INTERNATIONAL MONETARY FUND

Call of Duty

Industrial Policy for the Post-Oil Era

By Reda Cherif, Fuad Hasanov, and Madi Sarsenbayev

WP/24/74

2024
MAR

WORKING PAPER

 WP/24/74

IMF Working Paper
Institute for Capacity Development Department

Call of Duty: Industrial Policy for the Post-Oil Era
Prepared by Reda Cherif, Fuad Hasanov, and Madi Sarsenbayev*

Authorized for distribution by Oussama Kanaan
March 2024

ABSTRACT: Oil-exporting economies face the risk of an acceleration in the energy transition. A risk-based approach calls for urgent preparation for the post-oil era by diversifying exports and transforming the prevailing growth model. We outline the principles of industrial policy to achieve this objective based on the experience of the Asian Miracles and propose a sketch of the strategy required to transform these principles into practice. The key component of the strategy is to select sectors along two dimensions—proximity to the current production structure or capabilities set and a timeframe for results to materialize. The three strategies—snail crawl, leapfrogging, and moonshots—determine how far from the current production structure the selected sectors are. These sectors need to show results both in the short run to jumpstart growth and ensure policy continuity—"quick wins"—and the long run to create a new growth model—"transformative gains." We argue that the strategy should focus on supporting the exports of sophisticated sectors in both manufacturing and services while capitalizing on complex tasks and activities in existing industries but should leave non-sophisticated sectors such as tourism and non-tradable services to the private sector.

RECOMMENDED CITATION: Cherif, Reda, Fuad Hasanov, and Madi Sarsenbayev (2024), "Call of Duty: Industrial Policy for the Post-Oil Era," IMF Working Paper 24/74.

JEL Classification Numbers:	O57; O25; O14; Q40;
Keywords:	Diversification; Industrial Policy; Energy Transition; Oil Exporters
Author's E-Mail Address:	acherif@imf.org; fhasanov@imf.org; msarsenbayev@worldbank.org

* The authors would like to thank Oussama Kanaan, Amine Mati, Samir Jahan, Mariano Moszoro, Hugo Rojas-Romagosa, Nate Vernon, and economists in the IMF's GCC division for useful comments and suggestions. All errors are our own.

WORKING PAPERS

Call of Duty

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I. Oil Exporters' Call of Duty

Oil exporters are at the crossroads in the second decade of the 21st century in the face of a looming energy transition. The need to diversify their economies away from oil (and gas) has been a perennial challenge as oil has gone through several "super cycles" since the 1960s, notably in the 1980s when oil price remained low for two decades, triggering one of the deepest economic depressions (Cherif and Hasanov 2016). Yet this time is different. A conjunction of forces is pushing the world toward a rapid energy transition, away from fossil fuels toward renewables for power generation, transportation, buildings, and industry. The resulting permanent collapse in prices and revenues could still occur if some uses of oil and gas such as plastics and fertilizers do not fall victim to a disruption while technologies such as carbon capture, use and storage are unlikely to prolong the fossil fuel era without missing climate change targets (IPCC 2022, IEA 2022, and BP 2023). Since building new industries to replace oil exports takes decades, oil exporters are essentially living on a borrowed time. We argue that by adopting a risk-based approach it becomes clear that speculating on the path of oil prices during the energy transition is not much relevant for the current actions to be taken by policymakers. What matters for oil exporters is that even a small likelihood of a post-oil era starting in the next two decades, resulting in colossal export and fiscal income losses, would imply that diversification must start without delay to change the prevailing growth model and sustain the living standards for the future. This is oil exporters' call of duty.

In the decade following the collapse of oil prices in 2014, most governments in oil-exporting economies, and in particular, in the Gulf region, have acknowledged this duty as well as the inevitability of the transition away from fossil energy in the future. The governments have made bold announcements about economic transformation, typically in the form of vision documents, and undertaken radical reforms and massive investments in projects to diversify their economies. These long-term visions cannot yet be assessed in terms of success or failure. Yet as the visions are translated into concrete policies, we propose a framework to determine what constitutes "true" diversification, avoid the errors of the past, and establish priorities and metrics for assessing progress. In other words, we offer a lens to critically examine the following questions: among the plethora of policies and investment projects, which ones would effectively help prepare for the post-oil era, and are there scale and speed needed to meet the challenge of the energy transition?

"True" diversification requires changing the growth model of oil exporters, switching focus from non-oil GDP to non-oil exports. Although many oil exporters have attempted to diversify their economies, and despite major improvements in infrastructure, education and business environment, the strategies pursued so far have not yielded any major inroads as of the early 2020s. Oil exports still accounted for most exports, and oil revenues are recycled to drive the growth of non-oil GDP in the form of non-tradable production such as transportation, entertainment, and construction. In parallel, total factor productivity and GDP per capita have been falling behind other economies such as the U.S. and emerging economies. Sovereign Wealth Funds (SWFs) created to smooth oil price volatility and save for the future generations will not be sufficient to maintain high standards of living in the face of a rapid energy transition, including the massive SWFs of small rich oil exporters in the Gulf Cooperation Council (GCC) countries. The only path for sustained long run growth is to create a dynamic export sector beyond oil and gas to generate productivity gains ensuring sustainable long-term growth and welfare.

To change their growth model, oil exporters need to go beyond the standard growth recipe, which is not sufficient as it mostly tackles government failures, while many oil exporters' economies are riddled with market failures. GCC countries have successfully created one of the most business-friendly environments, with minimum regulations, low taxes, and state of the art infrastructure.[1] They also have one of the most flexible labor markets in the world if one considers the quasi-unlimited ability to import skilled and unskilled labor. However, this has not generated any significant nonoil exports. We argue that the lack of progress in creating a dynamic non-oil export sector stems from growth policies that successfully tackled government failures (e.g., the provision of infrastructure) but have not tackled market failures, which are particularly acute in the context of oil-exporting economies. The latter would require state intervention to coordinate efforts to enter tradable industries, mitigate risks, provide financing, and alleviate various constraints related to firm entry, growth, and exporting. In the absence of such intervention, firm entry would be concentrated in less risky activities, typically in non-tradable sectors such as construction, real estate, and services, including tourism. In contrast, high-tech export sectors, which would generate good paying jobs and growth, would be much less attractive.

The way forward for oil exporters is to pursue an industrial policy for export diversification—the key policy objective. Once policymakers make diversification their key goal, other policy priorities would support this ultimate objective. Only by focusing on this objective, policymakers can direct the attention, capacity, and resources required to fulfil it. To do so, they need to create a National Diversification System akin to the National Innovation System (Nelson 1993)[2]—a strategy with key objectives, sectors to support and resources needed, an institutional apparatus, policy instruments to use, and an accountability framework for firms for the support received.

This strategy is driven by three key principles of industrial policy (Cherif and Hasanov 2019). First, resources need to be directed to the development of sophisticated sectors. Second, export orientation should be the absolute priority, giving incentives for firms to do their best and compete in international markets. At the same time, domestic competition should be encouraged to increase the chances of the industry's survival as not all firms will succeed. It is not about "picking winners," rather the market will weed out non-performing firms. Third, accountability for the support received is important to avoid rent-seeking behavior and ensure that progress is made toward becoming competitive in international markets. The principles of industrial policy apply to all economies. However, for oil exporters, market failures are starker because of the Dutch disease, oil price volatility, and as we argue in this paper, the risk of a fast energy transition.

Since sector selection is the core of the strategy, it is important to consider the two dimensions as a guide—the current production structure or capabilities' set and a timeframe for the achieved results ("quick wins" in the short run vs. "transformative gains" in the long run). The three strategies—snail crawl, leapfrogging, and moonshots—determine how far from the current production structure the selected sectors are. Essentially, policymakers need to decide the level of ambition and risk they want to undertake to pursue these three strategies. The premise is that more sophisticated sectors are more likely to generate wages high enough to maintain the living standards of most nationals in rich oil exporters. We argue that this industrial strategy would focus on supporting sophisticated sectors in both manufacturing and services while capitalizing on complex tasks and activities in existing industries. In parallel, a "laissez-faire" approach in non-sophisticated sectors such as tourism and non-tradable services would be appropriate.

[1] There is a literature showing the structural effects of infrastructure, especially on jobs creation and growth (e.g., Agenor and Moreno-Dodson 2006, and Estache et al. 2013). However, in GCC countries and many other oil exporters, not only the level of investment was high, but its quality was also high (e.g., roads, airports and internet). Good infrastructure is important, but it is not sufficient to generate non-tradable industries without coordinating with other policies. In fact, some infrastructures could spur even more resources toward non-tradable industries.

[2] See also Freeman (1995) and Lundvall (2010).

In the following sections, we argue that the energy transition is about to hit an inflection point (Section II), calling for an urgent implementation of an ambitious diversification policy. We then lay down our arguments supporting industrial policy for export diversification and propose a sketch of the National Diversification System, including sector selection as a key component of the strategy (Section III). Section IV concludes the paper.

II. The Energy Transition and Oil Economies

A. The Looming Energy Transition

The energy transition away from fossil fuels accelerated in the 2010s, and it is likely to continue at a faster pace in the 2020s, with deep implications on oil prices and revenues. Several factors related to supply and technology as well as demand and regulation are at play: (i) large investments in the supply and R&D of renewable energy and alternative transportation are driving costs down rapidly. Cost competitiveness of renewables and EVs has become a reality in the early 2020s, marking the next phase of rapid disruption; (ii) a heightened awareness about the effects of climate change is changing consumer preferences and business regulations; and (iii) an increased frequency of extreme weather events is changing the prospects of the effects of climate change. These may lead to many government initiatives, new ones and extensions of those already in place, to limit emissions and accelerate the energy transition.

The levelized cost[3] of renewables such as solar and wind dropped at a rapid pace in the 2010s and was already below that of all fossil fuel sources by the end of the decade, including both natural gas and coal (Figure 1.A). The cost competitiveness of renewable energy reached such an extent that for virtually every existing coal power plant in the U.S., it would be 30 percent cheaper (per megawatt) to scrap it and replace it by building from scratch a new solar or wind farm nearby.[4] Indeed, renewable energy is expected to constitute about 35 percent of global power generation by 2025 (IEA 2023), and investment was turbocharged by energy security worries in Europe in the 2020s. As the issues of intermittency are tackled, this implies that natural gas prices could come under pressure in the next decade.

Meanwhile EVs sales have seen exponential growth, from negligible levels in the 2010s, to 4 percent of global sales in 2020, reaching 14 percent in 2022. Like renewable energy costs, battery costs declined rapidly in the 2010s (Figure 1.B-C). As costs fell dramatically, the adoption of renewables and EVs took off (Figure 2). The outlook for EVs suggests a further acceleration of the EV conquest of global markets, bolstered by stringent regulation. More than 80 countries, including major economies such as China and India and the state of California, announced deadlines for a complete or partial ban of ICE vehicles as early as 2035, and legislation has already been enacted in many nations.[5] Moreover, dozens of municipalities have more ambitious plans than the national ones in terms of limiting emissions from transportation. Car manufacturers have been vying for the domination of the EV market, preparing to launch close to 300 EV models over 2023-25 alone, many of which are planned to be priced below the average car price.

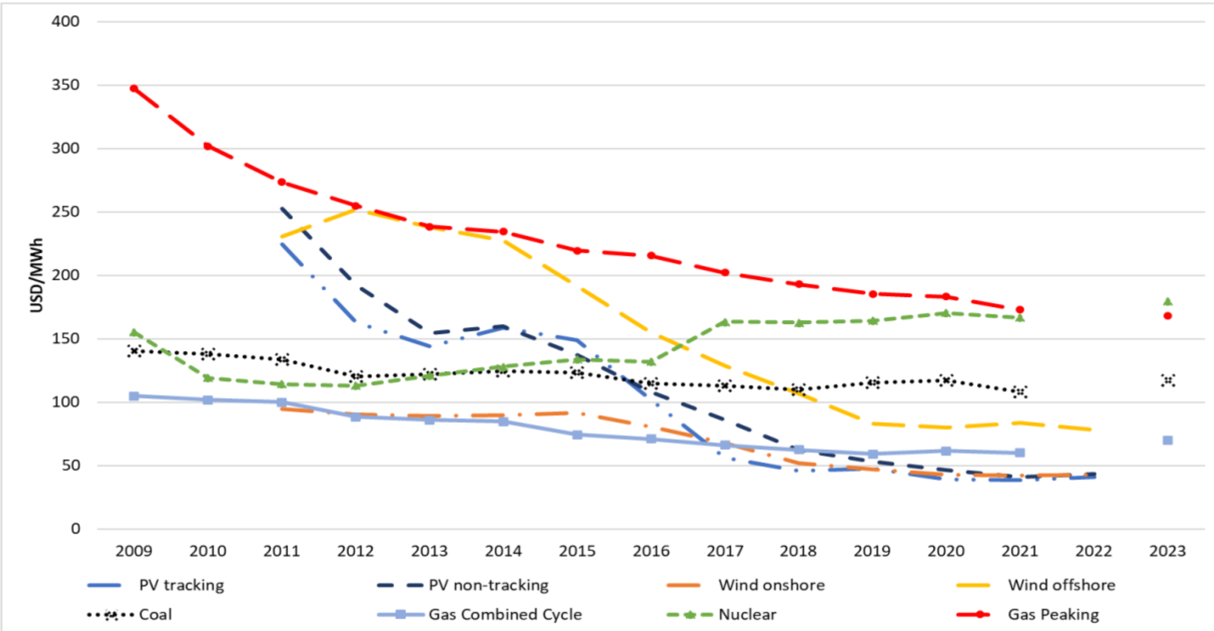
[3] It represents the average cost per unit of electricity generated, including building, installing, and maintaining a wind turbine or solar farm over its life cycle.

[4] See the Energy Innovation study at https://energyinnovation.org/publication/coal-cost-crossover-3-0-local-renewables-plus-storage-create-new-opportunities-for-customer-savings-and-community-reinvestment/.

[5] https://en.wikipedia.org/wiki/Phase-out_of_fossil_fuel_vehicles#Methods.

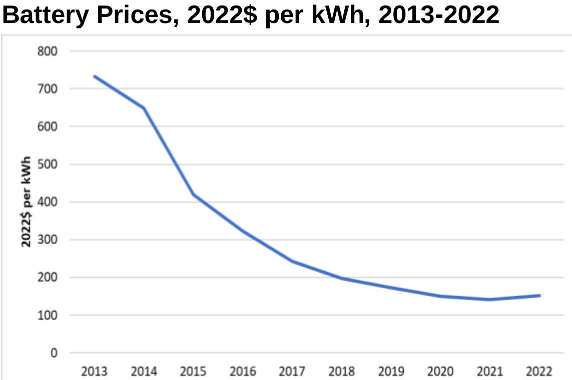
Figure 1. The Cost of Energy and Batteries

A. Levelized Cost of Energy, USD/MWh, 2009-2023



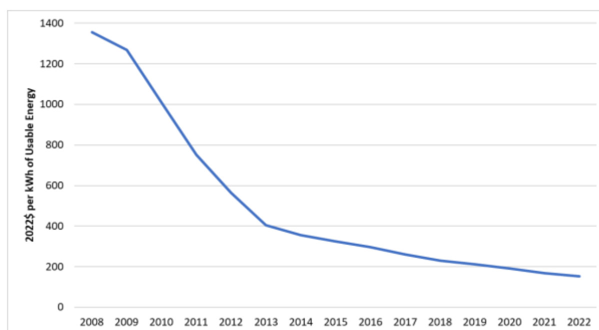
Note: Gas Combined Cycle represents a power plant that combines gas and steam turbines to generate electricity. Gas Peaking plants are power plants designed to respond to fluctuations in demand. Values are provided in real 2021 $/MWh terms, except for 2022 and 2023 data, which is in nominal. Data from Lazard is deflated using US CPI. BloombergNEF's semiannual estimates are averaged to obtain annual observations.
Sources: BloombergNEF Levelized Cost of Electricity Historic Dataset by Sector, Country (accessed 17 March 2023), Lazard (2023), and IMF's World Economic Outlook database, April 2023.

