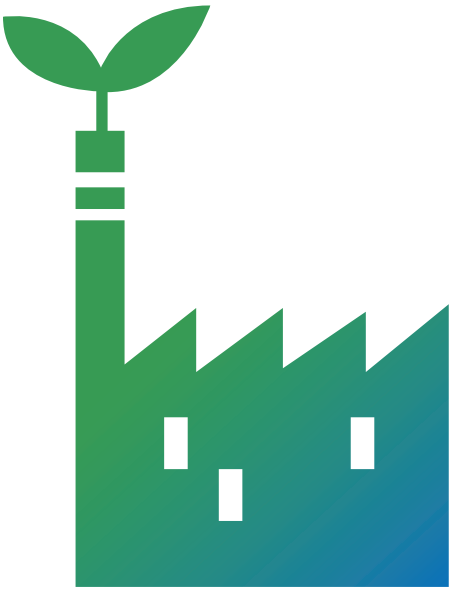

ENERGY MARKET CONSEQUENCES
OF AN EMERGING U.S. CARBON MANAGEMENT POLICY

Financial Imbalances, Middle East Industrialization, and Carbon Dioxide Emissions

Mahmoud A. El-Gamal, Ph.D.

ENERGY forum
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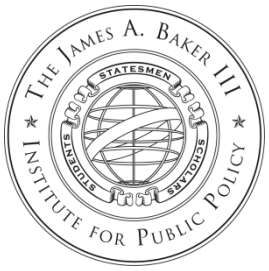

James A. Baker III Institute for Public Policy
Rice University

Financial Imbalances, Middle East Industrialization, and Carbon Dioxide Emissions

By

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Emerging energy and climate policies in the United States are accelerating the pace of technological changes and prompting calls for alternative energy and stricter energy efficiency measures. These trends raise questions about the future demand for fossil fuels, such that some energy-producing nations are reluctant to invest heavily in the expansion of production capacity. The abundance of shale gas resources in North America could allow the United States to utilize more gas in its energy mix as a means of enhancing energy security and reducing CO_2 emissions. However, this will only occur if U.S. policies promote and allow the benefits provided by natural gas to be realized. To examine these issues and changing trends in the U.S. energy and climate policy, the Baker Institute organized a major study investigating the North American and global oil and natural gas market consequences of emerging U.S. policies to regulate greenhouse gas emissions, as well as the potential role of alternative energy in the U.S. economy.

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Financial Imbalances, Middle East Industrialization, and CO_2 Emissions

Abstract

Early into the new millennium, many observers expected the financial imbalances between export-oriented East Asia, especially China, and consumption-oriented advanced economies, especially the U.S., to be sustainable. However, as El-Gamal and Jaffe (2010) have shown, the period of sustained growth despite those financial imbalances came to an abrupt end when petrodollar flows – forgotten since the 1980s – resurfaced to tip the balance and make the global credit bubble unsustainable.

One way to prevent petrodollar problems from continuing to resurface is for Middle-East countries to focus their efforts on enhancing intra-regional trade, especially in manufactured goods. Not only is this the proven path for overcoming the effects of the economic crisis, but it is also the path for enhancing the economic absorptive capacity of the region, thus ameliorating the cycle of petrodollar flows and the destructive credit crises that follow.

One of the potential side effects of industrialization in the Middle East would be significant increase in carbon emissions. This is indeed a major concern, especially given the recent focus in the region on energy-intensive industries and construction, which are not particularly friendly environmentally.

Using a large panel of 118 countries over the 40-year period 1969-2008, I show that although growth in industrial output (which includes mining, construction, electricity, water, and gas, as well as manufacturing) contributes significantly to the accelerated increase of carbon emissions, growth in manufacturing output does not. This suggests that carefully balanced industrial planning can allow manufacturing and intra-regional trade to increase without significantly contributing to accelerated growth in carbon emissions.

1 Imbalances, Crises, and Recoveries

There is no doubt that the East-Asia focus of the post-2000 explanation of global financial imbalances based on that region's export-oriented growth strategies was warranted. Figure 1 illustrates the incredible surge of Current Account surpluses that East Asia & Pacific region experienced following the Asian financial crisis of the late 1990s. The genesis of this surge of trade surpluses between East Asia and the rest of the world dates back to the mid 1980s, when appreciation of the Yen vis a vis the U.S. Dollar resulted in reduced competitiveness of Japan relative to neighboring countries in Southeast Asia, whose currencies were generally pegged to the Dollar. As a consequence, a decade of tremendous economic growth in East Asia was fueled mainly by intra-regional trade, which eventually gave rise to acceleration of exports to the rest of the world, especially after the 1990s crisis was overcome.[1]

On the other hand, the focus on Chinese exports to the United States before and after the Asian financial crisis was excessive. It is correct that in the late 1990s, developing Asian countries overcame the crisis through accelerated exports, as shown in Figure 2. However, that figure also shows that the bulk of this growth in exports was to countries other than the United States. In fact, even the Mexican recovery after the Tequila Crisis in the mid 1990s, which was mainly attributed to increased trade because of NAFTA, was in fact partly driven by exports to other countries.

In other words, recoveries from severe economic downturns, and long-term economic growth paths for developing countries and regions, continue to be shaped by export-oriented paths, both within as well as between regions. It is noteworthy, but not surprising, that a larger percentage of the growth in Mexican trade was with its direct neighbor, the United States. Likewise, a very large component of the growth in Asian exports was intra-regional. Figure 3 compares the percentage of intraregional exports as a share of total trade for developing Asia

[1] Yu and Xu (2001, p. 502).

