Scientific Research Publishing

Theoretical Economics Letters, 2025, 15(3), 763-778
https://www.scirp.org/journal/tel
ISSN Online: 2162-2086
ISSN Print: 2162-2078

The Risk in Moody's Global Rating and Institutional Image in Emerging Countries Issuing Carbon Credit: NTN-G and Carbon Tokenization in Brazil

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How to cite this paper: Leandro, A. C. G. (2025). The Risk in Moody's Global Rating and Institutional Image in Emerging Countries Issuing Carbon Credit: NTN-G and Carbon Tokenization in Brazil. *Theoretical Economics Letters, 15,* 763-778.
https://doi.org/10.4236/tel.2025.153042

Received: January 6, 2025
Accepted: June 20, 2025
Published: June 23, 2025

Abstract

This article analyzes how the global credit score assigned by Moody's influences Brazil's institutional image, focusing on ESG (Environmental, Social, and Governance) metrics and financial innovation represented by NTN-G (National Treasury Note Series G). The NTN-G, designed as a public bond backed by carbon credits and tokenizable through the startup iCarbon, is highlighted as a strategic solution to strengthen the country's reputation by promoting economic sustainability and alignment with global sustainable development goals. Based on financial management and socio-environmental governance frameworks, the study integrates ESG practices, technological innovation, and financial instruments to enhance Brazil's credibility in the global market.

Keywords

Sovereign Rating, Carbon Tokenization, Institutional Image

1. Introduction

A nation's institutional image is closely related to its financial reputation and the perception of its ability to meet economic and environmental commitments. Sovereign ratings, assigned by agencies like Moody's, synthesize these factors (2025), reflecting investor confidence and the country's competitiveness in the global market. For Brazil, historically marked by fiscal crises and political instability, building a solid institutional image depends on structural reforms and innovative initiatives.

NTN-G emerges as a pioneering instrument, integrating ESG practices and to-

kenization technology to transform carbon credits into financial assets. By promoting CO_2 emissions neutralization and attracting sustainability-aligned investments, NTN-G positions Brazil as a relevant player in the global sustainability market and strengthens its institutional image.

Brazil's credit rating transition by Moody's from Ba2 to Ba1, announced on October 1, 2024, reflects a mixed assessment between perceived institutional advancements and persistent fiscal challenges. The agency justified the upgrade based on "wishful thinking" linked to the possibility of compliance with the new fiscal framework—a measure presented as essential to consolidating the country's institutional credibility. However, the decision was widely questioned by experts, considering the increasing public finance uncertainties, projected fiscal deficits until 2027, and a growing public debt.

Despite the improvement in sovereign risk perception, the current economic environment presents a significantly more challenging scenario than in 2007, when Brazil experienced robust economic growth and stronger fiscal fundamentals. These elements highlight the role of institutional image in the performance of global ratings, reinforcing the need for sustainable fiscal policies and practices aligned with ESG criteria and carbon tokenization to strengthen international confidence. Moody's assessment illustrates not only Brazil's vulnerability to its fiscal limitations but also the impact that rating agency decisions have on the country's reputation in global markets.

2. Theoretical Framework

According to Assaf Neto (2012), sovereign ratings are a key indicator of a country's economic stability and financial risk management. Moody's evaluates sovereign issuers' credibility through criteria such as fiscal soundness, political stability, and socio-environmental commitment, forming an integrated view of institutional image.

The Integration of ESG metrics into global ratings, as described by Moody's, acknowledges the impact of environmental and social practices on credit risk. In this context, NTN-G, structured by the startup iCarbon, connects technology and sustainability, promoting greater transparency, liquidity, and scalability in the carbon credit market. Aligleri et al. (2009) argue that adopting ESG practices enhances the institutional image of companies and nations, creating competitive advantages in global markets.

Additionally, Porter and Kramer (2006) highlight that strategies aligned with corporate social responsibility strengthen organizational reputation and attract stakeholders committed to sustainable values. For Brazil, initiatives like NTN-G are essential to reversing negative perceptions associated with economic and environmental instability.

3. Methodology

This research was conducted through qualitative and documentary review, in-

cluding: Moody's reports, emphasizing ESG metrics and sovereign rating scales. The NTN-G project was analyzed in the carbon credit tokenization context by iCarbon. Academic literature on financial management, sustainability, and technological innovation. Regulatory analysis, considering the Basel Accord and international carbon market standards.

