing, or the regulation of global and local climates and the atmospheric dilution of pollutants, which appears with medium importance for almost all key manufacturing activities. In contrast, the supply chains for service activities exhibit much lower dependencies to ES, although storm mitigation and regulation of local and global climates appear with medium importance. Consequently, key industries with high or very high scores of indirect dependence on at least one ES are responsible for about 14% of gross output, 4% of employment and 6% of the economy-wide credit portfolio.

Figure 6: Dependencies on ES by the supply chains of key industries in the Mexican economy

The picture for environmental pressures is very similar. Thirty one of the 32 key industries have a high or very high score of indirect pressure for at least one category of environmental impact. These 31 industries are responsible for 16% of national gross output, 7% of total employment and 9% of the national credit portfolio. Examination of Figure 7 reveals that impact patterns are different between primary, secondary and tertiary activities. The supply chains for bovine production (1121) exhibits high and very high impact scores for the more categories, with waste generation and land use with the highest scores, and only excluding use of oceans and extraction of biotic and abiotic resources.

Figure 7: Environmental impacts throughout the supply chains of key industries in the Mexican economy



The water industry (2123) exhibits high impact scores on perturbations, generation of toxic wastes, GHGs and other atmospheric pollutants, and extraction of abiotic resources. Unlike their behaviour on dependencies, manufacturing activities show a more diverse environmental impact depending on particular activities. Supply chains for the food industry (3111 through 3119) have high impact on environmental perturbations, generation of toxic waste, of nutrients and other water pollutants, and water use. Meat processing (3116) stands out as also having high scores for land use, emissions of GHGs and of air and soil pollutants.

Supply chains for the chemical industries (3241 through 3261, from oil derivatives, fertilizers and pesticides, and plastics) are particularly important for environmental perturbations, the generation of toxic wastes, water and land use and the generation of air pollutants. In turn, supply chains for the production of glass, concrete, iron and steel (3272 through 3314) are quite important in terms of environmental perturbations, generation of toxic waste, land and water use, and the emission of GHGs and of other air pollutants. In general, services show weaker scores of environmental impact both directly or indirectly through their supply chains. Storage services (4931) has medium impact in terms of water and land use, generation of solid wastes and of air pollutants, whereas corporate services (5611) and support for businesses (5611) have a similar profile of environmental impact, with medium to high importance for water use and emissions of GHGs.

4.3 Scenario 1: physical risk

The previous assessment of economy-wide direct and indirect dependencies on ES highlighted the role of water-related services for the whole economy and for its key industries. Recall in Figure 3 how high and very high direct dependency on water-related services was concentrated in agricultural sectors, but it was then translated to other industries (particularly the food industry and other manufacturing) through the participation of the former in the supply chains of the latter. This assessment, however, utilizes categorical indicators of generic dependencies and needs to be complemented with real data on physical dependencies. As a means of illustrating the movement from categorical scores to real-world data on physical dependency, this section utilizes economy-wide information on water use in Mexico. The resulting assessment for both direct and indirect dependencies on water availability illustrates the potential risk contagion through economic supply-chains of water-related events.

Table 3 shows water concessions to economic activities in physical units as displayed by Mexico's water agency. Unfortunately, Mexico's water agency does not use the same industrial classification, and therefore a correspondence between its classification and the one in the NAICS needs to be established. Note the dominion of agricultural activities: the combination of agriculture, agro-industry, aquaculture, livestock, and other agriculture claims 76% of total withdrawals. Note also that the water agency distinguishes industrial and service activities by whether they are self-supplied, meaning direct access to water sources, or located in urban centres, implying being served by the urban water sector. Water allocated to urban centres comes second with 15% of total water use, and this volume is used by urban industry (only 1%), urban services (2.7%) and households (11%). The latter volume is treated exogenously in the economic model utilized in this study, implying that the use of water for economic production (that is, net of household use) is 78,997 HM^3. Thermoelectric generation (4.7% of the total) refers only to consumptive use, that is, excludes hydropower generation based on dams.

