Analytics in Action Case Study

Climate Change: Impact on the Auto Industry Credit Risk Depends on a Climate Scenario

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Introduction

Climate change affects financial performance and subsequently credit risk of car producing companies. The actual impact depends on the location of production for the physical risk and on the mix of production between electric and non-electric vehicles for the transition risk. These company-specific attributes interact with a given climate scenario. For example Tesla and to some extent Nissan benefit from transition scenarios as the demand for electric vehicles rises in this case. Volkswagen is relatively hedged across climate scenarios as it produces a combination of electric and non-electric vehicles.

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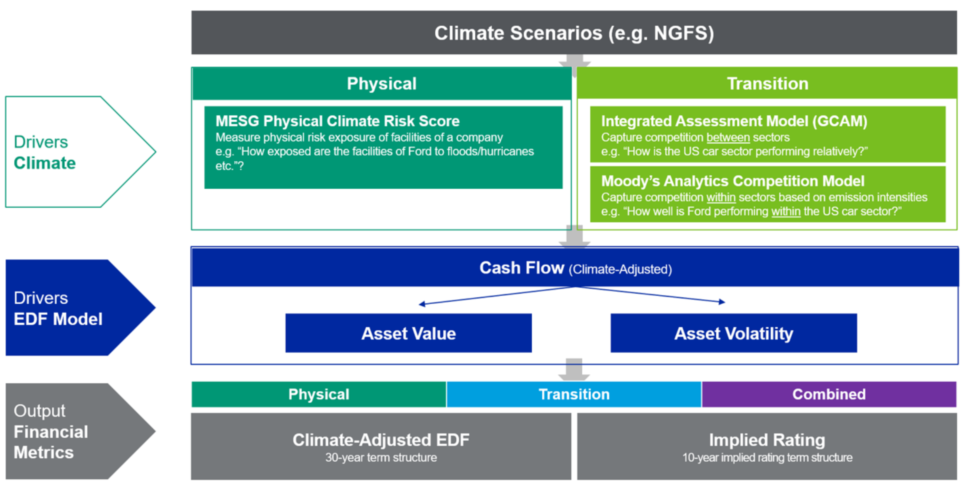
1. Introduction

In the last decade or so, the global temperature and frequency of acute climate events have increased. While the process of transition to a carbon-free economy has been slower than required to significantly limit global warming, it has indeed started. Due to its dependence on fossil fuels, the auto industry is sensitive to alternate future climate paths, or scenarios. Many countries have mandated the switch from combustion-engine cars to electric vehicles (EVs) by 2030[1] or just a few years later. For example, the U.K. government aims to end sales of new petrol and diesel cars by 2030 and the EU aims to ensure that new cars and vans will be zero-emission by 2035.[2] The question is how specifically will the auto companies be affected in terms of their financials and how their financial performance will affect the corporate probability of default on bonds issued by them. Toyota's EVP Bob Carter believes this will lead to an industry disaster which he refers to as 'electrified Armageddon' as the supply of electric vehicles will grow faster than demand.[3] On the other hand, some companies may be actually too slow to transition to the production of EVs. In this paper, we argue that many automotive companies have already started their internal transition to EVs and hedged against various climate scenarios. Companies such as Tesla that concentrate all of their production on EVs are essentially betting that the transition to the carbon-free economy will actually occur.

The key challenge in our analysis is combining in a meaningful way various pieces of information using data from many sources and models of different types. Figure 1 below illustrates how we approach this problem in the Moody's Climate Adjusted Expected Default Frequency (CAEDF) Model.[4] We combine firm-level risk assessment with global and sectoral dynamics. The initial point is a climate scenario – we focus on the third iteration of the scenarios by the Network for Greening the Financial System (NGFS). Firm-level physical risk is captured by a score aggregated across locations and climate hazards and is used to derive frequency and severity of climate events for the firm from damage functions. On the transition risk side, an Integrated Assessment Model (IAM) produces industry projections while firm-level emissions determine the company's costs and subsequently share in the industry based on a standard oligopoly model. The resulting climate adjusted cash flows are converted into asset value and asset volatility impacts which are then used as inputs in the Moody's public Expected default Frequency (EDF) model. The outputs include the CAEDF term structure as well as implied rating terms structure, separately and combined for the physical and transition risks.

Figure 1: Moody's Climate Adjusted Expected Default Frequency Model



1 See https://www.gov.uk/transport/low-emission-and-electric-vehicles for additional information. Retrieved on May 15, 2023.
2 See https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6462. Retrieved on May 15, 2023.
3 See https://www.axios.com/2019/12/06/electric-vehicles-toyota-general-motors. Retrieved on May 15, 2023.
4 For a detailed methodology overview, see https://www.moodysanalytics.com/whitepapers/pa/2023/quantifying-the-impact-of-climate-on-corporate-credit-risk.