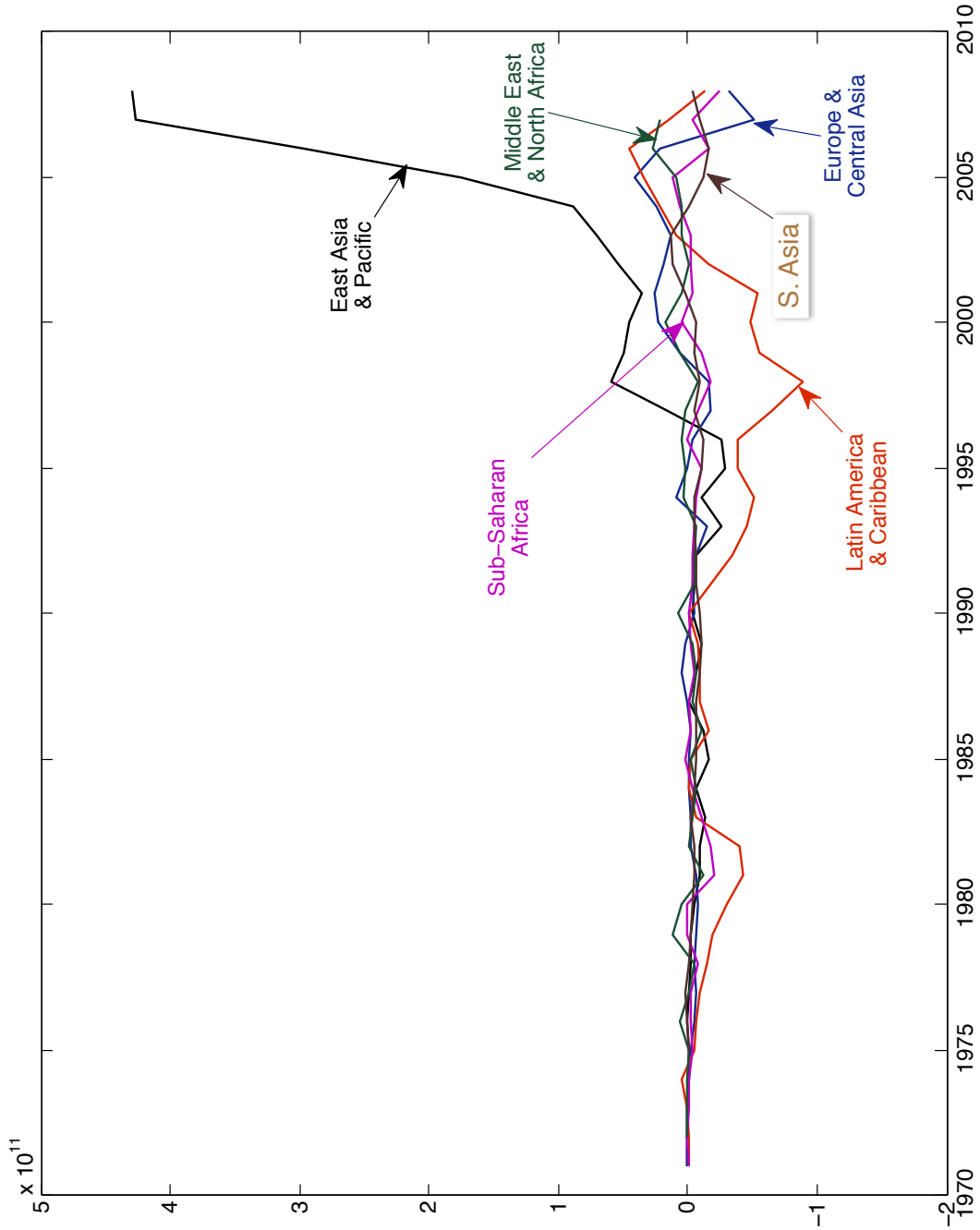

Figure 1: Current Account Balances by Region. *Source:* IMF, IFS.

and for the Middle East. It is interesting to note that the relative size of intraregional trade was higher in the Middle East during the late 1980s and early 1990s, before it stagnated, in part as oil prices began to rise again in 1998, whereas intraregional trade in developing Asia took off, reaching nearly double the respective share of intraregional trade for the Middle East.

As Dani Rodrik has argued,[2] trade is not an end in itself. Reconfiguring an economy in a manner that is more conducive to trade removes price distortions, and also serves as a form of institutional reform that is conducive to long term growth. Most importantly for countries that have pursued export-oriented growth strategies successfully, trade-oriented policies have also been conducive to industrialization, which enhances total factor productivity and eventually leads to higher income levels for all, even if some in the traditional sectors may suffer from increased income inequality in the short term. Intraregional exports provide incentives for specialization and increased efficiency, eventually enhancing competitiveness in world markets and making industrialization through export-oriented growth successful.

In this regard, it is well known that the Middle East has traditionally relied excessively on exports of low value added products such as crude oil or agricultural goods, thus making them victims of Dutch disease and resource curses more generally, and providing distorted incentives that discourage diversification of their economies. In the long run, terms of trade naturally move against exporters of such primary goods and in favor of exporters of higher value added manufactured goods (and certain services). It is in this direction that foreign direct investment from the U.S. (in Mexico and Asia) and from Japan in Southeast Asia have allowed the recipient economies to industrialize and to boost their export receipts and economic growth rates by selling increasingly higher value added manufactured goods.

The painful 1990s taught Middle East economies an important lesson on the need to diversify their economies, both for oil exporting countries and their neighboring labor exporting countries that depended on petrodollars for worker remittances and exports to the oil-rich

[2] In Hoekman et al. (2002, pp. 3-10), and Rodrik (2007).