B. Global Volume-weighted Average Lithium-ion Battery Prices, 2022$ per kWh, 2013-2022



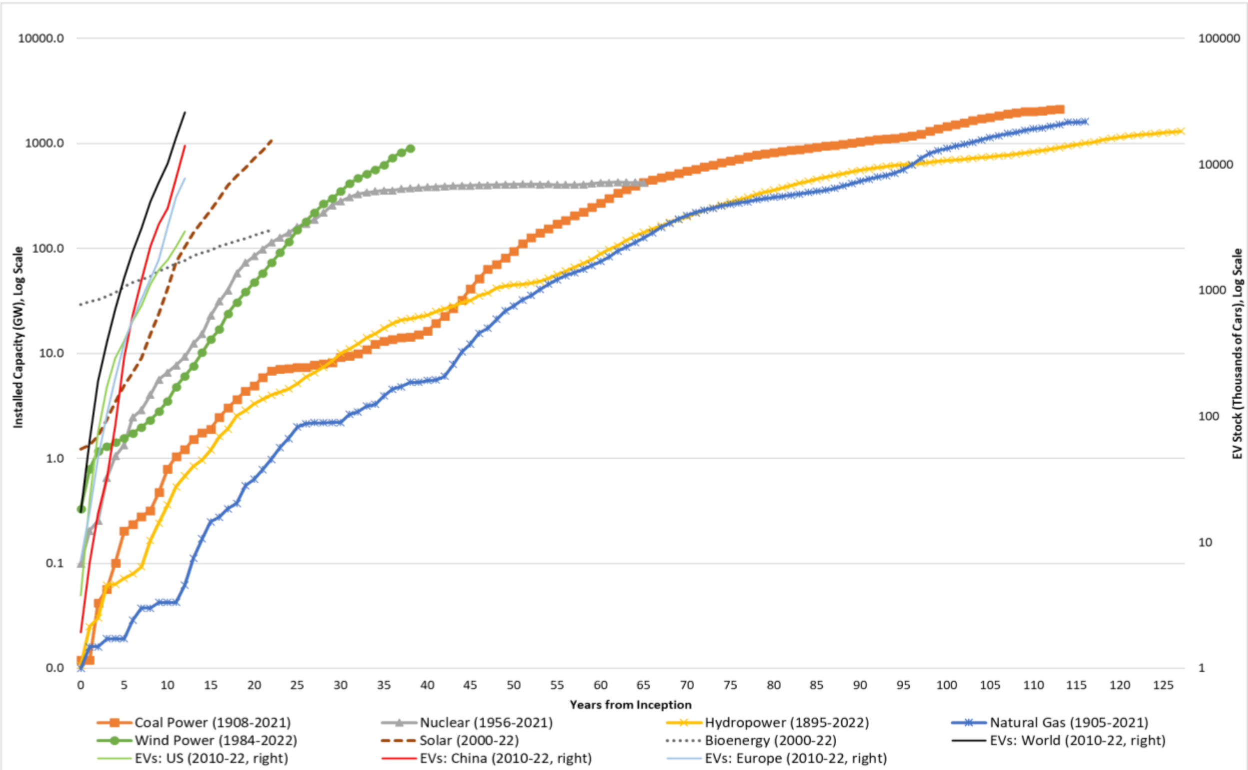
Note: Volume-weighted average values are based on 178 observations for passenger cars, buses, commercial vehicles, and stationary storage. Values include cell and pack.
Source: BloombergNEF (2022).

C. Estimated Electric Vehicle Lithium-ion Battery Pack Cost, 2022$ per kWh of Usable Energy, 2008-2022



Source: U.S. DOE (2023).

Figure 2. The Growth of Renewables and EVs



Sources: Bento and Wilson (2016), IEA (2019, 2022, 2023); IRENA (2022, 2023).

The conjunction of these factors suggests that oil could become the new coal by 2040. That is, it may still be "needed" in large quantities, as was the case with coal until the 2000s, but its price could still collapse to a level comparable to other energy sources such as coal per unit of energy. Although it was displaced in many industries as the main energy input (e.g., rail transportation), coal use was still increasing steadily in the second half of the 20th century. Its consumption peaked in the early 2000s at about double the quantity used on average in the first half of the century, while the price reached its lowest point since 1870 (Figure 3). Like coal, once oil loses its monopoly power on transportation, it has to compete with other energy sources and uses, with declining global demand pushing oil prices to about the same level as the price of natural gas and coal, or 15 dollars per barrel by some estimates (Cherif, Hasanov, and Pande 2017, 2021). Oil use in road transport comprised over 40 percent of global oil demand in 2022 (IEA 2022, p. 272), and with the EV revolution underway, the decline of oil is likely to accelerate as well. BloombergNEF (2023) shows that by 2022, 1.5 million barrels per day of oil consumption, representing 3% of total road fuel demand, had already been displaced by EVs.

Using an historical transition from horses to motor cars, broadly consistent with a Bass technology adoption model, Cherif, Hasanov, and Pande (2017, 2021) project that the adoption of electric cars could increase exponentially within the 25-year period. By the early 2040s, EVs would be ubiquitous, including in developing countries (Cherif, Hasanov, and Zhu 2021). This scenario is further supported by the climate transition goals and policies needed to reach net zero emissions. Even in the slow adoption scenario, it may only take an extra decade for EVs to reach a full market penetration by 2050 (Cherif, Hasanov, and Pande 2021). Most other scenarios of EV growth are also relatively fast, albeit at varying degrees (e.g., IEA 2023 vs. BloombergNEF

2023). More important, they regularly revise upward their projections while EV growth keeps beating expectations as "targets and ambitions for clean energy technology deployment are generally more easily formulated than they are achieved, but in the case of EVs, the momentum is clearly on the side of achievement" (IEA 2023).

There are alternative energy transition scenarios where oil price would remain high for long. In these scenarios, supply-side climate policies (e.g., regulation to restrict drilling) would lead to a decline in fossil fuel production (e.g., Delis et al. 2019, Bogmans et al. 2023, and Boer et al., 2023). When supply-side climate policies dominate demand-side ones (e.g., subsidies for EVs), some oil producers could even see their revenues from oil increase (Boer et al. 2023). However, as many oil exporters are completely dependent on oil exports, supply-side policies to restrict production are a non-starter.[6] In addition, market dynamics in the mid-2010s when a few existing EV models were priced at around $100,000 were bound to be dramatically different than the dynamics a few years later when dozens of models became available, some at around $30,000. More important, as we argue below, beyond the plausibility of any scenario, what matters for oil exporters is not the exact oil price path in the transition. It is instead the expected losses implied beyond the medium run. In other words, the question is not whether a world where oil prices remain high for long is *plausible* during the energy transition or afterward, but whether one can be *certain* that the transition will take a long time, or oil prices will stay high even after the transition, given what is at stake for oil exporters.[7]

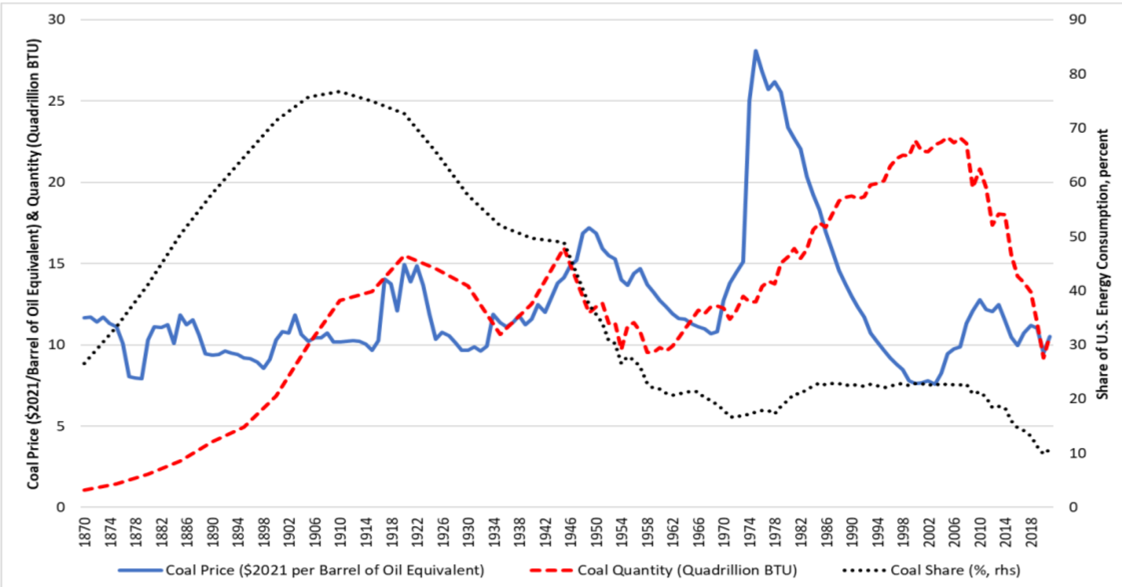
B. Are Oil Exporters Ready for the Energy Transition?

The prospect of a low oil price would eventually lead to a large contraction in most oil-exporting economies. For several major oil exporters, an oil price below $20 would not even cover the operating cost of their public oil company. Even if oil is used in large quantities as coal has been, permanently low oil prices will be challenging for many oil and gas exporters, including those with the lowest extraction costs. The experiences of the 1980s-90s highlight severe problems with the prevailing growth model of oil exporters, when consumption per capita and thus welfare fell by 20-30 percent (Cherif, Hasanov, and Zhu 2016). The conduct of macroeconomic policies in the low-oil price environment would also be challenging. The breakeven fiscal and current account oil prices for many oil exporters were in the range of $40-90 per barrel in 2022, suggesting increasing fiscal and external deficits if oil prices fall below those levels (Figure 4).

There are several arguments refuting the hypothesis that the countries with the lowest cost of extraction would escape a deep recession if oil prices fell permanently. First, such countries have had the lowest costs of extraction since the 1960s, and probably even lower in relative terms compared to the 2020s, and yet the slump of the 1980s did not spare any major oil exporter when consumption per capita took 25 years to recover its pre-crisis levels (Cherif, Hasanov, and Zhu 2016). Second, the "last man standing" scenario, in which a handful of oil producers would share the market, imply oil prices as low as $20-30 per barrel. The transition to this situation could turn out to be protracted and painful, as the experience of the 1980s shows, when most oil producers kept producing at very low oil prices to generate income. And even if this situation arises, to maintain living standards, volumes must increase dramatically to compensate for the decline in prices. Such an increase in volumes may not be possible without a sizable increase in production costs, and global oil demand in the context of an energy transition may not even meet the levels required to increase oil income substantially.

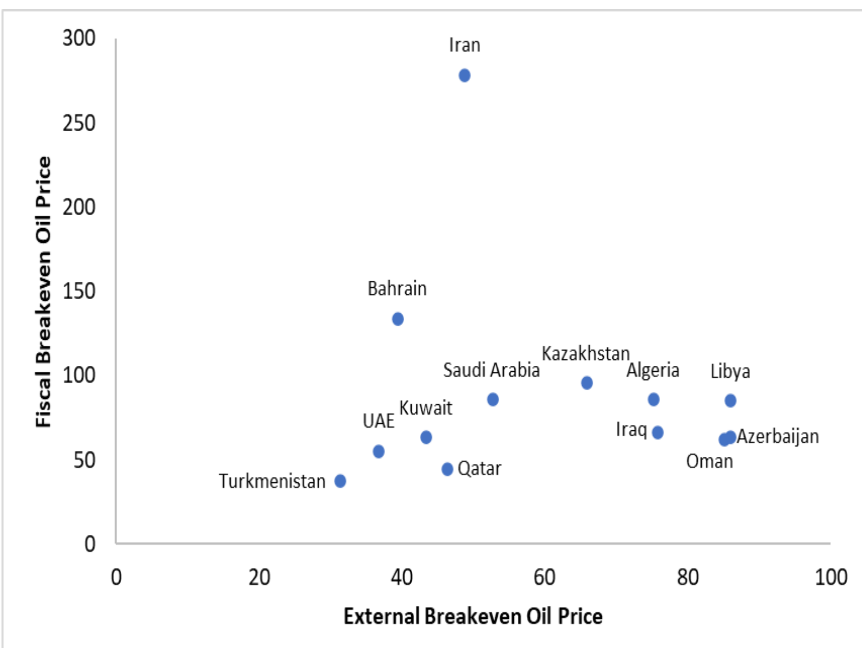
[6] Similarly, oil producers would not reduce investments and capacity to produce substantially to maintain oil income flows.
[7] To illustrate the extent of uncertainty, the range of possible long-run oil prices in Boer et al. (2023) spans $15 to $300 per barrel.

Figure 3. Coal Use and Prices (USA, 1870-2021



Sources: McNerney et al. (2011), U.S. EIA (2012a, 2012b, 2023a, 2023b), and Federal Reserve Bank of Minneapolis (2023)

Figure 4. Fiscal and Current Account Breakeven Oil Prices, US$ per barrel, 2022



Source: IMF (2023).

The prevailing growth model of many oil exporters is mostly focused on smoothing oil income volatility and managing fiscal spending. Many oil exporters have saved a large share of oil income in oil funds or sovereign wealth funds (SWFs) and central bank reserves that help manage oil price volatility. Many countries tend to run fiscal and current account surpluses although debt levels have been rising (Figure 5). Large SWFs could mitigate against temporary drops in oil prices, but permanently low oil prices would deplete them relatively fast without large cuts to consumption and thus welfare (Figure 6). Even for oil exporters that have accumulated large stocks of assets, the odds of replacing oil exports permanently while keeping the same standards of living are next to none. For instance, for Kuwait and Brunei, the annuity value of SWFs is substantial today, but it is still below the value of oil exports. This abstracts from the obvious dilemma faced by SWFs, where targeting greater returns would come with higher risks. To maintain real consumption over time in line with real income, without taking substantial risks, would require a massive accumulation of assets, beyond even the largest SWFs, and high real returns persisting into the future (Figure 7). SWFs could, however, smooth the transition to the post-oil future and support diversification efforts rather than eliminate the need to diversify. Financial diversification cannot substitute for the lost oil income in the post-oil future.

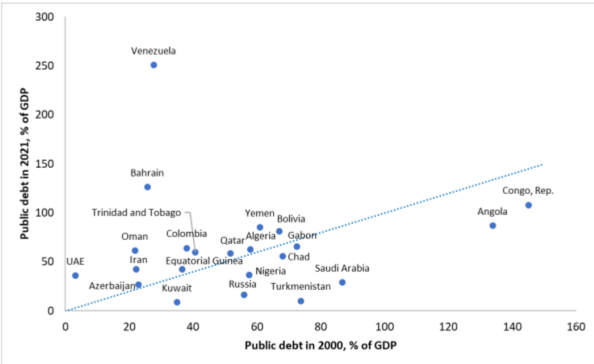
Although diversification has always been on policymakers' agenda, it has been pursued with a varying degree of vigor and policy continuity. The governments in oil-exporting countries have long understood that oil incomes would fall over time either due to production or price declines. However, during oil booms, this objective would slip down the priority list and jump up the list again during busts (Cherif and Hasanov 2014, 2016). When oil prices fell substantially in 2014, the diversification goal became more important than before as ever larger imports had to be financed. Many oil exporters have drafted Visions and growth strategies for the low-oil-price or post-oil future. Spending on public infrastructure, real estate, logistical and financial hubs, and tourism was prioritized. With energy transition intensifying, the recent diversification agenda has also entailed clean energy investment with a focus on renewables, electric cars, and carbon capture.