4. Discussion

Brazil's credit reputation and institutional image are intrinsically linked to its ability to implement sustainable and innovative policies. During periods of instability, such as between 2014 and 2016, the downgrade of the sovereign rating reflected fiscal and political fragility, undermining investor confidence. The NTN-G is presented as a solution to strengthen Brazil's institutional image by integrating ESG practices with advanced technologies. The tokenization of carbon credits enables greater transparency and liquidity, which are essential features for attracting global investors.

In addition, the use of technology in the trading of environmental assets promotes the neutralization of emissions, reinforcing Brazil's commitment to global climate goals. Leite (2009) and Aligleri et al. (2009) point out that sustainable initiatives, such as reverse logistics and the circular economy, not only reduce environmental risks, but also increase the credibility of companies and governments. Thus, the NTN-G consolidates an innovative approach to reposition Brazil as a leader in economic and environmental sustainability. The sovereign rating is an assessment given by credit rating agencies, such as Moody's, Standard & Poor's and Fitch, to indicate a government's ability to honor its debts. A higher rating, such as AA or AAA, suggests that the country has a low probability of default, which in turn results in lower interest rates in the financial markets. A lower rating, such as B or CCC, indicates greater risk and increases financing costs.

According to Assaf Neto (2012), risk classification involves a detailed analysis of economic variables, such as Gross Domestic Product (GDP), inflation rate, interest rate, as well as political and fiscal factors. However, agencies currently also incorporate environmental, social and governance (ESG) variables into their analyses, due to the growing importance of these factors in financial stability.

4.1. The Integration of ESG Metrics in Credit Risk Assessment

ESG metrics have become an essential factor in credit risk evaluation. Rating agencies now consider environmental, social, and governance policies alongside traditional financial indicators. Governments committed to sustainable and transparent practices tend to pose lower long-term risks, which can positively influence their credit rating.

One example is the green bond market, which finances projects with positive environmental impacts. Investors often accept a lower return (greenium) on green bonds compared to conventional bonds due to their lower perceived risk. The increasing adoption of ESG-aligned practices is linked to sovereign rating improve-

ments and public debt cost reductions.

4.2. NTN-G: A New Form of Public Debt Issuance

The NTN-G (National Treasury Note-Green) is an innovative example of a green bond issued by the Brazilian government to finance sustainability-focused projects. The tokenization of these bonds, as proposed by iCarbon, can increase market liquidity and transparency, making environmental asset transactions more accessible. This innovation aligns with ESG principles, promoting responsible governance and attracting sustainable investors.

4.3. Risk and Return: Green Bonds vs. Conventional Bonds

To understand how NTN-G can impact public debt costs and Brazil's risk perception, we compare green bonds with traditional bonds, the return on a bond can be calculated using the following formula:

$$Rt = C + (Pf - P0)/P0$$

where:

Rt = Bond return;

C = Coupon payment (interest);

Pf = Future selling price of the bond;

P0 = Initial purchase price of the bond.

The return can be adjusted according to the type of bond and the perceived risk. In the case of green bonds, this return is generally slightly lower, since investors are willing to pay a premium (the greenium) due to the social and environmental benefits provided. In addition, the volatility of an asset, which measures the risk of price fluctuation, can be given by the formula: Volatility (σ):

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(R_i - \bar{R}\right)^2}$$

It Green bonds, in theory, have lower volatility, as they are linked to sustainable projects that have greater long-term stability. The Bank for International Settlements (BIS)[1] provides a table that compares the performance of green bonds with conventional bonds, taking into account the average return, volatility and Value at Risk (VaR). VaR measures the maximum potential loss of an asset in a given period of time, given a confidence level (**Table 1**).

According to data from the Bank for International Settlements (BIS), green bonds generally offer a slightly lower return than conventional bonds but exhibit lower volatility and lower expected maximum loss (Value at Risk-VaR).