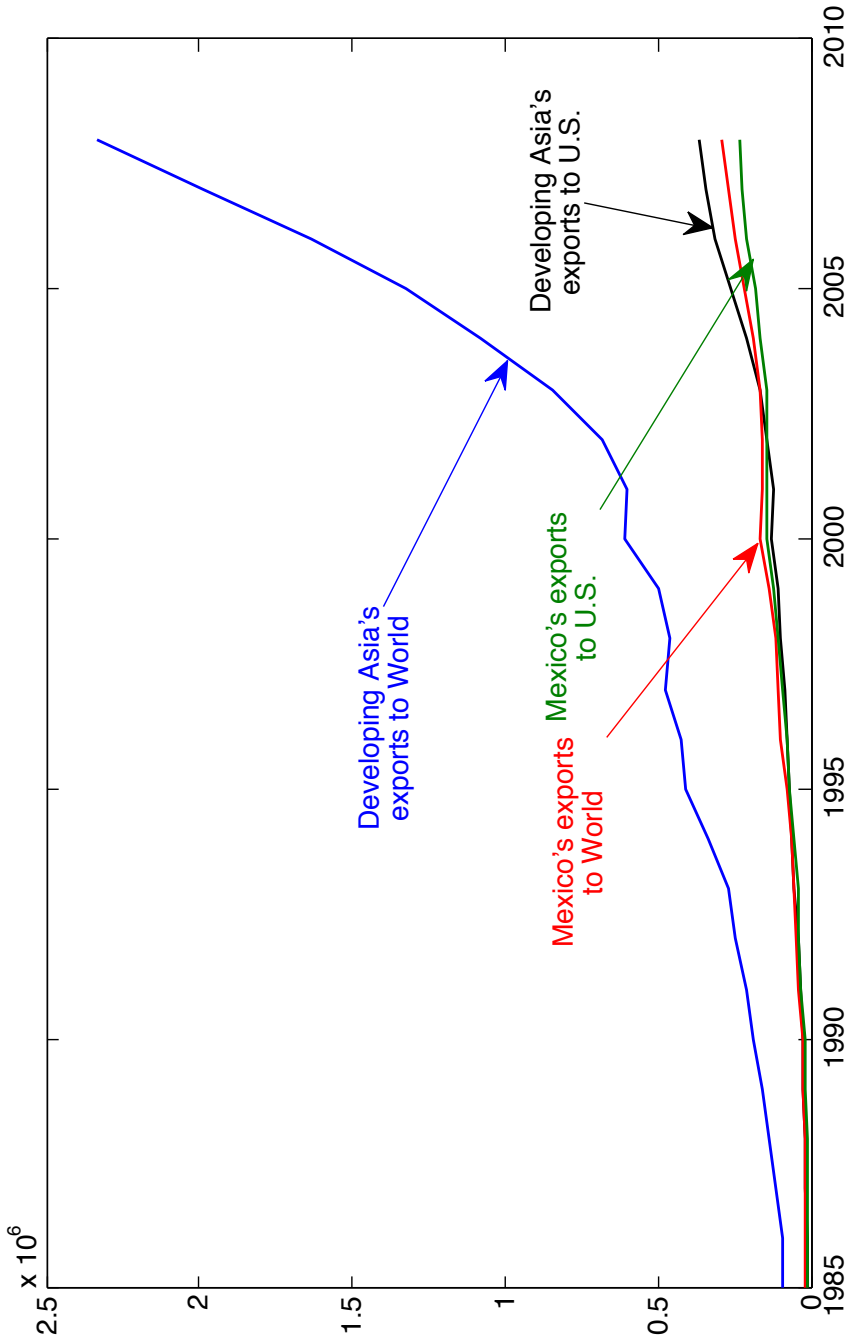

Figure 2: Exports by region. *Source*: IMF, DOT.

