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Mouez Fodha,[1] Djamel Kirat,[2] and Chahir Zaki[3]

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Send correspondence to:
Mouez Fodha
Paris School of Economics
mouez.fodha@univ-paris1.fr

[1] Paris School of Economics and University Paris 1 Panthéon-Sorbonne, France.
[2] University of Orléans, France. Email: djamel.kirat@univ-orleans.fr
[3] Faculty of Economics and Political Science, Cairo University and Economic Research Forum, Egypt. Email: chahir.zaki@feps.edu.eg

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Abstract

The objective of this paper is to examine how financial markets are affected by climate and energy transition risks. Our contribution is thus twofold. First, relying on the overlapping generations' model, we develop a simple theoretical model by taking into account the interplay between environmental quality and assets market. We show that when agents are sensitive to the environmental quality, they take decisions about savings and investment in line with the need for higher environmental protection. Second, we empirically test this model by assessing the nature and magnitude of the climate and energy transition determinants of the risk premium associated with public debt, with a focus on countries of the Middle East and North Africa (MENA) region, being one of the most abundant regions in natural resources. Our main findings show that fossil fuel subsoil wealth is associated to a higher risk premium. Moreover, this risk increases also with a higher level of CO2 emissions per capita or lower level of environmental performance index (EPI). This confirms how financial markets are accounting for climate and energy-transition risks. We also show that the quality of institutions plays an important role in counterbalancing the effects of climate-related variables on the risk premium. Finally, we conclude that financial markets could foster energy transition and encourage the implementation of effective environmental policies.

Keywords: Stranded Assets, Climate Risk, Risk Premium, MENA.
JEL Classifications: H63, P18, Q54.

ملخص

الهدف من هذه الدراسة هو البحث في كيفية تأثر الأسواق المالية بمخاطر تغير المناخ والتحول في الطاقة. ومن ثم فالدراسة تنطوي على جانبين، أولاً بالاعتماد على نموذج الأجيال المتداخلة، يتم تطوير نموذج نظري بسيط من خلال مراعاة التفاعل بين جودة البيئة وسوق الأصول، ليتضح أنه عندما يكون الوكلاء حساسين للجودة البيئية، فإنهم يتخذون قرارات بشأن المدخرات والاستثمار بما يتماشى مع الحاجة إلى حماية بيئية أعلى. ثانيًا تختبر الدراسة هذا النموذج تجريبيًا من خلال تقييم طبيعة وحجم العوامل المؤثرة في تغير المناخ والطاقة فيما يتعلق بعلاوة المخاطرة المرتبطة بالدين العام، مع التركيز على دول منطقة الشرق الأوسط وشمال إفريقيا باعتبارها واحدة من أكثر المناطق وفرة بالموارد الطبيعية. وتظهر النتائج الرئيسية التي توصلت إليها الدراسة أن الثروة الجوفية للوقود الأحفوري مرتبطة بعلاوة مخاطرة أعلى. علاوة على ذلك تزداد هذه المخاطرة أيضًا مع ارتفاع مستوى انبعاثات ثاني أكسيد الكربون للفرد أو انخفاض مستوى مؤشر الأداء البيئي(EPI) . وهذا يؤكد الكيفية التي تأخذ بها الأسواق المالية في الحسبان مخاطر تغير المناخ والتحول في الطاقة. ويتبين أيضًا أن جودة المؤسسات تلعب دورًا مهمًا في موازنة تأثيرات المتغيرات المتعلقة بالمناخ على علاوة المخاطرة. وأخيرًا تستنتج الدراسة أن الأسواق المالية يمكن أن تعزز التحول في الطاقة وتشجع على تنفيذ سياسات بيئية فعالة.

1. Introduction

A few years ago, the concept of "stranded assets" was considered as a hypothetical and abstract concept and a far-off concern of climate advocates and progressive investors. Indeed, where climate change could obliterate trillions of dollars of corporate and countries' value and turn assets into liabilities. Yet, today this hypothetical concept is rapidly turning into a hypercritical issue given that fossil fuels production and use are inconsistent with not only economics but with survival. Thus, in this paper, we seek to measure the financial consequences of climate change on the most exposed countries. To do so, we focus on the cost of sovereign debt, by empirically estimating the interdependence between exposure to energy transition and climate risks and the size of the risk premium on public debt[4]. In other words, our objective is to understand to what extent financial markets can take into account the climate crises.

A stranded asset can be defined as a piece of equipment or a resource that once had value or produced income but no longer does, usually due to some kind of external change, including changes in technology, markets and societal preferences. Moreover, it is important to note that such assets have suffered from unanticipated or premature write-downs, devaluation, or conversion to liabilities. In recent years, the issue of stranded assets caused by environmental factors, such as climate change and society's attitudes towards it, has become increasingly important. This is why, currently, the term "stranded assets" is most commonly used to describe oil and gas resources that have not yet been extracted, but which appear as assets on companies' ledgers and a few countries' balance sheets.[5]

Several economies rely on fossil fuel production and exports, especially the Middle East and North Africa (MENA) region. However, with the low-carbon technology diffusion, the advancement in renewable energy and the boom in environmental agreements, the demand for fossil fuel is likely to decline, leading to an increase in stranded assets. This reflects the energy transition risk for countries whose engine of growth is based on the exploitation of fossil resources, such countries in the MENA region. According to the Carbon Tracker, stranded fossil assets are very likely to cost oil producers over 28 trillion in revenues in the next 10 to 20 years with the Arab Gulf producers being, most likely, the major losers (Caldecott et al. 2016). In addition, these countries are also subject to climate risk. While the latter is measured by the cost a country must bear to repair the physical damage caused by climate change, we proxy this in our paper by the CO2 emissions (to GDP and per capita) and the index of environmental performance index. Indeed, the latter reflects the stringency of the environmental policy that should encourage mitigation and adaptation investments. Indeed, many phenomena such as natural disasters induced by extreme climatic and/or weather events, rise in ocean level, desertification, increase in pollution, decrease

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[4] The term risk premium generally refers to the cost of borrowing across the whole paper. Yet, it is important to note that we measure this cost of borrowing using three different variables, namely: the risk premium (the difference between the lending rate and the treasure bill rate that are risk free), the average cost of debt (by dividing the debt service by the stock of debt) and a variable of external sovereign default.

[5] See, for example, Caldecott et al. (2016) or van der Ploeg and Rezai (2020) for an overview of these issues.

in the productivity of labor and natural (agricultural) resources, climate migration, are consequences of climate change that entail repair and adaptation costs. The degree of exposure to climate and energy-transition risks depends on various parameters: i) the geography; ii) the productive structure of the country (services, industry, agriculture); iii) investments undertaken for the mitigation and adaptation to climate change; iv) the abundance of natural resources and / or the dependence to these resources;[6] v) the quality of institutions; vi) the demography (young/old, qualified/unskilled, etc.) and, vii) the structure of foreign trade. Financial market imperfections, in addition to natural resource dependence, have also been raised as potential determinants of vulnerability to shocks.[7] While these trends are closely related to climate change and environmental degradation, financial markets are not spared and can both affect and be affected by climate and energy-transition risks. These consequences on financial markets and economic actors, although highlighted for several years notably after the M. Carney[8] speech in 2015, have had an even greater echo since the interventions of L. Fink, especially in his letter to CEOs sent in January 2021.[9]

Our work is part of a still burgeoning literature on the consequences of climate change on the bonds and public debt markets. Indeed, even if the economic consequences of climate change are well documented, the mechanisms that pass through financial markets are still little studied. First, Kling et al. (2018) use indices from the Notre Dame Global Adaptation Initiative to investigate the impact of climate vulnerability on bond yields. They find that countries with higher exposure to climate vulnerability exhibit 1.174 percent higher cost of debt on average. In the same vein, Cevik and Jalles (2020a) investigate the impact of climate change vulnerability and resilience on sovereign bond yields and spreads in 98 advanced and developing countries over the period 1995–2017. They also show that the vulnerability and resilience to climate change have a significant impact on the cost government borrowing. In connection with the previous work, Cevik and Jalles (2020b) analyze how climate change may affect sovereign credit ratings. They show that climate change vulnerability has adverse effects on sovereign credit ratings. Therefore, countries with greater climate change resilience benefit from higher (better) credit ratings. Finally, Volz et al. (2020) focus on climate risk and sovereign debt cost, mainly for Asian countries. Using a sample of 40 developed and emerging economies, their econometric analysis shows that higher climate risk vulnerability leads to significant rises in the cost of sovereign borrowing. Premia on sovereign bond yields amount to around 275 basis points for economies highly exposed to climate risk. This risk premium is estimated at 113 basis points for emerging market economies overall, and 155 basis points for Southeast Asian economies.

[6] This point is related to the literature on the resource curse. The more a country suffers from this curse, the more it will be vulnerable in case of a climate shock or natural disaster.
[7] See Hausmann and Rigobon (2002).
[8] Breaking the Tragedy of the Horizon – climate change and financial stability, Speech given by Mark Carney, Governor of the Bank of England, Chairman of the Financial Stability Board, Lloyd's of London, 29 September 2015.
[9] CEO of BlackRock, https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter.

Against this background, this paper tries to analyze how financial markets are affected by climate and energy-transition risks. In other words, we ask whether these risks affect the cost of public borrowing, with a specific focus on countries of the MENA region. The question is interesting because financial markets are forward looking and are supposed to anticipate future shocks. Thus, if climate and energy-transition risks are correctly anticipated by the financial markets, the most exposed countries would face a risk premium, and therefore a higher cost of borrowing. Our insight is that financial market reactions to natural risks may in turn encourage the most exposed countries to take more stringent environmental measures. To do so, the contribution of the paper is twofold. First, relying on the overlapping generations' model, we develop a simple theoretical model by taking into account the interplay between the environmental quality and the asset market. We show that when agents are sensitive to the environmental quality, they take decisions about savings and investment in line with the need for higher environmental protection. Second, we empirically test this model by assessing the nature and magnitude of the energy transition and climatic determinants of the risk premium associated with public debt, with a focus on countries of the MENA region.

The MENA region is of interest since it is one of the most abundant in natural resources. It holds almost half of global oil reserves and a quarter of natural gas reserves. The hydrocarbon sector dominates most of these economies, accounting on average for 50 percent of GDP and fuel exports represent around three-quarters of merchandise exports. It is important to note that MENA countries can be classified depending on their dependency to fossil fuels (measured by the share of fuel exports in total exports for instance) into two groups: those that are more dependent on fossil fuels (and therefore less diversified economies) and those that are less dependent (presumably more diversified economies). The two groups have different debt levels, and consequently defaulting risk problems.