By issuing the NTN-G, the Brazilian government will not only be financing sustainable projects, but it can also improve its sovereign rating. This is because the

[1]Bank for International Settlements. Historical Statistics Using Monthly Returns from January 2014 to 2019. Sources: Board of Governors of the Federal Reserve System, Deutsche Bundesbank, Bloomberg, ICE BofAML Indices, authors' calculations. Statistics on green, conventional, and government bonds: average return, volatility, VaR, Expected Shortfall, probability of negative return, and duration.

adoption of sustainable practices and the integration of ESG policies reduce the country's risk perception, making it more attractive to investors. The positive impact on the cost of public debt can be seen with the reduction in interest rates applied to green bonds, which become cheaper due to greater demand and reduced risk. The issuance of green bonds such as the NTN-G represents an innovative and efficient strategy for Brazil, as it combines sustainability with responsible financial management.

Table 1. Green bonds vs. conventional bonds: performance analysis (BIS)[2].

Asset class summary statistics[1]

In per cent

	US dollar Assets			Euro Assets		
	Governments bonds	Green bonds	Conventional bonds	Governments bonds	Green bonds	Conventional bonds
Average return	0.19	0.26	0.24	0.34	0.36	0.39
Volatility	0.88	0.76	0.67	1.3	1.18	1.17
VaR return (97.5%)	−1.39	−0.97	−0.82	−2.17	−2.23	−2.18
Expected shortfall (97.5%)	−1.82	−1.55	−1.44	−2.37	−2.68	−2.69
Probability of negative return	52.31	35.38	36.92	38.46	30.77	29.23
Duration (years)	5	5	5	9	9	9

[1]Historical Statistics using monthy returns from January 2014 to July 2019. Sources: Board of Governors of the Federal Reserve System; Deutsche Bundesbank; Bloomberg; ICE BofAML Indices; authors calculations. *Bank for International Settlements[2].

The tokenization of carbon credits also facilitates participation in the global carbon market, while improving the country's sovereign rating contributes to reducing the cost of public debt. Based on risk and return analyses, green bonds not only attract investors committed to sustainability, but can also improve the country's economic position on the global stage.

4.4. Macroeconomic Implications of NTN-G and the Quantity Theory of Money

The monetary equation, as proposed by Paul Krugman et al. (2015), illustrates how money supply expansion affects inflation and economic growth:

$$PQ = MV$$

where:

P = Price level;

Q = Quantity of goods and services;

M = Money supply;

V = Velocity of money circulation.

The analysis of the market of green public securities, such as NTN-G (Treasury

Notes National-Green), is intrinsically linked to central macroeconomic concepts, such as the effects of currency offer and price dynamics. To contextualize, the formula fundamental of monetary theory, PQ = MV, proposed by Paul Krugman, illustrates how amount of currency (m) interact with the price level (p), the amount of goods and services produced (Q) and the currency circulation speed (V). This relationship offers a solid basis for understanding the tax and monetary implications that involve the issuance of green titles.

This equation helps analyze the effects of issuing NTN-G on inflation and economic stability. If the money supply (M) increases without a corresponding rise in production (Q), inflationary pressures may arise and the relationship provides a solid basis for understanding the fiscal and monetary implications of issuing green bonds.

It around this relationship is critical to understand the impact of excessive currency emission, which may occur when the government issues NTN-G to fund sustainable projects, without a corresponding increase in the actual production of goods and services. When that happens, it can result in inflationary pressures, since the supply of currency increases, but production (Q) remains constant or growing at a slower pace.

To illustrate this, consider a simplified projection table of NTN-G and its ecnomic impacts (Table 2):

Table 2. Expected issuance speed versus expected appreciation in line with inflation.

Year	Money emissions (M in billions of BRL)	Price level (P)	Money velocity (V)	Expected Inflation (%)
2025	500	1.05	1.2	5%
2026	550	1.07	1.1	6%
2027	600	1.10	1.05	7%
2028	650	1.12	1.0	8%

The table above projects a growing currency emission (m), which can lead to a acceleration at price levels (P) if there is no corresponding increase in the production of goods and services (Q). As we can see, the expectation is that the inflation increases over the years, mainly due to the growth of currency emission without the same rate of increased production.

In terms of Krugman's theory, the speed of currency (V) also performs a important role. In a scenario of sustained economic growth, the speed of currency tends to decrease (as illustrated in the table, where V decreases from 1.2 to 1.0), the that can signal a deceleration of the pace of transactions or a greater focus on value retention. This phenomenon can be a response to factors such as confidence in sustainable projects funded by NTN-G, which can lead investors to retain more money instead of spending it or investing more aggressively.