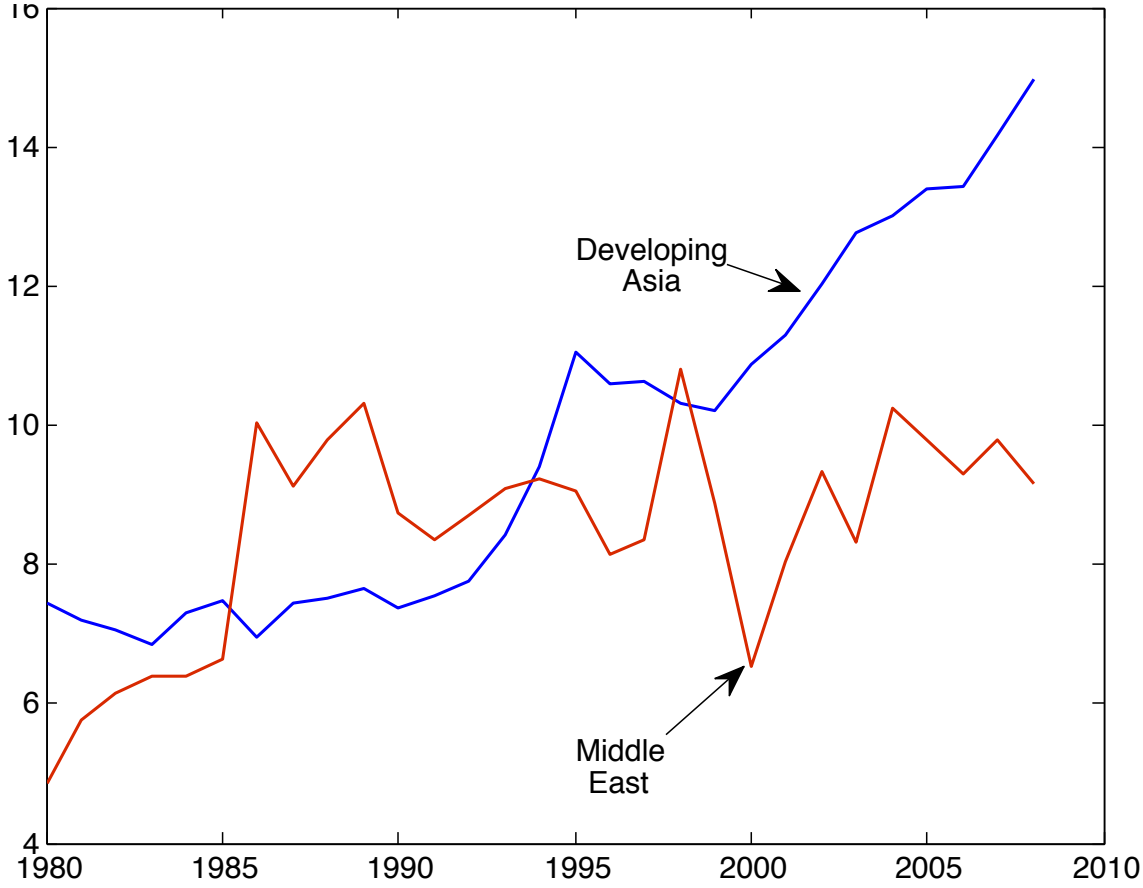

Figure 3: Intraregional exports as a percentage of overall exports. *Source*: IMF, DOT.

neighbors. Some have explicitly set forth industrial policies by designating specific cities and ports as industrial zones with preferential tariff and tax treatments. For instance, Egypt has sought to copy the Chinese model directly in its recently opened Suez Economic and Trade Cooperation Zone,[3] and Saudi Arabia has enunciated a clear industrial policy, including statements on the specific sectors to be promoted in each region.[4]

[3] http://tianjin.chinadaily.com.cn/m/tianjin/e/2009-11/09/content_8934405.htm
[4] http://www.commerce.gov.sa/industrial/

2 Manufacturing, Trade, and Industrial Policies

Of course, success is far from guaranteed when a country copies the industrial policies of other countries (as in the case of Egypt's China strategy), or dictating from above that certain sectors (including, surprisingly for the case of Saudi Arabia, nano-technology and bio-technology) are ones in which an economy has a comparative advantage. In this regard, Douglas North was correct in asserting that: "Economies that adopt the formal rules of another economy will have very different performance characteristics than the first economy because of different informal norms and enforcement,"[5] and, of course, assumptions about similarities of comparative advantage based on institutional and resource endowment analysis may be faulty.

That being said, Rodrik (2007) makes a good case that every recent success in generating significant rates of export-oriented economic growth has been associated with an industrial policy. In other words, even though there is no guarantee that any given industrial policy will work, i.e. an industrial policy is not sufficient for success, having an industrial policy appears to be necessary for successful industrialization and sustained growth. This is clearly shown in Figure 4, which illustrates that for all developing countries over the past quarter century, the fastest growing (East and South Asia, especially China and India, respectively) have also had the fastest rates of growth of manufacturing.

Suggesting appropriate industrial policies for the Middle East countries, which would require careful analysis of *potential* future comparative advantages of various countries and subregions, is not the subject of the current paper, albeit the subject of the author's ongoing research project.[6] I only wish to note in this section that economic development in the

[5] North (1994), as quoted in Rodrik (2007).

[6] Venables (1999) showed that such problems generally have multiple equilibria in terms of regional specialization and sector agglomeration; Rodrik (2007) argued that the optimal industrial policy for any given country depends on existing distortions that are binding. Coordination of industrial policies in the twenty-first century is particularly challenging in this regard, c.f. Ahish Arora and Alfonso Gamardella, "Emerging issues in the new economy and globalization," in Bianchi and Labory (2006, pp. 28-44).

