The impact of a shift in global demand for leather on Brazilian slaughterhouses

A report prepared by NINT for Rainforest Foundation Norway

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About NINT

NINT (Natural Intelligence), formerly known as the SITAWI Sustainable Finance Program, is Latin America's largest ESG research and consulting practice. With a team of 100+ employees and a local presence in Brazil and Latin America, we are one of the 5 best socio-environmental research houses for investors according to the Extel Independent Research in Responsible Investment – IRRI 2019. We are the first Latin American organization to provide second-party opinions for sustainable credit operations and funds. We have independently assessed 170+ sustainable financial instruments so far.

Summary

Executive summary

In December 2022, the European Union passed a new law on deforestation-free products, making it obligatory for companies to guarantee that goods placed on the EU market have not led to deforestation and forest degradation. Leather is one of the commodities that lies within the scope of this new regulation[1].

In Europe it is the automotive, footwear and furniture industries that are the main end users of leather. Representatives of these industries argue that leather is simply a by-product of beef production and as such is not a driver of deforestation.

This study aims to assess whether the restriction of leather exports from Brazil to the European Union would affect the economics of slaughterhouses and meatpacking companies in Brazil, especially those operating in the Amazon.

Beef production is the main source of revenue for slaughterhouses, but the sale of leather is also important for their profitability. Quantitative analysis was undertaken to assess the potential economic impact of the EU restrictions on leather exports under different scenarios. We assessed how slaughterhouses operating at different profit levels might be affected.

Financial metrics	Slaughterhouse A (low margin)	Slaughterhouse B (moderate margin)	Slaughterhouse C (high margins)
Profit margin before restrictions (%)	0.5%	3.9%	15.0%
Profit margins after restriction (%)	-1.4%	2.1%	13.5%
Difference in profit margins (%)	*-376.6%*	*-47.7%*	*-12.6%*
Payback before restriction (years)	161	20	5
Payback after restriction (years)	N/A	39	6
NPV before restrictions (BRL million)	(3.25)	(2.19)	1.22
NPV after restrictions (BRL million)	(3.83)	(2.76)	0.64
Difference in NPV (%)	*-17.9%*	*-26.5%*	*-47.6%*

Figure 1 - Slaughterhouses financial metrics with and without restriction on leather sales – worst-case scenario

The new deforestation-free product regulation is likely to make many slaughterhouses unprofitable and increase the risk of stranded assets in the sector.

This analysis shows that existing slaughterhouses operating with profit margins of 2% or less would cease to function as viable businesses and may become stranded. Investment in new slaughterhouses would only make sense if expected profit margins sit above 13%. It is also important to understand that profit margins in the slaughterhouse industry fluctuate with the price of cattle at any given time. Therefore,

[1] https://www.europarl.europa.eu/news/en/press-room/20221205IPR60607/deal-on-new-law-to-ensure-products-causing-deforestation-are-not-sold-in-the-eu

it can be seen that constraints in the demand for leather could have a huge impact on the profitability of this industry, which in turn could affect the appetite for new investments. The most vulnerable slaughterhouses would be those with poor supply chain management and high exposure to external markets.

Slaughterhouses located in the Amazonas, Tocantins, Goiás and Maranhão are more exposed to the European market, and therefore are more likely to be affected by the new regulation.

Figure 2 below shows the percentage of exports directed to the European Union. It is interesting to note that Amazonas, Tocantins and Maranhão form the Legal Amazon. Tocantins and Maranhão also form the MATOPIBA region, which has experienced high rates of concentrated deforestation over the last few years.

These states represent 15%[2] of the recent expansion of slaughterhouses in Brazil over the last ten years, which reinforces the role that the new EU regulation plays to tackle deforestation in the region.

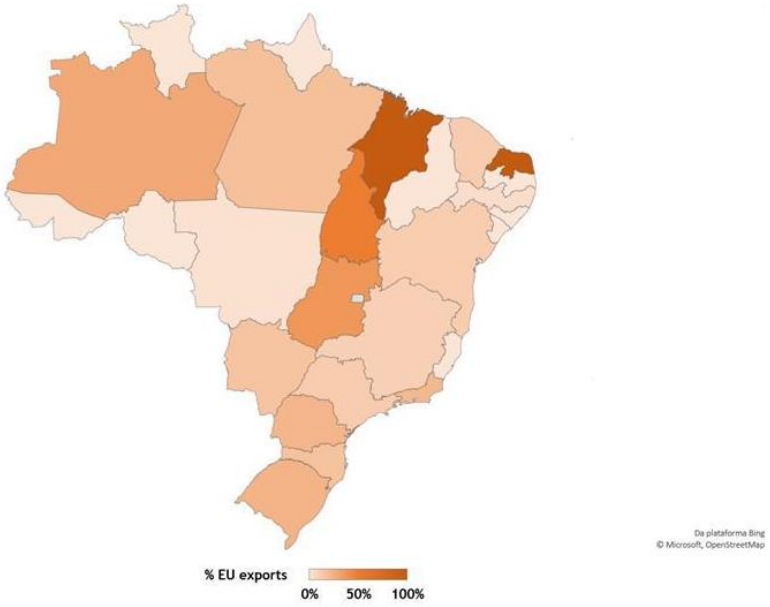

Figure 2 – Slaughterhouses' exposure to EU markets by state

This means that the profitability and expansion rate of slaughterhouses in these regions in particular are more likely to be impacted if they do not comply with the due diligence procedures demanded by the new EU regulation.

Restriction on leather exports is less likely to impact the bottom line of the large meatpacking companies, such as JBS and Minerva.