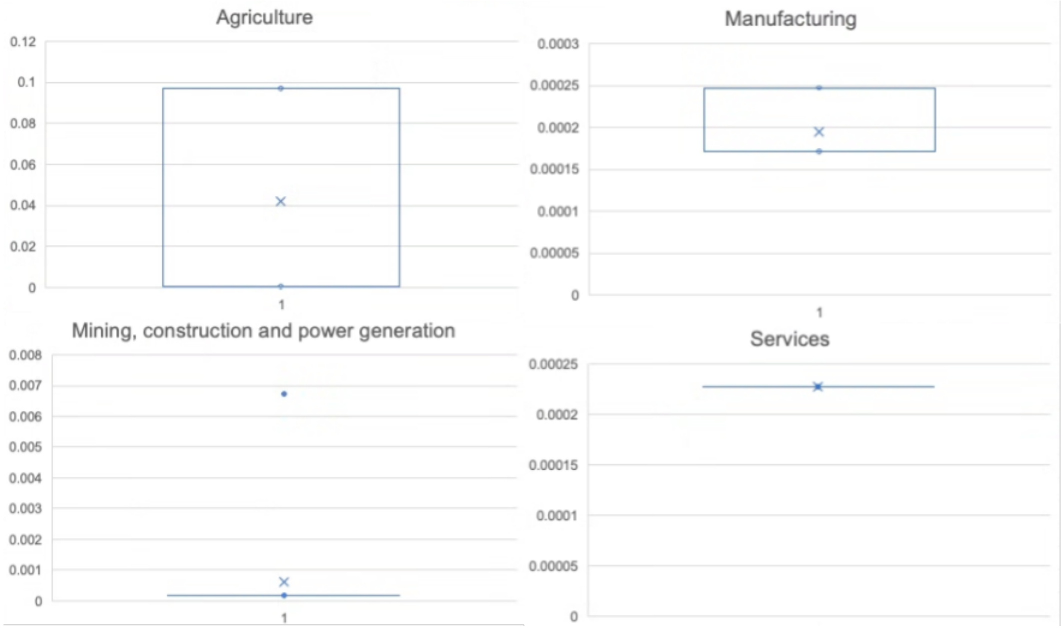
Table 3: Water concessions per economic activity, Mexico 2018

	Use HM^3	%
Agriculture	59,950.0	67.5
Agro-industry	4.2	0.0
Aquaculture	1,160.0	1.3
Self-supplied Services	1,637.0	1.8
Self-supplied industry	2,694.0	3.0
Thermoelectric generation	4,147.0	4.7
Livestock	226.0	0.3
Urban industry	884.3	1.0
Urban services	2,367.20	2.7
Households	9,842.5	11.0
Other agricultural	5,927.0	6.7
Commerce	0.1	0.0
Other	1.0	0.0
Total	88,840.2	100.0

Source: own elaboration.