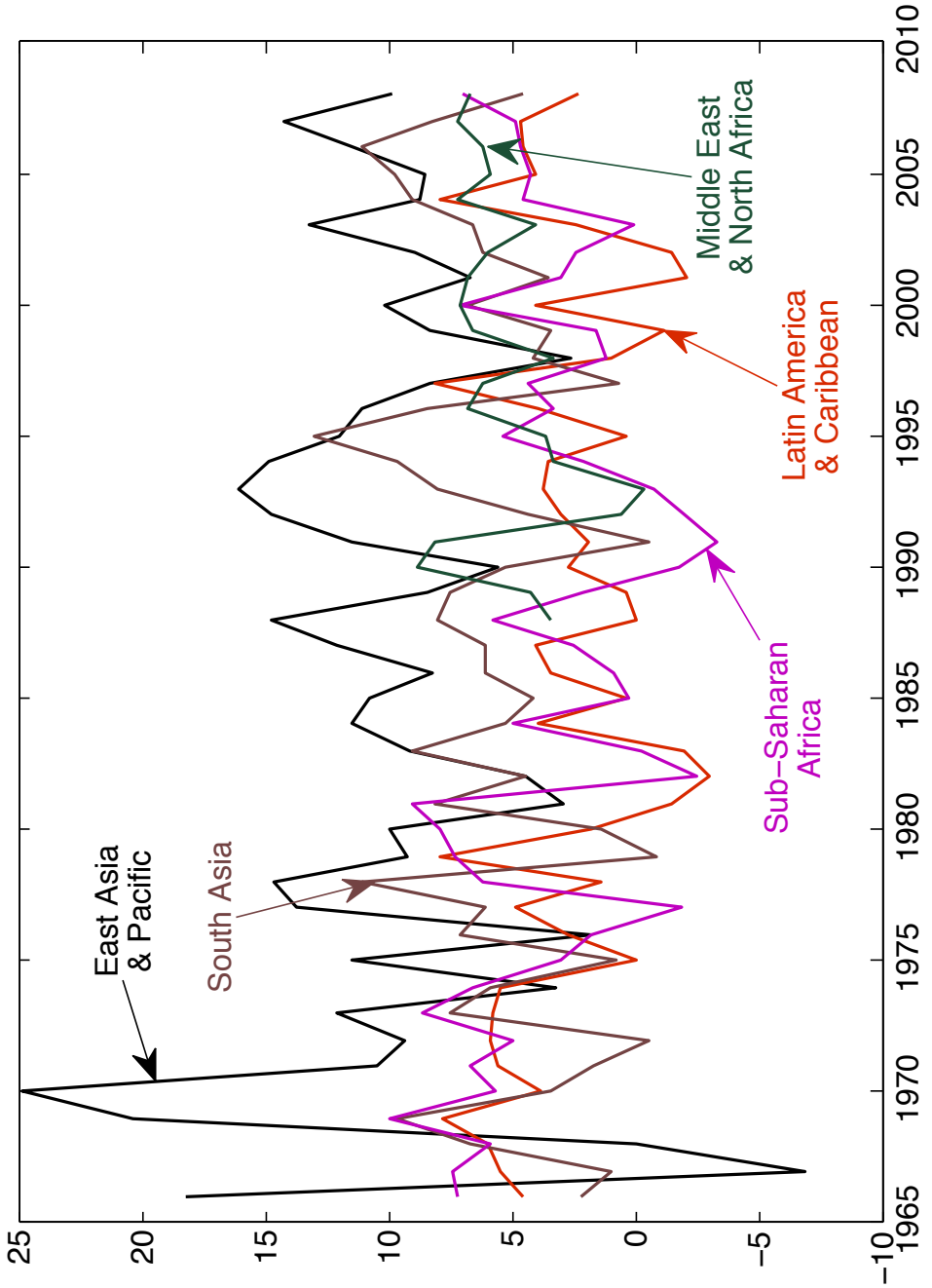

Figure 4: Manufacturing Growth Rates. *Source*: WB, WDI.

region, which El-Gamal and Jaffe (2010) have argued to be in the world's best interest in order to reduce the bubble-and-crash effects of petrodollar flows, would require a significant degree of industrialization. In this regard, Figure 5 illustrates that the Middle East and North Africa have the lowest levels of industrialization among all developing regions, including Sub-Saharan Africa, as measured by manufacturing value added as a percentage of GDP.

As we shall discuss in greater detail in the last empirical section, for our analysis, the relevant measure of industrialization using the World Bank's World Development Indicators (WDI) dataset should be manufacturing value added rather than industrial value added, because the latter includes not only manufacturing, but also mining, construction, electricity, water, and gas. Construction, in particular, has been one of the main engines of growth in the Middle East, but the link between construction, even infrastructure building, and eventual industrialization in the sense of increased manufacturing share in GDP, is very weak. Of course, construction-supporting industries such as cement are very carbon intensive.

Figure 6 shows a country-level comparison of some Middle-East economies' manufacturing value added as a percentage of GDP, and compares those levels to China's as well as those of Malaysia and Indonesia, which are majority-Muslim countries that started with levels of industrialization in 1980 that were comparable to some Middle East countries' current levels. I have labeled those countries with manufacturing value added to GDP ratios between fifteen and twenty five percent (Turkey, Jordan, Egypt, Tunisia, and Morocco) "pre-emerging economies," and labeled countries with ratios below fifteen percent (UAE, Iran, Saudi Arabia, and Algeria) as "resource curse economies."[7] Both categories of countries need in the short to medium term to pursue aggressive industrialization policies, and some have begun the process, as discussed previously.

[7] Of course, as an anonymous referee has pointed out, very advanced economies such as the U.S. would have very large service sectors and lower manufacturing to GDP ratios, but we are here comparing countries that are emerging or pre-emerging.