Given their market share and geography, these companies dominate the Brazilian cattle industry. We crossed data from the Federal Inspection Service and External

[2] https://dados.agricultura.gov.br/dataset/servico-de-inspecao-federal-sif/resource/97277e92-264a-4dc0-9aea-f87b8ea93798

Trade to estimate the potential impact on these companies of the EU restriction on leather exports, which is summarized in figure 3 below:

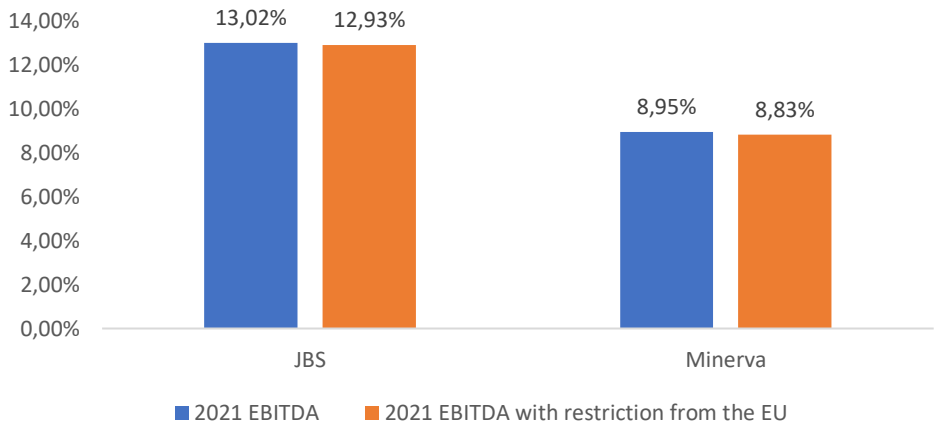

Figure 3 - Impact of restrictions to export leather to the EU on JBS and Minerva's EBITDA

The potential impact on the EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) of these companies is residual. However, restrictions to their export of leather may affect the profitability of specific assets, especially slaughterhouses and tanneries that lack proper traceability of cattle, which can affect the investment plan of these multinationals. As such, these companies are well-positioned to move their meat production away from areas with high deforestation risk.

Details of this analysis are presented in the forthcoming pages.

1. What is the relationship between leather car seats and deforestation in the Amazon?

Deforestation in the Amazon has been increasing over the last few years and cattle rearing is its main driver.

2022 was the year with the highest deforestation level in the Amazon since 2016, according to data from the Brazilian National Institute for Space Research (INPE). The data shows that more than 10,000 km² of land was subjected to deforestation or is under threat of deforestation[3]. Data from PRODES[4] also shows that deforestation in the Amazon has increased over the last few years.

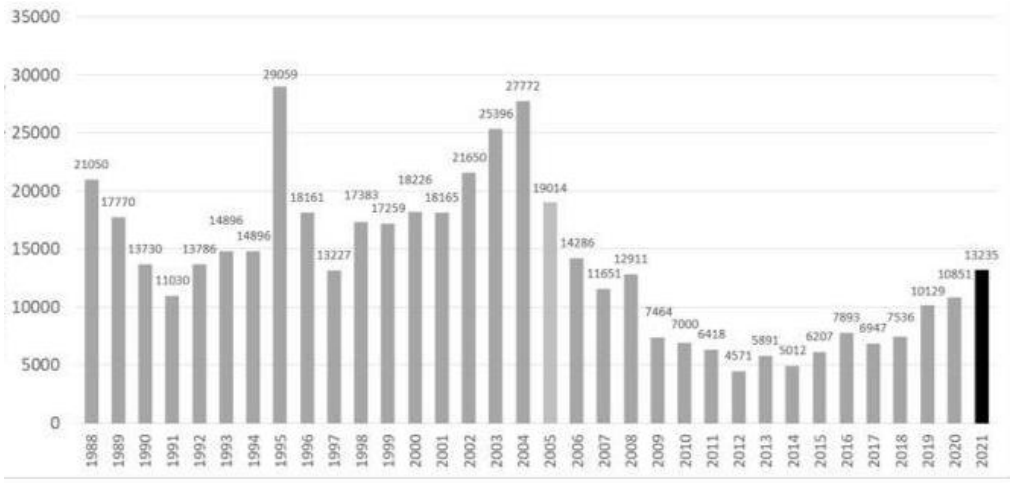

Figure 4 - Rate of Deforestation in the Amazon between 1988 and 2021 (km2 per year)

Cattle rearing is by far the main driver of deforestation in the Amazon. A study from the Instituto de Pesquisa Ambiental da Amazônia pointed out that 75% of deforestation in the Amazon was caused by cattle production[5]. Another study from MapBiomas showed that of all deforested area in Brazil, 90% was or is pasture[6].

According to the Brazilian Institute of Geography and Statistics (or IBGE, its Portuguese acronym)[7], Brazil has the largest cattle herd in the world, with 224.6 million animals

[3] https://www1.folha.uol.com.br/ambiente/2022/12/desmatamento-no-ultimo-ano-de-bolsonaro-ja-atinge-a-pior-marca-desde-2016.shtml

[4] http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes

[5] https://ipam.org.br/wp-content/uploads/2022/05/Amazo%CC%82nia-em-Chamas-8-pecua%CC%81ria-pt.pdf

[6] https://mapbiomas.org/en/amazon-is-the-biome-with-the-most-pastures-in-brazil

[7] https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/17353-municipal-livestock-production.html?=&t=destaques

in 2021. More than 40% of its cattle herd is raised in the Legal Amazon region[8]. According to the Quarterly Survey of Animal Slaughter from IBGE[9], the region is also home to almost 40% of Brazil's slaughtering capacity.

Besides meat products, which are mainly destined for China or sold internally, cattle production also has several by-products, such as gelatin, biofuel and leather. In 2021, Brazil exported a total of 395.6 thousand tons of hides and skins with a value of US$ 1.41 billion[10]. The main destinations of Brazilian leather exports are China, which accounts for 34% and the European Union, which represents 22.4% of the exports. About 50% of the leather exports are directed to the automotive industry, 20% to the footwear sector and 21% to the upholstery and furniture sectors[11].

Although the automotive industry is the main consumer of Brazilian leather, the European car sector still does not fully mitigate its deforestation risks.