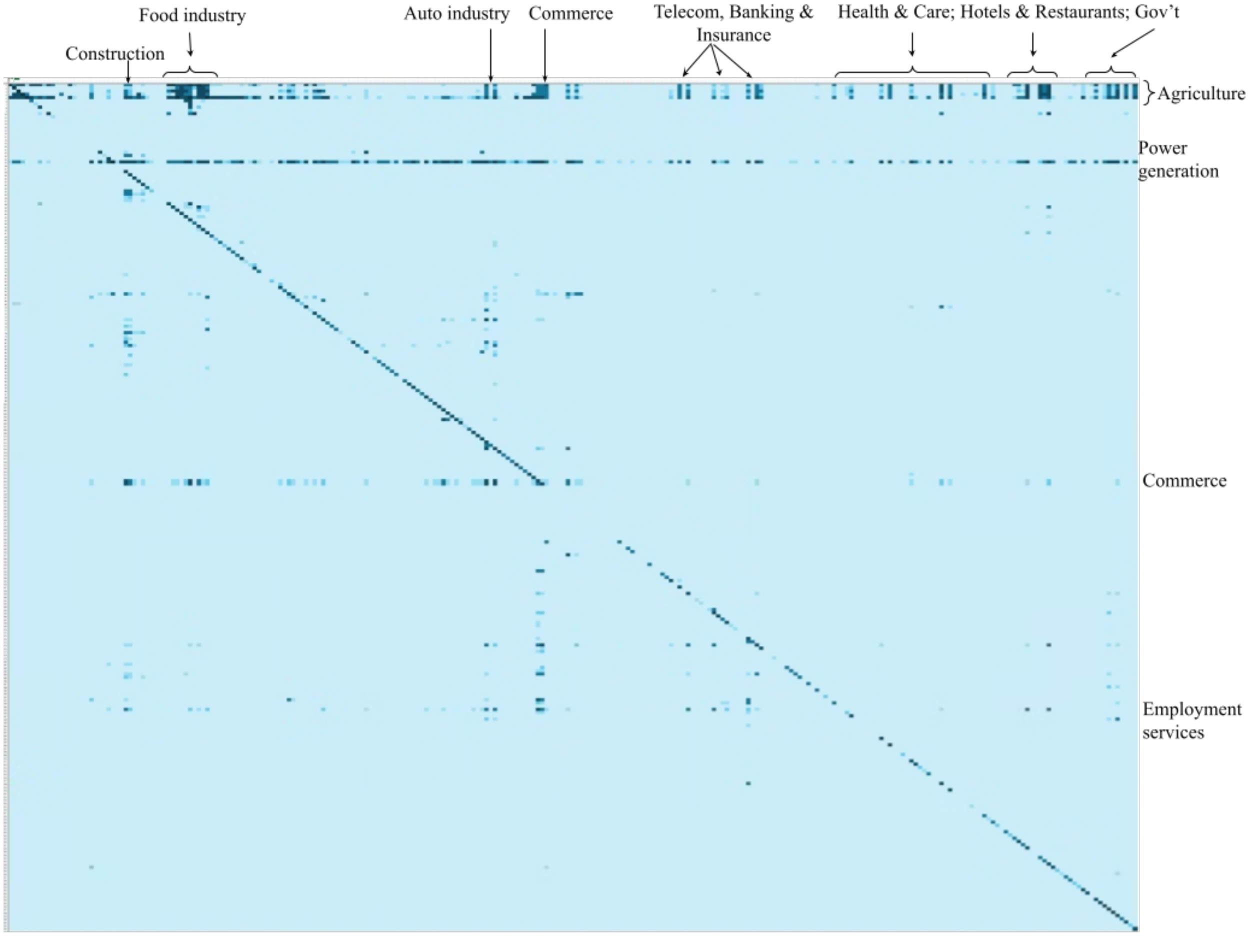
Once the sectoral correspondence between the industrial classifications in the NAICS and the one used by the water agency is established, we build a vector of water coefficients following the procedure explained in the methodology section. These coefficients measure in volume the direct dependency of each sector on either water withdrawals from different sources or on deliveries by the water sector in urban regions. Figure 8 shows the main differences between water coefficients for different sectors. Agricultural activities utilize the most water per unit of output measured in monetary units (1 million pesos in this case). The smallest coefficients in the box for agriculture correspond to several agricultural-related services, silviculture, forestry and livestock production, while the largest coefficients are for crop production.

Figure 8: Distribution of water coefficients per major group of economic activity. $HM^3/Million\ pesos$



Note the difference in order of magnitude between agricultural water coefficients and those for the rest of the economy. Coefficients for mining, construction and power generation are much more concentrated below 0.001 $HM^3/Million\ pesos$, while the coefficient for power generation stands out as an outlier, just below 0.007 $HM^3/Million\ pesos$. Coefficients for manufacturing are even smaller than those of mining and construction but more diverse, since they capture the difference between having direct access to water sources (in the self-supplied industry) and being served by the water sector (when located in urban centres). Finally, services are the activities consistently with the smaller water coefficients in the economy. Provided with this information, we compute matrix **W** as shown in the methodology section. This matrix shows the flows of water in physical units (HM^3) embedded in the inter-sectoral transactions of the input-output matrix, and is shown in Figure 9, whose colour code increases in intensity with larger volumes.