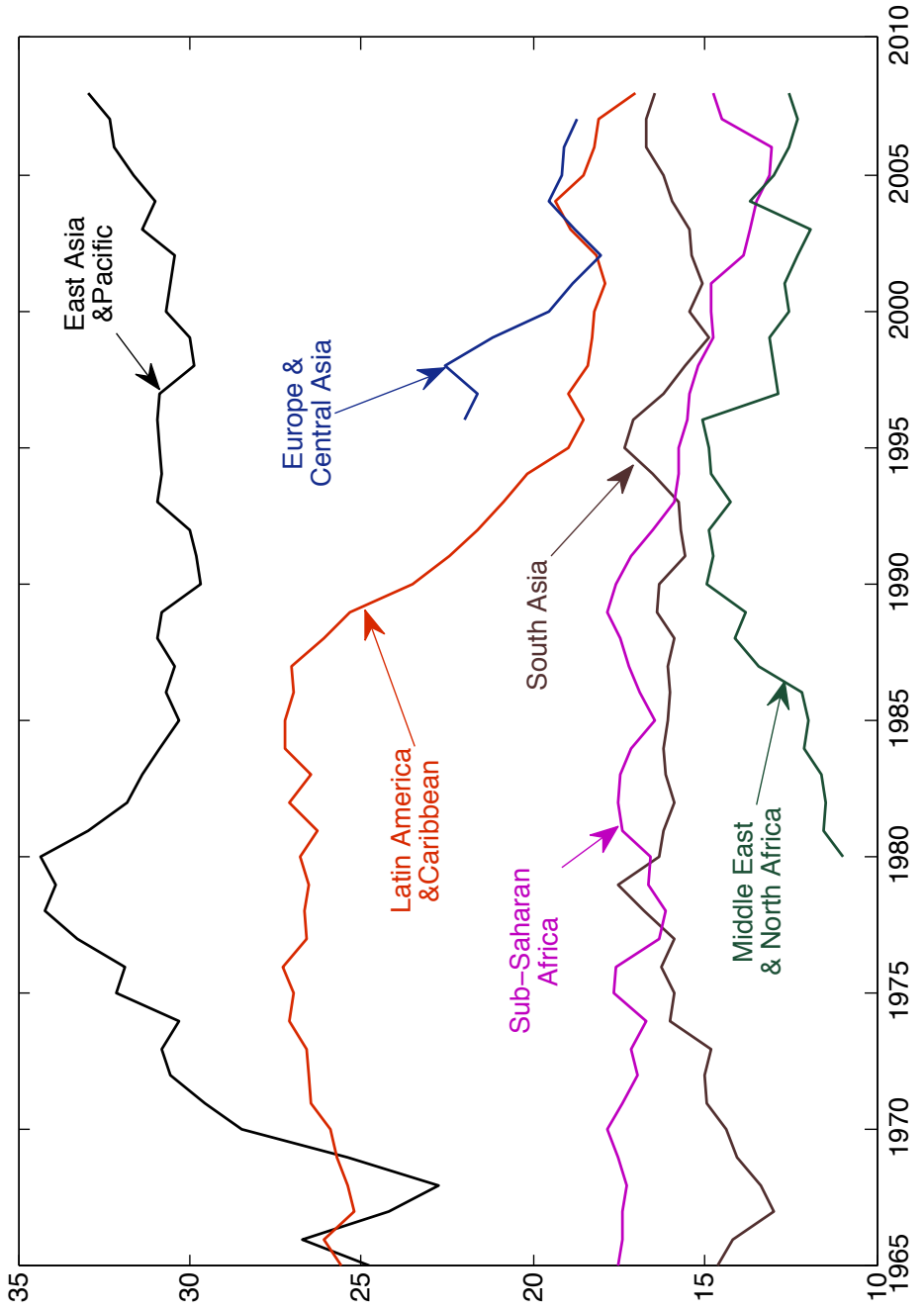

Figure 5: Manufacturing as a Percentage of GDP. *Source*: WB, WDI.

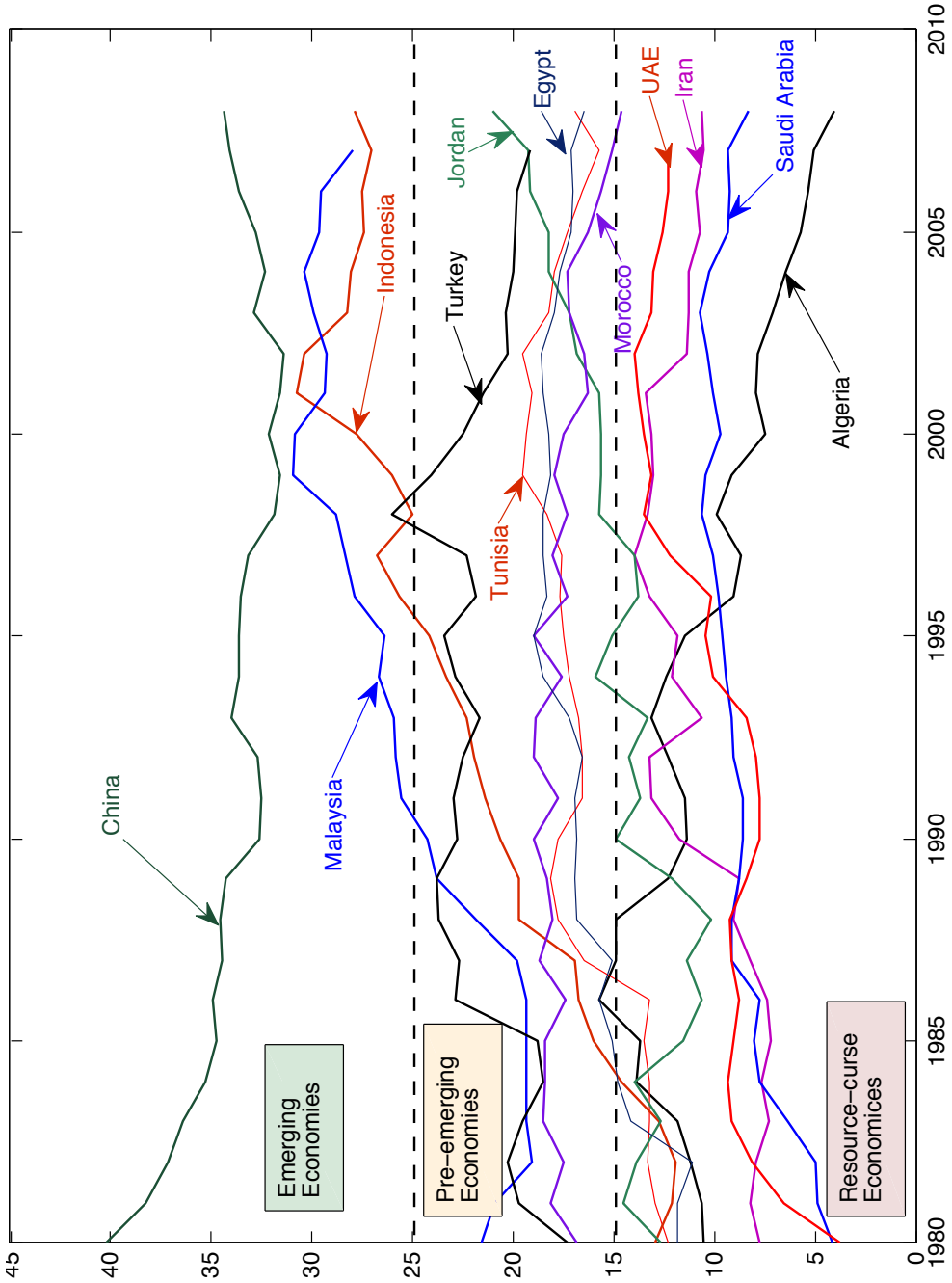

Figure 6: Manufacturing as a Percentage of GDP. *Source:* WB, WDI.