A recent benchmark conducted by Aidenvironment and RFN concluded that car seat manufacturers and automotive brands fall short in addressing their deforestation footprint. The report points out that although some of the companies implemented zero-deforestation policies, they still lack effective action.

According to the RFN 2021 Report, these companies believe that leather has a low-aggregate value for cattle producers in comparison to beef, and therefore their deforestation footprint is not relevant.

Challenges regarding the traceability of cattle and its complex supply chain make it more difficult to mitigate deforestation-related risks in the leather industry.

The bovine leather supply chain is highly complex, involving rural producers, slaughterhouses and meatpacking companies, tanneries, trading companies and finally the consumer goods industry.

The cattle traceability system in Brazil is fraught with difficulties, which paves the way for corrupt practices such as "cattle laundering".. This strategy consists in moving animals from irregular or embargoed farms to properties that comply with environmental and social requirements[12] before the cattle are sold to slaughterhouses or meatpacking companies.

[8] Besides the six states from the North region, the Legal Amazon is also represented by part of the state of Maranhão, from the Northeast region, and by the state of Mato Grosso, from the Central-West region.
[9] https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/16797-quarterly-survey-of-animal-slaughter.html?=&t=destaques
[10] https://cicb.org.br/storage/files/repositories/phpnDXHrq-total-exp-dec21-eng.pdf
[11] Driving deforestation: The European automotive industry's contribution to deforestation in Brazil. Available in: https://d5i6is0eze552.cloudfront.net/documents/Publikasjoner/Andre-rapporter/Driving_Deforestation_16_June-compressed.pdf?mtime=20210617202546
[12] EU Deforestation Law: Traceability Viable in Brazilian Cattle and Soy Supply Chains. Available in: https://chainreactionresearch.com/wp-content/uploads/2022/11/EU-Deforestation-Law_Traceability-Viable-in-Brazilian-Beef-and-Soy-Supply-Chains.pdf

Europe's new regulation for deforestation-free products will impose restrictions on the import of commodities linked to deforestation, including cattle and leather.

In December 2022, the European Union passed a new law on deforestation-free products, making it obligatory for companies to guarantee that goods placed on the EU market have not led to deforestation and forest degradation. Leather is one of the commodities that lies within the scope of this new regulation[13].

The new law requires manufacturers to conduct due diligence procedures to trace the origin of raw materials, such as leather, used in their products. As a consequence, the new regulation will restrict the number of slaughterhouses and tanneries that are able to export to the European Union, which may represent financial losses to these businesses. The EU is the second largest importer of Brazilian leather, which was responsible for 22.4% of its exports in 2021.[14]

Given the aforementioned context, this study aims to assess whether a shift in EU demand for leather may affect the profitability of slaughterhouses and meatpacking companies in Brazil, especially those operating in the Amazon.

To do that, chapter 2 will present financial analyses of the potential impact of the new regulation on slaughterhouses in Brazil, under different scenarios. Chapter 3 will present the potential financial impacts of the new regulation on large Brazilian meatpacking companies, such as JBS and Minerva. Finally, chapter 4 will present the main takeaways of the study and conclusions.

[13] https://www.europarl.europa.eu/news/en/press-room/20221205IPR60607/deal-on-new-law-to-ensure-products-causing-deforestation-are-not-sold-in-the-eu

[14] https://cicb.org.br/storage/files/repositories/phpnDXHrq-total-exp-dec21-eng.pdf

2. Scenario analysis: The impacts of a shift in global demand for leather on Brazilian slaughterhouses

This section presents the economic analysis of restrictions on the demand for animal leather under different scenarios. The assumptions behind each of the scenarios are described below:

2.1 Scenario 1: In this scenario, we are assuming that Brazilian slaughterhouses won't be able to sell any livestock-based leather (worst-case scenario)

This scenario assumes that due to environmental concerns or other reasons the market would replace animal leather with synthetic materials such as polyurethane (PU) or polyvinyl chloride (PVC). Other alternatives include cork, hemp, recycled plastics, cactus fiber, corn starch, polyester, recycled fishing nets[15] and mycelium.

The market for synthetic leather was valued at USD 33.7 billion in 2021 and is expected to expand at an 8% compound annual growth rate per year until 2030. The lower cost of synthetic leather, when compared to natural leather, is a factor that is driving this replacement. An increase in demand from the footwear sector in particular is propelling the synthetic leather market. The application of this material is similar to natural leather, such as in clothing, upholstery and industry[16].

This, of course, is an extreme scenario and is not likely to occur in the short term. However, it is an important test to understand how resilient the cattle industry is to demand shocks for leather.

To undertake this analysis, we used the assumptions from a study developed by ECAM (Amazon Conservation Team) in 2020. In this study, the author assessed the financial viability of a slaughterhouse in the State of Paraná, Brazil. This facility slaughters an average of 23.7 thousand bovines per year. The assumptions used are presented below:

a. CAPEX for a new slaughterhouse: BRL 3.4 million[17];
b. Annual revenue: BRL 4.2 million[18];
c. Slaughterhouses' profit margins: 0.5%; 3.95%; 15%[19].

[15] https://www.regnskog.no/en/news/auto-sector-falls-short-in-addressing-its-deforestation-footprint

[16] https://www.grandviewresearch.com/industry-analysis/synthetic-leather-market

[17] 2020 ECAM study http://ecam.org.br/wp-content/uploads/2020/07/Estudo-Cadeia-da-Pecu%C3%A1ria.pdf

[18] 2020 ECAM study http://ecam.org.br/wp-content/uploads/2020/07/Estudo-Cadeia-da-Pecu%C3%A1ria.pdf

[19] Data from market studies demonstrated that slaughterhouses' profit margins can vary from 0%-1% to 15%: https://valor.globo.com/agronegocios/noticia/2021/04/13/frigorificos-brasileiros-operam-com-margens-abaixo-de-3percent-diz-fonte.ghtml. The ECAM study considers a 17% profit margin. However, according to more recent date, the increasing costs of fat cattle are reducing margins of slaughterhouses.
https://www.scotconsultoria.com.br/carne/boi-gordo-carne/1020/conheca-os-indicadores.htm

d. Costs to dispose hides: R$1.26/kg or R$3.36/@[20]

Limitations of this scenario: We do not have access to the financials of specific slaughterhouses to conduct a more granular analysis, therefore we took three hypothetical facilities operating at three different profit levels, based on market information[21]. The profitability of slaughterhouses will depend largely on the price of fat cattle, which represents 70% of the total costs[22]. With that, we can understand what may happen to slaughterhouses in different economic scenarios. Other aspects that affect the profitability of these companies are scale, cost efficiency and access to external markets.