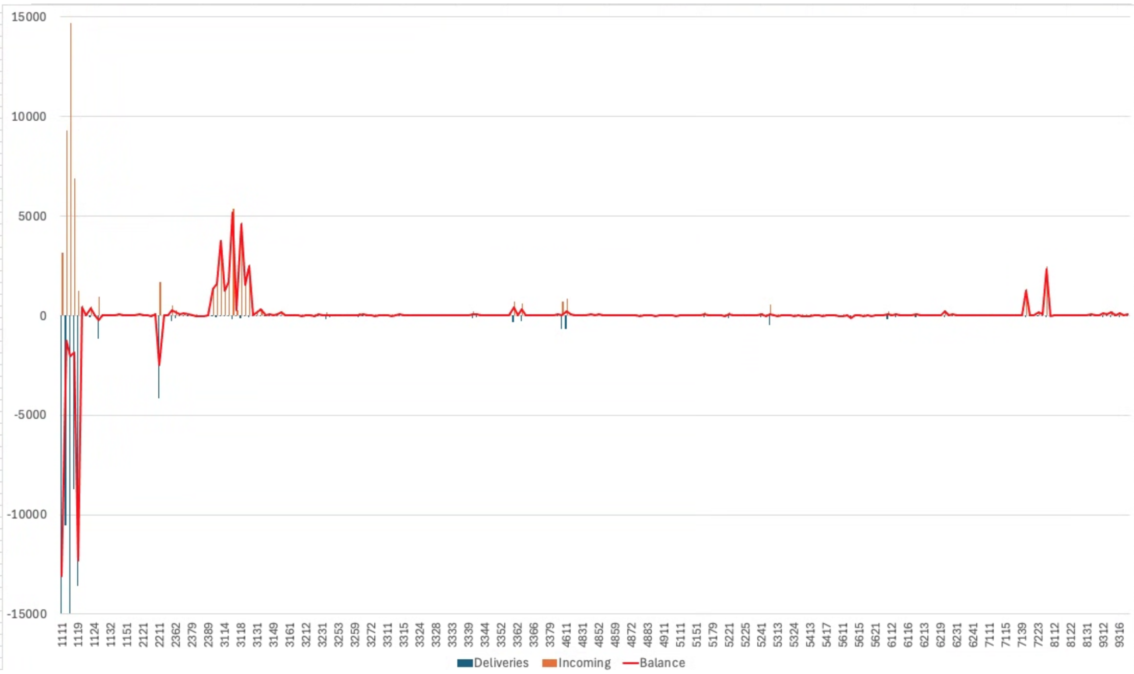
Figure 9: Inter-industrial flows of embedded water in the Mexican economy. 2018. HM^3



Matrix **W** organizes the 78,997 HM^3 used in economic production given the actual supply chains for each industry, and is useful to locate those that are more exposed to water-related disruptions. While water is essential for all economic transactions (i.e., there are no empty cells), there are some activities concentrating the largest volumes of indirect transactions of embedded water. Reading the Figure horizontally, we see the volumes of water embedded in the deliveries of each sector to the rest of the economy. Notably, the agricultural sector stands out for the volume of water indirectly delivered to throughout the economy, especially to the food and the auto industries, commerce, telecom and financial activities, several activities in health and care, hotels and restaurants, and in the operation of government. Power generation also stands out given the water utilized in producing the electricity delivered throughout the economy, particularly to manufacturing activities and services; while commerce (both wholesale and retail) also stands out by its deliveries to the rest of the economy, particularly to manufacturing activities.