To avoid the pitfalls of the past, a key lesson needs to be drawn that the current growth model is not sustainable. Despite substantial diversification efforts and investment over the past decades, non-oil exports and productivity growth were largely disappointing. For the past half-century, oil exporters have invested annually about 25 percent of GDP on average (Figure 7). Cherif and Hasanov (2013) argue that high investment is justified when productivity of the tradable sector is high enough. However, high investment rates have not resulted in the development of sizable non-oil exports in many oil exporters over the same time. Interpreting the numbers as rates of return of investment in terms of non-oil exports, the largest return, about 6.5 percent, from relatively high investments is generated in Bahrain and the UAE (Figure 8). Other oil exporters invested much less in per capita terms, and although for a few of them, returns have been higher, closer to 10 percent, the resulting non-oil exports per capita are still too small to create a dent in oil dependence. In addition, even though structural export sophistication (Cherif, Hasanov, and Wang 2018) has increased over time, another key indicator of export sophistication—real manufacturing exports per capita—has stagnated (Figures 9-10).[8] More important, total factor productivity and relative incomes of oil exporters have been on a decline or at best, have stagnated (Figures 11-12). In other words, even when oil prices remain high, the growth model of oil exporters is doomed to fail as oil exporters fall behind other economies.

[8] The export sophistication measure of Hausmann, Hwang, and Rodrik (2007) relates the sophistication of a product to the average income of economies exporting this product. It artificially inflates the relative value of the export sophistication of oil exporters given that there are many high-income (and small population) oil rich economies. Cherif, Hasanov, and Wang (2018) discounts the high share of commodity exports of high-income commodity exporters, correcting this bias.

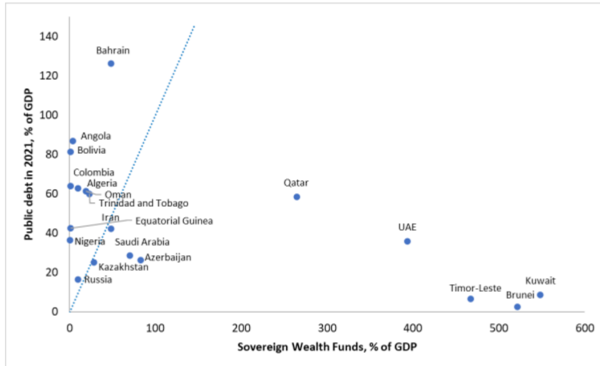
Figure 5. Public Debt and Sovereign Wealth Funds

A. Public debt, % of GDP, 2000 vs. 2021



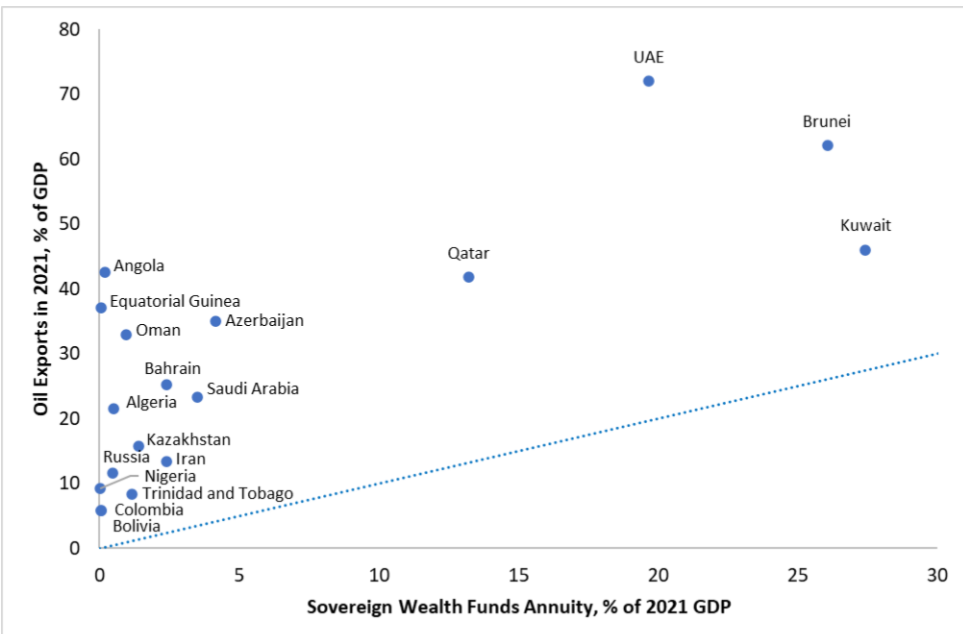
Note: The dotted line is a 45-degree line.
Source: IMF's World Economic Outlook database, April 2023.

B. Public Debt vs. Sovereign Wealth Funds



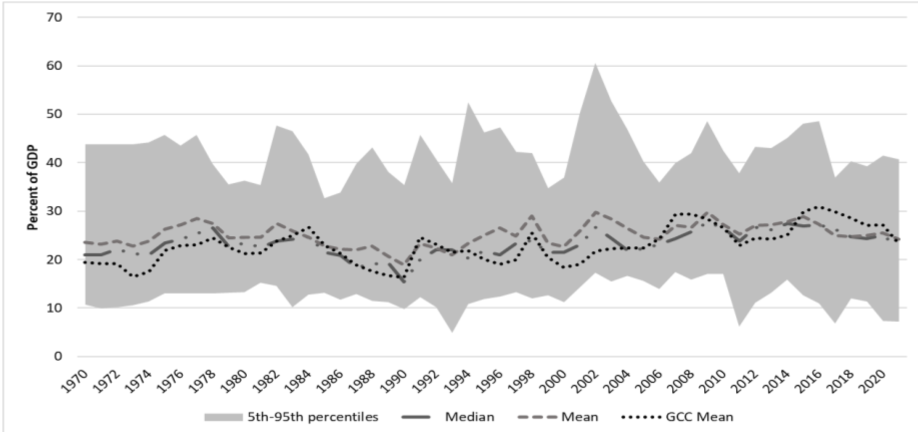
Note: Calculations of the ratio of SWFs to GDP use 2021 nominal GDP data. The dotted line is a 45-degree line.
Sources: IMF's World Economic Outlook database, April 2023, and Sovereign Wealth Fund Institute (accessed April 20, 2023).

Figure 6. Oil Exports vs. Sovereign Wealth Funds Annuity, % of 2021 GDP



Note: Calculations of SWF annuity assume a real interest rate of 5%. The dotted line is a 45-degree line.
Sources: IMF's World Economic Outlook database (April 2023), World Bank's World Development Indicators database (accessed May 9, 2023), and Sovereign Wealth Fund Institute (accessed April 20, 2023).

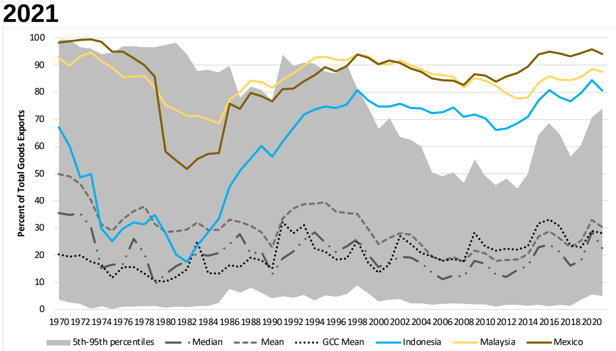
Figure 7. Total Investment (percent of GDP, 1970-2021



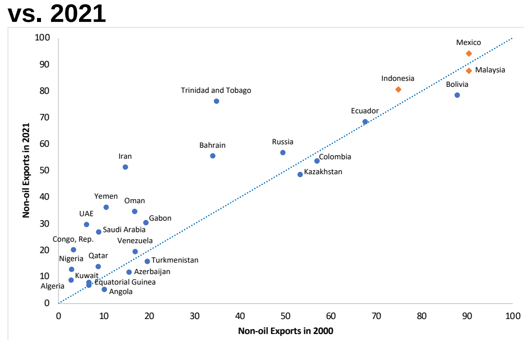
Source: IMF's World Economic Outlook database, April 2023.

Figure 8. Non-oil Exports

A. Non-oil exports, % of total goods exports, 1970-2021

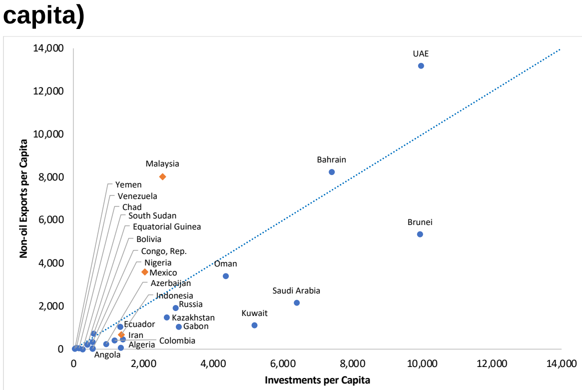


B. Non-oil exports, % of total goods exports, 2000 vs. 2021



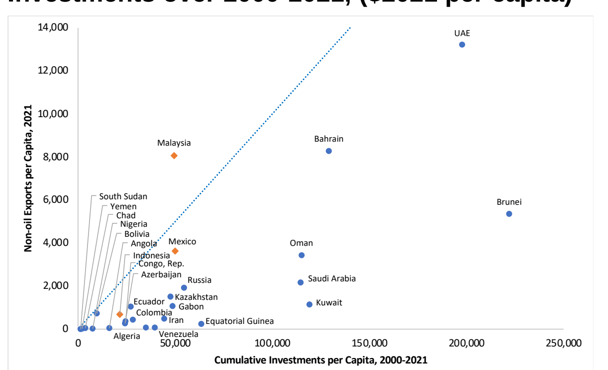
Note: The dotted line is a 45-degree line.

C. Non-oil Exports vs. Investments, 2021 (US$ per capita)



Note: The dotted line is a 45-degree line.

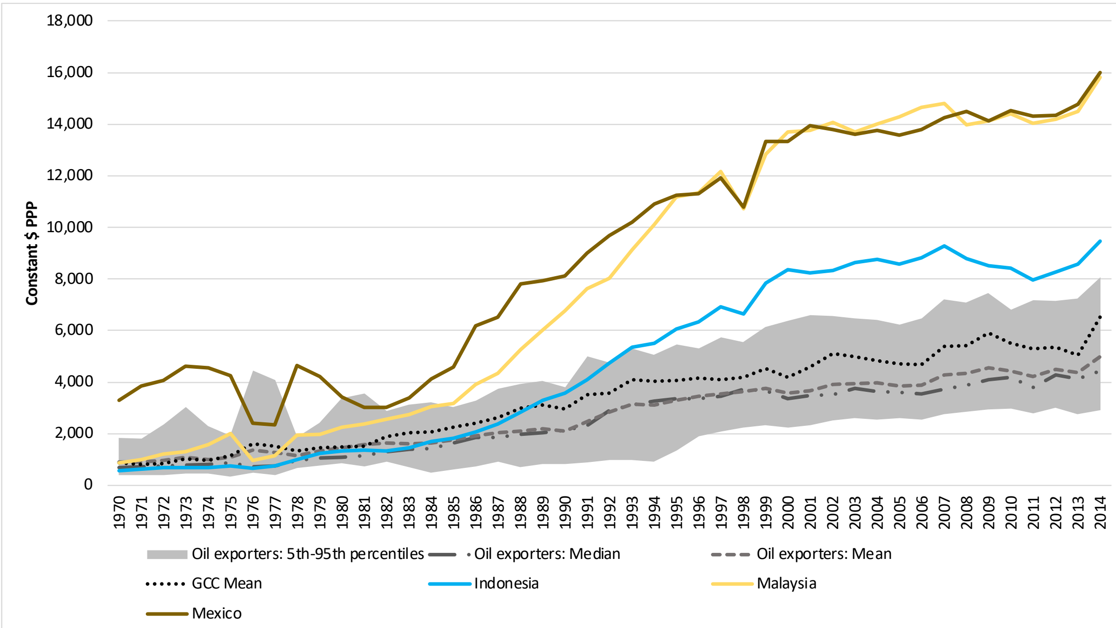
D. Non-oil Exports in 2021 vs. Cumulative Investments over 2000-2021, ($2021 per capita)



Note: Cumulative investments per capita are calculated by dividing the sum of real investments (in $2021) over 2000-2021 by population in 2021. The dotted line is a 45-degree line with a y to x axis scale of 1x10 (equivalent to a return of 10 percent).

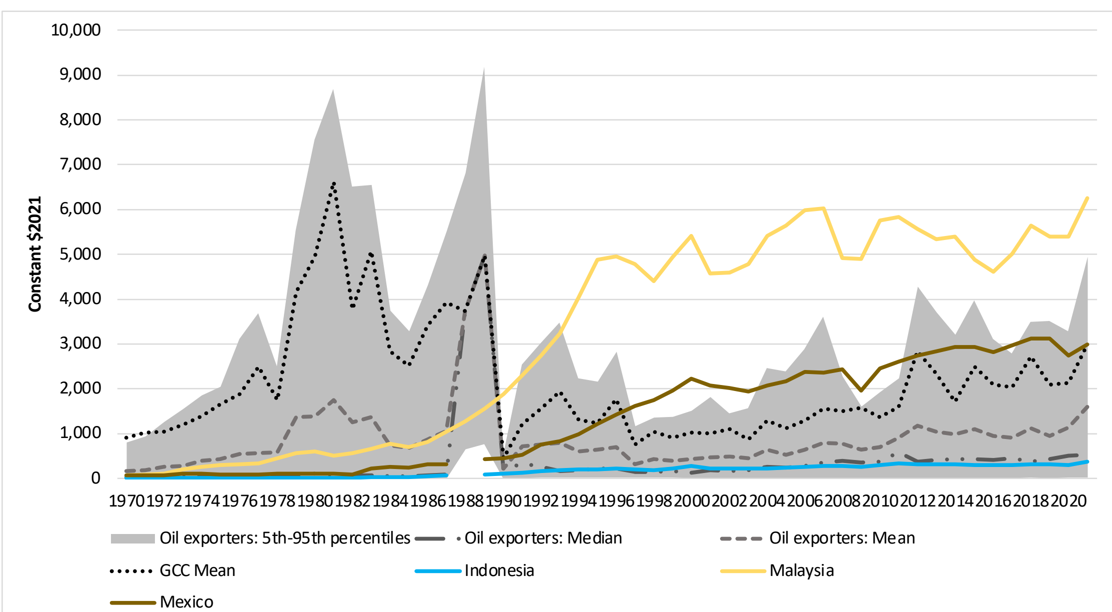
Sources: IMF's World Economic Outlook database (April 2023), and World Bank's World Development Indicators database (accessed May 9 and July 5, 2023).