We understand that if tanneries could no longer sell bovine leather, the price of fat cattle may drop or meatpackers may raise the price of beef to offset the lost leather revenue, which were not considered in this analysis.

Besides, we also understand that EU regulation won't necessarily restrict imports from Brazilian slaughterhouses, but it will require due diligence processes and traceability procedures from them. Therefore, the economic analysis from this scenario is applicable only to slaughterhouses that are unable or unwilling to comply with the EU deforestation regulation.

Based on this analysis, we derived the following financial indicators and impacts for slaughterhouses operating at different profit levels:

Financial metrics	Slaughterhouse A	Slaughterhouse B	Slaughterhouse C
Profit margin before restrictions (%)	0.5%	3.9%	15.0%
Profit margins after restriction (%)	-1.4%	2.1%	13.5%
Difference in profit margins (%)	*-376.6%*	*-47.7%*	*-12.6%*
Payback before restriction (years)	161	20	5
Payback after restriction (years)	N/A	39	6
NPV before restrictions (BRL million)	(3.25)	(2.19)	1.22
NPV after restrictions (BRL million)	(3.83)	(2.76)	0.64
Difference in NPV (%)	*-17.9%*	*-26.5%*	*-47.6%*

Table 1 - Financial analysis of slaughterhouses under scenario 1

https://anaiscbc.emnuvens.com.br/anais/article/view/4329

[20] @ is a unit of measure widely used to refer to the weight of the cattle carcass. 1 @ = 15 kilo and fat cattle has around 16.5@.
https://www.registro.sp.gov.br/arquivos/editais/Contrato%20n%20031-20%20-%20P.E.%20n%20071-19%20-%20AMBSERV%20TRATAMENTO%20DE%20RESIDUOS%20LTDA%20-%20Coleta%20de%20residuos%20de%20saude%20e%20carcacas%20de%20animais.docx

[21] Data from market studies demonstrated that slaughterhouses' profit margins can vary from 0%-1% to 15%: https://valor.globo.com/agronegocios/noticia/2021/04/13/frigorificos-brasileiros-operam-com-margens-abaixo-de-3percent-diz-fonte.ghtml. The ECAM study considers a 17% profit margin. However, according to more recent date, the increasing costs of fat cattle are reducing margins of slaughterhouses.
https://www.scotconsultoria.com.br/carne/boi-gordo-carne/1020/conheca-os-indicadores.htm
https://anaiscbc.emnuvens.com.br/anais/article/view/4329

[22] https://www.scotconsultoria.com.br/carne/boi-gordo-carne/1020/conheca-os-indicadores.htm

To estimate the payback ratio, we used the estimated profit margins as a proxy for the cash flow. To estimate the net present value, based on a discounted cash flow approach, we used Brazil's prime (basic) interest rate, as of 10/02/2023, of 13.75%.

In addition, we conducted some other tests to estimate how this general restriction would affect the financial metrics of slaughterhouses. The results showed us that any slaughterhouse operating at a 2% profit level or less would face negative profit margins in response to a total fall in global demand for leather. Even slaughterhouses with no debt would not be economically viable.

Investments in slaughterhouses showing profit margins of less than 13% would have a negative net present value. Meaning that new investments in these slaughterhouses would not pay off. This is a very relevant conclusion because many slaughterhouses over the last few years have faced long periods of profit margins below 10%.[23]

The analysis above demonstrates that the revenue from leather sales is material for the profitability of slaughterhouses.

However, although the analysis demonstrates that the leather business is relevant for slaughterhouses in Brazil, the complete restriction on leather sales is a very strong assumption. Analysis 2 below will focus only on restrictions on exports to the European Union.

2.2 Scenario 2: *Restriction of leather exports to the European Union*

This scenario assumes that only the exports to the European Union would face constraints, as a direct consequence of the deforestation-free products law, which came into force in 2023. According to Mamadova (2022), 80% of Brazilian leather production is exported. And 22.4% of the total leather production is exported to the European Union. Since we do not have granular information on exports for each slaughterhouse, we will assume a given slaughterhouse will export an average of 22.4% to Europe. The results are presented below:

Financial metrics	Slaughterhouse A	Slaughterhouse B	Slaughterhouse C
Profit margin before restrictions (%)	0.5%	3.9%	15%
Profit margins after restriction (%)	0.1%	3.5%	14.7%
Difference in profit margins (%)	-84.4%	-3.7%	-2.8%
Payback before restriction (years)	161	20	5
Payback after restriction (years)	1,027	23	6
NPV before restrictions (BRL million)	(3.25)	(2.19)	(1.28)
NPV after restrictions (BRL million)	(3.38)	(2.32)	(1.09)
Difference in NPV (%)	*-4%*	*-6%*	*-11%*

Table 2 - Financial analysis of slaughterhouses under scenario two

[23] https://www.beefpoint.com.br/frigorificos-brasileiros-operam-com-margens-abaixo-de-3-diz-fonte/

Limitations of this scenario: We are assuming that the hides no longer being sold to the European Union would be disposed of. It is of course possible that these hides could be directed to the internal market or to other countries. The level of exports may also vary from facility to facility. Therefore, the economic impact on slaughterhouses would depend on their exposure to external markets, particularly Europe. The EU regulation won't restrict imports from all Brazilian slaughterhouses, but it will require due diligence processes and traceability procedures from them. Slaughterhouses and tanneries that are exposed to the EU market will likely make efforts to comply with the new regulation, thereby minimizing the risk of restrictions.