Alternatively, reading the Figure vertically, we see the volumes of water embedded in the purchases of each industry from the rest of the economy, and it is indicative of the relevance of water in the economy's supply chains. Activities in construction and in the auto industry depend indirectly on water used in agriculture, in manufacturing and in services for producing inputs they demand, whereas the commercial sector depends more from water use in agriculture and in a variety of services. Another feature standing out in Figure 9 is the principal diagonal of matrix $\mathbf{W}$, which is a result of the high importance of intra-industrial transactions in each industry's supply chain. Figure 10 aggregates matrix $\mathbf{W}$ in terms of the volumes delivered to each industry by its upstream supply chain ("Purchases"), and the volumes delivered by each industry to its downstream supply chain ("Deliveries"), such that an assessment can be made about whether a industry is a net exporter of embedded water (volumes in deliveries are larger than in purchases) or a net importer of embedded water (the other way around). As can be seen, water embedded in deliveries downstream is concentrated in a small group of industries, mainly crop production, power generation, commerce (both wholesale and retail) and the auto industry. Water embedded in purchases upstream is concentrated also in agricultural sectors (reflecting mainly intra-industrial transactions), but notably in the food industry, in the restaurant and hotel sectors, and less so in the auto industry and in commerce (both wholesale and retail).

Figure 10: Industrial balance of embedded water in the Mexican economy. 2018. HM^3



In terms of balance, main net exporters of embedded water concentrate in agricultural activities and in power generation, while main net importers of embedded water concentrate in the food industry, in hotels and restaurants, and less so in the auto industry and in commerce. While Figure 10 shows the largest flows of embedded water, the majority of industries do trade embedded water to some degree, even in smaller volumes. In general, the majority of industries (182) in the economy behave as net importers of embedded water, while 79 are net exporters. Table 4 summarizes the flows of embedded water and links them to the exposure of the national credit portfolio per major group of economic activity.

The first thing to notice is that agriculture, while using the most water and also concentrating the largest exports of embedded water to downstream supply chains, with almost 30,000 HM^3, does not have a direct impact on the national credit portfolio, as only 2.6% of the latter is allocated there. In contrast, 80% of the credit portfolio concentrates in manufacturing and service activities, which are net importers of water, meaning that the water risk does not come from direct use, but from upstream the supply chains. Manufacturing concentrates 12.6% of the national credit portfolio and exhibits substantial net imports of water embedded in the upstream inputs, at 26,256 HM^3.

Table 4: Net exporters and importers of embedded water and exposure of national credit portfolio

	In deliveries downstream HM^3	**In purchases upstream** HM^3	**Net purchases of embedded water** HM^3	**% of credit portfolio**
Agriculture	67,269.6	37,315.1	-29,954.5	2.6
Mining, construction, power generation	4,771.2	2,995.7	-1,775.4	15.0
Manufacturing	2,989.0	29,245.0	26,256.0	12.6
Services	3,966.9	9,440.9	5,473.9	69.8
Total	78,996.7	78,996.7	-	100.0

Source: own elaboration.

While services utilize much less water than any other sector in the economy, they concentrate 70% of the national credit portfolio. These activities use directly relatively small volumes of water and also behave as net importers of relatively small flows of water embedded in their upstream supply chains, with 5,473 HM^3. These small volumes, however, are not to be interpreted as weak dependence or low importance, given the essentiality of water as a factor or production with no substitutes. Rather, these numbers imply that the activities relying on relatively small volumes of water can be affected by small disturbances in the availability of water not only available to them, but also to the industries in their upstream supply chain.