Our main results show a strong and positive association between both the cost of borrowing and energy-transition risks, and the cost of borrowing and climate risks in the MENA region, which behave not much differently than other countries of the sample. More specifically, we find for instance that the average costs of debt increase by 0.012 percentage-points following a 1% increase in oil resources. This result shows how financial markets account for the risk of energy transition as well as the climate risk and how they could encourage the implementation of effective environmental policies. Our conclusion is in line with the proposals of several scientists on the need to mobilize financial tools to achieve the zero-emission objective in the short term (see for instance Hourcade et al., 2021). We also show that the quality of institutions plays an important role in counterbalancing the effects of climate-related variables on the risk premium.

The remainder of the paper is structured as follows: Section 2 reviews the literature. Section 3 presents the theoretical framework on the link between financial markets and stranded assets.

Section 4 displays the data and some stylized facts. Section 5 is dedicated to the methodology and the estimation method. Section 6 analyses our results and section 7 concludes.

2. Literature review

2.1. Public debt and the environment: a recent and important macroeconomic issue

The Paris Agreement states that it is urgent "*making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development*". Indeed, given that climate change has already started to have an impact on economic growth, governments will need resources to invest in adaptation infrastructure and mitigation technologies. However, at the same time, it will be more difficult for countries to repay their debt as climate events and natural degradation are expected to slow down economic growth. In this article, we focus on the effects of natural risks (climate and fossil energies among others) on the cost of public debt. These interactions, which are little addressed in the economic literature, are nevertheless important and will be more constraining in the future.

First, the environment will entail economic costs for countries that are most exposed to both types of risk: climate change (natural catastrophes and loss of biodiversity) and transition (stranded assets) risks. As a consequence, economic growth will be slower, physical damages will increase, assets linked to the fossil fuel sectors will lose their value. These recessionary effects could increase the financing needs of governments, and increase, accordingly, the public debt levels, which will question the ability of countries to repay following new shocks (in particular the COVID-19 shock that led to a significant increase in debt levels). Hence, public borrowing becomes more difficult because it is costly and reimbursement of debt burden would be heavier with a higher risk premium.

Thus, we are interested in the consequences of climate change and natural resources on public debt, through the financial markets and ask whether they impose a risk premium to the most exposed countries. If financial markets take these risks into consideration by imposing a risk premium on countries, this will probably encourage countries to invest and to protect themselves against these risks. These countries may send signals to the financial markets by implementing stricter environmental policies, investing in adaptation and mitigation strategies, ratifying environmental treaties, diversifying their energy mix, and slowing down the exploitation of fossil fuels.

In a nutshell, financial markets would therefore be an important tool in the fight against climate change. Consequently, this means that (1) environmental risks are real and important, even from a financial perspective and (2) financial actors shall develop instruments to assess these risks (see Monasterolo (2020) for definitions and consequences of these risks).

2.2. Climate change vulnerability and economic costs

As it was mentioned before, climate change is expected to have many negative effects on economic growth, especially with governments that may have difficulties repaying their debt and may see their cost of borrowing increase. Before analyzing such costs, it is worthy examining the different types of climate change costs. The latter can be divided into two main aspects: the physical (climatic) risks and the energy transition risks (stranded assets). Both are expected to impact economic outcomes.

First, climate physical risks are related to all "*damages to physical assets, natural capital, and human lives resulting in losses of productive capacity and thus output and gross domestic product (GDP), as a result of climate-induced weather events*" (Monasterolo, 2020). Natural events refer to extreme climate events that could involve temperatures, sea levels and precipitation. These extreme consequences are likely to impact economic growth, productivity, financial asset values and compensation. In fact, the economic damage caused by climate change is already being observed and is likely to increase in the future. For example, IPBES (2019) estimates that land degradation has reduced the productivity of 23% of global land.

Second, climate change also involves transition risks measured by losses resulting from the revaluation of assets following a change in policy and/or regulation, poorly anticipated by economic actors in the sectors concerned. This risk is associated with fossil resources and is also called *low-carbon transition risk*. It corresponds to increased carbon pricing, stricter environmental standards, stranded assets, and market risks such as declining demand for high-carbon products. It includes technology shocks, policy and regulatory shocks, and financial shocks. This revaluation would result in a loss of value of fossil fuel-based assets relative to, for example, renewable energy assets.

Studies have attempted to measure the effects of climate change on macroeconomic indicators such as GDP or investment levels. For example, Beirne et al (2020) explain that climate change is expected to increase the frequency of extreme weather events, which will affect economic growth even in the long run. Climate change also explains the increase in global temperature, which will imply structural changes and affect production in the long run. Cantelmo et al. (2019) compared the costs of disasters by comparing disaster-exposed countries, defined as countries with an annual probability of experiencing a natural disaster in the top 25 percent of the distribution, to the remaining 75 percent of countries not exposed to disasters. They estimate that a natural event destroying 6.65% of GDP is associated with a decrease in public consumption and investment of 6% and an increase in public debt of about 3.5 percentage points. These consequences will be even more important if these phenomena become recurrent. Their evaluations show that these countries exposed to natural risks, compared to unexposed countries, have on average a lower annual GDP growth of almost 1% and a higher level of public debt of 1.54% of annual GDP. Thus, the physical risks and climate risks could have global effects on all economies, by propagation effect. The most impacted and vulnerable countries are often the poorest ones.

In addition to the risk to economic growth, climate change could compromise the ability of some countries to repay their debt. As Dibley et al (2021) point out, public debt is legitimate as long as it finances an investment whose returns offset the debt burden. However, climate change threatens economic growth and therefore weakens the countries affected by extreme events. This risk is all the more important as the health context in 2020 and 2021 has forced most countries to increase their public debt. In the event of an economic recession, it will be necessary either to take on more debt or to severely restrict public spending, which will reinforce the effects of the economic recession. The vulnerability of these countries is growing and may lead the most fragile and indebted to default and enter a sovereign debt crisis. Faced with this debt risk, which could be exacerbated by the consequences of climate change, investors will be tempted to increase their interest rates.

Beirne et al. (2020) show how public borrowing costs can be affected by climate change. The main channels are the decline in capital, the fiscal consequences of natural disasters, and government spending related to adaptation and mitigation needs. They estimate the impact of climate risks on bond yields and find increased vulnerability and lower resilience to climate risks lead to higher bond yields. Cantelmo et al. (2019) observe that between 1998 and 2017, on average, during months when natural disasters occurred in Jamaica, the interest rate paid on government debt increased by 3.15 percent. Malucci (2020) studies how natural disasters can exacerbate fiscal vulnerabilities and imply sovereign defaults, for seven Caribbean countries frequently hit by hurricanes. He shows that disaster risk reduces the government's ability to issue debt and that climate change further restricts government access to financial markets. Furthermore, he predicts that in Caribbean countries, if the frequency and intensity of hurricanes increase as expected, credit spreads will increase by more than 30 percent. This result is also supported by Kling et al. (2018) who estimate that countries vulnerable to natural disasters pay, on average, a 1.17 percent higher cost of debt compared to countries less exposed to climatic events.

The risk of default on public debt can be explained by the fact that financial markets currently take little account of climate change risks in their measures of the risks associated with financial contracts. Loans to exposed countries for highly polluting projects may be made, while conversely, sustainable investment strategies are discarded (Monasterolo, 2020). More generally, the mispricing of climate risks could lead to systemic risk and financial instability. For these reasons, it seems important that governments systematically assess their exposure to climate risks and disseminate these assessments and risks to economic actors. Only Ghana has conducted this risk assessment in order to borrow to address the COVID-19 crisis (Dibley et al, 2021). This information requirement would obviously lead to higher borrowing costs for exposed countries, which is clearly a disincentive to disclose information. Mostly, countries continue to invest in polluting assets and deepen their mismatch with future needs. They are therefore even more vulnerable to rising bond yields if investor behavior towards climate risks changes. Currently, investors are predominantly faced with contract that will finance polluting investments and that are especially linked to fossil fuels. Hence, revising their climate risks would help the reallocation of financial funds towards greener activities and sectors (Monasterolo, 2020). Moreover, it would prevent the development of polluting sectors in new fields and give more credibility to climate targets (Farmer et al, 2019). Consequently, central banks and financial supervisors have pushed forward the need for standardized metrics to include climate risks in financial contracts.

Against this backdrop, we first present a theoretical model that shows the relationship between environmental preferences and the risk premium. Second, we try to empirically examine this relationship with a special focus on the MENA region.

3. Theoretical Model

We consider a dynamic general equilibrium framework, based on the overlapping generations' model, and we focus on the capital market mechanisms. The borrowing rate results from the adjustment of the supply of public and private capital to aggregate savings. In this first step, we consider an aggregate measure of the environmental quality that is supposed to be an aggregate indicator of both natural disaster and climate issues (the Environmental Performance Index EPI[10] is a good example of such an aggregate indicator). Generally, an in-depth macroeconomic analysis of the interactions between public finance and the environment can be found in Fodha and Seegmuller (2012) and (2014).

More specifically, our theoretical model will be in line with the macroeconomic literature on the analysis of the determinants of public debt that is extensive and remains highly topical (Diamond, 1965). There is now a broad agreement that fundamentals play a crucial role in the level and cost of public debt. Among the important topics still under debate, the articles ask whether there is a limit to the debt ratio that can compromise long-term growth, how debt should be used to combat crises, particularly health and climate crises, and finally how to finance the energy transition. We focus on this last point in the context of the macro dynamic literature on public debt (Diamond 1965). We thus present an adaptation of Diamond's approach by taking into account the environmental quality in agents' decisions. The environment is no longer a pure externality, as in John and Pecchenino (1994) and (1995), Mariani et al (2010) for instance.

In this following, we present a very simple approach to show, in partial equilibrium, how the environment, through the capital market, can affect the return on capital, the interest rate, and thus increase the cost of borrowing.

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[10] Wendling, Z. A., Emerson, J. W., de Sherbinin, A., Esty, D. C., et al. (2020). 2020 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy. epi.yale.edu

We consider an overlapping generations model with discrete time ($t=0,\ 1,\ +\infty$), capital accumulation, and environmental quality which degrades with production, but may be improved by investment in mitigation. This model includes three types of agents: consumers, firms and a government.

Consumers live for two periods and the population size of each generation is constant and equal to N. Preferences of a household born at period t are represented by a simple Cobb-Douglas function defined over future consumption c_{t+1} and environmental quality E_{t+1}:

$$U(c_{t+1}, E_{t+1}) = c_{t+1}^{\alpha} E_{t+1}^{1-\alpha}$$

At the first period of life, a household born at period t supplies inelastically one unit of labor, remunerated at the competitive real wage w_t, and share his labor income between saving s_t, through available assets, and positive environmental maintenance $m_t \geq 0$. We assume complete depreciation of capital after one period of use. Therefore, r_{t+1} also denotes the real interest factor or marginal productivity of capital. At the second period of life, saving, remunerated at the real interest factor r_{t+1}, is used to consume the final good. Hence, a consumer faces the two following budget constraints:

$$w_t = s_t + m_t$$
$$c_{t+1} = r_{t+1}\, s_t$$

We further assume that capital stock degrades environmental quality, while private environmental mitigation can improve it. Assuming linear relationships, environmental quality follows the motion:

$$E_{t+1} = \varepsilon m_{i,t} + \varepsilon \sum_{j \neq i}^{N} m_{j,t} - \sigma K_t$$

where $\sigma > 0$ represents the rate of pollution coming from capital stock, while $\varepsilon > 0$ measures the efficiency of private mitigation.