To calculate the NPVs above we again used a discount rate of 13.75%. Based on this analysis, investments in new slaughterhouses operating at profit margins below 11.5% would not be economically viable, since their NPV would be negative. Furthermore, existing slaughterhouses operating at profit margins below 0.5% would no longer generate any profit.

This analysis shows that restrictions derived from the new EU regulation will have a consequence on the profitability of slaughterhouses and are likely to affect the appetite for new investments in the industry. Of course, this impact will depend on the management of deforestation risks by these facilities, as well as their exposure to EU markets and their capacity to redirect their production to other markets. If restrictions are imposed only in the European market, there is a risk of "deforestation leakage". That is, products with a deforestation footprint being directed to less restrictive jurisdictions, such as Asia. However, this may come at a cost since slaughterhouses and tanneries might have to accept lower prices to enter these markets.

The following analysis will combine information from different databases to understand how the location of a slaughterhouse can make them more likely to face restrictions under the new EU regulation.

2.2.1 How restrictions on leather exports may impact slaughterhouses in different geographical locations.

Slaughterhouses have different levels of exposure to external markets. Although the information on exports for each slaughterhouse is not available, data was combined from leather production and exports to make an estimate for each of the 26 states of Brazil. This analysis gives two relevant insights:

1) In which states slaughterhouses are most likely to be exposed to the European Union market.
2) Which slaughterhouses are located in areas with a high risk of deforestation.

For this estimation, information was retrieved from the Comex Stata's General Exports and Imports data[24]. This database provided the volume of exports (in total net kilograms) and FOB (US$) from each Brazilian state to the European Union, for the year 2021.

Export data from Comex was combined with production data from the IBGE's Quarterly Leather Production[25]. At this point, it is important to highlight that data from Comex and IBGE don't match perfectly. Therefore, the databases were harmonized to get the results[26]. In addition, it is also assumed that the slaughterhouses sell their leather to tanneries and exporters from the same state, which may not be true for all cases.

Based on this analysis, the following map was developed. The darker colors represent those states with a higher rate of exports to the European Union. The lighter colors are the opposite. Slaughterhouses located in states with a darker color that do not comply with the due diligence procedures established by the new EU regulation on deforestation-free products will have a higher risk of facing restrictions to export.

[24] Stata provides official data on Brazilian International Trade rhttp://comexstat.mdic.gov.br/en/geral The analysis covered 34 NCM (Nomenclatura Comum do Mercosul) codes for specific products related to bovine leather.

[25] IBGE is the Brazilian official statistics agency https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/16801-quarterly-survey-of-leather.html?=&t=destaques

[26] Since the data unit of measure from Comex and IBGE are different, we estimated the Brazilian bovine leather production from Comex data in net kilos, considering that around 80% of the production value of Brazilian bovine hides and leather are exported, as mentioned in Mammadova's article "Deforestation as a Systemic Risk. The Case of Brazilian Bovine Leather". Then, we applied the % of production for each state from the IBGE's data to estimate how many net kilos each state produces.

There are also some discrepancies between IBGE and Comex data since, according to IBGE data, some exporter states don't have production volume. We assumed that the production of these states is equal to their export production value. Another example of these discrepancies was that some states volume exports were greater than the production estimated from the share given from IBGE data. In these cases, we also assumed that the share of export volume was 100%.

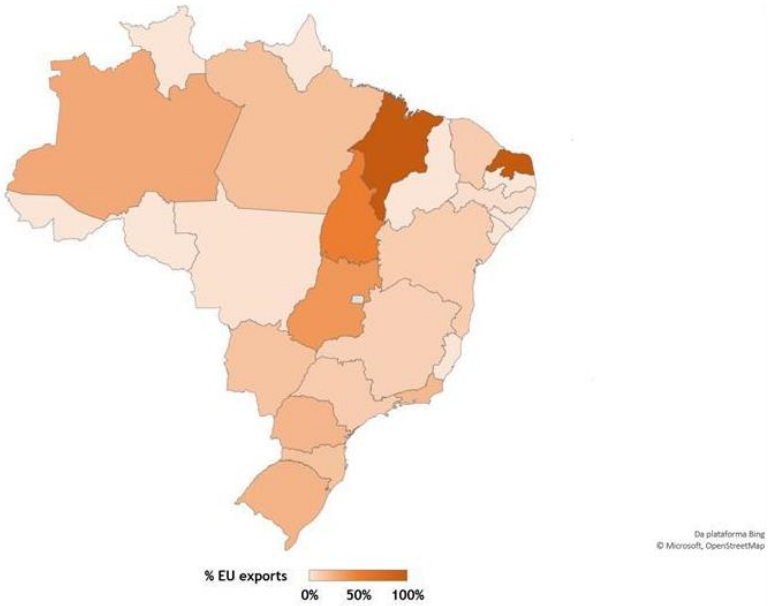

Figure 5 – Slaughterhouses' exposure to EU markets by state

The map above shows that Maranhão is more exposed to EU markets, followed by Tocantins, Goiás and Amazonas states[27]. It's interesting to highlight that Maranhão, Amazonas and Tocantins form part of the Legal Amazon. Also, Maranhão and Tocantins are part of the MATOPIBA region, where most deforestation is concentrated in the Cerrado biome[28].

The four states with higher exposure to EU markets represented, in 2021, 20% of the Brazilian cattle herd[29], 15% of the Brazilian slaughtering capacity[30], 16% of slaughterhouses with federal inspection in Brazil[31] and 10% of leather production[32].

Because of their exposure to the EU, these are the slaughterhouses that are more likely to face restrictions if they fail to achieve the due diligence standards required by EU regulations. In addition, these states represent 15%[33] of the recent expansion in slaughterhouses in Brazil over the last ten years, which reinforces the role that the new EU regulation plays to tackle deforestation in the region.