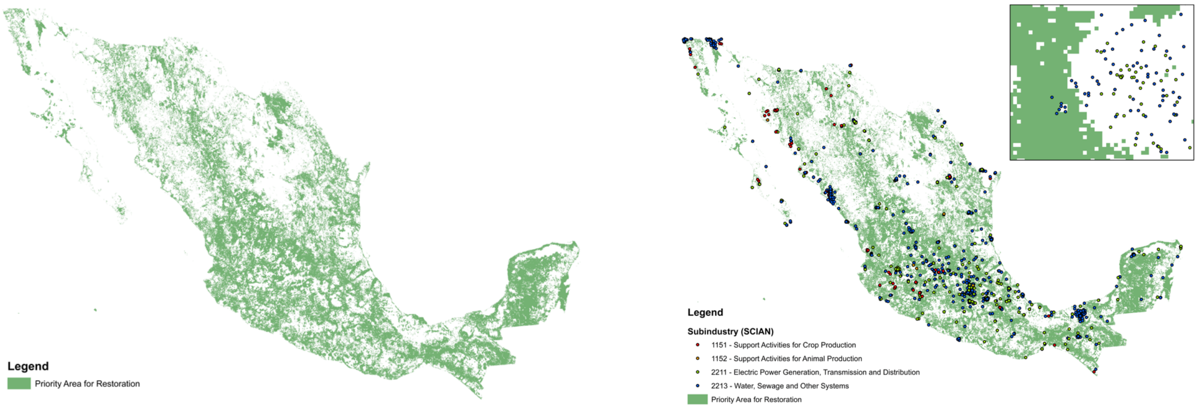
4.4 Scenario 2: transition risk

For the countrywide transition risk scenario, we utilise target 2.1 of the Kunming-Montreal Global Biodiversity Framework in which Mexico would *'Ensure that at least 30% of terrestrial degraded ecosystem areas are subject to effective restoration.'* In this regard, the National Biodiversity Commission (CONABIO by its acronym in Spanish), through the National Restoration Programme, have identified the Restoration Priority Areas (RPA) in Mexico (CONABIO, 2024). Figure 6a shows the spatial distribution of these areas. Such areas comprise 75.5 million hectares, that is, 40% of the national territory. This is larger than the target, but it indicates where restoration activities would be developed in the next years.

The National Statistical Directory of Economic Units (NSDEU) published by the INEGI geographically locates all firms within the Mexican territory. Apart from, latitude and longitude coordinates, the directory comprises firm-specific NAICS codes and the size of firm. Based on firm's coordinates, we perform a spatial match to identify firms located within the RPA, where is likely that authorities prohibit harmful economic activities. Figure 6b displays the intersection between RPA and large[6] and medium-sized[7] firms with a high or very high negative impact on ES, more specifically, on the land use pressure. Furthermore, we focus on large and medium-sized firms as they grasp most of credit portfolio in Mexico.

To obtain the economic exposure of firms subject to regulation, we compute the average output and jobs by firms size and industry using microdata from the 2019 Economic Census (INEGI, 2019). Using these averages and the spatial join in Figure 6b, we calculate the total output value and jobs at risk. For financial exposure, there is no data available on credit per firm, so we assume proportionality between output and credit within each industry to obtain the total value at risk.

Figure 11: Transition risk scenario



(a) Restoration Priority Areas

(b) Large and medium-sized firms

Source: INEGI (2019) and CONABIO (2024).

The results indicate that if Mexican authorities put the restoration policy in effect, 30 firms from subindustries such as Support Activities for Crop Production, Support Activities for Animal Production, Electricity Power Generation, Transmission and Distribution, and Water, Sewage, and Other Systems would be directly under threat, especially the Electricity Power Generation industry. This translates into $1,141 and $290 million USD of total output and credit at risk, respectively, along with 4,480 jobs.

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[6] Firms with more than 250 employees.

[7] Firms with more than 50 and less than 251 employees.

Table 5: Economic and financial exposure (transition risk)

Direct Pressure	**Industry**	**Output (M USD)**	**Jobs**	**Debt (M USD)**
Number	4	1,141.11	4,480	290.61
Percentage	1.5%	0.0524%	0.02%	0.10%
Indirect Pressure	**Industry**	**Output (M USD)**	**Jobs**	**Debt (M USD)**
Number	37	8,828.75	65,471	702.44
Percentage	14.1%	0.4050%	0.24%	0.24%

Source: own elaboration.