In addition, the relationship between the amount of currency (m) and the price level (P) requires a delicate balance. The increase in NTN-G emission has a direct impact on supply currency, which can result in greater pressure on prices, especially if the production (Q) Do not grow significantly. The expansion of the production of goods and sustainable services, which is one of the main objectives of issuing NTN-G, must be accompanied by an increase in productivity so that the growth of the economy does not be overloaded by inflation.

The formula of the amount of currency can be even more illustrated by the following formula derived from Krugman, where the speed of the currency (V) is adjusted by the amount of transactions or market trust:

$$P = M \cdot V/Q$$

The application of this formula suggests that if the increase in currency supply (m) is not sccompanied by proportional growth in the amount of goods and services (Q), the price level (P) will increase, resulting in inflation.

As projected, the emission of NTN-G tends to increase by 2028, mainly due the growing demand for sustainable investments and the need for the government of finance projects related to sustainability goals. However, the continuous expansion of currency emission without proportional growth of production can lead to a increased inflation rates, as illustrated in the previous table. If the government does not implement policies to increase production or not to balance the supply of currency with economic growth, a scenario of increasing inflation may occur, which would affect directly the real return on investments in NTN-G.

Furthermore, it is important to highlight that the relationship between supply of currency, production and level price is affected by market trust and currency speed. If the investors realize that sustainable projects funded by NTN-G are not reaching its sustainability goals or that the economy is not growing from surrounding way, confidence can decrease, resulting in an acceleration of inflation.

Therefore, NTN-G, as sustainable financing instruments, face a challenging scenario. Its success depends on the government's ability to balance the currency emission with the actual growth of the economy and the production of goods and services sustainable. Otherwise, inflationary risks can compromise the real income of these assets.

The return of government securities, such as NTN-G, is closely linked to the dynamics of interest rate and the perception of risk of investors in relation to the economic future. In simple terms, the investors who buy these titles are looking for a profitability, which will be determined by several factors, such as the basic interest rate of the economy (Selic rate), the perceived risk of government default, and the expectation of inflation. In addition, in the specific case of NTN-G, which are titles linked to sustainability, investors also evaluate the solidity of public policies of sustainability, which can directly impact the success of the project and, consequently, the future returns of these titles.

The profitability of NTN-G is calculated based on the variation of the nominal interest rate, which reflects the dynamics of the financial market and monetary

policy. These titles pay a profitability that, by its nature, seeks to remunerate the investor both by the variation inflation as for the real interest rate. Therefore, the return of these titles can be attractive to investors, especially in increasing inflation scenarios, as their profitability is linked to the consumer price index (IPCA), which ensures that the return is greater than inflation, preserving the investor's purchasing power.

In addition, the valorization of the title in the secondary market, which reflects the conditions economic, it can also influence the investor's return. If the economy demonstrates growth and trust in public sustainability policies, the demand for these titles tends to increase, which can raise its price and, consequently, the return for investors who buy them in the secondary market. This means that, besides fixed profitability provided for at the time of purchase, investors can also obtain additional gains with the valorization of the title.

Around the tax scope, the issuance of NTN-G brings significant benefits to both the government as for the market. One of the main benefits is the possibility of using the issuance of these titles as a way to "lengthen" public debt. This is because, By issuing securities with longer salaries, the government can postpone the payment of a significant part of the debt, offering short-term relief in your accounts tax.

Moreover, in the specific context of sustainability, the issuance of NTN-G can be seen as a strategy of diversification of public debt, allowing the government access a market of investors interested in funding projects infrastructure environment, such as renewable energy, sustainable agriculture and green infrastructure.

This can generate additional demand for these titles, which can result in lower interest rates for the government, since the market may be willing to accept a lower return in exchange for investing in projects that contribute to the Global sustainability.

Another relevant point is the positive impact on Brazil's international perception in regarding its fiscal and environmental policy. NTN-G emission can be seen as a government's way of aligning its fiscal policy with development objectives sustainable (SDGs), which can result in an improvement in the country's image in the market international, increasing the confidence of foreign investors and allowing a more efficient appeal capture.

Among the direct tax benefits, the issuance of NTN-G can also help reduce the pressure on public finances strategically. In issuing these titles, the government can direct resources to green infrastructure projects and other sustainable investments, which can generate a positive return to the economy in the long term. This economic recovery may result in an increase in tax revenues future, which can be used to repay public debt, thus balancing the immediate impact of emission.