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28 https://ipam.org.br/matopiba-bate-recorde-historico-de-desmatamento-no-cerrado/

29 https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/17353-municipal-livestock-production.html?=&t=destaques

30 https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/16797-quarterly-survey-of-animal-slaughter.html?=&t=destaques

31 https://dados.agricultura.gov.br/dataset/servico-de-inspecao-federal-sif/resource/7d02af92-e3cf-4ae4-af8a-0dad334ffdfa

32 https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/16801-quarterly-survey-of-leather.html?=&t=destaques

33 https://dados.agricultura.gov.br/dataset/servico-de-inspecao-federal-sif/resource/97277e92-264a-4dc0-9aea-f87b8ea93798

2.3 The risk of slaughterhouses becoming stranded

Stranded assets are usually described as "assets that have suffered from unanticipated or premature write-downs, devaluation or conversion to liabilities"[34]. Amongst other things stranded assets may be caused by environmental and climate issues. There are an array of factors that could contribute to the rise of this phenomenon, such as new technologies, changes in consumer behavior or new regulations.

In the case of the leather industry, we are discussing the risk of "strandization" due to environmental concerns regarding the connection between cattle leather and deforestation. This risk can materialize through multiple channels, such as:

a. New technologies: Animal leather is a luxury item that is being gradually replaced by alternatives, such as PU, PVC and plant-based alternatives;
b. New regulations: the EU deforestation-free product law that came into force in 2023 may trigger similar regulations in other regions;
c. Change in consumer behavior: According to a survey from The Grand View Research, the global demand for vegan leather is increasing worldwide and its market may achieve a US$ 85 billion value in 2025. Automobile brands such as Tesla, BMW, Mecedes-Benz, Lexus and Ferrari already offer cars with vegan leather[35].

There are several participants in the cattle leather industry, such as rural producers, slaughterhouses and meatpacking companies, tanneries, trading companies and the consumer goods industry. Among these players, the tanneries face the highest risk of becoming stranded, since leather is their main product. However, slaughterhouses and meatpacking companies are also likely to be impacted due to changes in the demand for leather.

According to our analysis, there are four main factors that may increase the risk of slaughterhouses becoming stranded:

1) Profit margins: which are highly dependent on the price of fat cattle, representing 70% of the total costs of slaughterhouses.
2) Exposure to more restrictive markets: Our analysis shows that slaughterhouses located in Maranhão, Tocantins and Goiás tend to have higher exposure to the European Union markets.
3) Management of deforestation risks: If slaughterhouses can trace the cattle back to their origin and comply with due diligence practices, it will minimize the risk of facing restrictions to export;

[34] https://www.smithschool.ox.ac.uk/sites/default/files/2022-04/Stranded-Assets-and-Scenarios-Discussion-Paper.pdf
[35] https://veganbusiness.com.br/mercado-de-couro-vegano/#:~:text=Dados%20da%20consultoria%20Grand%20View,e%20de%20impactos%20ambientais%20negativos.

4) Operational flexibility: If a slaughterhouse can direct its production to the domestic market or other countries with fewer environmental regulations, their losses may be mitigated.

Under Scenario 1 outlined above, existing slaughterhouses operating within profit margins of less than 2% would not generate any profit and therefore would become stranded. Similarly, investments in new slaughterhouses that are expected to generate profit margins of up to 13% would not be economically feasible and would also become stranded.

The more realistic Scenario 2 shows us that existing slaughterhouses operating below a 0.5% profit margin would become stranded. Likewise, investment in new slaughterhouses that are expected to generate less than 13.5% would also not be considered viable and become stranded.

3. Impacts of a shift in global demand for leather on Brazilian-listed meatpacking companies

One of the objectives of this study is to generate investable conclusions and opportunities for engagement with investors. To do so, in this chapter we'll assess how the EU regulation on deforestation-free products would impact the economics of Brazilian meatpacking companies, especially JBS and Minerva.

The reasons to choose these companies are:

1) These are companies listed on the stock exchange, with investors and creditors all around the world. Also, a considerable proportion of the shareholders of JBS (36%) and Minerva (18%) have ESG and/or anti-deforestation policies and commitments[36]
2) These companies are major players in the cattle industry and represent almost 40% of the Brazilian meatpacking industry market share[37]
3) These companies have been at the center of scandals and controversies involving deforestation in the supply chain[38]

JBS is the largest beef producer in Brazil and operates through five divisions: JBS USA Beef, JBS Brazil, Pilgrims' Pride, JBS USA Pork and Seara. JBS has production facilities and sales offices in 15 countries.

Minerva is the third-largest beef company in Brazil. The company processes 17,300 heads of cattle per day worldwide.

Marfrig is the world's second-largest beef company by production capacity, however, export data used in this study suggest that Marfrig does not export leather directly from its facilities. According to Aidenvironment and Rainforest Foundation Norway (2021)[39], Marfrig probably supplies leather to large tanneries operating in the Legal Amazon, such as Vancouros, Durlicouros and Viposa. Therefore, Marfrig is also likely to be affected by restrictions on leather exports, but as we don't have the precise data to calculate the amount of leather that Marfrig indirectly exports to the European Union, we'll focus this analysis on JBS and Minerva.

[36] Deforestation-related risks in the Brazilian meatpacking industry: Impacts on JBS, Marfrig and Minerva. Available in: https://esg.nintgroup.com/riscos-desmatamento-frigorificos-brasileiros?_ga=2.235073537.169741629.1670862596-56842122.1654197027

[37] The exact market share for each company is difficult to precise. The number presented are estimates based on XP internal research.