If we consider indirect linkages, 479 firms from 37[8] industries would be affected, including mining, cultural and entertainment activities, and food production. These firms together produce \$8,829 million USD, have credit for an amount of \$702 million USD, and they employ 65,471 persons. Although the amount of credits at risk is moderate, it reflects the potential impact that a transition risk may have on the economy and financial sector. Additionally, the impacts on employment and production of micro and small businesses, and agricultural sector should also be considered.

When reviewing each industry, the results show relevant differentiated outcomes. The proportion of credit risk is the firms' credits that are located inside the RPA in relation to the total credit of the industry. Thus, of the industries that have indirect impacts, the metal ore mining industry can reach 32.9%, for sugar and confectionery product manufacturing it is 15.51%, and Scheduled Air Transportation is 14.82%, the remaining industries are shown in Figure 12. In this way, the results indicate that risk exposure depends on the specific industry.

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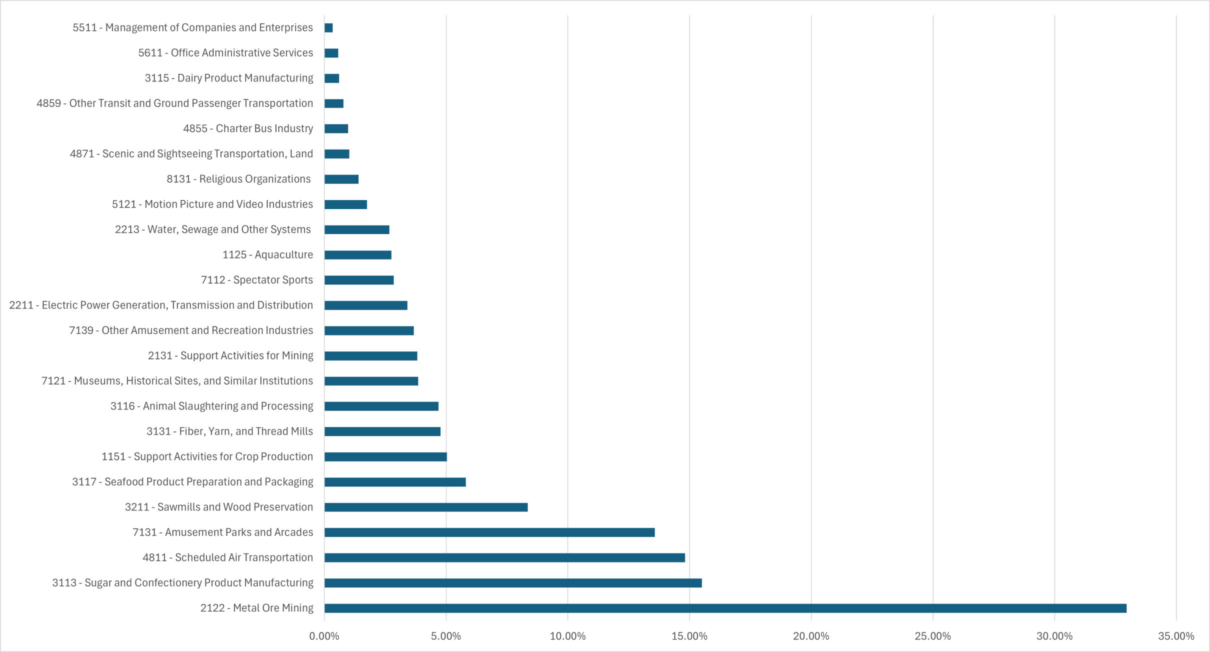
[8] Although there are 37 industries with high and very high scores, there is no related data from the economic census for 3 industries, and 9 industries do not have firms inside the RPA.

Figure 12: Credit at risk (% of total credit by industry)



Source: BM (2024) and CONABIO (2024).