However, so that the deduction of public debt is successful and the tax benefits materialize, it is essential that projects funded with NTN-G resources be effective and successful. This includes not only the realization of projects green infrastructure, but also the generation of jobs and the encouragement of growth sustainable

economic. If the resources are well allocated, the positive effects may not only seen in economic growth, but also in reducing the cost of public debt over time, since the return generated by the issuance of NTN-G may reduce the need for new more costly titles emissions.

Table 3 illustrates a projection of the impact of NTN-G emission on public debt and in economic growth. The government, by issuing R $ 500 billion in NTN-G in 2025, for example, it expects to stimulate economic growth by 3.5% and generate a reduction of public debt of R $ 15 billion. Over the years, as the economy stabilizes and grows, debt reduction can be increased, as is the interest rate pays on titles decreases, reflecting a scenario of greater confidence and stability economic.

Table 3. Projection table of the impact of NTN-G emission on public debt and the economy.

Year	NTN-G issuance (in billions of BRL)	Economic growth stimulus (%)	Public debt reduction (in billions of BRL)	NTN-G interest rate (%)
2025	500	3.5	15	5.5
2026	550	4	20	5.3
2027	600	4.5	25	5.1
2028	650	5	30	4.8

Therefore, the issuance of NTN-G not only presents an opportunity to finance long term for sustainable projects, but it can also be an effective strategy for the reduction of public debt, provided that the resources are well managed and the projects financed actually promote economic growth. The combination of profitability for investor and tax benefits for the government can make these titles an essential tool in the fiscal policy of countries that seek to balance their accounts promote sustainability and stimulate economic growth in a balanced and responsible. However, the effectiveness of this strategy will depend on the capacity the government of ensuring the successful execution of projects and continuous trust of market in the long-term objectives of this issue.

In the Moody's perspective on the institutional image of Emerging Emerging countries Carbon credit, especially in the context of NTN-G (National Treasury notes Green series) in Brazil, it is essential to understand how these titles can influence public finances and international perception of the country. In the Brazilian case, the Issuance of NTN-G is deeply linked to the issue of sustainability, being a way to fund environment-related projects, such as energies renewables, forest preservation and development of clean technologies. Those titles can play a crucial role not only in reducing public debt, but also in improving Brazil's institutional image in the global scenario.

The Impact of NTN-G on the institutional image of Brazil reflects in Moody's,

one of the main risk classification agencies, evaluates the broadcasters of credit based on several factors, including fiscal solidity, the credibility of economic policies and the government's ability to implement reforms and projects sustainable. In the case of Brazil, the issuance of NTN-G reflects a commitment to the sustainability and fiscal responsibility, which are important aspects for the image of the country before international investors.

By choosing to issue titles related to the financing of environmental projects, Brazil sends a clear message that it is aligned with the global sustainability goals, as the UN Sustainable Development Goals (SDGs). This can have a positive impact on the perception of international investors and in risk classification, which can see these initiatives as an indicative of stability and economic predictability.

At the context of Brazil, NTN-G in the Brazilian Green Credit Case can be seen as a success case of how emerging countries can take advantage of the green economy to generate economic value and, to at the same time, reduce public debt. NTN-G are linked to investments in sustainable projects and, by their nature, can attract investors seeking assets aligned with ESG metrics (environmental, social and governance).

This alignment with the ESG criteria, especially in the environmental sector, can result in an improvement in Brazil's credit classification. Moody's and other agencies rating tend to value countries that demonstrate commitment to growth sustainable economic and responsible management of its natural resources, which translates in a positive assessment for the country's fiscal and economic stability.

Insights about the carbon and sustainability credits in the Brazilian markets are aother relevant aspect is the carbon credits market, which is also closely linked to NTN-G. Brazil, with its vast extension of forest areas and environmental conservation projects, has the potential to become a global leader in carbon credits market. In integrating these credits in the context of NTN-G, the country can attract even more investors, especially those who are increasingly focused on sustainable finances.

By the way, the Moody's, when evaluating Brazil, takes into consideration not only the tax and public debt, but also the potential for generation of value through initiatives sustainable, such as the carbon market. Emerging countries like Brazil, which can integrate these initiatives with consistent and transparent fiscal policies, tend to improve its institutional image, which results in lower financing costs and greater ability to attract international investments.