Notice that $-E_{t+1}$ can be interpreted as a pollution stock. Assuming that E_{t+1} does not depend on the current level of environmental quality E_t means that pollution is a flow or a stock with full regeneration after one period. Since we consider an overlapping generation model with two-period lived agents i.e. the length of period is quite large, this does not seem to be a too restrictive assumption. E_t is a public good, σK_t an intergenerational externality and $m_{i,t}$ represents the individual private expenditure on pollution control. We assume that the agent i invests against pollution regardless of the actions of other individuals. We also assume that all individuals are identical and we consider only a symmetric equilibrium.

A representative agent's *i* program writes:

$$Max \quad c_{i,t+1}^{\alpha} E_{t+1}^{1-\alpha}$$
$$s.t. \begin{cases} w_t = s_{i,t} + m_{i,t} \\ c_{i,t+1} = r_{t+1} s_{i,t} \\ E_{t+1} = \varepsilon m_{i,t} + \varepsilon \sum_{j \neq i}^{N} m_{j,t} - \sigma K_t \end{cases}$$

then, the savings function is derived as: $s_{i,t} = \frac{\alpha}{(1-\alpha)\varepsilon} E_{t+1}$.

Taking into account that one unit of labor is inelastically supplied at each period, the production is given by $Y_t = AK_t^{\beta} N^{1-\beta}$, where K_t denotes the capital stock and $\beta \in (0,1)$. From profit maximization, we get:

$$r_t = A\beta K_t^{\beta-1} N^{1-\beta} \equiv r(K_t)$$
$$w_t = A(1-\beta) K_t^{\beta} N^{-\beta} \equiv w(K_t)$$

The aim of the government is to finance public spending G_t in order to provide public goods (health or education for instance). To do so, the government can use a debt B_t. The intertemporal budget constraint of the government can be simply written:

$$B_t = r_t B_{t-1} + G_t$$

with $B_{-1} \geq 0$ given.

In this example, following the seminal paper by Diamond (1965), we focus on equilibria with constant debt, i.e. $B_t = B > 0$ for all $t \geq 0$. We also consider that public spending is an exogenous instrument for public policy. Hence, public spending is also constant, i.e. $G_t = G > 0$ for all $t \geq 0$.

The capital stock in period $t+1$ is equal to the young individuals' savings in period t minus the public debt in t. Since the labor market also clears, the equilibrium in the goods market, $y_t = c_t + k_{t+1} + G_t$, is satisfied by the Walras' law.

The market-clearing condition for capital market is $Ns_{i,t} = B_{t+1} + K_{t+1}$, which finally gives:

$$K_{t+1} = N \frac{\alpha}{(1-\alpha)\varepsilon} E_{t+1} - B$$

Finally, from the First Order Conditions of the firms, we obtain that the real long-term interest factor writes:

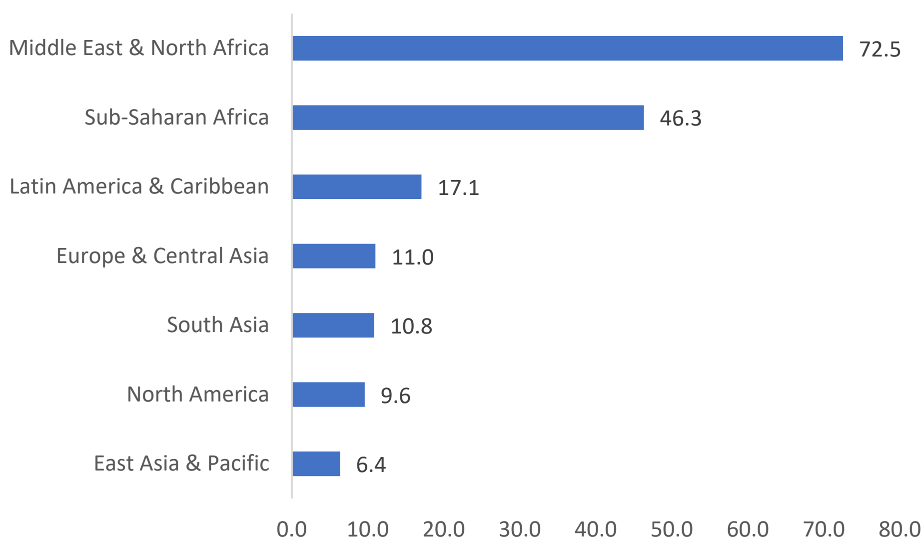
$$r_{t+1} = A\beta\left(\frac{1}{\frac{\alpha}{(1-\alpha)\varepsilon}E_{t+1} - B}\right)^{1-\beta}$$

We hence find that, when agents take into account the environmental quality in their savings choices, the interest rate could be decreasing in the environmental quality. It implies that lower environmental indexes, higher will be the long-term interest rate. The mechanisms are quite simple. When agents anticipate a deterioration in the environmental quality index, they protect against the risk by diverting their savings from polluting capital. Thus, the supply of capital falls, which increases the interest rate and therefore the cost of public debt.

4. Data and Stylized Facts

As it was mentioned before, the MENA region is of interest since it is one of the most abundant in natural resources. Figure 1 compares this region to other emerging and advanced ones and shows that fuel exports represent 72.5% of merchandise exports, while this share is significantly lower in Sub-Saharan Africa (46.3%), Latin America (17.1%), and North America (9.6%). Moreover, it holds almost half of global oil reserves and a quarter of natural gas reserves.

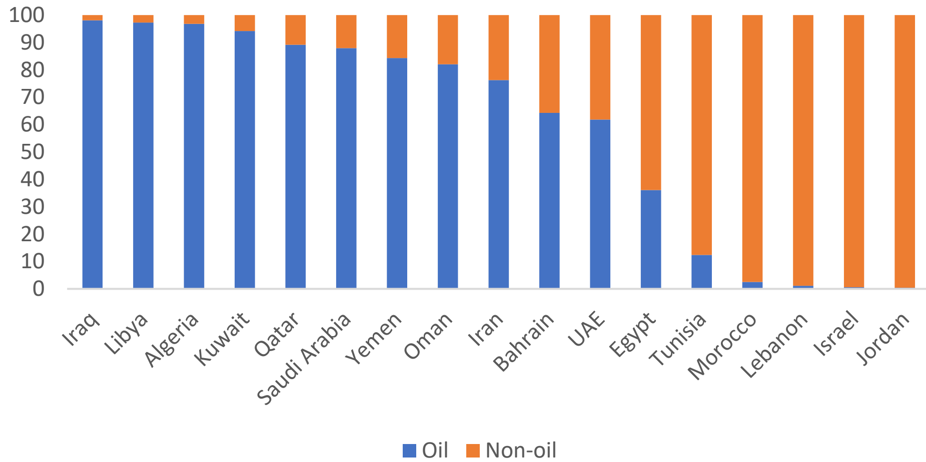
Figure 1. Fuel exports (% of merchandise exports)



Source: Authors' elaboration using the World Development Indicator dataset.
Note: Figures are average over the period 1995-2019.

Yet, within the region, there is an important heterogeneity. Indeed, MENA countries can be classified depending on their dependency to oil into two groups: those that are more dependent on fossil fuels (and therefore less diversified economies) and those that are less dependent (presumably more diversified economies). Figure 2 shows that the former group is chiefly dominated by the Gulf Cooperation Countries (GCC), Algeria, Libya, Yemen, and Iran.

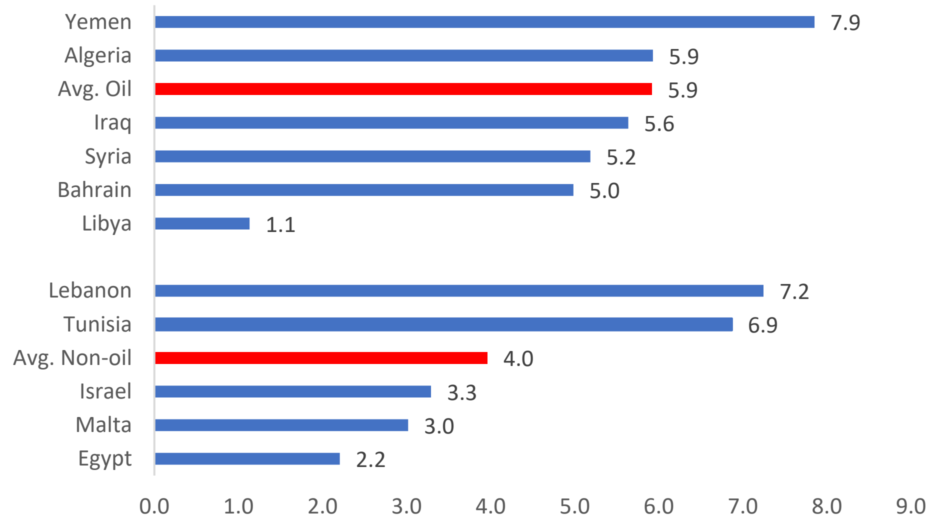
Figure 2. Oil vs. non-oil exports (by country)



Source: Authors' elaboration using the World Development Indicator dataset.
Note: Figures are average over the period 1995-2019.

Obviously, the two groups have different debt levels, and consequently defaulting risk, problems. Figure 3 compares the risk premium, being the difference between the lending rate and the Treasury bill rate (risk free) for the groups of countries. First, the average risk premium of oil exporting countries is higher than that of oil importing ones (5.9 vs. 4), confirming our main hypothesis. Second, with the exception of Lebanon (because of its current economic and political crisis) and Tunisia, all oil exporting countries have a higher risk premium compared to other MENA countries. For instance, Yemen's premium is 7.9, Algeria's one 5.9, whereas Israel's one is 3.3 and Egypt's one is 2.2.