Figure 9. Structural Export Sophistication (constant $ PPP, 1970-2014)



Source: Cherif, Hasanov, and Wang (2018).

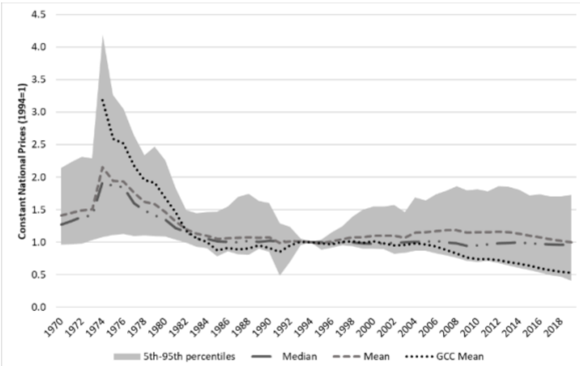
Figure 10. Real Manufacturing Exports per Capita (constant $2021, 1970-2021)



Source: World Bank's World Development Indicators database (accessed April 6, 2023).

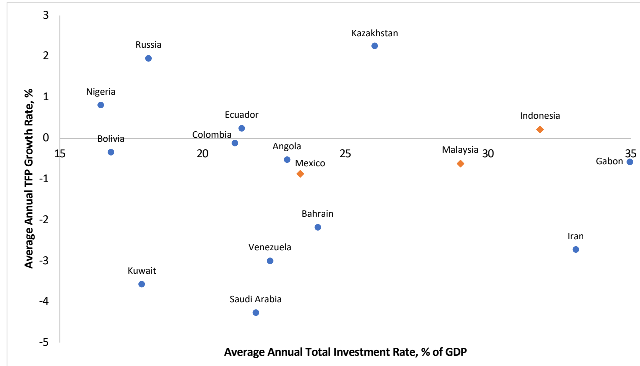
Figure 11. Total Factor Productivity

A. Total Factor Productivity, Constant National Prices (1994=1), 1970-2019



Source: Penn World Table, version 10.01 (Feenstra et al. 2015).

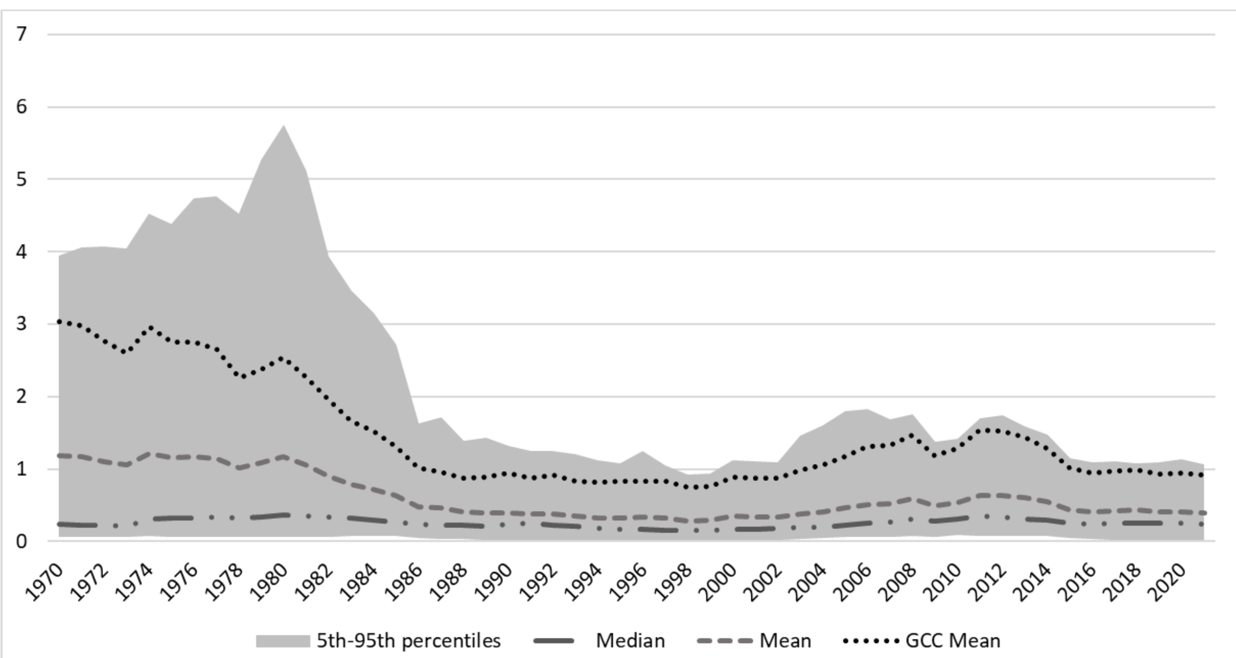
B. Total Factor Productivity Growth Rate vs. Investment Rate



Note: Average annual TFP growth rate is an arithmetic average of TFP growth rates from 1970 to 2019, calculated based on TFP at constant national prices (2017=1). Average annual total investment rate is an arithmetic average of gross capital formation (% of GDP) from 1970 to 2021.

Source: Penn World Table, version 10.01 (Feenstra et al. 2015), and IMF's World Economic Outlook database, April 2023.

Figure 12. Real GDP per Capita Relative to that in the U.S. (chained 2017 PPP US$, 1970-2021)



Note: Observations for 2021-22 were extrapolated using GDP per capita data (PPP, 2017 international $) from IMF's World Economic Outlook database.

Source: Penn World Table, version 10.01 (Feenstra et al. 2015), and IMF's World Economic Outlook database, April 2023.

To prepare for the post-oil future, the key policy priority is clear, that is, to generate sufficient non-oil exports to cover a large share of current oil exports, with other economic policies supporting this objective. It is a priority for several reasons. Since oil revenues account for a large share of current and fiscal accounts, a drop in oil prices would put a pressure on external and budget balances as high fiscal and external breakeven prices show (Figure 4). On average, the replacement rate of imports is 79 percent in 2021 (94 percent for GCC member states),[9] that is, oil exporters need to finance 79 percent of imports with exports other than oil to keep imports stable. For fiscal accounts, the replacement rate of spending is 45 percent in 2021 (67 percent for GCC member states). More important, export diversification allows the development of the tradable sector, especially manufacturing, that has a potential of creating many good-paying jobs with positive spillovers to other sectors such as manufacturing-linked services and nontradables. Empirical evidence suggests that export sophistication is a key and robust determinant of growth (Hausmann, Hwang, and Rodrik 2007 and Cherif, Hasanov, and Wang 2018). Developing a dynamic non-oil export sector would not only support diversification away from oil but also generate the needed productivity gains for sustained growth and good-paying jobs.

More important, the sizable non-tradable sectors have been financed essentially with oil exports and give the illusion of the production taking place because it is part of the GDP statistics. What could be seen as economic dynamism can be summarized by the metaphor of the shopping mall built with foreign labor, paid in hard currency that leaves the country immediately through remittances, in which the stores offer mostly imported goods, themselves financed by oil revenues, and where the customers are typically nationals who in general work in the public sector, which is itself financed by oil revenues. The reverse dynamic when oil revenues plummet is not difficult to imagine, and none of the "real assets" built can be a substitute for the loss of oil exports. All these activities could be highly profitable and would make "economic" sense from an individual perspective (e.g., firms and consumers), but overall and over time, like a river digging its bed, this chain of activities only entrenches the dependence on oil and the extent of the damage when the energy transition reaches its tipping point. Every mall is a missed opportunity to build the next start-up incubator or advanced manufacturing plant.

B. A Risk-Based Approach to the Looming Energy Transition

Uncertainty about the future of the energy transition is not sufficient for oil exporters to delay the ambitious diversification policies as various forces could delay the transition. Oil (and gas) may become the new coal, and although it might take decades to materialize, the development of tradable industries, or export diversification, takes decades as well. The low level of investment and potential conflicts could unbalance demand and supply in the market leading to high persistent prices during the transition. High interest rates and crushing debt could cripple most developing countries' ability to invest in green infrastructure. Moreover, the political reality in many countries, including advanced ones, makes it difficult to envisage an easy lifting of fuel subsidies, let alone the application of carbon taxes, the tool of choice in fighting climate change. Many oil companies and oil-exporting countries are betting on carbon capture technologies to delay the demise of fossil fuels.

As policymakers in oil-exporting countries make sense of these conflicting forces, we argue that oil exporters must adopt a risk-based, or probabilistic, approach to tackle the looming acceleration of the energy transition instead of attempting to foresee the path of oil prices. Quantifying the precise likelihood of the demise of oil in the next couple of decades is not important from an industrial policy perspective. Even if the probability of the "pessimistic" oil price scenario is low, given the colossal income losses that oil exporters would incur, the

[9] IMF's World Economic Outlook database (April 2023), and World Bank's World Development Indicators database.

expected income loss of the post-oil future would remain enormous. In other words, if policymakers are convinced that the probability of a rapid transition is not negligible—and the evidence points in this direction—they must set out on an ambitious plan for the post-oil future with a focus on policy actions now rather than later.

We illustrate this argument using a simple formalization. We take the example of an economy exporting on average \$10 billion per year, based on an average \$75 per barrel price. We have argued in the previous section that oil price could fall to \$15 per barrel as the energy transition accelerates and EVs take over global markets. We also assume that this "looming energy transition" scenario has a probability *p* of occurrence. If the oil-exporting economy is not ready by the time the prices collapse, we estimate that it would take at least two decades for the economy to transform. In other words, the lost income would be 80 percent of the cumulative exports over twenty years, i.e. \$200 billion (without using a discount rate and with same volumes), which is \$160 billion. We also assume that there exists an industrial policy leading to the successful diversification of the economy, making up for the lost income. It could be interpreted as an insurance policy against the energy transition. This policy would entail an upfront investment *I*. A risk-neutral policymaker would be ready to pay this cost as long as *I* is lower or equal to the expected loss, which is *p* multiplied by the cumulative lost income.[10] If *p* is 10 percent, the upfront investment worth incurring to avoid the energy transition scenario would equal \$16 billion, or 160 percent of annual exports. This would be a massive investment by any standard.

One could generalize by stating that a risk-neutral policymaker would be ready to incur an upfront investment to successfully diversify the economy as long as:

$$I \leq p \cdot e \cdot R \cdot T \tag{1}$$

where the right-hand side of equation (1) is the expected loss from the energy transition; *p* is the probability of the energy transition; *e* is the expected fall in exports in percent; and T is the number of years it would take to successfully diversify the economy. The maximum investment cost, *I**, as a ratio of annual export revenue can be expressed as:

$$\frac{I^*}{R} \leq p \cdot e \cdot T \tag{2}$$

Using this theoretical argument, we back out the link between the level of confidence of policymakers in the status quo, that is, the implicit odds that the energy transition would be protracted, and the effort required to diversify. The level of confidence would be translated into the amount invested as a percent of annual exports to diversify the economy away from oil, assuming that it would be equal or close to *I**, the investment level that maximizes the odds of success. This could also be interpreted as the shadow price of an insurance policy against the energy transition.

[10] This is when the expected cost equals the expected gain.

Figure 13. The Price of Confidence in the Status Quo: Investment vs. Probability of No Transition

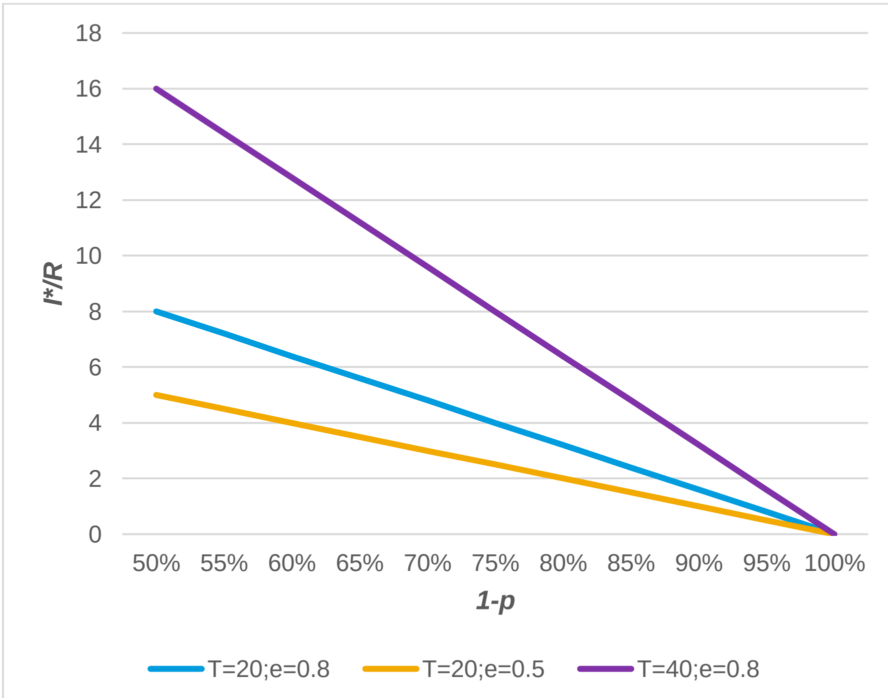


Figure 13 shows the relationship between *I*/R*, the investment-revenue ratio, and *(1-p)*, the odds that the energy transition will be protracted, for different values of *e* and *T*, the loss of income because of the energy transition and the number of years needed to diversify the economy, respectively. It is striking that even under conservative assumptions (risk neutrality, no discounting, and no endogeneity), and for an optimistic scenario where the energy transition would lead to a loss of 50 percent of revenues (instead of 80 percent as we argued in the previous section), a policymaker with 90 percent confidence in the status quo would still invest 100 percent of annual exports upfront to diversify the economy (the lowest line in Figure 13). For instance, this would represent between $200 billion and $300 billion for Saudi Arabia. In contrast, with a still relatively conservative 50-50 chance, and under the assumptions that revenues would fall by 80 percent, the amounts to be invested are vast, multiple times annual export revenues, which would represent trillions of dollars for the Saudi economy. It would be more plausible to assume that policymakers are not risk-neutral, which would make our argument even starker.

The practical implication of our analysis is a reframing of the policy discussion around the energy transition in oil-exporting economies. The only ground to delay a massive effort to diversify the economy away from oil toward other tradable industries, most likely at the expense of consumption in the short to medium run, would be confidence close to absolute certainty that the energy transition would not take place for another three or four decades. In contrast, we argued that over the 2000s and 2010s the odds have shifted dramatically toward a faster energy transition. The advent of the Inflation Reduction Act in the U.S., with large subsidies for investment in renewables and EVs, and the European drive to ensure their energy security through renewable technologies will only accelerate this trend in the following decade, further supported by China and India.