Thus, the NTN-G growth projection in the international market regarding projections, the growing emission of NTN-G in Brazil can signal a broader movement within emerging markets, where countries with policies robust inspectors and commitments to sustainability stand out. The perspective of Moody's for these countries is strongly linked to the ability to implement projects concretes that promote the transition to a low carbon economy and ensure alignment with international commitments. For international investors, the combination of green titles, fiscal credibility and environmental commitments makes Brazil an attractive des-

tination, especially for investment funds that seek sustainable assets. By strengthening its institutional image through these emissions, Brazil can not only improve its credit classification, but also play a leadership role in the market Global of green titles and carbon credits.

Table 4 projects not only the growth of NTN-G emission, but also the evolution of the carbon credit market and the improvement in the institutional image of the Brazil, as indicated by the rating agencies such as Moody's. The improvement of Institutional image over the years reflects the growing international confidence in the Brazil's commitment to sustainability, which has a direct impact on its ability to raise funds to more favorable fees and reduce the cost of public debt.

Table 4. NTN-G emission projection table and impact on Brazil's institutional image.

Year	NTN-G issuance (in billions of BRL)	Carbon credit market growth (%)	Improvement in institutional image (Moody's indicators)
2025	500	4	+1.0
2026	550	5	+1.5
2027	600	6	+2.0
2028	650	7	+2.5

Therefore, the perspective of Moody's regarding the institutional image of countries emerging carbon credit emitters is critical to understanding how NTN-G can positively influence Brazil's perception in the global scenario. The issuance of these titles represents a commitment to sustainability and fiscal responsibility, aspects valued by risk classification agencies.

In addition, the carbon credit market and the growing demand for assets sustainable position Brazil as a potential leader in the global finance market green, resulting in lower financing costs and a better classification of credit, consolidating the country's image as an attractive destination for investments international.

This issuance of NTN-G (National Treasury Notes-Green Series) is a reflection of Brazil's strategy to align its fiscal policy with the global objectives of sustainability and, at the same time, reduce its public debt through investments in environmental projects. These emissions are analyzed from various perspectives, including the return, volatility, and the impact on public debt, with a projection methodology based on the PQ = MV formula, proposed by Paul Krugman, which describes the relationship between the amount of currency (m), the circulation speed (V) and the price level (P) and the number of transacted goods and services (Q). To understand the effects of these emissions, it is important to incorporate financial elements such as return, volatility, value at risk (VAR) and the correlation between the credit rating and the institutional image of Brazil.

The NTN-G, when issued with the objective of funding sustainable, search, simultaneous form, attract investors focused on ESG (Environmental, Social, and

Governance), which require, besides profitability, a clear commitment to practices responsible environmental ones. The return of NTN-G is linked not only to performance of the financial market, but also the success of the projects they finance. As example, if the preservation projects of forests or renewable energy have success, this can have a positive effect on both the return of the title and the image institutional of the country. The impact on public debt is double: on the one hand, NTN-G can be seen as a way of increasing indebtedness, but on the other, they allow financing at a relatively lower cost, with a more interest curve attractive, given the green and sustainable appeal of the projects.

When NTN-G volatility is directly linked to the risk associated with projects financed, as well as market response to any change in tax conditions of the country. However, with the increase in confidence in sustainable policies and the market carbon credits, volatility tends to be reduced over time, once that NTN-G consolidate themselves as a stable asset in the investor portfolio. Return to the period from 2025 to 2028, as an example, it can be estimated as follows in Table 5, considering historical performance and increasing demand for assets sustainable:

Table 5. Projection of return to the period from 2025 to 2028.

Year	Return estimate (%)	Volatility estimate (%)	Value at risk (VaR) (%)
2025	5.5	7.0	3.0
2026	6.0	6.5	3.2
2027	6.5	6.0	3.5
2028	7.0	5.8	3.8

Furthermore, the projected growth of NTN-G in Brazil can be associated with the evolution of the carbon credit market, with a direct impact on public debt and the country's institutional image. The formula PQ = MV, adapted to the context of bond issuances, can be interpreted as the relationship between the amount of currency that the government issues through NTN-G (M) and the amount of sustainable financial goods and services that are traded (Q), multiplied by the velocity of circulation (V), which in this case would represent the effectiveness of green policies in generating market confidence. The velocity of circulation (V) is high when the carbon credit market is active, and the amount of goods traded (Q) increases as sustainable projects generate new capital flows. This scenario contributes to an increase in Brazil's sustainable asset base, improving the country's international perception.