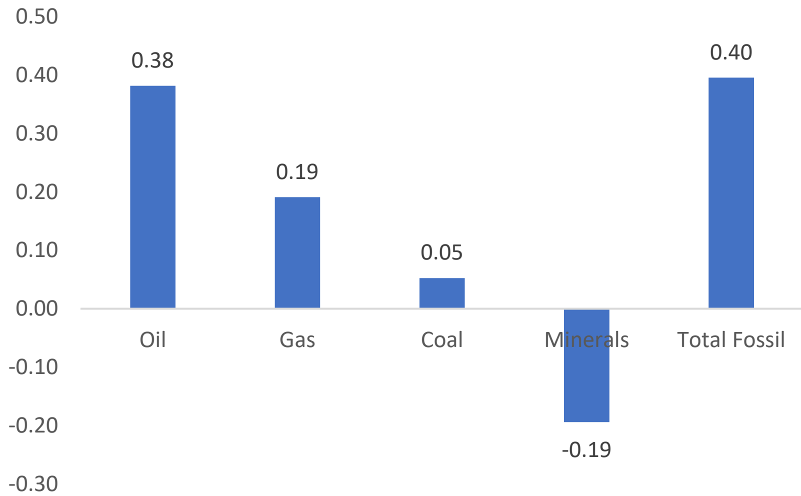
Figure 3. Risk premium (oil exporters vs. oil importers)



Source: Authors' elaboration using the World Development Indicator dataset.
Note: Figures are average over the period 1995-2019.

Figure 4 confirms another interesting fact as it shows the correlation between different types of natural resources and the risk premium in the MENA region. First, except the correlation coefficient of coal, all the other coefficients are statistically significant at 1%. Second, the correlation of the risk premium with oil and with natural gas is positive showing how resource rich countries endowed with stranded assets are more likely to have a higher risk. Second, when fossil fuels are compared to mineral ones, the former is positively and the latter is negatively associated to the risk premium. This result is of particular interest since fossils result from the decomposition of formerly living organisms buried for millions of years. In contrast, minerals are inorganic substances that occur naturally and form an exact crystalline structure. In fact, the energy transition will involve a slowdown, or even a break, in the need for fossil resources. The energy mix will be composed mainly of renewable energies, whose infrastructures (especially wind and photovoltaic) contain large quantities of mineral resources. Thus, the fall in demand for fossil resources should lead to an increase in demand for mineral resources (Fabre et al, 2020).

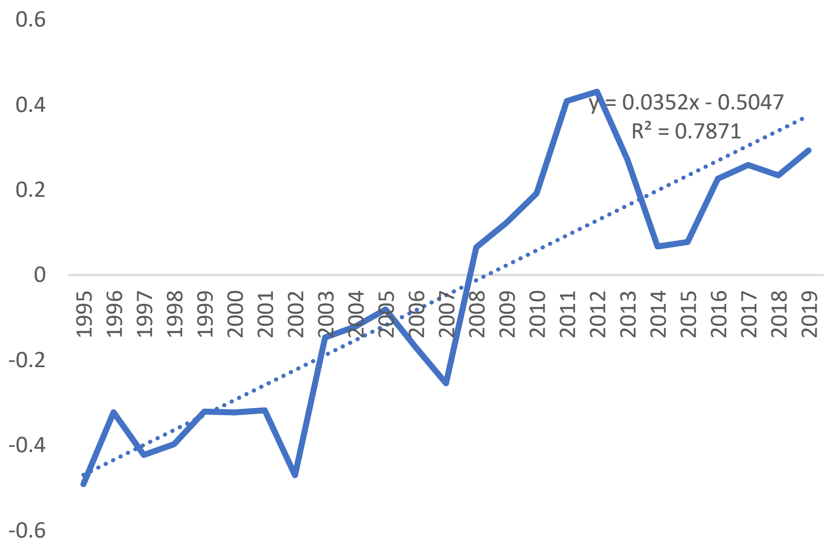
Figure 4. Correlation between natural resources and risk premium



Source: Authors' elaboration.
Note: Figures are average over the period 1995-2019

The evolution of the association between these two variables is worthy to be investigated. Indeed, Figure 5 shows that, over time, the correlation coefficient between fossils and risk premium is increasing over time and shifted from a negative correlation in the 1990s to a positive one starting 2008. This can be potentially explained by two reasons. On the one hand, several MENA oil exporting countries relied on their wealth of natural resources making them less risky. Yet, over time, the more the resources were depleted, the more the risk premium increases and the more these countries become aware of the more serious future risks they might face. Second, the financial crisis of 2008 marks also an important turning point given the increase of the risk and the use of oil rents in bailout policies to support the economy.

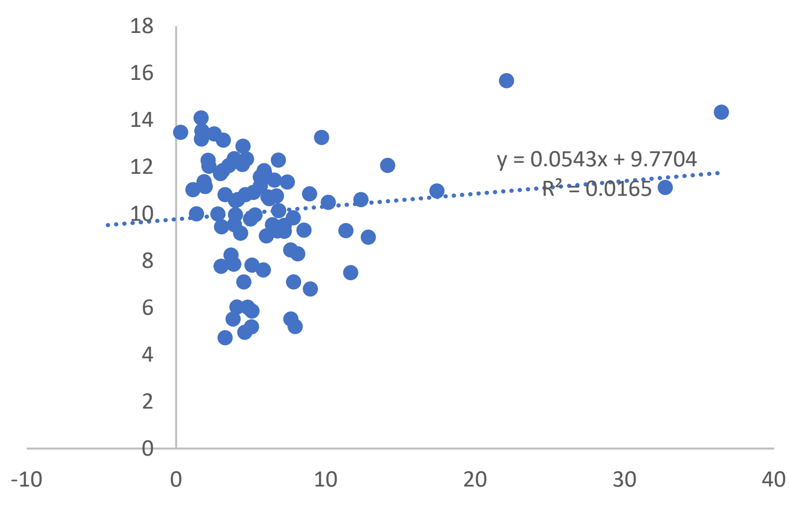
Figure 5. Evolution of the correlation between fossil fuels and risk premium



Source: Authors' elaboration using the World Development Indicator dataset.

In the same vein, and as it was argued by Beirne et al (2020), Figure 6 shows that countries at highest risk of climate change effects (measured by the greenhouse gas emissions) are also the ones that will suffer the highest premium.

Figure 6. Correlation between Risk Premium and Greenhouse Gas Emissions



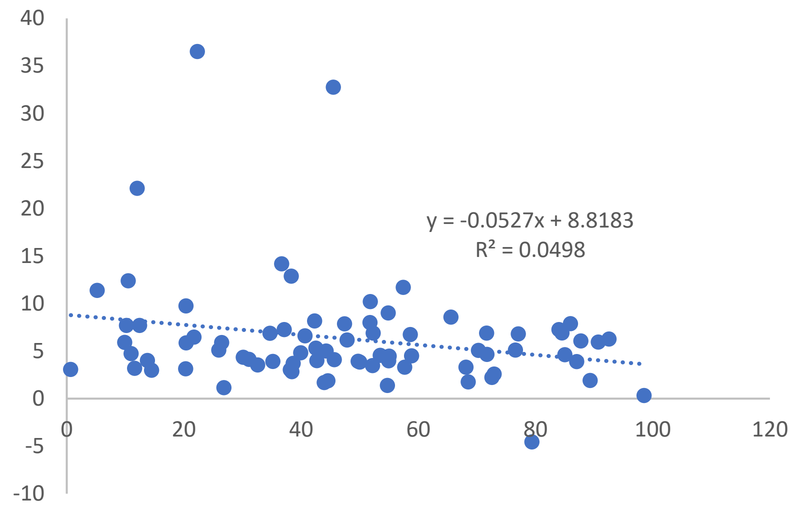
Source: Authors' elaboration using the World Development Indicator dataset.

The quality of institutions is an important determinant of risk premium. In fact, Figure 7 shows the negative correlation between the World Governance Indicator[11] and the risk premium. Indeed, better institutions will lead to better enforcement of contract and hence lower risk. It is also

[11] We use an average of the six sub-indices: voice and accountability, political stability, rule of law, regulatory quality, government effectiveness and control of corruption.

important to highlight that the quality of institutions is associated to the impact of natural resources on growth. Indeed, this is line with the findings of Selim and Zaki (2016) who argue that, in the MENA region, political institutions do not always have an effect on growth. Yet, when these interact with natural resources, they reduce the negative effect of natural resources on growth but do not offset it. This is why the resource curse in the Arab world is primarily an "institutional curse".

Figure 7. Correlation between institutions and risk premium



Source: Authors' elaboration using the World Development Indicator and World Governance Indicators dataset.
Note: Figures are average over the period 1995-2019.

It is worthy to note that, using alternative measures for the risk premium (such as the average cost of debt and external sovereign default) gives similar associations between the risk measure, institutions and natural resources. Against this background, understanding how financial markets account for climate and energy-transition risks in the interest rate is highly interesting.

5. Empirical Specification

In order to examine the effect of environmental risks which enclose both energy transition risks (stranded assets) and climatic risks on the country's costs of debt, we estimate a model where the countries' risk premium is the dependent variable and the standard explanatory variables from the macro and financial literature dealing with the decomposition of risk premiums as follows:

$$Y_{it} = \alpha + \beta\, EnvRisk_{it} + \gamma\, Z_{it} + \beta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where Y_{it} refers to the risk premium of country *i* in year *t*. This variable is defined in the macroeconomic literature as the difference between the expected return on the risky market portfolio and the risk-free interest rate. In our estimations, we propose/use three distinct/alternative indicators to measure the risk premium: (1) the difference between the lending rate and the treasure bill rate (risk free), (2) the average cost of debt (by dividing the debt service by the stock of debt) and (3) a variable of external sovereign default (that takes the value of 1 if the country experienced an external sovereign default and 0 otherwise). Z is a matrix of control variables that include the short-run external debt as share to GDP (that increases the risk premium), inflation rates and GDP growth to control for the macroeconomic environment, and the quality of institutions that is likely to reduce the risk premium. γ represents a vector of parameters associated with control variables. β_i denotes a full set of country fixed-effects, which will capture the impact of any time-invariant country characteristics, λ_t year fixed effects and ε is the error term.

Our independent variables of interest can be classified into two main groups: natural resources one (that includes total natural resources that is further decomposed into minerals and fossil fuels then into oil, coal, and natural gas). The second group encompasses environmental variables that include CO2 total emission (kg per 2010 US$ of GDP), total greenhouse gas emissions (kt of CO2 equivalent), CO2 per capita, and the Environmental Performance Index. We also control for the endogeneity of CO2 emissions as it will be shown later.

It is important to note that, in order to identify the risk premiums associated with climate and/or energy transition (stranded assets), our idea is to conduct a decomposition analysis of the countries' risk premium. Since we extend the model by including proxies for climate risk and/or stranded assets, the estimated parameters associated with the latter variables may be interpreted as the shares of climate risk and/or energy transition risk (stranded assets) in the total risk premiums countries are facing. We consequently compute the countries' risk premiums as the predicted values from the estimated parameter associated with climate risk proxy times the value of the proxy.

Our data come from different sources. Risk premium (as measured by the difference between the lending rate and the treasure bill rate), inflation, GDP growth and short term external debt, CO2 total emission (kg per 2010 US$ of GDP), total greenhouse gas emissions (kt of CO2 equivalent), CO2 per capita come from the World Development Indicators. Banking Crisis and external sovereign default come from the Global Crises Data (Harvard Business School). GHG per capita comes from the Environmental Performance Index. Energy resource variables come from the World Bank (Lange et al., 2018) and are measured as the subsoil wealth per capita in constant 2014 US$.