III. Industrial Policy for Diversification in the Age of the Energy Transition

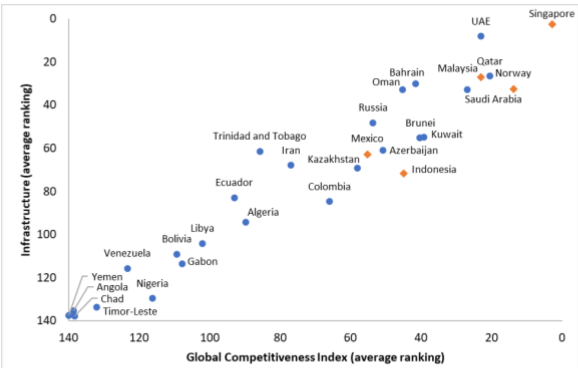
A. Standard Growth Recipe is Not Sufficient

The standard growth recipe tackles mostly government failures, necessary but far from sufficient, especially in oil-exporting economies. The GCC countries represent an ideal quasi-natural experiment in assessing the limits of a focus on alleviating government failures alone. The GCC countries, by and large, have successfully tackled most government failures such as improving physical infrastructure, easing product and labor market regulations (e.g., opening business, reducing trade barriers, and bringing skilled and unskilled labor), and levying minimum taxes. Moreover, Special Economic Zones (SEZs) in the region have had even more favorable conditions to attract foreign firms and encourage the development of the private sector. Compared to other former large oil exporters like Malaysia, Indonesia, and Mexico, the GCC countries have done well on most dimensions of the standard growth policy advice. Even in comparison to Norway, the GCC countries have done relatively well on regulatory, trade, and infrastructure indicators (Figure 14). On governance indicators, the GCC countries are in the middle of the pack (Figure 14). Nonetheless, the presence of large conglomerates in the GCC countries that effectively do not face many government failures like governance challenges or red tape, suggests that these constraints are not necessarily the binding ones in diversifying away from oil and gas and developing non-oil exports (Figure 15) (Cherif and Hasanov 2014, 2016). In fact, this outstanding physical and institutional super-infrastructure of the GCC mostly encouraged even more non-tradable investment and production. The access to almost unlimited expatriate labor, for example, an ideal situation for the proponents of development through a better business environment, only fueled the non-tradable sector, mostly services, and generated even more demand for nontradables (housing and entertainment services) and imports.

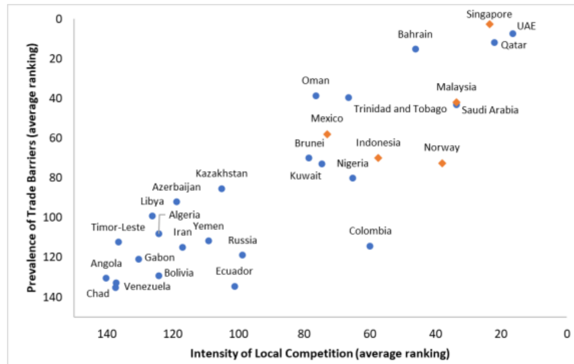
The standard growth recipe failed to produce sustained and high growth because of the pervasiveness of market failures. The market failures in large oil exporters are especially acute, which are magnified by Dutch Disease effects, as incentives to develop non-oil tradable sectors are minimal with huge inflows of oil income year after year. Firms do not internalize positive externalities like knowledge spillovers and learning-by-doing in production in sophisticated sectors such as manufacturing, fall prey to coordination and information failures, and face risk-return tradeoffs favoring sectors that recycle oil revenues, mostly nontradables, such as construction, real estate development, and various services, and import businesses (Figure 16) (Cherif and Hasanov 2014, 2016). Examining the sectors that the GCC countries have not entered suggests that the missing sectors are sophisticated sectors like many manufacturing industries and high-skilled services linked to these industries. Even in many oil and oil-related industries such as oil extraction or petrochemicals, intermediate goods and services like machinery, equipment, and geophysical exploration were not largely developed unlike in other advanced oil exporters like Norway and Canada (Cherif and Hasanov 2016, 2019b). As observed earlier, the relative stagnation of productivity and income is not puzzling any more as sophisticated sectors either did not exist or had little linkages to the rest of the economy (Figures 11-12). These missing sophisticated sectors are the ones that need to be developed for sustained growth, good-paying jobs, and inclusion (Aghion, Cherif, and Hasanov 2021). Indeed, these are the sectors that catapulted the Asian Miracles to high-income status in a couple of generations.

Figure 14. Tackling Government Failures in the GCC Countries

A. Global Competitiveness Index vs. Infrastructure, Average Rankings over 2007-2019

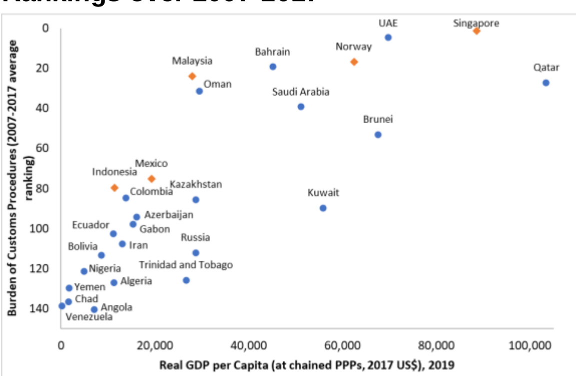


B. Monopoly Related Indicators, Average Rankings over 2007-2017



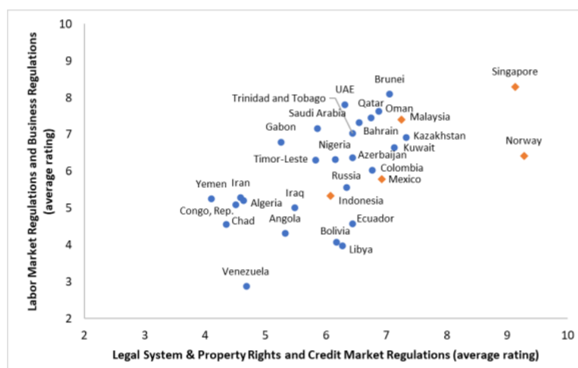
Source: World Economic Forum (Global Competitiveness Index rankings for various years, data downloaded via World Bank).

C. Burden of Customs Procedures, Average Rankings over 2007-2017



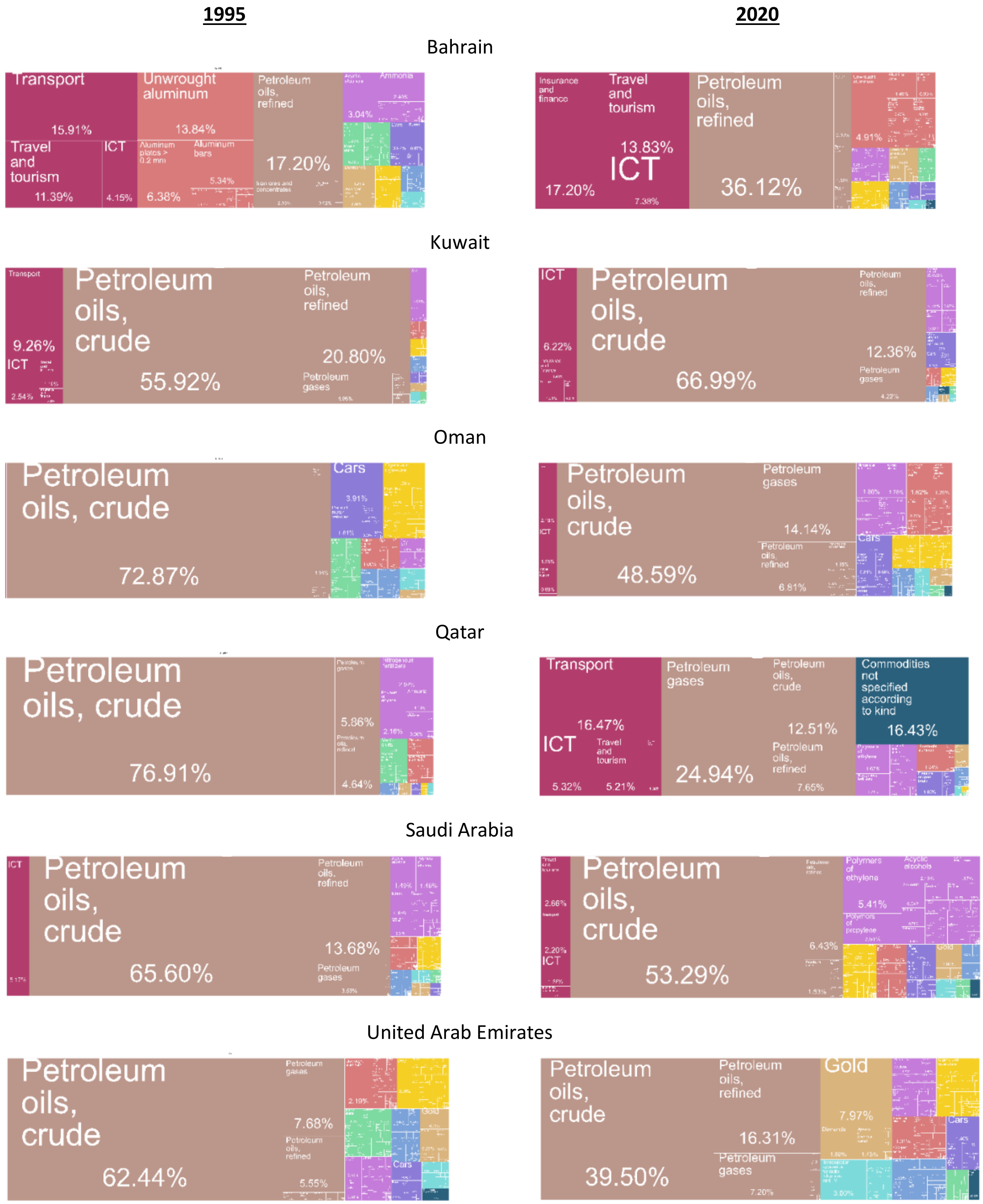
Sources: World Economic Forum (Global Competitiveness Index rankings for various years, data downloaded via World Bank), and Penn World Table, version 10.01 (Feenstra et al. 2015).

D. Governance Indicators, Average Ratings over 2000-2020



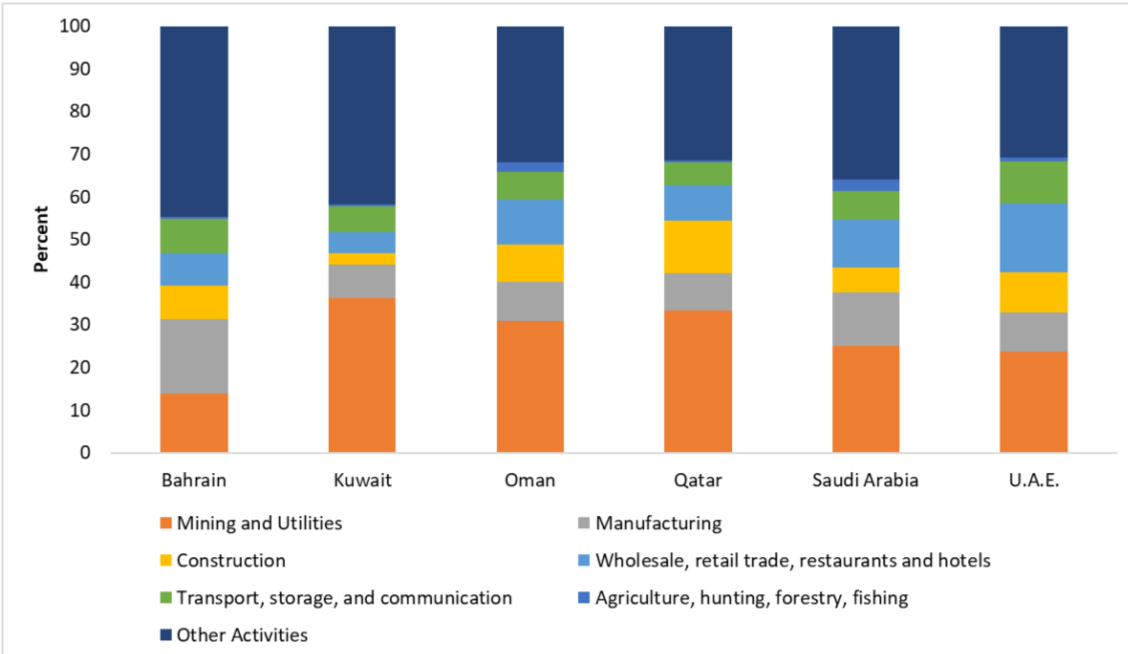
Note: Ratings are out of 10. Ratings are averaged both over indicators and years.
Source : Fraser Institute (Gwartney et al. 2022).

Figure 15. Export Composition of GCC Countries



Note: Due to unavailability of services exports data for later years, Bahrain's 2020 exports chart represents the country's exports basket in 2018. Services exports data are not available for the United Arab Emirates.
Source: The Growth Lab at Harvard University. The Atlas of Economic Complexity. Available: http://www.atlas.cid.harvard.edu.

Figure 16. Decomposition of Real GDP by Sector in GCC Countries, 2019 (2015 constant $)



Source: National Accounts Section of the United Nations Statistics Division, National Accounts Main Aggregates Database. Available: https://unstats.un.org/unsd/snaama/Downloads (accessed May 20, 2023).

Resolving market failures to develop sophisticated sectors requires state intervention. However, the way the state intervenes and uses market signals as feedback is important, which could result in success or failure. Since the market does not take a chance on sophisticated sectors, the state should take a leading role, which Cherif, Hasanov, and Zhu call the "leading hand of the state" (2016). Once the state leads, resolving risk, alleviating uncertainty, providing finance and necessary public goods relevant for these sectors, including physical and human capital, and coordinating across various public and private sector players, the market follows. This is the type of intervention that is needed, and the successful experience of the Asian Miracles shows how to do it (Cherif and Hasanov 2019a, 2019b). This is "true" industrial policy, which is essentially Technology and Innovation Policy (TIP) as viewed through the lens of the Asian Miracles.

B. Principles of "True" Industrial Policy

The three key guiding principles of "true" industrial policy—technology and innovation policy, or TIP—are a focus on sophisticated sectors, export orientation, and competition and accountability. The experience of the Asian Miracles suggests that these three key principles were paramount to their success (Cherif and Hasanov 2019a, 2019b). These principles resulted not only in physical and human capital accumulation but also substantial productivity gains, created large exporters and industry champions, and fair and inclusive domestic markets (Aghion, Cherif, and Hasanov 2021).

Entry into sophisticated sectors is key to sustained and inclusive growth. Investment-based strategies are not sufficient in the long run for productivity gains, and innovation-based strategies are important for sustained growth (Acemoglu, Aghion, and Zilibotti 2006). In other words, factor accumulation alone is not enough, and to spur productivity growth, innovation is crucial. Sustained growth thus involves continuously introducing new goods and tasks (Lucas 1993), moving up the quality ladder (Aghion and Howitt 1992), creating new technologies (Romer 1990, Jones 2005), and improving production and business processes. These economic activities largely occur in sophisticated sectors. These sectors are sophisticated because they involve large amounts of R&D, learning-by-doing, a high content of intermediate goods and services, linkages with other tradable industries, and spillovers to other firms and industries through agglomeration (Marshallian externalities). These sectors are not necessarily high value-added, which tend to be capital intensive or service-oriented (e.g., petroleum, chemicals, utilities, and finance). Rather, these industries continuously evolve and create new products and processes resulting in productivity gains for sustained growth. Lucas (1993) argued that to continuously introduce new products, a country must be a large exporter. Indeed, export sophistication is one of the most important and robust empirical determinants of growth (Hausmann, Hwang, and Rodrik 2007, Cherif, Hasanov, and Wang 2018).