The correlation between Brazil's credit rating and its institutional image is a crucial factor in understanding the impact of NTN-Gs. The assessment made by the main rating agencies, such as Moody's, takes into account not only the country's fiscal health, but also confidence in its economic and environmental policies. The issuance of NTN-Gs, associated with a growth in the carbon market and the

attraction of sustainable investments, can contribute to an improvement in the credit rating, since these actions demonstrate a solid commitment to fiscal sustainability and the transition to a green economy. With the increase in the issuance of sustainable bonds and the consolidation of low-carbon policies, Brazil's institutional image in the international market tends to strengthen, generating a positive correlation with the country's credit rating. This projected growth in the issuance of NTN-Gs, associated with increased confidence in sustainable projects and responsible fiscal management, can result in a decrease in volatility and fiscal risk over time.

As a positive impact on public debt is reflected in the reduction of financing costs, while Brazil's institutional image improves with the increased adoption of environmental and sustainable practices. In this way, Brazil has the potential to not only improve fiscal credibility and reduce the cost of public debt, but also to become a global leader in the green bond and carbon credit market.

This translates into the projection of continued growth in NTN-G and the reduction of volatility associated with these assets, with the stabilization of the country's credit rating and growing confidence in its commitment to global environmental goals. Analysis of the Correlation between Green Sovereign Public Bonds and Global Green Bonds Demand for Sustainable Assets The expansion of the green bond market reflects a growing demand for sustainable assets, driven by: Institutional investors seeking to align portfolios with ESG criteria International commitments, such as the Sustainable Development Goals (SDGs) and the Paris Agreement Growing investor preferences for positive environmental impact.

In according with the Impact on the Cost of Financing, the NTN-G can benefit from this global trend, attracting both international and local investors seeking diversification in sovereign assets linked to sustainability.

The issuance of green sovereign bonds is often associated with lower financing costs compared to conventional bonds due to: Greenium: A green premium (reduced spread) associated with high demand and the perception of lower environmental risk. Sovereign Rating Improvement: A commitment to sustainability can improve the credit risk rating of issuing countries, such as Brazil, and positively impact the costs of their public debt. Competition for Resources in the Green Bond Market Despite the growth of the global green bond market, competition between issuers can affect: Interest Rates: An increase in the supply of sovereign and corporate green bonds can generate a convergence of spreads, impacting financing conditions. Strategic Positioning of NTN-G: As a security linked to "green bond" indexes, NTN-G should differentiate itself through solid projects and transparency in the allocation of resources. Public Policies and Resource Allocation NTN-G can position itself as an effective mechanism to finance sustainable projects aligned with national priorities, such as: Green infrastructure (renewable energy, clean transportation). Public health programs associated with the reduction of environmental risks, initiatives to reduce carbon emissions.

By ensuring efficient allocation and measurable impact, NTN-G strengthens its

position in the global market and Risks and Challenges Associated with the Issuance of Green Bonds Market Risk: Fluctuations in global interest rates can impact the return and demand for green bonds. Greenwashing Risk: The lack of clarity in the allocation criteria can harm the credibility of the bond. Environmental Risk: Changes in global climate policies or natural disasters may affect investor perceptions.

The conceptual Model Proposal A model to analyze the relationship between the NTN-G and global green bonds should include: 1) Demand and Supply: Incorporate data on sovereign and corporate bond issuance volumes. 2) Return and Risk Indicators: Consider metrics such as average return, volatility, VaR and probability of negative return (according to BIS data). 3) Macroeconomic Factors: Monetary and fiscal policies, inflation, exchange rate and GDP growth. 4) ESG Policies: Analysis of sustainable initiatives associated with the bonds As a green sovereign bond, the NTN-G has great potential to take advantage of the growth of the global green bond market.

Some benefits such as lower financing costs, positive impact on institutional image and contribution to environmental goals position Brazil as a strategic player in the sustainable capital market. Possible Lines of Discussion: 1) The impact of the COVID-19 pandemic on the allocation of sustainable resources and the issuance of green bonds. 2) The role of rating agencies, such as Moody's, in promoting green sovereign bonds. 3) The relationship between green bonds and the achievement of the SDGs, with a focus on the energy transition and carbon neutrality.