6. Empirical Results

In order to assess the impacts of environmental risks on country's costs of debt, we estimate model (1) of risk premium with both country-specific fixed effects and time fixed effects by considering alternately two dimensions of the environmental risks, which are the energy transition risks or stranded assets and the climate risks. Consequently, this section is divided into four subsections. Section 6.1 is devoted to the analysis of the impact of stranded assets on the costs of debt. Section 6.2 deals with the impact of climatic risks on the costs of debt. Section 6.3 assesses how the institutional quality influences the relationships between environmental risks and the costs of debt. Finally, section 6.4 addresses the issue of potential endogeneity of explanatory variables used to proxy for environmental risks.

6.1. Macroeconomic Risk and Stranded Assets

When estimating model (1), we use three different variables to proxy for the dependent variable: i) the average cost of debt; ii) the risk premium which equals to the difference between the lending rate and the treasure bill rate; and iii) the sovereign external default. Accordingly, the results of the estimation for each of the proxies are presented in Tables 1, 2 and 3.

Table 1 presents the estimation results from model (1) when the dependent variable is the average cost of debt and the environmental risk proxied by various variables measuring fossil fuel subsoil wealth. Table 1 is divided into six columns representing different specifications corresponding to the use of various proxies for the subsoil wealth. The latter allows to measure the energy-transition risk and the set of proxies include: mineral resources, natural resources, fossil fuel resources as a whole, and alternately oil, gas and coal. Alongside subsoil wealth, all of the specifications include standard explanatory variables from the macroeconomic and financial literature on risk premium decomposition such as short-term external debt, inflation, GDP growth, the quality of institutions and the type of regime exchange (fixed or intermediary). As our focus is particularly on countries of the MENA region, we introduce a dummy variable for countries belonging to the MENA region and an interaction term between variables proxying the environmental risks and the MENA region dummy. The latter allow to check whether the costs of debt in countries of this region behave differently with regard to the environmental risks.

In terms of our control variables, the results in Table 1 show that the short-term external debt do not play a significant role in determining the average cost of debt. They also show that the estimated coefficients associated with the institutional quality, even when they are insignificant, are of the expected sign. The average cost of debt is negatively related to the institutional quality of a country. Thus, bad institutional quality is associated with higher cost of borrowing. The estimated parameters associated with GDP growth and inflation have the expected sign when they are significant at standard statistical levels. For instance, GDP growth reduces the average cost of debt.

The coefficient associated with the dummy variable representing whether a country belongs to the MENA region or not measures the difference in the conditional mean of the cost of debt of MENA countries relative to the rest of the world and acts as a fixed effect common to this region. In the same vein, the parameter associated with the interaction term between the subsoil wealth variable and the MENA dummy variable measures the particularity of countries belonging to this region relative to the rest of the world in terms of risk premium associated with stranded assets. The latter is only significant for oil resources. Indeed, the first column of Table 1 show that oil resources do not impact the cost of borrowing of countries except for those of the MENA region, given that it is the most abundant region in oil. The estimates show that their average cost of debt increases by 0.012 percentage points following a 1% increase in oil resources. This points out the fact that financial markets include risk premiums to hedge against energy-transition risks in countries of the MENA region.

With regard to the other subsoil wealth variables, results in Table 1 show strong evidence that natural resources as a whole and coal in particular increase significantly the cost of borrowing in all countries of our sample. The results are different for both gas and mineral resources. While natural gas does not affect risk premiums as the estimated parameter associated with natural gas appear to be insignificant, mineral resources reduce significantly the cost of borrowing.

Such results are consistent with those in the literature on stranded assets where resource-rich countries are considered as potentially more exposed to the energy-transition risk. Indeed, Delis et al. (2019) show an increase in the total cost of borrowing for fossil fuel firms with proved reserves after 2015. They also provide some evidence that “green banks” charge marginally higher loan rates to fossil fuel firms. We conclude that the energy-transition risk is accounted for by lenders and financial markets foster energy transition in countries of the MENA region.

Table 2 presents the estimation results of model (1), where the cost of borrowing is proxied by the risk premium that equals to the difference between the lending rate and the treasure bill rate. The results in Table (2) show that countries of the MENA region do not behave differently that other countries of the sample in terms of risk premiums associated with stranded assets. Moreover, the results in Table 2 show that all of the estimated parameters associated with macroeconomic variables when significant have the expected sign except for GDP growth. Indeed, the results show that GDP growth increase the costs of borrowing and seems counter-intuitive. Yet, an in-depth analysis of the dependent variable which is defined as the difference between the lending rate and the treasure bill allow to explain this result. In fact, the dependent variable represents also the mark-up of banks, which partially explains the positive impact of GDP growth. The estimated parameters associated with the short-term external debt variable have the expected sign when they are significant at standard statistical levels and shows that the country’s risk premium increases with the level of its external debt. Finally, bad institutional quality is associated with higher cost of borrowing.

Regarding the subsoil wealth variables, the results in Table 2 show strong evidence that fossil fuel resources and more specifically natural gas resources increase significantly the cost of borrowing. The estimates show that risk premiums increase by 0.0505 and 0.0014 percentage-points following a 1% increase in fossil fuel and natural gas resources, respectively.

Table 3 presents the estimation results of model (1), where the cost of borrowing is proxied by the sovereign external default. Our results remain relatively robust since they confirm the positive impact of bad institutions on the cost of borrowing and the energy transition risk premium faced by countries abundant in fossil fuels especially oil rich ones.

Table 1. Average Cost of Debt and Stranded Assets

	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost
Short Ext. Debt.	-0.00366	-0.00418	-0.00298	-0.00221	0.00251	-0.00203
	(0.00288)	(0.00304)	(0.00265)	(0.00253)	(0.00367)	(0.00238)
Inflation	-0.000228	-0.000233	-0.000219	-0.000247*	-3.48e-05	-0.000263*
	(0.000147)	(0.000154)	(0.000145)	(0.000145)	(0.000155)	(0.000148)
GDP growth	-0.00763*	0.000542	-7.51e-05	0.000491	-0.00890*	-0.000618
	(0.00459)	(0.00328)	(0.00282)	(0.00283)	(0.00495)	(0.00291)
Fixed ER	-0.0240	0.0130	0.0958	0.0282	0.00368	0.113
	(0.148)	(0.158)	(0.130)	(0.130)	(0.193)	(0.114)
Inter. ER	0.108	0.122	0.186*	0.145	0.187	0.177*
	(0.120)	(0.130)	(0.105)	(0.105)	(0.159)	(0.0926)
Institutions	-0.00112	-0.00644	-0.00897*	-0.00872*	-0.000295	-0.00579
	(0.00547)	(0.00568)	(0.00469)	(0.00469)	(0.00641)	(0.00434)
MENA	-12.99	0.308	3.238***	3.433***	5.787**	3.601***
	(9.014)	(3.734)	(0.422)	(0.251)	(2.466)	(0.462)
Ln(Oil)	-0.0119					
	(0.0155)					
Ln(Oil)*MENA	1.209*					
	(0.675)					
Ln(Gas)		-0.00302				
		(0.0104)				
Ln(Gas)*MENA		0.204				
		(0.246)				
Ln(Coal)			0.0258**			
			(0.0114)			
Ln(Coal)*MENA			-0.0155			
			(0.0202)			
Ln(Minerals)				-0.0125**		
				(0.00624)		
Ln(Minerals)*MENA				0.0156		
				(0.0178)		
Ln(Fossil)					0.0346	
					(0.0622)	
Ln(Fossil)*MENA					-0.112	
					(0.114)	
Ln(Nat. Res.)						0.139*
						(0.0781)
Ln(Nat. Res.)*MENA						-0.236
						(0.279)
Constant	-4.944***	-5.332***	-5.401***	-5.417***	-6.354***	-5.418***
	(0.467)	(0.319)	(0.179)	(0.178)	(1.719)	(0.172)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	832	787	986	990	593	1,236
R-squared	0.759	0.734	0.757	0.756	0.769	0.737

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 2. Risk Premium and Stranded Assets

	Risk Prem.	Risk Prem.	Risk Prem.	Risk Prem.	Risk Prem.	Risk Prem.
Short Ext. Debt.	0.125*	0.0156	0.202***	0.196***	0.00264	0.107***
	(0.0641)	(0.0524)	(0.0485)	(0.0461)	(0.0682)	(0.0382)
Inflation	-0.0682*	-0.0545**	-0.0645	-0.0661*	0.116	-0.0663**
	(0.0347)	(0.0267)	(0.0563)	(0.0348)	(0.0741)	(0.0326)
GDP growth	0.0324	0.307***	0.0319	0.0245	0.261**	0.0349
	(0.127)	(0.109)	(0.110)	(0.109)	(0.125)	(0.0892)
Fixed ER	-1.555	0.359	-3.211	-1.774	-0.516	-1.440
	(2.497)	(2.044)	(2.318)	(2.272)	(3.354)	(1.667)
Inter. ER	-10.35***	-5.989***	-5.775***	-5.927***	-12.30***	-2.140
	(2.111)	(1.937)	(1.753)	(1.726)	(3.311)	(1.390)
Institutions	-0.392***	-0.527***	-0.314***	-0.300***	-0.629***	-0.244***
	(0.0885)	(0.0729)	(0.0890)	(0.0880)	(0.0954)	(0.0709)
MENA	14.75	-38.06	6.199	10.41*	31.76	-6.827
	(9.598)	(41.91)	(6.439)	(6.261)	(59.40)	(6.287)
Ln(Oil)	0.165					
	(0.307)					
Ln(Oil)*MENA	7.235					
	(8.373)					
Ln(Gas)		0.137*				
		(0.0823)				
Ln(Gas)*MENA		2.819				
		(2.049)				
Ln(Coal)			-0.0736			
			(0.176)			
Ln(Coal)*MENA			-0.172			
			(0.352)			
Ln(Minerals)				0.269***		
				(0.0914)		
Ln(Minerals)*MENA				-0.153		
				(0.214)		
Ln(Fossil)					5.048***	
					(1.905)	
Ln(Fossil)*MENA					0.923	
					(2.691)	
Ln(Nat. Res.)						-2.204
						(1.365)
Ln(Nat. Res.)*MENA						4.497
						(4.154)
Constant	30.33***	26.92***	25.12***	17.38***	-87.77*	29.27***
	(8.853)	(3.829)	(4.963)	(4.189)	(48.83)	(5.885)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	353	300	405	409	206	510
R-squared	0.808	0.600	0.767	0.772	0.675	0.756

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 3. External Default and Stranded Assets