A crucial element in developing sophisticated sectors is homegrown innovation or technology creation by domestic firms. The extent to which domestic firms drive innovation and industry development increases the odds of reaching high income status in a short time (Cherif and Hasanov 2019c, 2015). The taxonomy of private R&D spending in innovative countries suggests that the largest spenders are large domestic firms in sophisticated sectors, mostly manufacturing (Cherif and Hasanov 2019a, 2019b). Relying on multinational corporations (MNCs) or domestic state-owned enterprises (SOEs) may not produce desired outcomes. For instance, the development of the electronics sectors in Malaysia and Korea took different paths as Korea put a strong emphasis on domestic technology creation through local conglomerates, or chaebols, while Malaysia was more focused on attracting FDI and MNCs and was not very successful in spinning out local technology firms (Cherif and Hasanov 2019c). In the latter case, the creation of domestic value chains and backward and forward linkages, investments in R&D, and learning-by-doing would be limited. In contrast, the focus on private domestic firms, eventually becoming large firms, to compete in international markets, would create larger spillovers and productivity gains.

Second, export-orientation is crucial to have access to large markets, compete with the best, and more important, create market signals. To compete on price and quality, firms must produce at scale. For small open economies like many oil exporters, access to the global market provides this opportunity. Even large economies that could theoretically achieve big economies of scale domestically, need a global market. Competing with the best, or the most advanced and innovative firms globally, does align incentives correctly to continuously improve, innovate, and stay ahead of competition, expanding the technological frontier. As late Andy Grove of Intel once famously said, “Only the paranoid survive.” More important, export-orientation provides market signals. It allows policymakers to assess whether firms are making progress, especially firms that have received state support. It also aligns manager incentives with the firm's success as competing externally would mitigate corruption and cronyism problems. Historically, import-substitution industrialization (ISI) policies largely failed in the 1950s-60s as, despite the initial increase in manufacturing production, many firms and industries eventually faltered under mismanagement, low quality production, and negative macroeconomic shocks (Cherif and Hasanov 2024).

Third, to increase chances of success in growing industries, a key criterion is not only competition in international markets but also domestic competition, combined with accountability for the state support received. Although export-orientation provides external competition, it is not sufficient as it is not clear ex-ante which domestic firm could succeed in its quest to become a global player. Rather than “picking winners,” the state should encourage domestic competition to weed out weak players and help reallocation of resources to most innovative and efficient producers.[11] In this regard, it is not the state but the market that "picks" winners. In addition, both domestic competition and export-orientation provide important market signals, making firms accountable for the support received. These are key accountability criteria, and other performance criteria such as R&D spending and patents could be considered as well. The key is that the support received is not a blank check and comes with conditions related to a firm's growth.

There are various recurrent arguments against industrial policy, but a "true" industrial policy has been tried by a handful of economies. The arguments include the prevalence of industrial policy failures in the past, the potential to encourage rent seeking activities, poor governance, and limited state capabilities to implement policy, and the perennial danger of "picking winners" by the government. Although many countries did use state intervention to develop new industries, very few countries followed all the principles outlined above. Indeed, most countries followed an Import Substitution Industrialization strategy as opposed to export orientation (Cherif and Hasanov 2024). Moreover, it is difficult to disentangle luck from policies when studying cross-country growth outcomes, which makes the interpretation of "failures" potentially misleading (Cherif and Hasanov 2023). The idea that industrial policy would worsen rent seeking, especially in the presence of poor governance is not borne out by the experience of the Asian miracles (Chang 1991). Moreover, this argument is particularly spurious in the context of oil exporters, where the potential for rent seeking is much greater for large infrastructure projects compared to TIP, which calls for a multiform support system for the creation and growth of firms competing on international markets. As for picking winners, as argued in this paper, oil exporters have in general already picked a winner for the past few decades, that is, the non-tradable sector. The principles of TIP imply supporting a tradable sector (mainly a sophisticated one) rather than firms, which means restructuring or closing non-performing firms when needed as was the case in the Asian miracles.

C. From Principles to Practice: A Sketch of the Industrial Strategy

a. Major Elements of the Strategy

A strategy for export diversification needs to address several key elements. First, the objectives need to be set, followed by a sector selection, containing an analysis of sectors to pursue and a roadmap for the results (e.g., "quick wins" vs. long-run outcomes). Once the strategy, or "what," is in place, then the assessment of "how" needs to be developed. Essentially, all key binding constraints to the industry or sector creation and development need to be alleviated with various tools such as financing, skill training, tax and regulation, infrastructure, and institutional and legal support, available in policymakers' toolbox. The "how" section, or the "tactics" of the strategy, would need to be detailed in industry and market analysis reports.

The strategy first needs to specify its key objectives. The ultimate objective is the development of non-oil exports while ensuring productivity growth and good-paying jobs. GDP growth is a secondary goal, and, in the transition, there could even be a period of negative growth. Indeed, as argued above, the preponderance of non-tradable services means that a redeployment of resources towards the tradable sector could be initially accompanied by a shrinking of the non-oil sector, especially low-skilled services. We have also argued that to attain these objectives, export-orientation in sophisticated sectors is important. In this regard, intermediate goals, or targets, in achieving productivity gains and employment amount to exports and innovation. Building a dashboard of data related to these objectives—exports, or global market shares, of goods and services, innovation indicators like patents and R&D spending, the number and type of jobs created, and productivity and

[11] Studwell (2013) also argues for combining export orientation with domestic competition.

growth measures like labor productivity, TFP, and business dynamism (e.g., firm entry and exit, startups, firm growth, and product variety)—would provide a timely monitoring and assessment of policy support. In addition, granular data on firms, production, and inputs/outputs in a supply chain as well as market indicators globally (competition, trade, etc.) would further provide relevant information to aid policymakers in the industry and market analysis.

Once the objectives are clearly set, a sector or industry selection analysis needs to be conducted. This is the core of the strategy. The analysis needs to identify industries in three areas: existing, emerging, and potential. The strategy also needs to produce a roadmap with a timeframe for reaching the objectives, short run vs. medium- to long-run results or outcomes. We propose three strategies to implement this sector-time taxonomy.

We argue that a combination of the three strategies—snail crawl, leapfrogging, and moonshots— would help achieve the goals while minimizing risks (Cherif and Hasanov 2019b). These descriptions refer to how far from the current production structure or the capabilities set a country is entering and to what extent these activities are undertaken by domestic firms. The premise is that sustained growth is more likely following the entry into more sophisticated products where technology is mostly developed by domestic firms. In the first approach—a snail crawl strategy—the sectors pursued could be "close" to the sectors in the country's current production structure, or more relevant, to the tasks and activities that require similar or close capabilities to those that local firms possess—essentially, a comparative advantage method of selecting industries (Hidalgo and Hausmann 2009). In this regard, a snail crawl approach explores opportunities essentially in existing sectors without a notable expansion of domestic capabilities. This approach may produce some quick wins, for example, by providing fertilizers to farmers, but not sustained growth. At the other extreme, the moonshot approach consists in going far beyond the current comparative advantage into sectors, tasks, and activities that are increasing in the level of sophistication, or the capabilities set. Meanwhile, domestic firms would lead technology creation. Korea's Hyundai in the car industry or Brazil's Embraer in the aircraft industry are stark examples of a moonshot approach. It took decades and heavy investment to enter a high technology sophisticated sector.

In between, there lies a spectrum of 'leapfrogging" strategies with varying combinations of technological leaps and ownership. Attracting FDI in electronics, a sophisticated industry, while relying exclusively on MNCs in the production process and importing the most critical inputs would be an example of high-tech sector/low ownership. Another example consists in full domestic ownership and innovation in a medium technology or industry. Malaysia pursued both types of leapfrogging strategies simultaneously, in electronics for the former, and in rubber and palm oil for the latter. Chile did the same in the salmon industry. Leapfrogging does also involve state intervention, including in the cases of Malaysia and Chile (Cherif and Hasanov 2019c). However, the spillovers and productivity gains would also lie between the snail-crawl and moonshot approaches. These strategies were typically successfully pursued by countries that managed to reach middle-income status. But the absence of sufficient "moonshots" could also explain their inability to reach high-income status, in contrast to the Asian miracles.[12]

Leapfrogging could also potentially create some quick wins, where entry/sector requirements are not substantial, but most sectors pursued by leapfrogging and moonshot strategies would be transformative and may produce substantial results in the medium to long term. Table 1 shows these three strategies in the space

[12] The empirical literature on the spillovers effect from FDI is mixed (e.g., Huang 2004 and Wei and Liu 2006). In the context of China, Jiang et al. (2018) show that join ventures with domestic firms led to greater spillovers and technology transfers compared to fully owned FDI.

of technological distance (a capability set or comparative advantage) vs. ownership (of firms/technologies). Overall, by pursuing these strategies, in some sectors—whether existing, emerging, or potential—improvements can be made relatively quickly, reaping the benefits in short time, while in others, it will take time to experiment and build.

Table 1. A Taxonomy of Sector Selection Strategies

Ownership/Technological distance	*Existing Capabilities / Low-tech*	*Around existing capabilities / Medium-tech*	*Beyond existing capabilities / High-tech*
Low	Snail-crawl	-	-
Medium	Snail-crawl	Leapfrogging	Leapfrogging
High	-	Leapfrogging	Moonshot

These three broad strategies involve different time and risk structures, and an optimal overall strategy would combine the three at the same time. The time dimension involves “quick wins” for the short run as well as “transformative gains” for the medium to long run. The risk of jumping further away from existing capabilities or to high-tech sectors is the highest while that of pursuing efficiency improvements in existing industries is the lowest. Although the risk seems to be the lowest in continuing producing what is already being done, the interaction of time and risk may suggest that achieving “transformative gains” with the snail-crawl strategy has in fact the highest risk. In this regard, the pursuit of all three strategies should provide the highest benefits in both short and long runs while mitigating the risks over time.

“Quick wins” could be characterized by achieving results in a short time. For the snail crawl strategy, the key is productivity improvements—efficiency gains—in existing and emerging industries and firms. Opportunities for improvements and expansion, especially globally, could be identified, tested, and then disseminated across firms and industries. Identifying “quick wins,” or industries that could produce the desired results in the short run, is important for several reasons. First, for economic purposes, growth must be generated from the outset to start improving living standards and help policymakers address many fiscal, social, and other priorities with less tradeoffs. Second, quick wins create a demonstration effect for the policies pursued. Moreover, this approach creates opportunities for policymakers to assess, learn, and adjust relatively fast to make sure that policies succeed in their objectives. Lastly, for political economy and macroeconomic stability purposes, the continuity of industrial policy is key to creating a long-lasting success, and without quick wins, it may be hard to justify the continuation of policy with the long run impact or buy time for “transformative gains” in the production structure of the economy.

For leapfrogging around the current production structure, in existing and emerging sectors, young firms and startups could be given needed support for growth and expansion—a scaleup approach. Supporting the entry of new firms and more startups could also be beneficial, including those in potential sectors. It may also involve enhancing or building new partnerships for existing domestic firms operating in the export sector, typically petrochemicals or agri-industry, aimed at acquiring new capabilities. In addition, preparing the ground for the development of a sophisticated sector as part of leapfrogging and moonshots with investment in physical and human capital would also generate short-run growth and employment gains.

Although “transformative gains” are only expected to be generated in the medium to long run, nonetheless, they require action in the short run. For the existing firms and industries in sophisticated sectors, to sustain growth beyond the snail crawl strategy, a focus on innovation is crucial. Firms must stay competitive in the global marketplace, and innovation will give firms this advantage. It also implies that new startups and firms have to enter the existing or “close” industries to preserve competition and keep incumbents innovating and competing. The leapfrogging strategy implies supporting growth of emerging or new sectors further away from existing industries, as firms grow large and expand globally. Eventually, a new industry becomes the existing sector, requiring a stronger focus on innovation as well. For moonshots to succeed in the long run, a much more intense use of the whole innovation system—support for startups, scaleups, industry growth, and innovation—is required.

Quick wins and transformative gains could be identified in the existing, emerging, and potential sectors, but fully developing sophisticated sectors may only materialize in the medium to long run. In addition, the level of ambition and risk-taking would determine the relative focus of strategies pursued—snail crawl, leapfrogging, or moonshots. At the same time, it is not only the existing sectors that could produce quick wins, but emerging or potential sectors could grow potentially quickly early on as well. For instance, many oil and gas exporters have petrochemical or chemical industries that usually require a lot of intermediate goods, or inputs, for production such as equipment and machinery and basic chemicals. These backward linkages, or parts of the value chain, could create opportunities in the short run, that is, quick wins, because learning has already taken place or does not require a lot of resources and time (snail crawl). In contrast, other backward linkages that require a lot of resources and time would have higher likelihood of success in the medium to long run (leapfrogging and moonshots). Essentially, the latter would amount to an entry into a new sophisticated sector. Similarly, with emerging and potential sectors, the three strategies discussed could explore both quick wins and transformative gains. Sectors that require less resources, time, and learning—most likely, around existing industries (snail crawl)—could have higher chances of success in the short run, or quick wins. Perhaps information technology and software development fit the description. Advanced manufacturing, in contrast, may require many more resources, being further away from the current production structure (leapfrogging and moonshots), and may generate transformative gains in the long run.

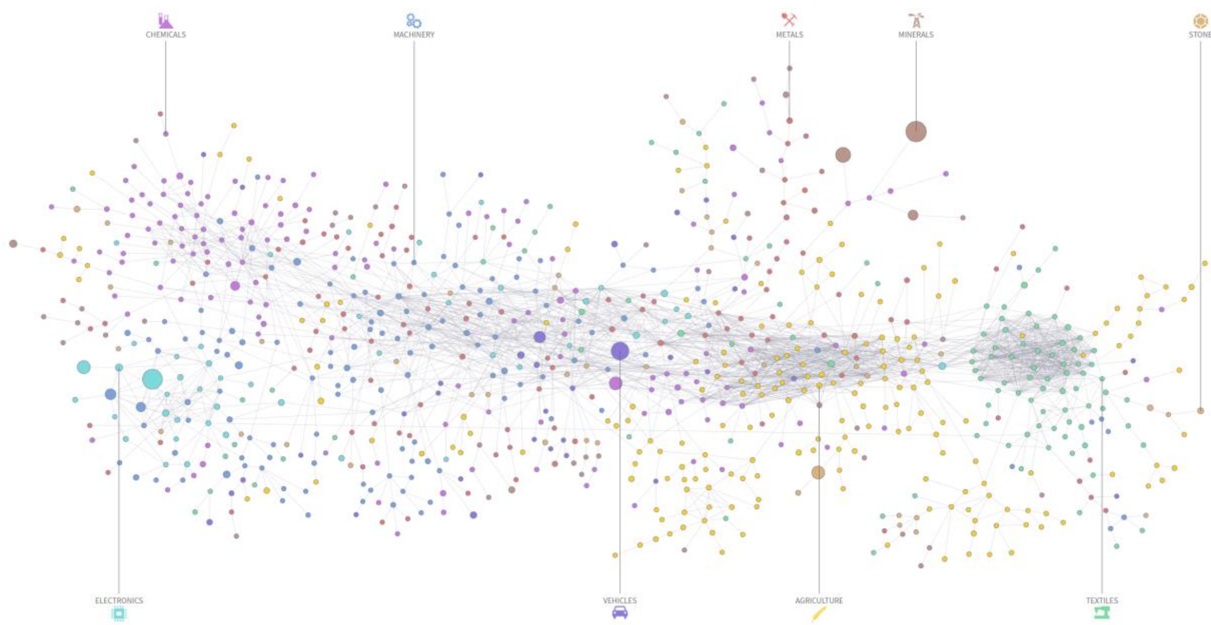
In the sector identification stage, once broad or aggregate sectors such as renewables, electric cars, or electronics have been selected, a detailed industry and market analysis needs to be done. The analysis needs to identify specific sectors, or subsectors, worth pursuing with the expected outcomes in the short run vs. the long run. In addition to standard industry and market analysis examining strengths, weaknesses, opportunities, and threats (SWOT), the report needs to explore the binding constraints and policies needed to alleviate them. These binding constraints would depend on the sectors and subsectors selected, ranging from land and infrastructure, skills, market, legal, and business regulations, and other specific requirements. In addition, resources, time, and learning needed will need to be assessed on a spectrum of the desired production structure (from snail crawl to leapfrogging and moonshots).