2. Analyzing the Climate Impact on Automotive Companies through NGFS Scenarios

In this study, we focus on three companies: Volkswagen, Nissan, and Tesla. Their IDs, location of headquarters, sales, assets , and the key sector are in Table 1.

Table 1: Volkswagen, Nissan, and Tesla: Basic Information

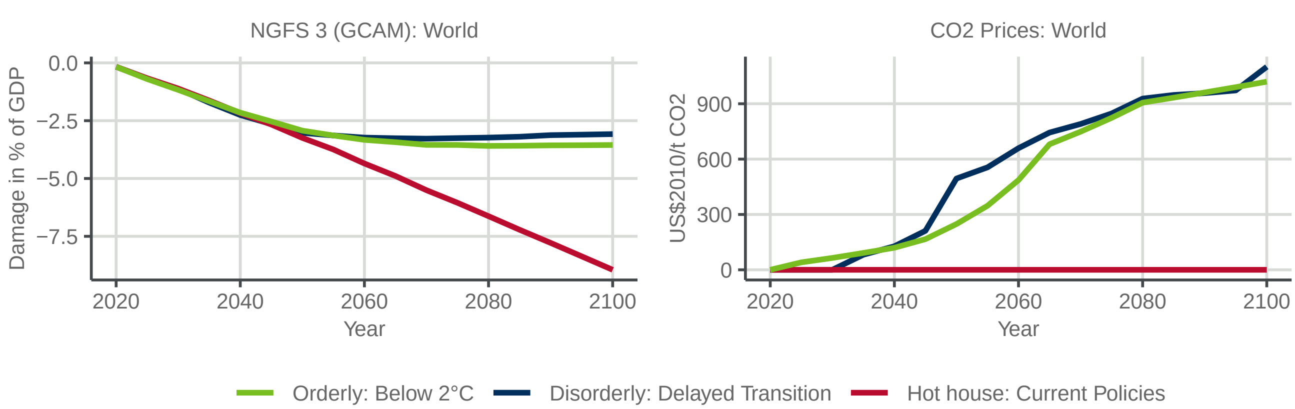
Concept	VOLKSWAGEN AG	NISSAN MOTOR CO., LTD.	TESLA, INC.
BvD ID	DE2070000543	JP9020001031109	US912197729
Country	Germany	Japan	United States of America
Sales (in million USD)	296 126	77 794	81 462
Assets (in million USD)	629 770	129 197	82 338
Key Sector	Car - Non Electric	Car - Non Electric	Car - Electric

Our analysis of the performance of the automotive companies depends on the type of risk and a given climate scenario. Climate scenarios cover a broad range of possible future climate trajectories. We look at the impact of climate risks on the car industry through the lenses of three main NGFS III scenarios:

1. Orderly (Below 2°): Assumes gradual increases in the stringency of climate policies, giving a 67% chance of limiting global warming to below 2°C.
2. Disorderly (Delayed transition): Assumes annual emissions do not decrease until 2030. Strong policies are then needed to limit warming to below 2°C.
3. Hot house (Current Policies): Assumes that only currently implemented policies are preserved, leading to a global warming of 3°C+ by 2100 and high associated climate impacts.

The associated global damage paths (in % of GDP) can be thought of as reflecting physical risk and the associated paths of CO2 prices are a reflection of transition risk, see Figure 2. The aggregate view of climate risk is then translated into firm specific counterparts.

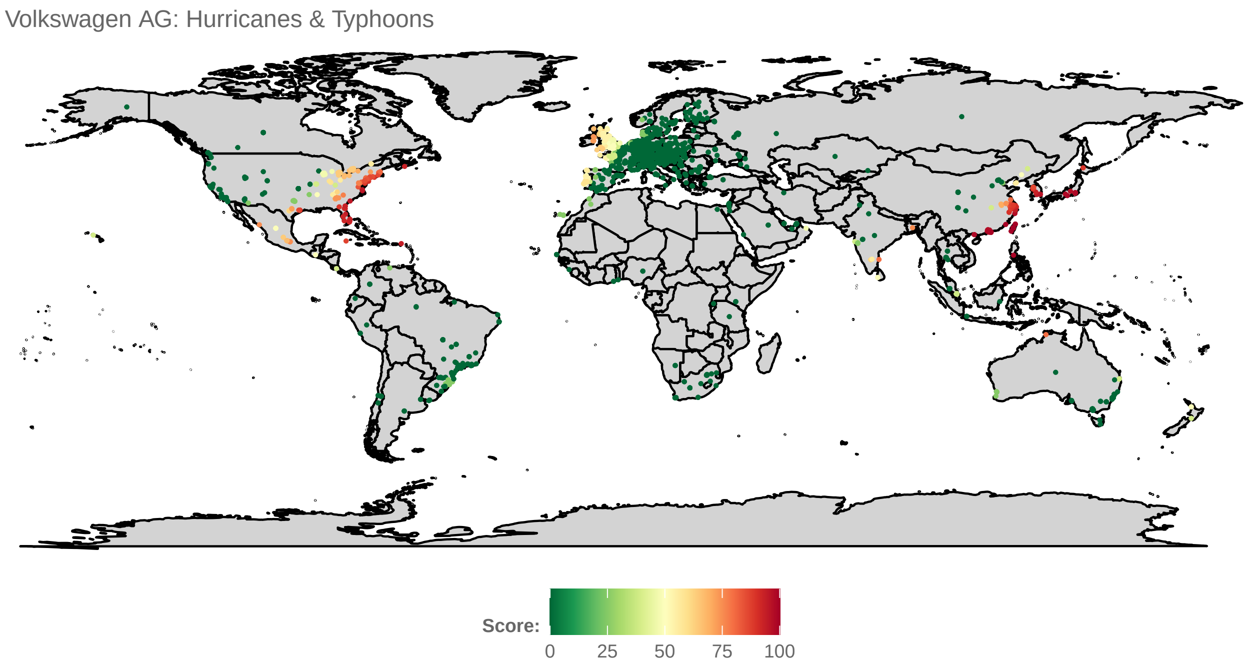
Figure 2: NGFS Climate Scenarios: Damage and CO2 Price Paths