In this regard, the Asian experience, as shown in Figures 3 through 6 serves as the ideal model for the Middle East to follow. The growth in developing Asia's exports, both intra-regionally and overall, was coupled with fast inflows of foreign direct investment and increasing shares of manufacturing in exports (and GDP, as shown for some countries in Figure 6).[8] Trade integration and coordination of financial policies were explicitly pursued in the region, but one may argue that the region's configuration allowed for a *de facto* industrial plan, with Japan as an industrial center with declining export competitiveness after the Plaza and Louvre accords in 1985 and 1987, respectively, and the systematic appreciation of the Japanese Yen.

There has been no shortage of multilateral and regional preferential and free trade agreements in the Middle East, both within the region (as in the Greater Arab Free Trade Area, or GAFTA) and with nearby industrial centers (as in the Euro-Mediterranean Free Trade Area). However, intraregional trade in the Middle East remains anemic despite literally hundreds of such bilateral and multilateral agreements, and the promised economic dividends in terms of industrialization and growth have never been fulfilled.[9]

One of the possible explanations for this failure of trade policies is that countries in the region may have approached trade liberalization in a mercantilist manner: hoping that more access to markets will help them to increase their exports to other countries, rather than approaching the deals as win-win strategies for regional growth and development. A prime example of this may be the recently ratified free trade agreement between Egypt and Turkey, which was signed in 2005 and took effect in subsequent years. Figure 7 shows clearly that the two countries have indeed expanded their trade significantly after their bilateral agreement, with both Turkish imports from Egypt and exports to Egypt increasing after a period of relative stagnation leading up to 2005.

[8] Krumm and Kharas (2004, p. xvii) note that trade and investment integration in East Asia was a key factor in the region's successful growth and development.

[9] See Safadi (2004) and the articles therein for full treatment, especially of the region's failure to increase its trade relative to other regions, based on econometric gravity models as well as institutional analyses.

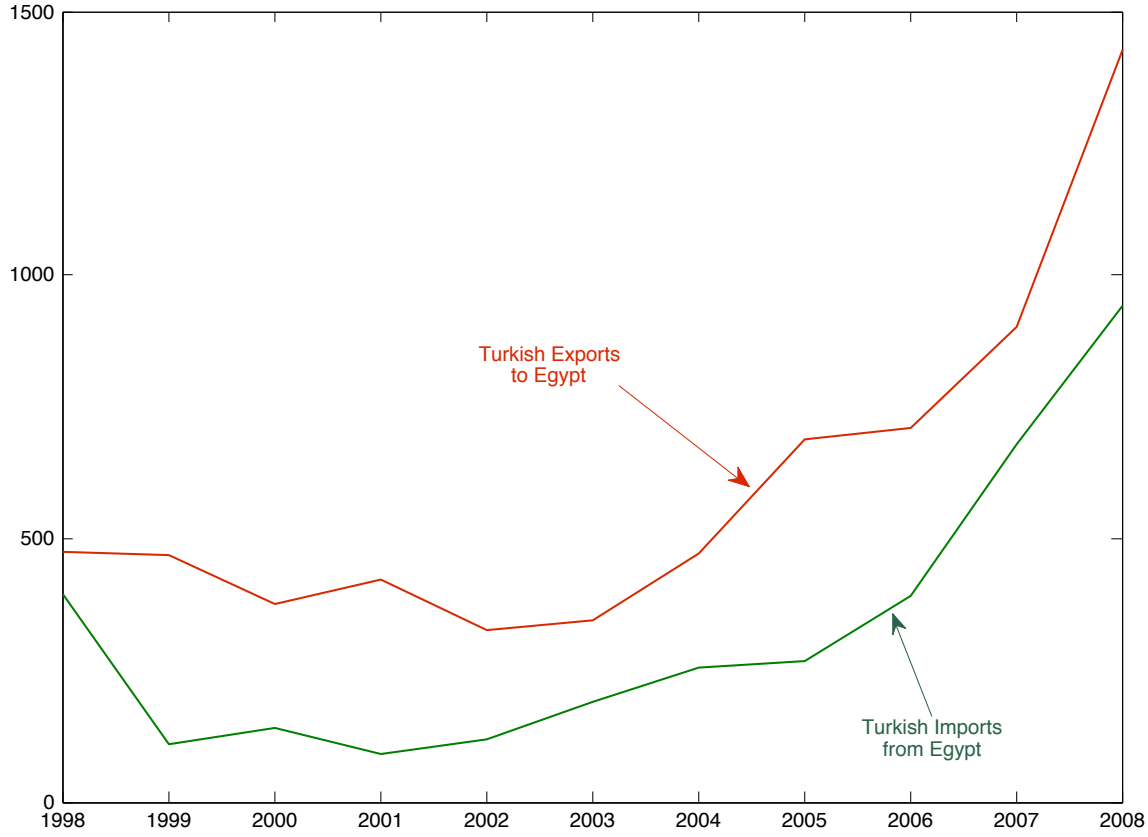

Figure 7: Bilateral Exports for Egypt & Turkey, Millions of Dollars. *Source*: IMF, IFS.