	Ext. Default	Ext. Default	Ext. Default	Ext. Default	Ext. Default	Ext. Default
Short Ext. Debt.	-0.00365**	-0.00180	-0.00256*	-0.00251*	-0.00220	-0.00263**
	(0.00152)	(0.00136)	(0.00134)	(0.00131)	(0.00159)	(0.00132)
Inflation	1.11e-05	6.29e-06	1.10e-05	4.12e-06	6.02e-06	9.37e-06
	(4.45e-05)	(4.06e-05)	(4.27e-05)	(4.27e-05)	(4.13e-05)	(4.25e-05)
GDP growth	-0.000469	-0.000234	0.000304	0.000640	-0.00135	0.000450
	(0.00151)	(0.00137)	(0.00139)	(0.00139)	(0.00141)	(0.00138)
Fixed ER	0.0605	0.0688	0.0902	0.0581	0.0376	0.0604
	(0.0642)	(0.0581)	(0.0607)	(0.0621)	(0.0689)	(0.0614)
Inter. ER	0.0417	0.0845	0.0812	0.0599	0.0565	0.0621
	(0.0586)	(0.0513)	(0.0542)	(0.0548)	(0.0663)	(0.0544)
Institutions	-0.0115***	-0.0122***	-0.00945***	-0.00893***	-0.0163***	-0.00962***
	(0.00217)	(0.00205)	(0.00191)	(0.00189)	(0.00222)	(0.00190)
MENA	2.576***	0.663	0.659***	0.655***	1.932	0.639***
	(0.791)	(1.425)	(0.142)	(0.157)	(1.475)	(0.145)
Ln(Oil)	0.0635**					
	(0.0269)					
Ln(Oil)*MENA	0.124					
	(0.221)					
Ln(Gas)		0.00428				
		(0.00361)				
Ln(Gas)*MENA		0.00928				
		(0.0693)				
Ln(Coal)			0.00380			
			(0.00346)			
Ln(Coal)*MENA			-0.00124			
			(0.00839)			
Ln(Minerals)				-0.00426*		
				(0.00231)		
Ln(Minerals)*MENA				0.00280		
				(0.00526)		
Ln(Fossil)					0.0321	
					(0.0239)	
Ln(Fossil)*MENA					-0.0285	
					(0.0713)	
Ln(Nat. Res.)						-0.0645**
						(0.0292)
Ln(Nat. Res.)*MENA						0.101
						(0.119)
Constant	-1.752**	-0.142	-0.0636	-0.0582	-0.857	-0.0247
	(0.722)	(0.110)	(0.0728)	(0.0727)	(0.641)	(0.0744)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	506	461	556	556	360	556
R-squared	0.511	0.575	0.714	0.715	0.643	0.716

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

6.2. Macroeconomic Risk and Environment

We reproduce the analysis in section 6.1 to assess the impact of climate risks faced by a country on its costs of borrowing. Table 4, 5 and 6 report the estimation results from equation (1) where we substitute proxies of subsoil wealth with those of environmental quality to account for the climate risks. Here again, the average cost of debt, the risk premium and the sovereign external default are successively used as proxies for the cost of borrowing. These tables are divided into four columns where different measures of the environmental quality are alternately considered: carbon intensity (CO_2/GDP), CO_2 per capita, Greenhouse gas emissions (GHG) and an environmental performance index (EPI).

First, it is important to note that the MENA dummy is positive and significant (in Table 4 and 6) pointing out that this region is more likely to have a higher likelihood of external default or a higher cost of debt compared to other countries. Moreover, in some regressions, an intermediate exchange rate is associated to a higher cost (Table 4) or a higher external default (Table 6). In fact, intermediate exchange rate regimes that are widely adopted in the Arab region are associated to more uncertainty in their exchange rate policy than countries with fixed peg or flexible regimes. Consequently, this will exert a positive effect on the cost of borrowing.

The estimation results in Table 4 show that the impact of climate risk on the cost of borrowing depend on the proxy of environmental quality we consider. When we proxy the climate risk with CO_2 emissions per capita, we find strong and significant positive effect of pollution on the cost of borrowing. This result reflects the fact that financial markets are including a risk premium to hedge against country's climate risks. This result is consistent with Beirne et al. (2020) who find that the cost of borrowing increase with climate risks. When country's total GHG or EPI are used to account for the environmental quality, the corresponding estimated parameters appear to be insignificant as is the case in columns 3 and 4 in Table 4.

Table 5 reports the estimation results of model (1) where the cost of borrowing is proxied using the risk premium that equals the difference between the lending rate and the treasure bill rate. They show insignificant estimated parameters associated with carbon intensity (column 1) and total GHG emissions (column 3). They also show a negative and significant effect of CO_2 per capita on the risk premium and positive and significant impact of the EPI on the risk premium. This counter-intuitive result means that climate risks do not increase the borrowing burden but lighten it on the contrary. This last result can be interpreted as if the financial markets grant a premium on pollution.

The results in Table 6 show insignificant effects of climate risks on the cost of borrowing except for the EPI. Indeed, when we proxy climate risks using EPI, we find a negative and significant effect of environmental quality on the cost of borrowing. This is evidence toward financial markets include climate risk premium in the total cost of borrowing.

Finally, the results are mixed with regard to how financial markets account for climate risks and depend on the proxy variable used to measure the cost of borrowing. With the average cost of debt or the sovereign external default, we find that financial markets include a risk premium to hedge against country's climate risks. However, the results change when the difference between the lending rate and the treasure bill rate is the measure of the cost of debt.

Table 4. Average Cost of Debt and Climate Risk

	Avg. Cost. Debt	Avg. Cost. Debt	Avg. Cost. Debt	Avg. Cost. Debt
Short Ext. Debt.	-0.00311	-0.00209	-0.00479*	-0.00320
	(0.00230)	(0.00236)	(0.00248)	(0.00257)
Inflation	-0.000246*	-0.000247*	-0.000253*	-0.000250
	(0.000140)	(0.000147)	(0.000136)	(0.000152)
GDP growth	-0.000637	-0.000990	0.00197	-0.000638
	(0.00267)	(0.00279)	(0.00265)	(0.00319)
Fixed ER	0.0873	0.0801	0.103	0.0711
	(0.109)	(0.114)	(0.113)	(0.120)
Inter. ER	0.181**	0.157*	0.160*	0.166*
	(0.0880)	(0.0926)	(0.0924)	(0.0985)
Institutions	-0.00593	-0.00601	-0.00270	-0.00525
	(0.00410)	(0.00425)	(0.00421)	(0.00464)
MENA	2.551***	3.065***	0.695	2.930**
	(0.474)	(0.366)	(4.500)	(1.378)
Ln(CO2_GDP)	0.0426			
	(0.0879)			
Ln(CO2_GDP)*MENA	-1.597**			
	(0.770)			
Ln(CO2_ capita)		0.221***		
		(0.0849)		
Ln(CO2_ capita)*MENA		-0.326		
		(0.573)		
Ln(GHG)			0.0569	
			(0.0605)	
Ln(GHG)*MENA			0.255	
			(0.411)	
GHP EPI				0.00486
				(0.00613)
GHP EPI*MENA				0.0180
				(0.0291)
Constant	-5.318***	-4.933***	-6.032***	-5.866***
	(0.180)	(0.239)	(0.583)	(0.643)
Year dum.	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES
Observations	1,240	1,244	1,101	1,136
R-squared	0.756	0.739	0.780	0.732

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Risk Premium and Climate Risk

	Risk Premium	Risk Premium	Risk Premium	Risk Premium
Short Ext. Debt.	0.111***	0.114***	0.131***	0.107***
	(0.0383)	(0.0380)	(0.0442)	(0.0410)
Inflation	-0.0599*	-0.0599*	-0.0517	-0.0647*
	(0.0325)	(0.0325)	(0.0332)	(0.0336)
GDP growth	0.00165	0.000320	0.0331	-0.0653
	(0.0885)	(0.0882)	(0.0896)	(0.0977)
Fixed ER	-1.223	-1.012	-0.456	-2.032
	(1.662)	(1.664)	(1.721)	(1.690)
Inter. ER	-2.418*	-2.521*	-0.893	-2.312*
	(1.384)	(1.380)	(1.483)	(1.396)
Institutions	-0.216***	-0.224***	-0.217***	-0.0849
	(0.0693)	(0.0695)	(0.0735)	(0.0816)
MENA	2.127	3.406	-17.28	-24.85
	(4.761)	(7.488)	(79.22)	(35.49)
Ln(CO2_GDP)	-2.041			
	(1.854)			
Ln(CO2_GDP)*MENA	-10.46			
	(12.74)			
Ln(CO2_ capita)		-3.238**		
		(1.637)		
Ln(CO2_capita)*MENA		-0.444		
		(8.257)		
Ln(GHG)			-0.0600	
			(0.945)	
Ln(GHG)*MENA			1.463	
			(6.451)	
GHP EPI				0.261**
				(0.102)
GHP EPI*MENA				0.323
				(0.631)
Constant	19.30***	21.27***	20.12**	2.176
	(3.561)	(3.139)	(10.14)	(6.764)
Year dum.	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES
Observations	508	508	438	444
R-squared	0.755	0.756	0.777	0.779

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 6. External Default and Climate Risk

	Ext. Default	Ext. Default	Ext. Default	Ext. Default
Short Ext. Debt.	-0.00218*	-0.00233*	-0.00270*	-0.00378**
	(0.00132)	(0.00133)	(0.00144)	(0.00155)
Inflation	1.14e-05	8.03e-06	1.59e-06	-1.38e-05
	(4.27e-05)	(4.28e-05)	(4.50e-05)	(4.49e-05)
GDP growth	0.000876	0.000382	0.000273	0.00287
	(0.00142)	(0.00140)	(0.00149)	(0.00211)
Fixed ER	0.0977	0.0846	0.0834	0.112*
	(0.0610)	(0.0611)	(0.0659)	(0.0634)
Inter. ER	0.0930*	0.0760	0.0695	0.104*
	(0.0550)	(0.0560)	(0.0592)	(0.0566)
Institutions	-0.00874***	-0.00913***	-0.00945***	-0.0110***
	(0.00191)	(0.00190)	(0.00206)	(0.00212)
MENA	0.662***	0.606***	0.284	0.594
	(0.141)	(0.234)	(2.240)	(0.976)
Ln(CO2_GDP)	-0.0526			
	(0.0369)			
Ln(CO2_GDP)*MENA	0.0326			
	(0.312)			
Ln(CO2_ capita)		0.00472		
		(0.0346)		
Ln(CO2_ capita)*MENA		0.0334		
		(0.222)		
Ln(GHG)			0.0297	
			(0.0297)	
Ln(GHG)*MENA			0.0250	
			(0.182)	
GHP EPI				-0.00965***
				(0.00264)
GHP EPI*MENA				-0.00443
				(0.0171)
Constant	-0.126	-0.0492	-0.330	0.873***
	(0.0859)	(0.110)	(0.287)	(0.271)
Year dum.	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES
Observations	556	556	507	493
R-squared	0.715	0.714	0.694	0.725

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

6.3. On the Role of Institutions

Although the previous results show strong evidence that bad institutions increase borrowing costs, this section ask whether the institutional quality has an impact on the energy-transition risk premium included in the total cost of borrowing. More specifically, we test to what extent the institutional quality affects the relationship between subsoil wealth and the cost of borrowing. We consequently introduce an interaction term between the quality of institutions and the proxy variable accounting for the energy transition risk. The results are reported in Tables 7, 8 and 9.