2.1 Physical Risk

Conditional on the scenario-dependent global damage path, a firm-specific magnitude of physical climate shocks to a firm's asset value is gauged leveraging on Moody's physical risk scores. These scores reflect an assessment of the locations of a firm's production facilities and physical assets. The output is a relative physical risk exposure composite score from 0 (low risk) to 100 (high risk). Figure 3 showcases the distribution of the Hurricanes & Typhoons sub-score across the facilities of Volkswagen as an illustration. Most facilities are located in Europe, which in general has little exposure to physical risk. Nevertheless, some Volkswagen facilities are located on the US East Coast, which is exposed to hurricanes and tropical cyclones.

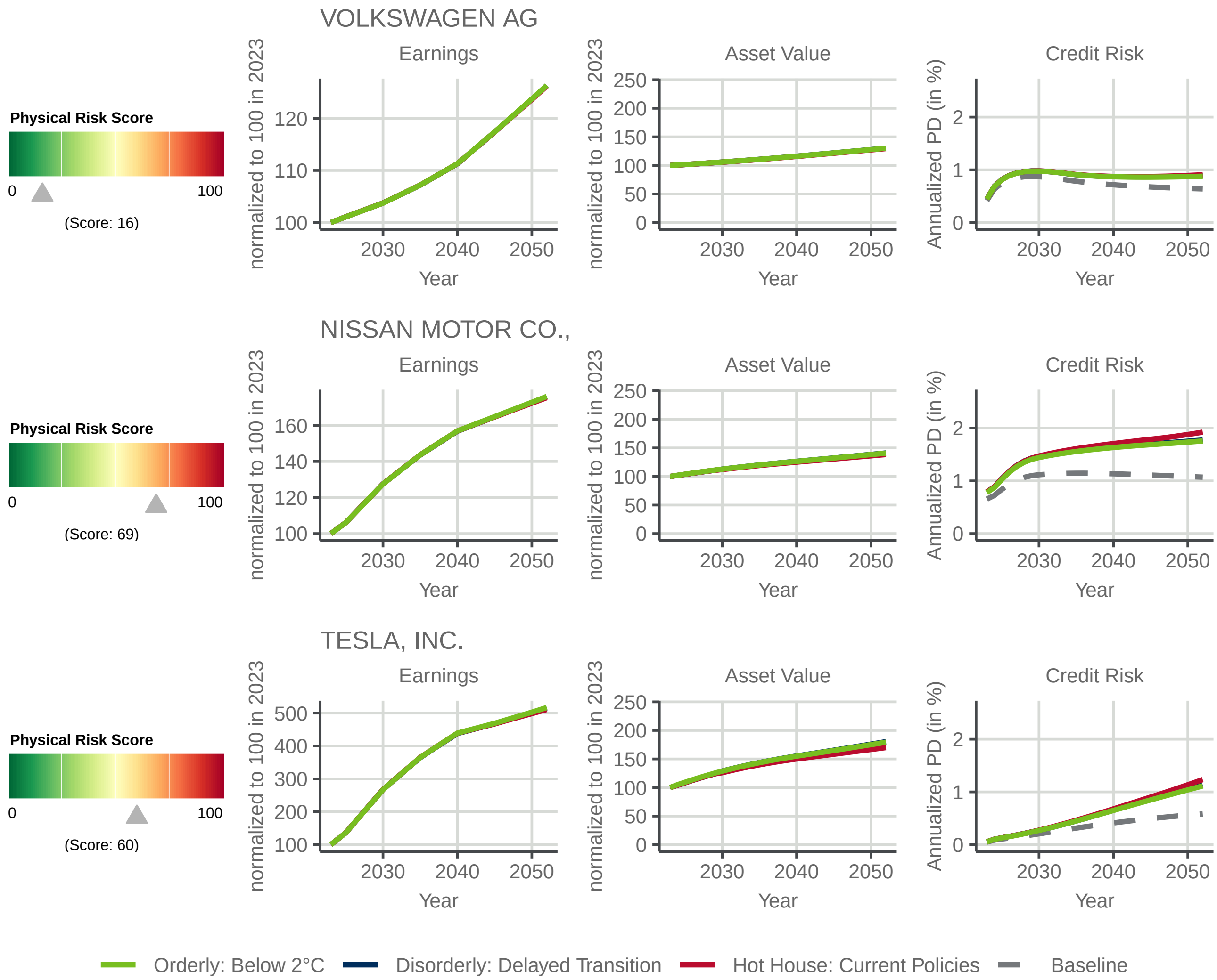
Figure 3: Little Exposure to Hurricanes and Typhoons of Volkswagen AG