The last element of the strategy could provide an overview of “how” the identified constraints in sectors and subsectors could be eliminated for industry development and firm growth. Whether these are legal changes, improvements in market competition, introduction or modifications of tax breaks, or access to loans, various tools policymakers have at their disposal need to be clearly geared to specific constraints and challenges that could inhibit the industry and firm growth. The identification of constraints and tools to solve them could also provide a clearer picture of policy assessment over time and across industries. Resources needed and an accountability framework for firms need to be specified as well.

b. Sector Selection Analysis

A well-known approach for selecting sectors is the revealed comparative advantage method using a product space of country's exports (Figure 17). The Atlas of Economic Complexity at Harvard University's Growth Lab graphically depicts a country's export composition and current product space, highlights new products and their growth in the export basket, and finally proposes a strategy to diversify.[13] This research was pioneered by Hausmann, Hwang, and Rodrik (2007) and Hidalgo and Hausmann (2009), and their key idea that the complexity of the productive structure is important, which supports the argument in favor of focusing on sophisticated sectors. The Economic Complexity analysis builds on what a country exports and its existing capabilities in the product space and proposes diversifying into products with similar knowhow, or links to the current production (comparative advantage approach). Since the production structure of many oil exporters exhibits a low-density network, that is, has a low number of sector links to the mining sector (Figure 18), it is not clear into which sectors/products oil exporters should diversify. This methodology calls for a "strategic bets" approach to select products that are not too "far" from the current export structure and existing knowhow while complex enough to provide growth opportunities. Going into more complex products is even more important for richer oil exporters like the GCC countries that have high wages.

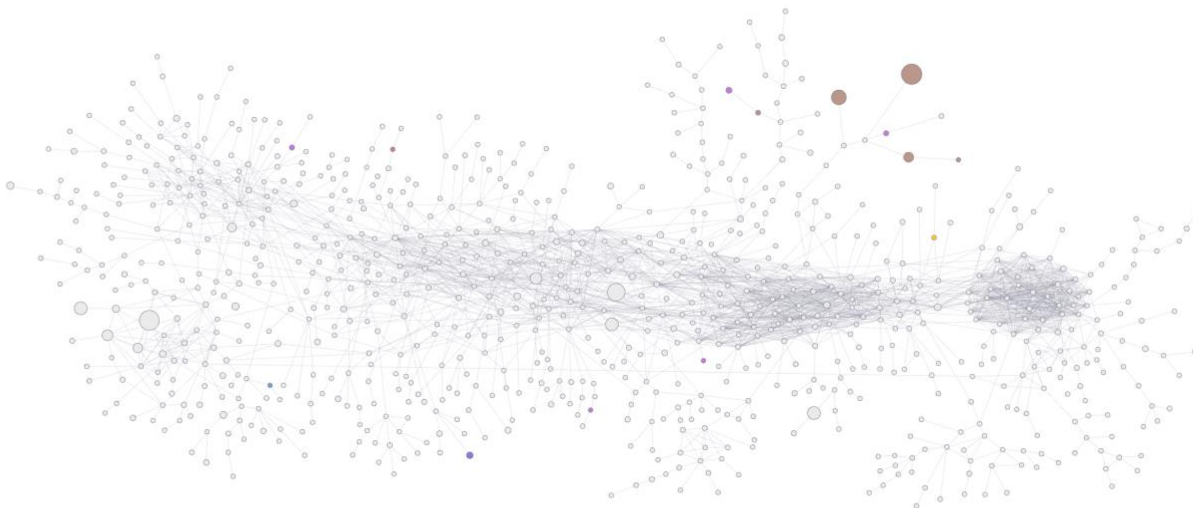
Figure 17. The Product Space



Source: The Growth Lab at Harvard University. The Atlas of Economic Complexity. Available: www.atlas.cid.harvard.edu.

[13] The Atlas of Economic Complexity. Growth Lab, Center for International Development. Available: https://atlas.cid.harvard.edu.

Figure 18. The Product Space of Kuwait, 2020



Source: The Growth Lab at Harvard University. The Atlas of Economic Complexity. Available: www.atlas.cid.harvard.edu.

In selecting industries to pursue, policymakers could use three analytical methods as part of snail crawl, leapfrogging, and moonshot strategies. The first one, an existing industry method, involves examining closely the current production structure, or more precisely, linkages and tasks performed in the existing and emerging industries. The second one, a narrative method, examines the past success cases of countries that were at the same level of development as a country in question today and applies them to today's context. Lastly, in a prospective fashion, the "industries of the future" method amounts to entering very sophisticated industries from the onset, which is part of a moonshot strategy. As discussed earlier, there are three types of sectors to explore—existing, emerging, and potential—keeping in mind the timeframe required, quick wins and transformative gains, to achieve results and risks involved.

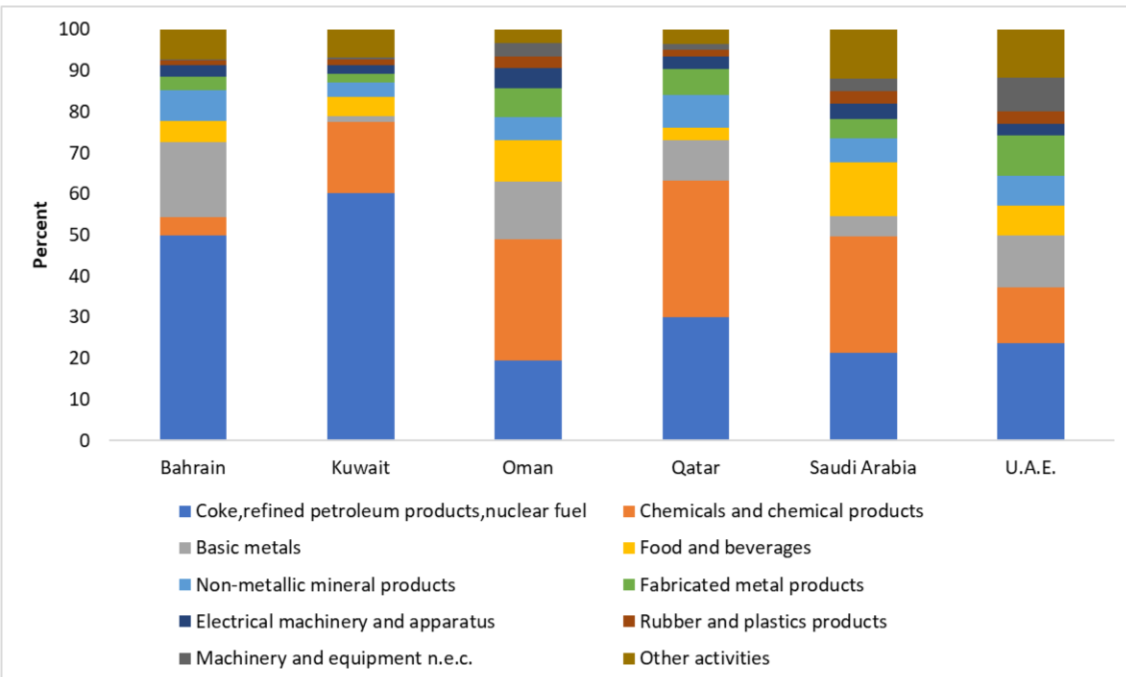
In the existing industry method, a strategy needs to examine the existing production structure with its linkages and tasks performed by foreign and domestic entities. These linkages and tasks as parts of the value chain, could create opportunities for domestic firms, whether for entry or expansion. In many oil-exporting countries, oil/gas and related sectors are a large part of the domestic tradable sector. A significant part of this sector is being dominated by foreign multinationals that largely use imported inputs. Domestic oil companies generally do not account for a significant share of production of sophisticated components and inputs like drilling and extraction equipment and related service activities such as geophysical exploration and data analysis. The tasks and activities that could be done by local firms in the short to medium run would help build higher domestic value added and create good-paying jobs. What is important to assess in this analysis is not only pursuing forward linkages in the oil and gas sector like petrochemicals and refining, which many oil exporters have done, but also examine opportunities present in the backward linkages like drilling equipment, machinery, boats, vehicles, exploration and drilling data analysis, engineering, and other sophisticated activities and tasks.[14] Some of these activities could be close to existing capabilities—snail crawl sectors—and may be quick wins, producing desired results in the short run. Other subsectors could constitute leapfrogging and moonshots,

[14] Exploiting such backward linkages is export oriented by nature as it is part of an export-oriented industry. This can be done without falling back into an import substitution strategy (Cherif and Hasanov 2024) and it does not mean disconnecting from global value chains. On the contrary, as shown by the experience of Japan and the Asian miracles, intra-industry trade and integration in GVCs can increase while global competition increases.

jumping above or far beyond from the current capability set, producing perhaps a few quick wins but mostly laying out the ground for transformative outcomes and the evolving production structure toward sophistication.

The large subsectors of manufacturing in the GCC countries are in oil-related and metal production (forward linkages), but the production of goods and services featuring backward linkages such as machinery and equipment is small (Figure 19). In addition, these linkages create opportunities for entry into global value chains (GVCs) and may require hyper specialization in a niche market. Similar to the production of many products that are mostly produced in or dominated by a certain location, the economies of scale and agglomeration would allow these new sectors to be competitive on the global stage. The backward linkages and GVCs further provide links to industries unrelated to oil and gas that create more diversification opportunities in the future, especially as the energy transition accelerates.

Figure 19. Decomposition of Manufacturing Output in GCC Countries, 2019 (nominal national currencies)



Note: Bahrain's data represents its manufacturing output decomposition in 2018.
Source: United Nations Industrial Development Organization, INDSTAT 2 2022, ISIC Revision 3. Available: www.unido.org (accessed May 21, 2023).

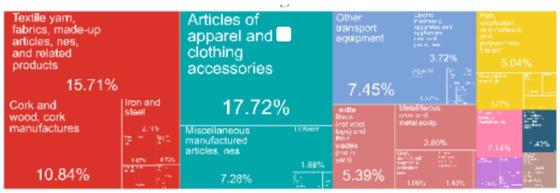
The second analytical method is examining past successes, inferring the sectors pursued, and applying the lessons to today's environment. The Asian Miracles such as Korea and Singapore are the most well-known success cases in modern history, or the second half of the 20th century. Malaysia is another interesting case that has been successful in growing at high rates and improving its living standards substantially but has not been able to do this as well as Korea. Malaysia is still in the middle-income trap with income of less than 50 percent of the U.S. real GDP per capita while Korea is closer to 75 percent, notwithstanding that Korea was much poorer than Malaysia in the 1960s-1970s and overtook it only in the mid-1980s. The export structure of

Korea over time shows that it kept growing not only its total exports but also its sophistication structure (Figure 20). Interestingly, textiles, a relatively low sophistication product, was a large part of its export structure for decades until the product essentially became irrelevant. Korea has started entering sophisticated industries relatively early on, and the manufacturing part of its export structure was nonexistent in the 1960s and miniscule in the 1970s but was steadily rising while getting more sophisticated over time to become the dominant export. Malaysia's export structure, interestingly, has largely followed a similar pattern (Figure 21).

Figure 20. Korea's Export Structure (1970-2020)

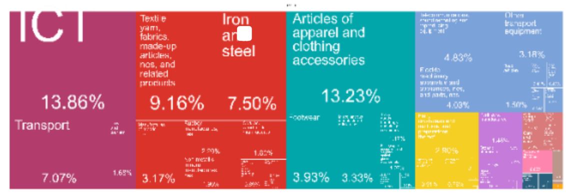
1970

(Total exports: $805m)



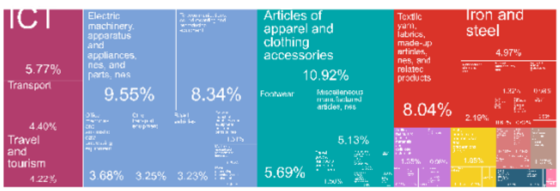
1980

(Total exports: $22b)



1990

(Total exports: $75b)

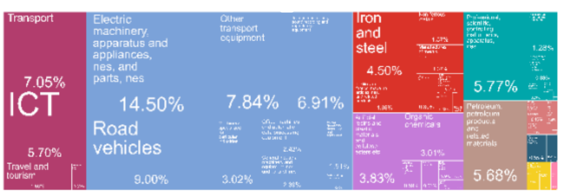


2000

(Total exports: $202b)

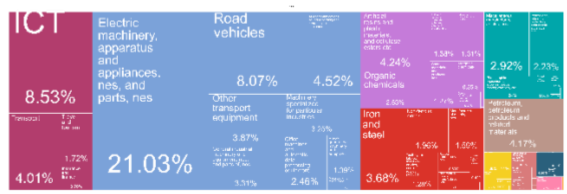
2010

(Total exports: $553b)



2020

(Total exports: $596b)



Note: Services exports data is not available for 1970.

Source: The Growth Lab at Harvard University. The Atlas of Economic Complexity. Available: www.atlas.cid.harvard.edu.