The results in Table 7 show that the relationship between the average cost of debt and the variables reflecting energy transition risks is independent of the quality of institution. However, better institutions *per se* reduce the cost of debt. Moreover, it is important to note that the MENA dummy is always positive and significant pointing out that this region is more likely to have a higher risk premium or a higher cost of debt compared to other countries. Moreover, the natural resources variable is positive and statistically significant.

Those in Table 8 show that the relationship between the risk premium and the variables reflecting energy transition risks are also independent of the quality of institution at the exception of natural gas and coal. The semi-elasticity of the risk premium relative to the natural gas subsoil wealth equals to 0.289-(0.00658*institutional quality). Thus, the higher is the institutional quality, the lower the energy-transition risk premium included in the total cost of borrowing.

The results in Table 9 show the same conclusions concerning the effect of institutional quality on the relationship between energy transition risks and the cost of borrowing proxied with the sovereign external default. Indeed, looking to the estimated parameters associated with either oil, gas or fossil fuels shows that financial markets put a penalty on countries with fossil fuels subsoil wealth. The penalty is lower for countries with high institutional quality.

Table 7. Average Cost of Debt, Institutions, and Stranded Assets

	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost	Avg. Cost
Short Ext. Debt.	-0.00321	-0.00416	-0.00308	-0.00227	0.00184	-0.00207
	(0.00288)	(0.00302)	(0.00263)	(0.00253)	(0.00364)	(0.00237)
Inflation	-0.000223	-0.000230	-0.000219	-0.000249*	-4.48e-05	-0.000279*
	(0.000147)	(0.000154)	(0.000145)	(0.000145)	(0.000155)	(0.000148)
GDP growth	-0.00758*	0.000386	0.000157	0.000696	-0.00846*	-0.000662
	(0.00460)	(0.00327)	(0.00283)	(0.00285)	(0.00497)	(0.00291)
Fixed ER	-0.0455	0.00462	0.0914	0.0303	-0.0484	0.107
	(0.148)	(0.157)	(0.129)	(0.130)	(0.192)	(0.114)
Inter. ER	0.0945	0.128	0.181*	0.140	0.156	0.177*
	(0.120)	(0.130)	(0.104)	(0.105)	(0.161)	(0.0925)
Institutions	0.00539	0.00354	-0.0104**	-0.0102**	0.00624	-0.00139
	(0.0103)	(0.00863)	(0.00506)	(0.00508)	(0.0252)	(0.00519)
MENA	3.452***	3.518***	3.281***	3.451***	3.494***	3.158***
	(0.535)	(0.297)	(0.486)	(0.252)	(0.603)	(0.278)
Ln(Oil)	0.0114					
	(0.0352)					
Ln(Oil)*Inst.	-0.000372					
	(0.000498)					
Ln(Gas)		0.0119				
		(0.0142)				
Ln(Gas)*Inst.		-0.000644				
		(0.000417)				
Ln(Coal)			0.00619			
			(0.0235)			
Ln(Coal)*Inst.			0.000218			
			(0.000311)			
Ln(Minerals)				-0.0210		
				(0.0145)		
Ln(Minerals)*Inst.				0.000157		
				(0.000205)		
Ln(Fossil)					0.0311	
					(0.0735)	
Ln(Fossil)*Inst.					-0.000294	
					(0.00106)	
Ln(Nat. Res.)						0.263**
						(0.116)
Ln(Nat. Res.)*Inst.						-0.00316
						(0.00199)
Constant	-5.573***	-5.690***	-5.396***	-5.420***	-6.218***	-5.482***
	(0.980)	(0.394)	(0.178)	(0.178)	(2.006)	(0.178)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	832	787	986	990	593	1,236
R-squared	0.758	0.735	0.757	0.756	0.769	0.738

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 8. Risk Premium, Institutions, and Stranded Assets

	Risk Premium	Risk Premium	Risk Premium	Risk Premium	Risk Premium	Risk Premium
Short Ext. Debt.	0.137**	0.0369	0.208***	0.193***	0.0118	0.109***
	(0.0607)	(0.0494)	(0.0483)	(0.0461)	(0.0619)	(0.0383)
Inflation	-0.0649*	-0.0494*	-0.0899	-0.0716**	0.142*	-0.0652**
	(0.0345)	(0.0265)	(0.0569)	(0.0346)	(0.0732)	(0.0326)
GDP growth	0.0342	0.278**	0.0258	0.0215	0.272**	0.0329
	(0.127)	(0.107)	(0.109)	(0.108)	(0.124)	(0.0892)
Fixed ER	-1.817	0.180	-2.245	-1.846	-0.119	-1.347
	(2.500)	(2.037)	(2.327)	(2.267)	(3.369)	(1.669)
Inter. ER	-10.31***	-5.975***	-6.015***	-5.661***	-11.88***	-2.211
	(2.112)	(1.931)	(1.740)	(1.732)	(3.329)	(1.392)
Institutions	-0.264*	-0.426***	-0.409***	-0.263***	-0.0783	-0.264***
	(0.151)	(0.0888)	(0.0978)	(0.0951)	(0.535)	(0.0776)
MENA	14.50	21.78***	-7.305	11.64*	51.42***	-6.037
	(9.603)	(4.691)	(8.049)	(6.205)	(9.563)	(6.142)
Ln(Oil)	0.546					
	(0.478)					
Ln(Oil)*Inst.	-0.00738					
	(0.00737)					
Ln(Gas)		0.289**				
		(0.119)				
Ln(Gas)*Inst.		-0.00658*				
		(0.00361)				
Ln(Coal)			-1.413**			
			(0.586)			
Ln(Coal)*Inst.			0.0171**			
			(0.00744)			
Ln(Minerals)				0.560*		
				(0.288)		
Ln(Minerals)*Inst.				-0.00444		
				(0.00387)		
Ln(Fossil)					6.664***	
					(2.134)	
Ln(Fossil)*Inst.					-0.0219	
					(0.0212)	
Ln(Nat. Res.)						-3.086
						(1.933)
Ln(Nat. Res.)*Inst.						0.0317
						(0.0348)
Constant	20.97*	23.69***	45.70***	11.63*	-129.7**	31.17***
	(12.33)	(4.149)	(9.862)	(6.923)	(54.79)	(6.882)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	353	300	405	409	206	510
R-squared	0.808	0.602	0.771	0.772	0.677	0.756

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. External Default, Institutions, and Stranded Assets

	Ext. Default	Ext. Default	Ext. Default	Ext. Default	Ext. Default	Ext. Default
Short Ext. Debt.	-0.00359**	-0.00181	-0.00251*	-0.00254*	-0.00221	-0.00282**
	(0.00142)	(0.00128)	(0.00134)	(0.00131)	(0.00150)	(0.00131)
Inflation	2.28e-05	1.18e-05	8.81e-06	2.61e-06	1.31e-05	1.36e-05
	(4.35e-05)	(3.95e-05)	(4.28e-05)	(4.26e-05)	(4.03e-05)	(4.23e-05)
GDP growth	1.33e-05	-0.000124	1.03e-05	0.00101	-0.000872	0.000278
	(0.00147)	(0.00133)	(0.00143)	(0.00142)	(0.00138)	(0.00138)
Fixed ER	0.0603	0.0808	0.0823	0.0635	0.00793	0.0318
	(0.0625)	(0.0565)	(0.0610)	(0.0621)	(0.0675)	(0.0621)
Inter. ER	0.0499	0.102**	0.0754	0.0602	0.0149	0.0386
	(0.0571)	(0.0500)	(0.0544)	(0.0547)	(0.0654)	(0.0549)
Institutions	0.00915*	0.00451	-0.00887***	-0.00954***	0.0204**	-0.0127***
	(0.00469)	(0.00398)	(0.00200)	(0.00194)	(0.00928)	(0.00227)
MENA	2.244***	1.276***	0.610***	0.727***	1.600***	0.828***
	(0.768)	(0.172)	(0.148)	(0.145)	(0.250)	(0.152)
Ln(Oil)	0.107***					
	(0.0276)					
Ln(Oil)*Inst.	-0.00104***					
	(0.000211)					
Ln(Gas)		0.0426***				
		(0.00863)				
Ln(Gas)*Inst.		-0.00102***				
		(0.000210)				
Ln(Coal)			0.0155			
			(0.0133)			
Ln(Coal)*Inst.			-0.000148			
			(0.000161)			
Ln(Minerals)				-0.0101*		
				(0.00554)		
Ln(Minerals)*Inst.				9.51e-05		
				(7.69e-05)		
Ln(Fossil)					0.120***	
					(0.0317)	
Ln(Fossil)*Inst.					-0.00154***	
					(0.000378)	
Ln(Nat. Res.)						-0.147***
						(0.0446)
Ln(Nat. Res.)*Inst.						0.00194**
						(0.000768)
Constant	-2.932***	-1.065***	-0.0568	-0.0658	-3.223***	0.0536
	(0.742)	(0.218)	(0.0732)	(0.0727)	(0.853)	(0.0805)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	506	461	556	556	360	556
R-squared	0.536	0.598	0.715	0.716	0.661	0.720

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6.4. Controlling for the endogeneity of environmental variables

Some studies argue that the quality of environment is not exogenous. Thus, we cannot assume that CO2 per capita is strictly exogenous with respect to the risk measure given that countries that are less averse to risk, are more likely to borrow at a higher cost and, with less stringent regulations, they might have higher CO2 emissions. Indeed, we test for the endogeneity of the CO_2/capita variable and find it endogenous. This is why we instrument using two variables: the legal origin of the country and the number of environmental treaties. The rationale behind is as follows: the higher the number of environmental treaties, the lower the CO_2 emissions and obviously the risk premium will only be affected by treaties through their effect on CO_2 emissions. The same holds for the legal origin of the country. In fact, legal origins have important economic consequences since they influence resource allocation through their effect on finance, labor markets, and environment (La Porta et al., 2008). Common law legal origin is associated with significantly higher emissions of CO_2 (Kock and Min, 2016). Table 10 shows that, once we control for the endogeneity of CO_2 per capita, the effect of climatic risk on the three dependent variables (risk premium, average cost of debt and external default) is positive and statistically significant. Moreover, the Sargan and Basmann tests of the overidentifying restrictions present strong evidence for the null hypothesis that the overidentifying restrictions are valid (given that the P values are not significant).