For each company, we aggregate the risk sub-scores across climate hazards and across locations. The aggregate physical risk score denotes the percentile of the company in relation to all other companies. The physical risk associated with climate change stems from production to be disrupted and a reduction in demand. The companies' physical risk scores, earnings, asset value paths, and the projected EDF are depicted in Figure 4.

We find that all companies are negatively affected by physical risk. Our model projects an EDF increase for Nissan and Tesla for the 30-year horizon. For Nissan, the term structure of EDF features an increase over the first years and then a relatively flat profile for longer tenors. For Volkswagen the EDF increases initially for but then levels off and even slightly declines. The magnitude of the physical risk impact varies across firms but relatively little across scenarios. Little scenario-dependence suggests relative certainty about the quantitative impact of physical risk.

Figure 4: Minor Differences of Chronic Physical Risk Across Scenarios



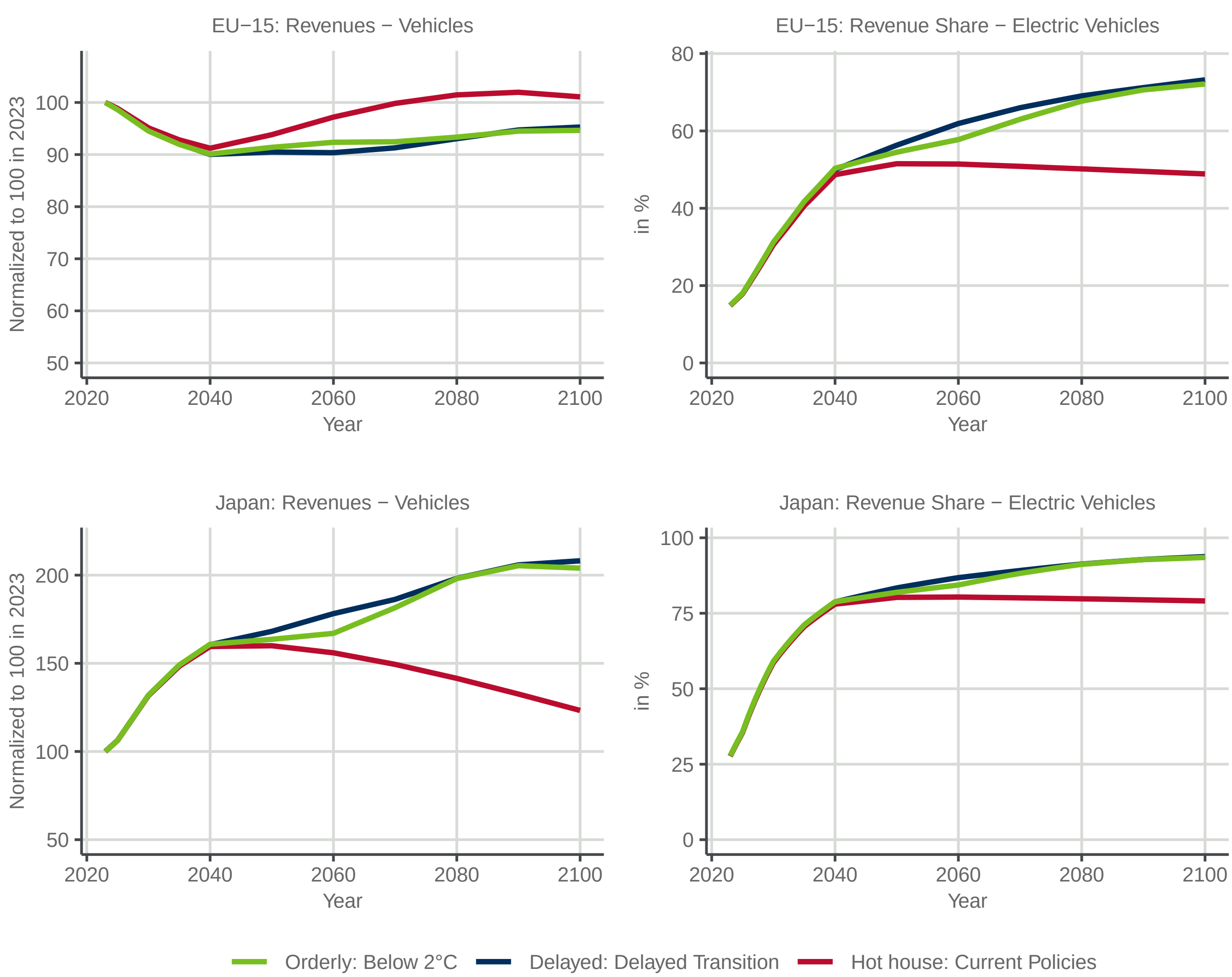
2.2 Transition Risk

We capture the impact of transition risk on a firms financials through two steps: First, we use an Integrated Assessment Model (IAM) to capture how a firm's sectors evolve in a competitive economy given carbon prices developments, regulations, and shifts in consumer demand. Specifically, we use the Global Change Analysis Model (GCAM). We employ GCAM due to its granularity in terms of industries and regions. Second, we analyze how a firm competes within a given sector, leveraging our oligopoly model. A firm's competitive position in this sector is driven by its Scope 1 and 2 emission intensities.

2.2.1 IAM Output: In-between Sector Competition

GCAM enables us to disaggregate the general automotive industry in two markets, the market for EVs and the market for non-electric vehicles, respectively. We would like to contrast the impact of transition risk on Volkswagen and Nissan and therefore focus on the geographic regions of the EU-15 and Japan. Figure 5 shows the GCAM-generated sum of the revenues from the two markets, and the share of the electric vehicles as a part of the total. Interestingly, in the EU-15 overall revenue in the automotive sector in the hot house world scenario increases after an initial drop while in Japan it declines in this scenario. Additionally, the climate projections indicate a larger dispersion of sector revenues across scenarios for Japan than for the EU-15 reflecting Japan's larger sensitivity to climate change policies. Japan benefits more in disorderly and orderly transition scenarios relative to hot house scenarios, while the opposite is true for the EU-15. The share of the production of EVs plateaus in the hot house world scenario but increases in the transition scenarios for both regions.

Figure 5: Demand for Vehicles and Share for EV: EU and Japan