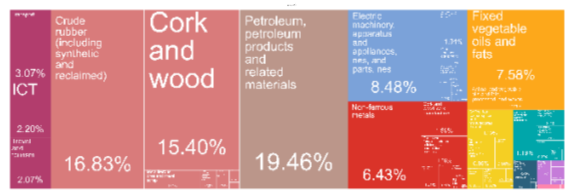
Figure 21. Malaysia's Export Structure (1970-2020)

1970

(Total exports: $1.9b)

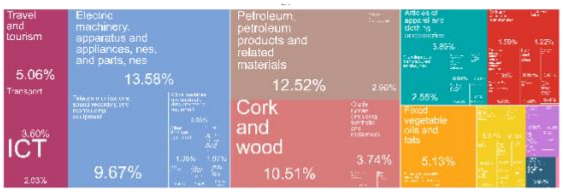
1980

(Total exports: $15.4b)



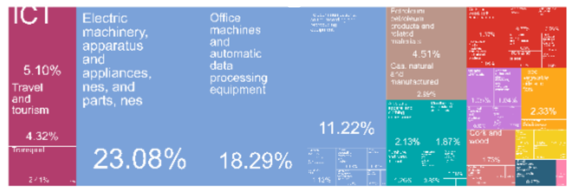
1990

(Total exports: $33.3b)



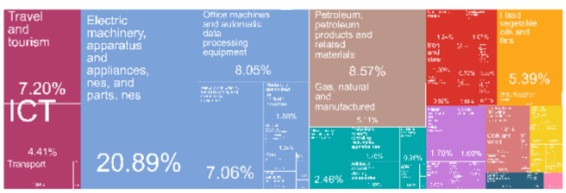
2000

(Total exports: $116b)



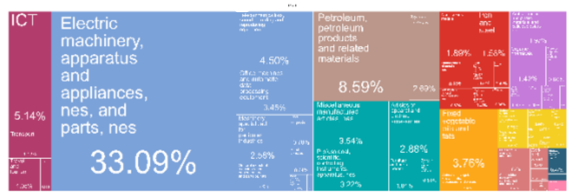
2010

(Total exports: $252b)



2020

(Total exports: $287b)



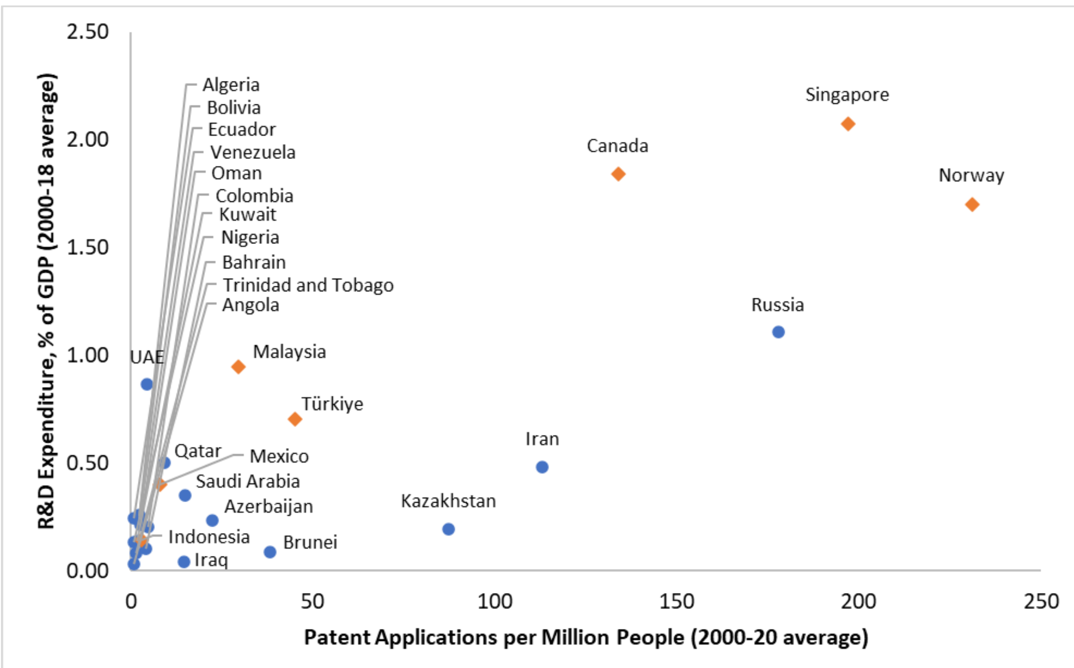
Note: Services exports data is not available for 1970.
Source: The Growth Lab at Harvard University. The Atlas of Economic Complexity. Available: www.atlas.cid.harvard.edu.

The experience of Korea and Malaysia suggests using the three approaches of snail crawl, leapfrogging, and moonshot at the same time. While producing and exporting close to and around its existing capability set in the 1960s and 1970s like textiles, minerals, and agricultural goods—a snail crawl strategy—both countries have been entering sophisticated sectors like cars, ships, and electronics to create a favorable dynamic of learning and exporting more sophisticated products—leapfrogging and moonshot strategies—that became prominent in later decades. In this regard, examining revealed comparative advantage (RCA) indicators would not necessarily show that the RCA sectors are the sectors to focus on (Cherif and Hasanov 2019). Although initially the sophisticated sectors pursued were away or far away from the existing capabilities (and had low RCA), eventually, moonshots became leapfrogs and have turned into the snail crawl today as the countries' capabilities and production structure evolved. This method suggests that advanced countries have to keep this dynamic in place as leapfrogging and pursuing moonshots would imply the development of much more sophisticated products, or "industries of the future."

Identifying the "industries of the future" is a third method of the sector selection. It seems it is hard to know which industries would be dominant in the future, but in fact, these industries of the future are relatively obvious. One can observe emerging technologies, market trends, startups, young firms, and evolving global and local challenges to infer the potential industries aimed at tackling them. More simply, the strategies announced by all major economic blocs, the U.S., EU, and China, contain almost the same list of target sectors, e.g., AI, quantum computing, robotics, sensors, biotechnology, nuclear fusion, space exploration, and technologies tackling the energy transition and climate change. These sophisticated industries—with many linkages and spillovers, large content of intermediate goods, and high innovation intensity—provide ample opportunities for many countries and firms to enter whether as a snail crawl, leapfrogging, or a moonshot strategy.

Diversification by local companies into more sophisticated sectors, including “industries of the future,” would require higher R&D spending and a greater level of innovation as proxied by patent applications. These indicators have historically been low in most oil exporters, lagging those of their more diversified counterparts (Figure 22).

Figure 22. R&D Spending vs. Patent Applications



Source: Ritchie et al (2023).

In general, countries should pursue a sector selection strategy based on a few key elements. First, snail crawl, leapfrog, and moonshot strategies, as defined by selecting sectors based on the proximity to the current capability set or production structure, need to be explored and pursued simultaneously. Second, these strategies need to examine existing, emerging, and potential sectors and identify “quick wins” for the short run vs. “transformative gains” for the long run. The opportunities could become apparent as tasks and linkages in the existing and emerging industries, especially backward linkages, industries successfully pursued by East Asian and other countries, and “industries of the future” are closely examined. The current production structure thus provides important clues for the sector selection, and the three strategies—snail crawl, leapfrogging, and moonshot—will determine how ambitious and risk-taking policymakers would like to be. Detailed industry and market analysis, including resources, time, and learning needed, is an important part of the industrial strategy.

Finally, in the sector selection, not only the current production structure or the capabilities set but also a few other features are important to consider. The country’s size and its resources are relevant as they would determine whether entering a few or many industries is needed. In addition, if producing a final good, which requires a lot of resources and potentially a vertical integration of production, is too costly, an entry into the intermediate good production or global value chains could be more feasible.

c. An Early Appraisal of Diversification Strategies 2.0: From Long-Term Visions to National Systems of Diversification

As noted in our introduction, policymakers in oil-exporting countries have generally shown heightened awareness about the importance and urgency of diversifying their economies since 2014 with a persistent fall in oil prices. They have laid out long-term visions and undertaken ambitious investment projects, including Special Economic Zones, to an extent comparable to the first wave of diversification attempts in the 1970s. These experiences, which can be described as Diversification Strategies 2.0, vary, and it is too early to measure their effectiveness, especially in terms of export diversification and productivity growth. However, we critically assess salient features of the archetype of the new wave of diversification strategies through the lens of our framework, identifying the following avenues to help improve the chances of success.

When translating visions of economic transformation, goals and aspirations into short-term policies, there is a need for a broad trajectory or timeline of actions and an associated national system of innovation to clarify a hierarchy of policy priorities. We argue that, ultimately, policies need to be aligned to fulfill the strategic objectives of the visions and that all state actions and investments in tangible and intangible assets are coordinated. A trajectory is defined as an approximate timeline for the replacement of oil and gas as the main sources of income with alternative export industries. The state sets broad but concrete objectives in terms strategically betting on certain sectors within a certain timeframe, i.e., a certain share of oil exports would be replaced by exports from specific industries within a specified time horizon. This approach would clarify the policy priorities, the need for coordination, and how to allocate both financial and human resources to the stated objectives. In other words, it implies the establishment of a national system of diversification, similar to the National System of Innovation (NSI) (e.g., Lundvall 1992, Nelson 1993 and Freeman 1995), with the objective of changing the current growth model. As in the NSI, all the tools are mobilized to spur development of and innovation in non-oil exportable industries (e.g., education, public research institutes, financing vehicles) while taking into account the specificity of oil-exporting economies and the urgency of diversification.[15] This includes setting up an adequate institutional apparatus to drive the system (Cherif, Hasanov and Xie 2024), as well as the coordination with fiscal, monetary, and financial policies, considering the fiscal costs and macroeconomic effects of the policies pursued.[16]

In contrast, Diversification Strategies 2.0 typically deal with the long run without offering a concrete picture of how each industry selected would contribute to replacing oil exports. This implies that without a set trajectory, there is no sense of priorities in terms of infrastructure, reforms, or human capital investment. There would also be a lack of concrete intermediate goals, making the strategies difficult to assess in the absence of measurable feedback. The required approach would also force a discussion of the macroeconomic policies needed to avoid the Dutch disease while finding sources of financing when and if oil revenues start falling rapidly. As argued

[15] Diversification could also help increase female labor participation in a context where most of university graduates are female (Francis, Hasan and Zhu 2016).

[16] Fossil fuel subsidies are prevalent in oil-exporting countries (explicit subsidies of 5.1 percent of GDP, see Box 1.2 in *Fiscal Monitor*, October 2023), and GCC countries have among the highest emission-intensity of GDP. Phasing out fossil fuel subsidies could support energy efficiency and diversification, while helping offset some decline in revenue from reduced fossil fuel rents.

earlier, while the economy switches from oil driven non-tradable sectors toward tradable industries, GDP in general, and non-oil GDP in particular, would take less priority as an indicator to assess policies in favor of a dashboard of indicators such as growth of non-oil exportable sectors (e.g., value added, employment, and volumes), exports, patents, and productivity.

To illustrate our argument, we give the example of an oil exporter betting on microchips as a potential industry for its post-oil future (see previous sections on sector selection), aiming at replacing 25 percent of its oil exports within 10-15 years. This objective sets an indicative path for the rise of this export industry with specific intermediate goals, and mobilizes state resources to provide incentives, infrastructure, inputs, and environment for the private sector to meet the challenge of international competition. In this context, the institutional apparatus would naturally enforce coordination and identify priorities in all relevant areas: the education ministry would focus on STEM in primary and secondary education, and solid-state physics and electronics engineering in tertiary education while sending massively students abroad to study electronics (Cherif and Hasanov 2019b). Instead of broad-based “structural reforms” to attract foreign skills, mostly in the non-tradable sector, labor market policy would focus on attracting skilled workers with long careers in the microchip industry with the intent of training local staff as was the case in Singapore (Yeo 2016). Structural, or growth, reforms to reduce red tape and excessive regulations and improve infrastructure and human capital may be helpful, but as noted by Cherif and Hasanov (2016), these reforms may not be sufficient.

The “system” approach would clarify which key reforms would contribute to diversification away from oil. For instance, infrastructure requirements become clear: a microchip production requires sizable and reliable power generation. Costa Rica increased its power generation by a third to lure Intel in the 1990s, which again reinforces the importance of a focused approach (Spar 1998). Meanwhile, this industry requires relatively little “heavy infrastructure” such as deep seaports or logistics hubs as they are typically transported by air. The need for, location, and purpose of a special economic zone would be determined by the objective of developing microchips. This approach would also give a clear direction to other policy tools such as financing, tax incentives, and public R&D. For example, the sizable SME funds, which are prevalent in oil-exporting economies, could be geared toward fast growing firms in microchip production and design. It would free resources for these programs, for example by not undertaking investment in infrastructure that is not required for the targeted industry.

Defining a trajectory prevents an overemphasis on “sideshow” sectors while focusing on sophisticated industries as argued earlier. "Sideshow” sectors are defined as those that are unlikely to generate sufficient exports or good-paying jobs to maintain the living standards of citizens. Diversification Strategies 2.0 typically emphasize tourism, finance, real estate, logistics, and potentially agriculture. These sectors could broadly be a potential source of non-oil exports, but for many economies with sizable populations or high levels of income, they are unlikely to reach the scale and productivity gains to replace a sizable share of oil exports, especially considering regional competition and the lack of regional coordination (Cherif and Hasanov 2016).[17] Moreover, these sectors are not typically associated with spillovers, and they create either too few jobs or too many low-paying jobs.[18]

[17] The context of oil-rich economies such as in the Gulf calls for a particular attention to incentive structure (Cherif and Hasanov 2016).

[18] Agriculture, if it is done in a modern fashion, would be highly productive and would employ a small fraction of the labor force. Tourism, on the other hand, has the potential to employ many workers but at low wages, which implies employing mostly low-skill foreigners in the context of high-income oil exporters.

It is common in Diversification Strategies 2.0 to put investment in renewables (e.g., importing solar panels for power generation) under the umbrella of diversification. Green power generation is helpful to fight climate change, but it may not be directly related to the effort to diversify away from fossil fuel exports. In contrast, investing in the capabilities to create the next generation of technologies to produce solar panels, batteries, EVs and other green technologies is not only a potential alternative to oil exports but also is the perfect hedge. Indeed, long-term oil prices and green technologies ought to be negatively correlated. Moreover, Diversification Strategies 2.0 still retain elements of import substitution, for example, by attracting FDI geared exclusively toward the domestic and relatively captive market in return for huge tax incentives and other state support. This corresponds to a version of ISI that has shown its limits in the past (Cherif and Hasanov 2024).

Diversification Strategies 2.0 have yet to incorporate a risk-based approach to investment as outlined in this paper. Investments, whether in infrastructure or portfolio investments by the SWF, should be assessed along two dimensions: (i) their contribution to the trajectory of diversification, that is, whether they contribute directly to the development of the selected non-oil exporting sectors; and (ii) their contribution to mitigating the risk of a persistent decline in oil prices before the emergence of alternative non-oil exports. Investments, especially large-scale ones, that are not fulfilling either of these dimensions in any tangible way, are worth (re)considering in the light of the risk of a persistent fall in oil prices (or financial risks for portfolio investments abroad). As argued above, even a small risk, in the order of 5 percent, may still lead to colossal “expected” losses in terms of opportunity costs, i.e., these resources could have been invested instead in developing the industries of the future.

IV. Conclusion

Oil exporters, including GCC economies, invested large amounts in the diversification of their economies, but historically little was achieved to prepare them against the looming energy transition. Under the umbrella of diversification, sector development focused on mostly non-tradable activities and an infrastructure, which in theory could be used for exports, but, in most cases, ended up facilitating more non-tradable services and imports.

With the acceleration of the energy transition, especially the increased adoption of renewables and EVs, oil and gas exporters have limited time to achieve export diversification. By 2040, oil price could converge to that of other energy commodities, and oil could become the new coal. Even if policymakers may consider that this scenario has a relatively small chance of occurring, the colossal costs it entails makes export diversification the utmost priority of oil and gas exporters.

To achieve export diversification within a decade, policymakers need to pursue an ambitious industrial policy. The goal of the policy is to develop sophisticated export-oriented sectors with strong domestic competition and an accountability framework for firms for the support received. To implement the policy, industrial strategy needs to focus on which sectors to develop, coupled with market and industry analysis, resources needed, policy instruments, and an accountability framework for firms.

The key component of the strategy, a sector selection, is implementing the three strategies—snail crawl, leapfrogging, and moonshots—depending on the proximity to the current production structure to pursue desired results both for the short run, “quick wins,” and the long run, “transformative gains.” The existing and emerging sectors of a country and potential sectors informed by the success cases of other countries and “industries of the future" could provide a large list of sectors to pursue. Detailed market and industry analysis with resources needed and constraints to be alleviated would further inform this choice. Clearly, moonshots are the most ambitious and potentially risky, at least in the short to medium run, whether in existing, emerging, or potential sectors.

All-in-all, the key element of industrial policy should be to build capabilities and enter ever more sophisticated sectors as the production structure evolves. This approach does not imply that only middle income and advanced countries should pursue sophisticated sectors; rather, these countries should pursue it more broadly while low-income countries should not shy away from entering sophisticated sectors since they take decades to grow.

Lastly, whether examining the current industry structure, or what other successful countries have done, or exploring the industries of the future, policymakers should not ignore serendipity and pivot as needed because failures in one sophisticated industry may lead to a success in another one. As such, it is trial and error in the sophisticated industries that is a must, eventually leading to the emergence of young firms and growth of new industries.

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