Table 10. Endogeneity of CO2 per capita

	Risk Premium	Avg. Cost Debt	External Def.
Ln(CO2_capita)	13.97***	1.558***	0.291*
	(4.217)	(0.521)	(0.157)
Short Ext. Debt.	-0.454**	-0.0420*	-0.0202*
	(0.213)	(0.0230)	(0.0105)
Inflation	0.204	0.000292	0.000108
	(0.130)	(0.000412)	(0.000112)
GDP growth	0.208	0.0157	0.0111
	(0.256)	(0.0104)	(0.00697)
Fixed ER	-18.38***	-0.308	0.125
	(5.744)	(0.250)	(0.118)
Inter. ER	-22.13***	-0.274	0.150
	(5.824)	(0.251)	(0.141)
Institutions	-0.292***	0.00364*	0.00399**
	(0.0525)	(0.00200)	(0.00179)
MENA	-10.84**	-1.201*	-0.699**
	(4.772)	(0.655)	(0.325)
Constant	48.47***	-1.468**	0.102
	(8.976)	(0.601)	(0.135)
Observations	409	998	556
P value - Sargan	0.6224	0.4418	0.8388
P value - Basmann	0.6266	0.444	0.8402

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7. Conclusion

The objective of this paper is to examine how financial markets are affected by climate and energy-transition risks. Our contribution is thus twofold. First, relying on the overlapping generations' model, we develop a simple theoretical model by taking into account the interplay between the environmental quality and the asset market. We show that when agents are sensitive to the environmental quality in the future, they take decisions about savings and investment in line with the need for higher environmental protection. Second, we empirically test this model by assessing the nature and magnitude of the climatic determinants of the risk premium associated with public debt, with a focus on countries of the MENA region, being one of the most abundant regions in natural resources.

Our main findings show that fossil fuels are associated to a higher cost of borrowing. Moreover, these costs increase also with a higher level of CO2 emissions per capita or lower level of country's environmental performance index (EPI). This confirms how financial markets are affected by climate and energy-transition risks. We provide evidence that financial markets are accounting for the risks of energy transition as well as the climate risks. Thus, we conclude that financial markets could foster energy transition and encourage the implementation effective environmental policies.

From a policy perspective, three recommendations are worthy to be mentioned. First, the study helps understand to what extent financial markets can represent a buffer or a last resort to mitigate the natural risks that the region is currently facing. Indeed, given the high dependence of the MENA region on fossil fuels, it is important to see how macroeconomic policies and the financial market can help mitigate the risks associated to climate change. The results highlight that there is a significant risk premium linked to natural risks, the consequences could be significant for the future of the climate. Indeed, this financial-market risk premium would replace climate policy through sending a signal to market players. An additional cost of public borrowing, and therefore an increase in the cost of public debt, should encourage countries to take the necessary measures to protect themselves against these risks and thus reassure the financial markets. In the shorter term, these risk premiums would further weaken the public finance of countries already exposed to major risks, which would exacerbate the difficulties of financing investments necessary to protect against environmental degradation. Second, our study highlights also the role of institutions and how, in some cases, better institutions can reduce the impact of climate or transition risk on the macroeconomic risk. This is why deep institutional reforms will have to accompany reforms related to climate change. Third, in the case of sovereign bonds, government should better assess and disclose their climatic and transition risks. Only Ghana did it fully when borrowing to face the COVID-19 crisis (Dibley et al, 2021). Yet, countries face many disincentives to do so as they would face higher costs of borrowing. As countries keep investing in polluting assets and deepen their maladjustment to future needs, they become even more vulnerable to increased bond yields in the event of a change in investor's behavior towards climate risks. Consequently, central banks and financial supervisors have pushed forward the need for standardized metrics to include climate risks in financial contracts.

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Appendix: Empirical Results

Table A.1. Banking Crisis and Stranded Assets

	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis
Short Ext. Debt.	-0.00456	-0.00287	-0.00402	-0.00552**	-0.00111	-0.00518*
	(0.00289)	(0.00270)	(0.00277)	(0.00270)	(0.00328)	(0.00274)
Inflation	2.28e-05	-2.09e-06	2.66e-06	-1.21e-05	-8.83e-06	9.19e-06
	(8.39e-05)	(8.03e-05)	(8.68e-05)	(8.58e-05)	(8.45e-05)	(8.66e-05)
GDP growth	0.00311	0.00158	0.00319	0.00395	0.000193	0.00305
	(0.00285)	(0.00270)	(0.00282)	(0.00280)	(0.00289)	(0.00282)
Fixed ER	0.334***	0.408***	0.429***	0.321**	0.421***	0.393***
	(0.121)	(0.115)	(0.123)	(0.125)	(0.141)	(0.125)
Inter. ER	0.0729	0.167	0.162	0.0906	0.0641	0.140
	(0.111)	(0.101)	(0.110)	(0.110)	(0.136)	(0.111)
Institutions	0.0134***	0.0197***	0.00635	0.00671*	0.0203***	0.00500
	(0.00409)	(0.00406)	(0.00389)	(0.00380)	(0.00456)	(0.00387)
MENA	2.787*	-1.506	-0.186	-0.315	2.047	-0.280
	(1.493)	(3.350)	(0.288)	(0.317)	(3.759)	(0.295)
Ln(Oil)	0.128**					
	(0.0508)					
Ln(Oil)*MENA	-1.046**					
	(0.458)					
Ln(Gas)		-0.00691				
		(0.00713)				
Ln(Gas)*MENA		0.0107				
		(0.163)				
Ln(Coal)			-0.00453			
			(0.00702)			
Ln(Coal)*MENA			-0.0226			
			(0.0174)			
Ln(Minerals)				-0.0175***		
				(0.00464)		
Ln(Minerals)*MENA				0.0214**		
				(0.0106)		
Ln(Fossil)					0.109**	
					(0.0489)	
Ln(Fossil)*MENA					-0.124	
					(0.182)	
Ln(Nat. Res.)						-0.0959
						(0.0595)
Ln(Nat. Res.)*MENA						0.311
						(0.243)
Constant	-3.691***	-0.000581	-0.246*	-0.236	-3.032**	-0.201
	(1.363)	(0.217)	(0.148)	(0.146)	(1.313)	(0.152)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	503	458	553	553	357	553
R-squared	0.492	0.493	0.446	0.458	0.500	0.446

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2. Banking and Environmental Risk

	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis
Short Ext. Debt.	-0.00462*	-0.00562**	-0.00357	-0.0116***
	(0.00270)	(0.00275)	(0.00285)	(0.00306)
Inflation	4.32e-06	-1.14e-06	1.18e-05	-3.83e-05
	(8.59e-05)	(8.67e-05)	(8.83e-05)	(8.66e-05)
GDP growth	0.00200	0.00234	0.00309	0.00265
	(0.00287)	(0.00284)	(0.00292)	(0.00406)
Fixed ER	0.385***	0.397***	0.412***	0.444***
	(0.123)	(0.124)	(0.129)	(0.122)
Inter. ER	0.117	0.109	0.135	0.193*
	(0.111)	(0.114)	(0.116)	(0.109)
Institutions	0.00456	0.00564	0.00511	0.00800*
	(0.00384)	(0.00384)	(0.00404)	(0.00409)
MENA	-0.188	-0.729	3.720	-4.784**
	(0.283)	(0.477)	(4.562)	(1.888)
Ln(CO2_GDP)	0.133*			
	(0.0743)			
Ln(CO2_GDP)*MENA	1.883***			
	(0.633)			
Ln(CO2_GDPcap)		0.127*		
		(0.0705)		
Ln(CO2_GDPcap)*MENA		0.286		
		(0.462)		
Ln(GHG)			-0.0448	
			(0.0583)	
Ln(GHG)*MENA			-0.303	
			(0.370)	
GHP EPI				-0.0260***
				(0.00509)
GHP EPI*MENA				0.0603*
				(0.0330)
Constant	-0.106	0.0540	0.139	2.329***
	(0.173)	(0.224)	(0.563)	(0.523)
Year dum.	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES
Observations	553	553	505	490
R-squared	0.457	0.446	0.437	0.489

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.3. Banking, Institutions, and Stranded Assets

	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis	Bank Crisis
Short Ext. Debt.	-0.00597**	-0.00265	-0.00450	-0.00562**	-0.00154	-0.00491*
	(0.00284)	(0.00264)	(0.00276)	(0.00271)	(0.00319)	(0.00271)
Inflation	1.97e-05	-7.81e-06	1.12e-05	-6.48e-06	1.68e-06	-4.19e-06
	(8.45e-05)	(7.96e-05)	(8.67e-05)	(8.62e-05)	(8.32e-05)	(8.56e-05)
GDP growth	0.00287	0.00143	0.00447	0.00409	0.000969	0.00366
	(0.00287)	(0.00268)	(0.00289)	(0.00288)	(0.00286)	(0.00279)
Fixed ER	0.336***	0.395***	0.448***	0.335***	0.375***	0.482***
	(0.122)	(0.114)	(0.124)	(0.126)	(0.140)	(0.126)
Inter. ER	0.0691	0.148	0.177	0.0986	-0.00135	0.213*
	(0.111)	(0.101)	(0.110)	(0.111)	(0.135)	(0.111)
Institutions	0.0145	0.000458	0.00431	0.00606	0.0818***	0.0153***
	(0.00912)	(0.00805)	(0.00407)	(0.00393)	(0.0194)	(0.00459)
MENA	3.067**	-1.771***	-0.0663	-0.0100	-0.0700	-0.662**
	(1.499)	(0.346)	(0.300)	(0.293)	(0.516)	(0.308)
Ln(Oil)	0.141***					
	(0.0539)					
Ln(Oil)*Inst.	-4.96e-05					
	(0.000410)					
Ln(Gas)		-0.0508***				
		(0.0174)				
Ln(Gas)*Inst.		0.00117***				
		(0.000425)				
Ln(Coal)			-0.0569**			
			(0.0270)			
Ln(Coal)*Inst.			0.000609*			
			(0.000327)			
Ln(Minerals)				-0.0190*		
				(0.0112)		
Ln(Minerals)*Inst.				7.46e-05		
				(0.000156)		
Ln(Fossil)					0.256***	
					(0.0659)	
Ln(Fossil)*Inst.					-0.00257***	
					(0.000790)	
Ln(Nat. Res.)						0.185**
						(0.0902)
Ln(Nat. Res.)*Inst.						-0.00596***
						(0.00155)
Constant	-4.016***	1.054**	-0.276*	-0.255*	-6.999***	-0.453***
	(1.450)	(0.439)	(0.148)	(0.147)	(1.774)	(0.163)
Year dum.	YES	YES	YES	YES	YES	YES
Country dum.	YES	YES	YES	YES	YES	YES
Observations	503	458	553	553	357	553
R-squared	0.487	0.502	0.448	0.454	0.516	0.460

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.