The automotive sector is by far the largest sector where the selected companies operate but the three selected companies also operate in other sectors and the impact from these sectors is aggregated. Table 2 lists the shares of revenues from various sectors for the three companies in the base year. The G-sectors correspond to our classification of GCAM sectors. N-sectors are industries according to internal Moody's classification which are not affected by transition and for which we use general output dynamics from the IAM.

Table 2: Volkswagen, Nissan, and Tesla: Basic Information

Company	Sector	Country	Share (SIC based)
VOLKSWAGEN AG	Car - Non Electric (G30)	Germany	76%
VOLKSWAGEN AG	Lessors (N32)	Germany	16%
VOLKSWAGEN AG	Car - Electric (G46)	Germany	8%
NISSAN MOTOR CO., LTD.	Car - Non Electric (G30)	Japan	62%
NISSAN MOTOR CO., LTD.	Finance Companies (N23)	Japan	32%
NISSAN MOTOR CO., LTD.	Car - Electric (G46)	Japan	6%
TESLA, INC.	Car - Electric (G46)	United States of America	95%
TESLA, INC.	Electricity Prod. - Gas (G09)	United States of America	1%
TESLA, INC.	Delivered Elect. Indust. (G35)	United States of America	1%

Globally, sales of EVs are 9.8% of the total sales of vehicles according to the Global EV Outlook of the International Energy Agency. We therefore assign this value to the share of revenues from selling EVs as a part of the total car sales for Volkswagen and Nissan in the base year of 2023. Tesla's revenues within the overall car sector are 95% from selling EVs. The earnings paths for the most important sectors of Volkswagen as an example are shown in Figure 6. We can see that earnings for non-electric cars are greater in the hot house world scenario as compared to the other two scenarios, while the opposite is the case for electric cars. This means Volkswagen is well hedged, doing well whether the transition occurs or not.

2.2.2 MA Oligopoly Model: Within Sector Competition

We develop an oligopoly model to determine the company's share within each industry. We use a standard Cournot model and calculate shares of individual companies to match the prices and industry-level quantities from GCAM. The model takes into account scope 1 and 2 emissions at the company level. We scale the emissions by sales to determine the intensity of emissions. In general, if the company's emission intensity is lower than in the industry (i.e. it is less than 100%), it will gain market share over time in a scenario featuring elevated CO2 prices. Figure 6 includes relative emission intensities in three sectors where Volkswagen competes. Based on scope 1 and 2 costs of emissions, the company is less competitive in markets for both electric and non-electric cars. For the financial industry 'Lessors' the company is below average for scope 1 emissions and above average for scope 2 emissions. Overall, the within sector competition has less of an impact in the automotive industry as the relative intensities are close to the industry average.