[38] For more details, see Figure 4 Deforestation-related risks in the Brazilian meatpacking industry: Impacts on JBS, Marfrig and Minerva. Available in: https://esg.nintgroup.com/riscos-desmatamento-frigorificos-brasileiros?_ga=2.235073537.169741629.1670862596-56842122.1654197027. The Figure shows the milestones regarding controversies and actions to tackle deforestation in the beef industry since 2009 until 2021. Recently

[39] https://d5i6is0eze552.cloudfront.net/documents/Publikasjoner/Andre-rapporter/Driving_Deforestation_16_June-compressed.pdf?mtime=20210617202546

The restriction on exports to the European Union will potentially impact the sales and revenues of these companies, as well as increase the costs to dispose of bovine hides.

We used Municipal Exports and Imports data from Comex Stata[40] for 3 SH4 codes of specific products related to bovine leather. From this data, we found the volume of exports in total net kilograms and FOB (US$) for the year 2021 and from the municipalities where JBS and Minerva have tanneries[41]. From this analysis, we found the following results:

Company	Leather exports to the EU in 2021 (US$ 000)	Leather exports to the EU in 2021 (tons)
JBS	340,358	19,135
Minerva	31,256	2,456

Table 3 - JBS and Minerva exports of leather to the EU in 2021

The data in Table 3 allow us to estimate the potential impact that a restriction to access the EU market would have on JBS and Minerva, considering the impact on revenues and increased costs to dispose of hides.

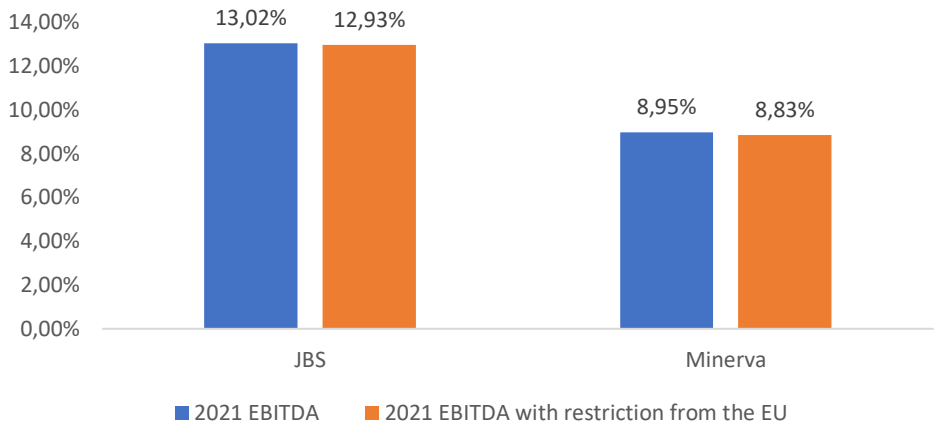

Figure 6 - Impact of restrictions to export leather to the EU on JBS and Minerva's EBITDA

In 2021 JBS's EBITDA stood at approximately BRL 45 billion, while their leather exports to the EU represented around BRL 340 million (~0.7%). In the same period, Minerva's EBITDA was around 2.4 billion, while their leather exports to the EU stood at roughly 31 million (~1.3%). Although the impact on the companies' EBITDA is not so material,

[40] http://comexstat.mdic.gov.br/en/municipio

[41] According to the last JBS Reference Form, the municipalities where the company has tanneries are Naviraí - MS, Porangatu - GO, Colorado do Oeste - RO, São Luís de Montes Belos - GO, Barra do Garças - MT, Colíder - MT, Marabá - PA, Nova Andradina - MS, Cacoal - RO, Pedra Preta - MT, Uberlândia - MG, Montenegro - RS, Lins - SP, Cascavel - CE e Itumbiara - GO. According to the last Minerva Reference Form, the municipalities where the company has tannery is Barretos - SP.

restriction on leather exports may affect the profitability of specific slaughterhouses and tanneries that lack proper traceability of cattle, which may affect the investment plan of these companies. Also, these are multinational companies that are well-positioned to move their production away from areas with high deforestation risk.

It is very unlikely therefore that a restriction to export leather to the EU itself would generate an economic incentive for these companies to implement best practices to mitigate deforestation risks in the supply chain.

As an extension to the study, we estimated the impact that this restriction would have on JBS and Minerva's market cap and stock value.

To do so, we applied the impact on EBITDA in a discounted cash flow perpetuity model. We used the weighted average cost of capital (WACC) from Bloomberg, which was 12.8% for JBS and 10.8% for Minerva. This impact was compared to the market capitalization of each company on 09/01/2023. The result of this analysis is presented below.

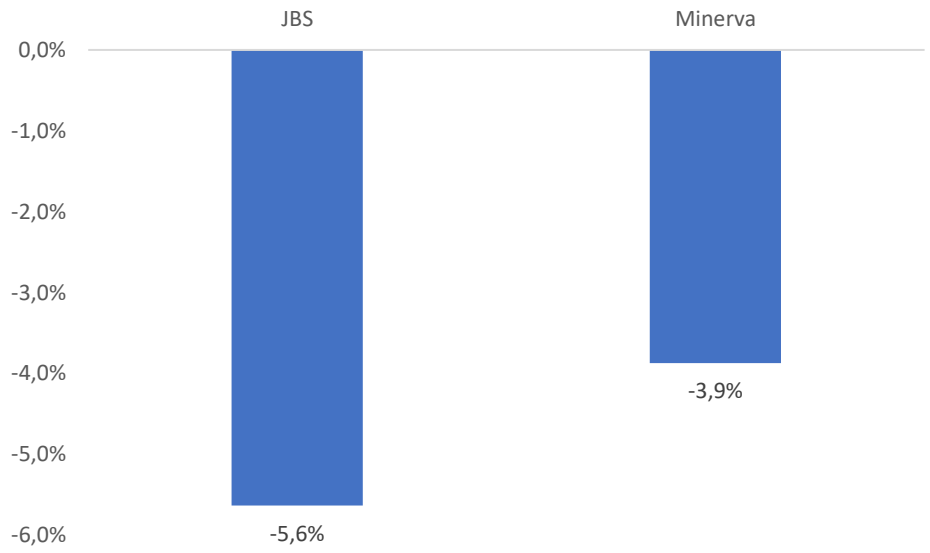

Figure 7 - Impact of leather export restrictions on JBS and Minerva market cap

Limitations of the analysis: These results assume that restrictions on leather exports would last for perpetuity. However, companies of this size are more likely to adapt and find new opportunities for the leather that they would no longer be selling to Europe. We also assumed that all leather exported to the EU would be restricted in this scenario, which is a very strong assumption. These companies are already developing mechanisms to trace the origin of the cattle, which may mitigate the risk of restrictions.