A progressive increase in NTN-G issuance may lead to improve higher public investments in green projects for an economic growth through sustainable infrastructure to lower inflation risks if managed effectively.

The Moody's Perspective on Institutional Image and Sovereign Green Bonds currently on the institutional image of emerging countries issuing carbon credits, particularly in the context of NTN-G (National Treasury Note-Green) in Brazil, is crucial for understanding how these bonds can influence public finances and the country's international reputation.

It issuing NTN-G, Brazil aligns its fiscal policy with global sustainability goals while also reducing public debt through environmental investments. These bonds finance projects such as: Renewable energy development, forest conservation initiatives, clean technology advancements and the Role of Rating Agencies in Sustainable Finance of Moody's evaluates sovereign issuers based on: Fiscal soundness, Economic policy credibility and Commitment to sustainable reforms.

By the way, the Green bond issuance signals commitment to ESG principles, influencing investor confidence and improving sovereign ratings. Countries with stable fiscal policies and sustainable projects tend to receive better credit ratings, resulting in lower borrowing costs.

The Brazil's NTN-G strategy strengthens its institutional image by reinforcing its commitment to sustainability and financial responsibility. Additionally, integrating carbon markets into sovereign debt management enhances the country's

attractiveness to international investors.

Thus, the Projected Growth of NTN-G in International Markets reflects a broader trend among emerging markets adopting green finance. Moody's forecasts suggest that countries implementing sustainable fiscal policies will benefit from stronger institutional images and higher investor confidence.

For global investors, the combination of green bonds, fiscal responsibility, and environmental commitments makes Brazil a compelling investment destination. Strengthening its institutional image through NTN-G issuance enhances its sovereign rating, reinforcing its position in green finance leadership.

The major risks and Challenges of Green Bond Issuance despite its advantages, issuing green bonds presents challenges that must be addressed:

1) Market Risk: the global interest rate fluctuations affect returns and demand for green bonds and, the economic downturns may reduce investor appetite for long-term sustainability projects.

2) Greenwashing Risk: lack of clear allocation criteria can damage credibility. Thus, the investors demand transparency on how funds are used for environmental projects.

3) Environmental Risk: climate policy changes impact investor perception. Additionally, the natural disasters may affect the financial performance of sustainability projects. Or, addressing these risks.

To mitigate risks, NTN-G should:

Align with global sustainability standards (EU Taxonomy, ICMA Green Bond Principles), ensure transparency in fund allocation and promote independent verification of environmental impact.

5. Conclusion

The institutional image of a nation is a strategic asset, influenced by its Credit reputation, public policies and sustainability practices. The study concludes that the implementation of instruments such as NTN-G, which integrates sustainability, technological innovation and governance, is essential to strengthen Brazil's credibility in the global market.

By aligning ex-expert practices and financial innovation, NTN-G promotes the neutralization of CO_2 emissions, attracts sustainable investments and contributes to the construction of a solid and competitive institutional image. This model, when associated with a responsible governance and adherence to international standards, can significantly raise Brazil's status in global credit and sustainability rankings.

The analysis shows how the global credit score attributed by Moody's impact a directly the institutional image of Brazil, especially in a scenario where expert metrics and innovative instruments such as NTN-G gain protagonism. NTN G, by uniting economic sustainability and carbon tokenization, emerges as a strategic example to strengthen the country's credibility in the face of challenges Global socio-environmental. Inside this result, the articulation between ESG practices,

efficient governance and financial innovation offers not only one way to improve the reputation of Brazil in the international market, but also reinforces the alignment with the goals of sustainable development. In this context, it is crucial that the country promotes policies consistent and reinforces compliance with tax frameworks to consolidate trust in the global scenario.

This model, when combined with responsible governance and adherence to international standards, can significantly elevate Brazil's position in global credit and sustainability rankings.

Always, the Moody's global credit assessment directly impacts Brazil's institutional image, particularly as ESG metrics and innovative financial instruments like NTN-G gain prominence. By merging economic sustainability with carbon tokenization, NTN-G emerges as a strategic tool to bolster Brazil's reputation amid global socio-environmental challenges to solidify international confidence, Brazil must implement consistent fiscal policies, ensure compliance with ESG frameworks and expand green finance initiatives.

Thus, NTN-G positions Brazil as a global leader in sustainable finance, reinforcing its institutional credibility and economic resilience in international markets.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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