The firm-level results for transition risk are in Figure 7. As expected, the EDF under transition risk scenarios is lower for Tesla than for the other two car makers for the first twenty years. Then the level of EDF and hence credit risk due to the transition to a carbon-free economy is actually similar. This reflects the reliance on other sectors as well as a greater portion of revenue to come from the sales of EVs. Tesla is affected more negatively in the hot house world scenario as compared to scenarios where a transition occurs as the demand for EVs is likely to be negatively affected in scenarios with no transition. This effect is often not fully appreciated in the climate scenario analysis.

2.3 Combined Risk

We combine the impact of both the physical and transition risks on earnings, asset values, and credit risk. Figure 8 shows the results that confirm previously observed patterns. Tesla and Nissan have higher earnings, higher asset value paths, and subsequently lower credit risk in the transition scenarios. This effect is more pronounced for Tesla where we see the bifurcation for the asset value path in 2030 when carbon dioxide tax is imposed in the delayed transition scenario. Volkswagen is well hedged across the climate risk scenarios and is also less exposed to physical risk due to majority of its production being in Europe.

Figure 6: Sector Earnings Paths and Emission Intensities: VW

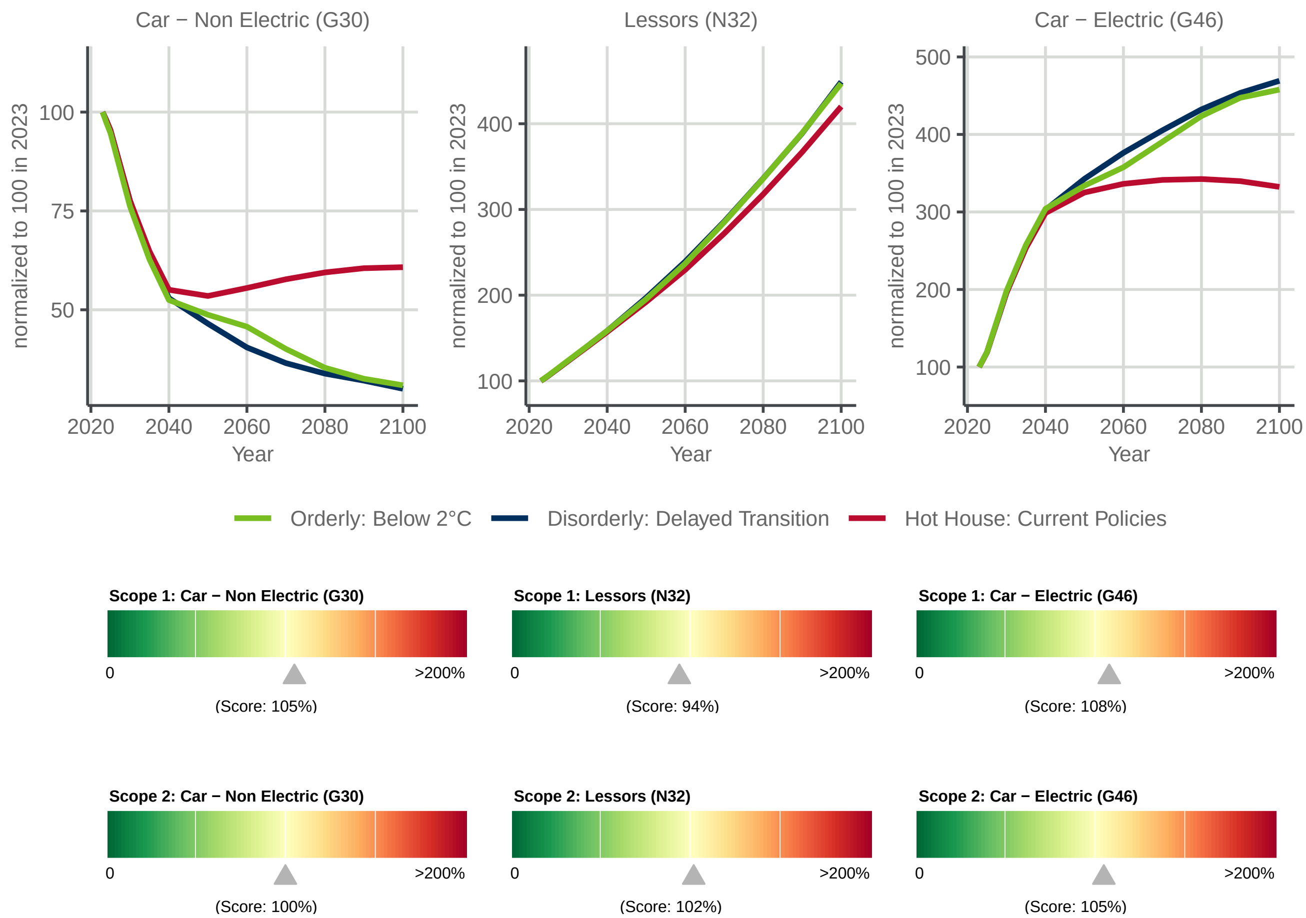


Figure 7: Transition Risk Differentiates only Moderately

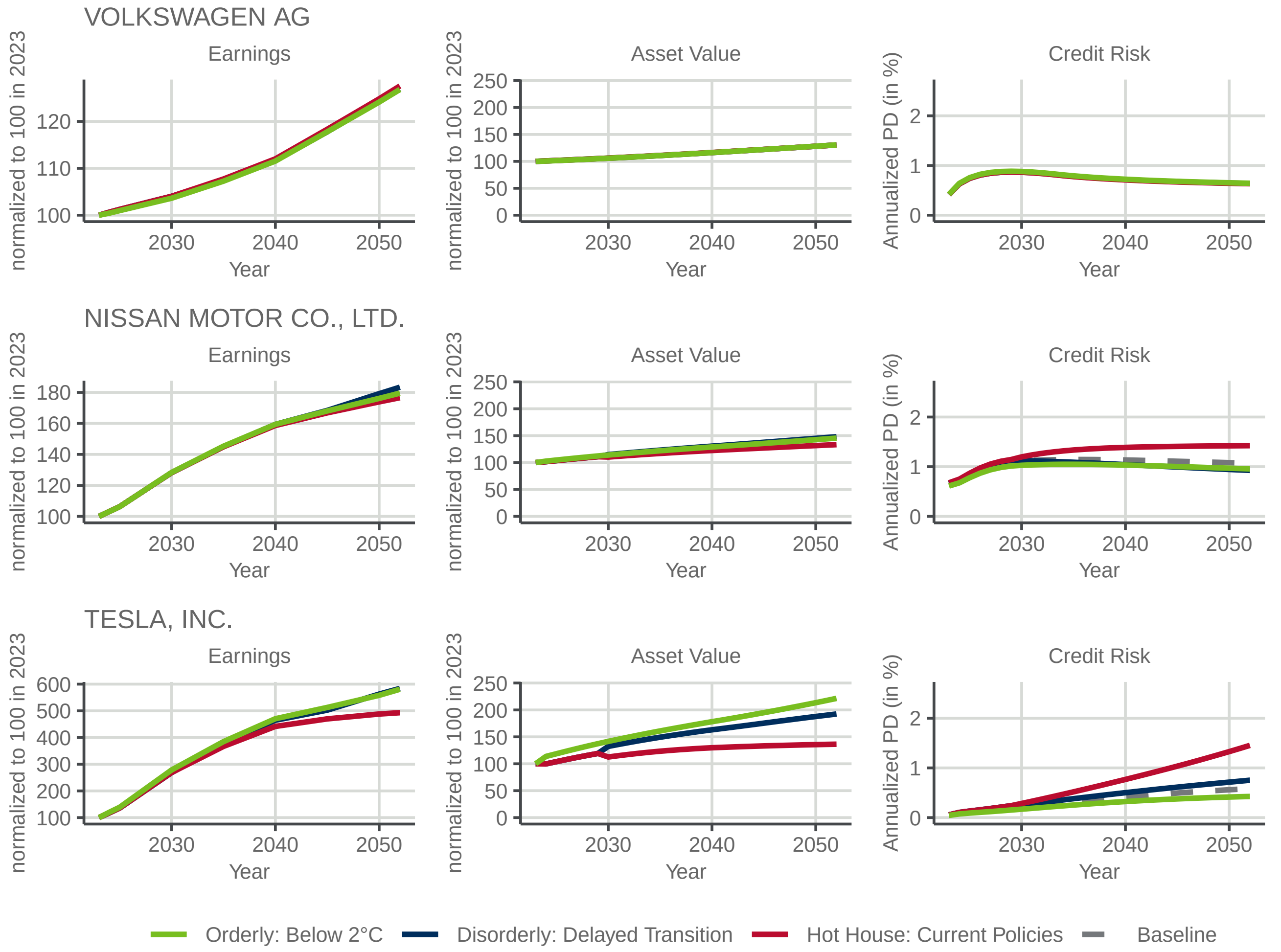
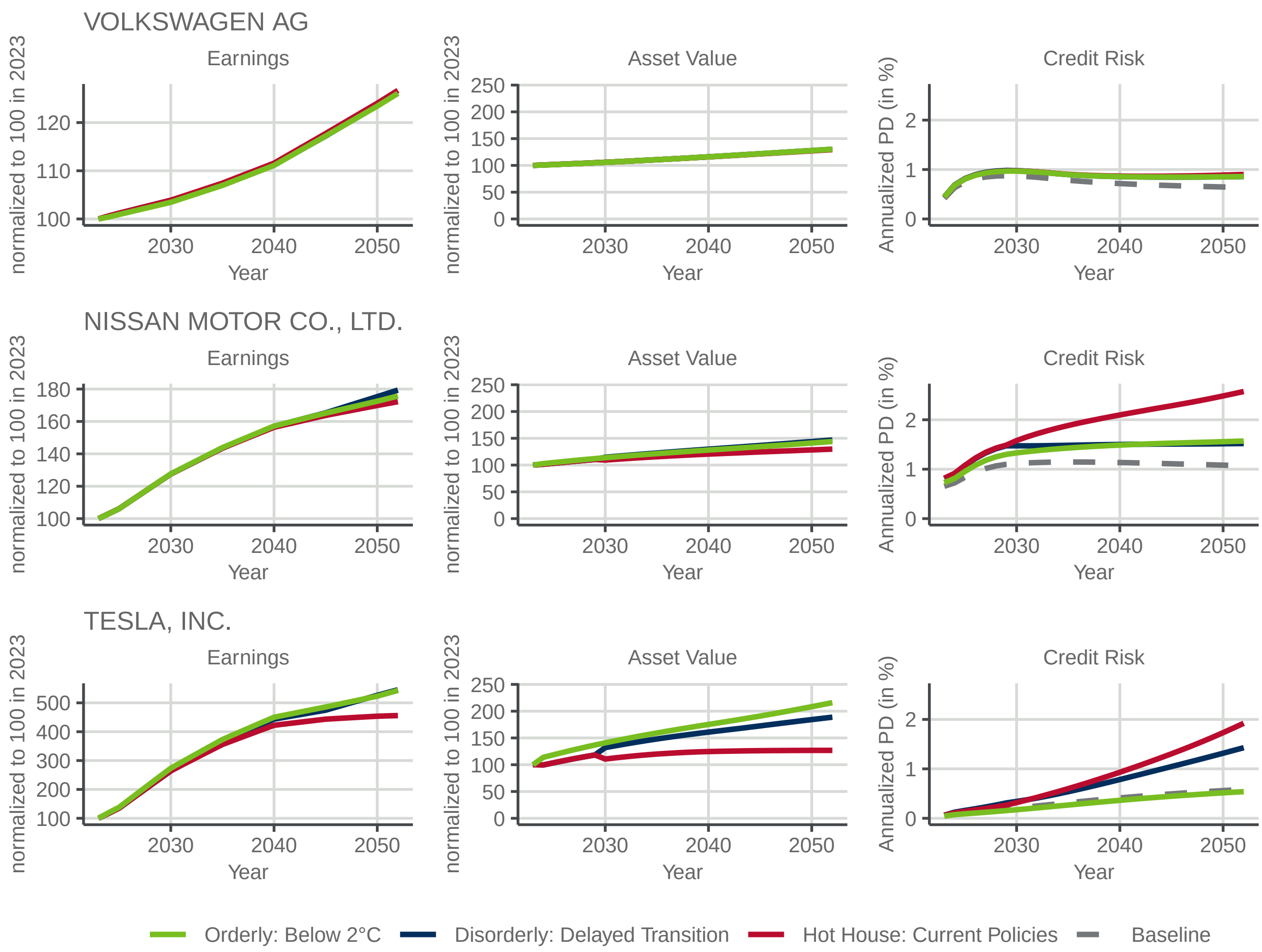


Figure 8: Combined Risk Pattern



3. Conclusion

The auto industry is very much subject to the risk associated with climate change and the corresponding transition to EVs as opposed to the petrol or diesel cars. The impact of these changes on credit risk is linked both to individual characteristics of the firms as well as to the climate scenarios. The physical risk is mainly driven by the location of production and it is highest in scenarios where there is less transition to a carbon-free economy. Revenues from a combined production of vehicles in the hot house world scenario will be lower in Japan vs the EU-15 as the Japanese islands are more exposed to the climate change. Nissan's asset revenues and asset value are lower, implying greater credit risk. In terms of the transition scenarios, they are triggered by economic policies such as imposing a CO_2 tax. Makers of EVs such as Tesla will benefit from such policies but will do worse in scenarios where transition does not occur. Companies such as Volkswagen are well hedged as its production facilities are primarily located in Europe and the firm is starting to produce EVs. Finally, scope 1 and 2 emissions mainly affect industry competitiveness due to costs of production but the impact on the auto industry appears to be minor. In contrast, scope 3 emissions are driven by the product demand and depend on the climate scenario.