However, given these limitations, the analysis shows that restrictions on leather exports to the EU are likely to affect their stock prices, raising additional concerns for investors.

It is worth highlighting that JBS exports only 13% and Minerva 19% of its leather production to Europe. Besides that, beef production is considerably more important for these companies than leather.

It can be concluded that restrictions on leather exports are not likely to have a drastic effect on the profitability of large meatpacking companies. However, as previously stated, this restriction can create an economic incentive for these companies to stop investing in areas with a higher deforestation risk. It is also important to highlight that these meatpacking companies usually operate at higher profit and EBITDA margins than smaller slaughterhouses, and have more operational flexibility. Therefore, they are more likely to redirect their production to other markets in response to restrictions from Europe.

4. Conclusions

With the introduction of the new EU regulation surrounding deforestation-free products, slaughterhouses in Brazil will face increased risks of becoming stranded based on a number of factors. It will depend on their exposure to the EU market, their ability to manage and trace their supply chain, their current profit levels and their operational flexibility. Conversely, the policy shift can also present financial opportunities for slaughterhouses with good environmental practices.

Tanneries will face the highest risk of becoming stranded assets, given that their revenue is entirely derived from leather production. However, slaughterhouses will also face significant risks. Our analysis shows us that slaughterhouses located in Maranhão, Tocantins and Goiás are, on average, more exposed to the EU markets. Therefore, if they do not comply with the traceability and due diligence practices required by the deforestation-free product law, they are more likely to be negatively impacted.

On the other hand, many slaughterhouses already acting in accordance with the new regulations will continue to export to Europe, and the new law can represent opportunities for slaughterhouses willing to comply with the EU requirements. Furthermore, if EU consumers move away from doing business with slaughterhouses and tanneries from high-risk areas such as the Amazon and the Cerrado, demand for intensive cattle production may increase in other regions.

Restrictions on leather use may increase over time, especially if the industry does not address its deforestation footprint.

The EU deforestation-free product law is the first of many restrictions that may affect the global demand for animal leather. Although a total ban on leather sales is a very

strong assumption, it is reasonable to assume that changes in consumer behavior, civil society demands, and new technologies may affect the future prospects of tanneries and slaughterhouses.

The fashion industry, one of the top consumers of animal leather, is becoming increasingly aware of the rise in popularity of leather alternatives[42]. Currently, polyurethane (PU) leather is the most common textile alternative to bovine leather.

Other options include cork leather. This biodegradable and sustainable material is harvested from cork trees in a process that poses no risk to the tree itself, which mitigates the risk of replacing one deforestation-related product with another. MIRUM®[43] leather, a plant-based material produced from mycelium, is another recently developed alternative to leather. It is plastic-free and made entirely from natural materials.

The automotive industry is also aware of this shift in consumer attitudes. Mercedes Benz, for instance, claims to be conducting intensive research into animal-free alternatives to leather, using materials such as powdered cactus fibers or mycelium[44]. Faurecia and Hyundai also report on their respective use of hemp-based materials and eco-friendly PU leather. Other alternatives considered by the industry include recycled plastics, corn starch, polyester and recycled fishing nets[45].

The challenge for the growth of greener alternatives, among other existing sustainable innovations, lies in their technical and financial performance, such as their durability, organoleptic properties, competitive costs, and growing demand. To overcome these challenges, more investments into research and development (R&D) are needed.

The risk of "deforestation leakage" must also be taken into consideration for leather suppliers.

The European Union is one of the main global consumers of leather, but it's not the only one. Unless other major importers of leather such as China also impose regulations and controls to mitigate the risk of deforestation, we may see a leather market leakage. That is, the products that are no longer accepted in the Europe Union may be absorbed by other markets with looser environmental laws.

Therefore, it is important to assess how the new EU regulation and the underlying due diligence procedures required by leather exporters will support these players in adopting better traceability mechanisms and reducing the deforestation footprint of such products.

[42] https://www.collectivefashionjustice.org/leather-alternatives#:~:text=Recycled%20PU%20'leather',solution%20for%20truly%20sustainable%20fashion.
[43] https://mirum.naturalfiberwelding.com/about
[44] https://group.mercedes-benz.com/sustainability/climate/against-deforestation.html
[45] https://www.regnskog.no/en/news/auto-sector-falls-short-in-addressing-its-deforestation-footprint

Traceability of cattle is still the most important challenge in this industry.

The biggest challenge to tackling deforestation in the cattle and leather supply chain is due to the lack of monitoring of indirect suppliers.

Traceability strategies for leather may be even harder since it includes tanneries, which is another link in this complex supply chain. The Leather Working Group (LWG) recently launched a Traceability Roadmap[46] to achieve deforestation and conversion-free (DCF) leather by 2030 and intends to develop a Global Due Diligence Framework with tools related to deforestation.

Meatpacking companies claim to be developing blockchain-based technologies and are engaging with their suppliers to mitigate their deforestation footprint. Besides that, support from the government and regulators will also be needed, especially if we aim to use the Animal Transit Guides (Guia de Trânsito Animal) as a tool to monitor the sourcing of cattle. The costs to implement traceability technologies (such as electronic chips for cattle) are still high, especially for small cattle producers.

[46] https://www.leatherworkinggroup.com/fileadmin/uploads/lwg/Images/LWG_Traceability_Roadmap_.pdf

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