4.5 Discussion and implications

Our results shed light on the importance of enhancing the resilience of the financial system. In terms of magnitudes, the set of findings is in line with previous studies that also examined biodiversity-related risks for the economy and the financial system. They add further empirical evidence on the relatively high values at risk when biodiversity losses are taken into account. The study also provides two illustrative examples of physical and transition risk scenarios that allow us to assess the potential impacts on both the economy and financial sector. These examples are used to show how research can analyse the potential impacts of changes in nature or policies that aim to protect the environment.

The applicability of this analysis to other contexts depends on the following conditions. First, a clear correspondence between industry classifications to link country-specific socioeconomic data to ENCORE's ratings. Second, availability of macro and micro-level data such as input-output matrices, the loan portfolio, or firms' socioeconomic information. It is preferable that those databases comprise the location of economic units. Third, the existence of transition and physical risk scenarios with high probability of occurring, while at the same time, researches should be able to locate their potential impacts. Thus, it is important that central banks collect such information to enhance the resilience of the financial system.

Implications in terms of policy in Mexico

In terms of limitations that remain unsolved, although the ENCORE database is very useful for associating the dependencies and impacts of economic activities on nature, when using the information, we identified that it may have some inaccuracies. An example is the case of land use pressure, where economic activities can have important impacts in some sectors, especially in countries with less stringent environmental regulations. Empirical evidence indicates that mining causes changes in land use and the cover and biophysical characteristics of the soil in various parts of the world. For example, a remote sensing-based approach analysis identified significant past land use losses associated to mining activities in Iran, Canada, Germany, and India (Firozjaei et al., 2021).

5 Conclusions

This paper examines to what extent biodiversity loss can potentially affect the financial system in Mexico. To do so, we combine dependency and impact ratings from ENCORE, input-output matrices, microdata from the Economic Census, and GIS data to provide an assessment of the amount of credit and output value at risk, along with the number of jobs, arising either from changes in ES or regulations that prohibit harmful economic activities, that is, from physical and transition risk scenarios. Our findings shed light on the complex challenges surrounding the resilience of financial system in terms of those risks associated to biodiversity loss.

The results indicate that 48%, 47%, and 46% of output, jobs, and credit portfolio directly depend on at least one ES. In terms of direct impacts on nature, 49%, 33%, and 28% of the same indicators are at risk because these industries have harmful effects on the environment. Once we consider indirect linkages between industries along the supply chain, 66%, 53%, and 52% of output, jobs, and credit portfolio show a high or very high dependence of ES while 66%, 70%, and 53% of the same variables are at risk if the government puts new regulations in effect to protect biodiversity. The input-output analysis suggests that there are 32 key industries, by looking at their backward and forward linkages in the supply chain, in which policy makers should concentrate their efforts to mitigate biodiversity-related risks in the financial system.

This work also provides insights into how countrywide physical and transition risks would impact the financial system. On the one hand, we examine the implications of a water shortage for the economy and the financial system and find that the exposition of the credit portfolio is not direct, instead, it is indirectly seen through the supply chain since 80% of the total credit is allocated to net importers of embedded water. On the other hand, using target 2.1 of the Kunming-Montreal agreement, we assess the risks associated to the National Restoration Programme in Mexico. As a result of the prohibition of harmful economic activities in the RPA - 75.5 million hectares, $1,141 and $290.61 million USD of total output and credits, along with 4,480 jobs would be at risk. Taking into account backward and forward linkages leads to significantly larger values, that is, $8,829 million USD of output, $702 million USD of credits, and 65,471 jobs. Our research work adds further support to previous findings as it provides empirical evidence on the link between biodiversity loss and the economy and, consequently, the financial system.

Add policy recommendations

Future research should explore biodiversity-related risk management options for central banks. These options should aim to reduce the degree of financial exposure to shocks in ES or new regulations limiting economic activities with a negative impact on the environment. Additionally, calibrating dependency and pressure ratings to local contexts, e.g. countries, could improve the accuracy of similar assessments because the current version of ENCORE ratings seems to be adapted to countries with stringent environmental regulations, for example, mining does not have a high or very high impact on nature but that is not always the case in developing countries.

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