However, this growth in bilateral trade between the two countries has not necessarily translated into greater regional trade integration. Indeed, we can see in Figure 8 that while the exports of Turkey and Egypt to the Middle East have increased as a percentage of their total respective exports, their imports from the region have only increased very marginally – and possibly only because of the aforementioned increase in trade. In this regard, increased intraregional trade as a percentage of total trade may not necessarily be a positive result, because increased intraregional trade due to preferential and free bilateral trade agreements may lead to reduced efficiency because of trade diversion.[10]

[10]It would not be good if increased intraregional trade comes at the expense of trade with other countries and

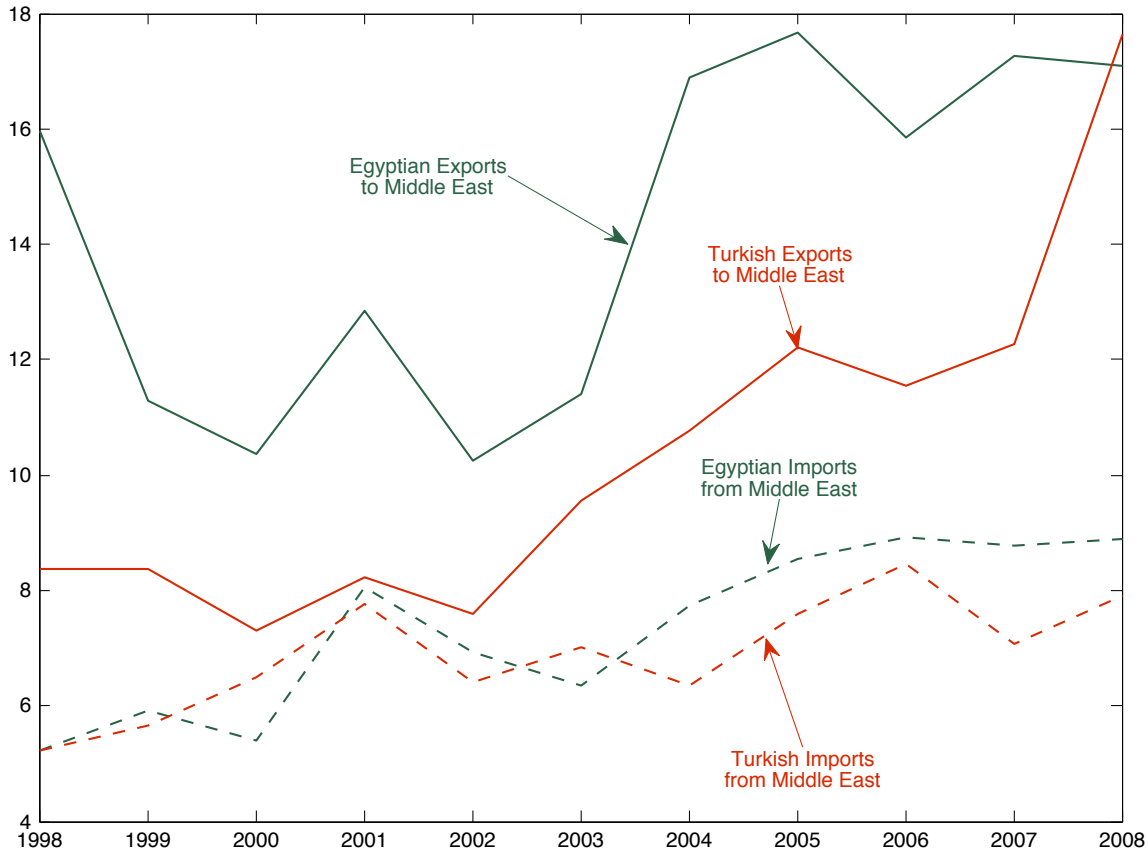

Figure 8: Exports and Imports from Middle East for Egypt & Turkey as percentages. *Source*: IMF, IFS.

It must also be noted that industrialization strategies in a number of countries, especially in the oil-rich Gulf region, seem to have focused on capital-intensive sectors such as infrastructure construction, aluminum smelting, refining and petrochemicals, etc., despite the ticking demographic time bomb because of the very large and quickly increasing problem of youth unemployment.[11] Balancing the needs for absorption of the fast-growing labor force on the

regions who provide the same goods and services at better prices, which diversion would lead to reduced rather than increased efficiency, c.f. Hoekman and Kostecki (2010, pp. 500, 508).

[11] See the Millennium Development Goals in the Arab Region at http://www.arab-hdr.org/publications/other/undp/mdgr/regional/mdg-arab-07e.pdf, and the Arab Human Development Report at http://www.arab-hdr.org/contents/index.aspx?rid=5.

one hand and higher value-added in regional exports on the other is the subject of my related ongoing research. The focus of this paper, to which we turn empirically in the final section below, is on the potential environmental impact of a successful regional industrialization and trade policy in the Middle East. The main question addressed in this paper – as part of the Carbon-Management study at the Baker Institute for Public Policy – is whether a focus on increasing the proportion of manufacturing output in regional exports and GDP must by necessity require higher levels of carbon pollution.

3 Carbon Emissions

Some of the ongoing industrialization policies, for example in Saudi Arabia, where water desalination is one of the main concerns, are expected soon to migrate from carbon unfriendly technologies – burning fossil fuels – toward cleaner solar-energy-based technologies.[12] However, overall, the environmental record of industrialization in the region has been less than encouraging. Indeed, as we can see in Figure 9, the rate of growth of carbon dioxide emissions in the Middle East and North Africa has been disproportionately high relative to its increased manufacturing activity. Of course, it is not surprising to see the highest rates of growth in CO_2 emissions coming from the fast growing and industrializing East Asia region. However, if – as my research agenda aims to suggest – the correct policy for the Middle East is to emulate the East Asian model of trade and investment integration toward the goal of higher rates of industrialization and growth, then one must ask whether such a growth path is feasible under the increasing international scrutiny of environmental impact in the new millennium.

[12] After the first version of this paper was written, Saudi Arabia announced its ninth development plan for 2010-4, with SR1.44tr (approx. US$384 billion) in spending aimed at diversifying the economy and creating job opportunities for the country's youth, but details were not available at the time of this revision, especially with regards to distribution between cleaner and more polluting sectors and technologies. Saudi Arabia has in recent years put significant emphasis on enhancing regional exports, including in foodstuffs, as a complement to its industrial policies.

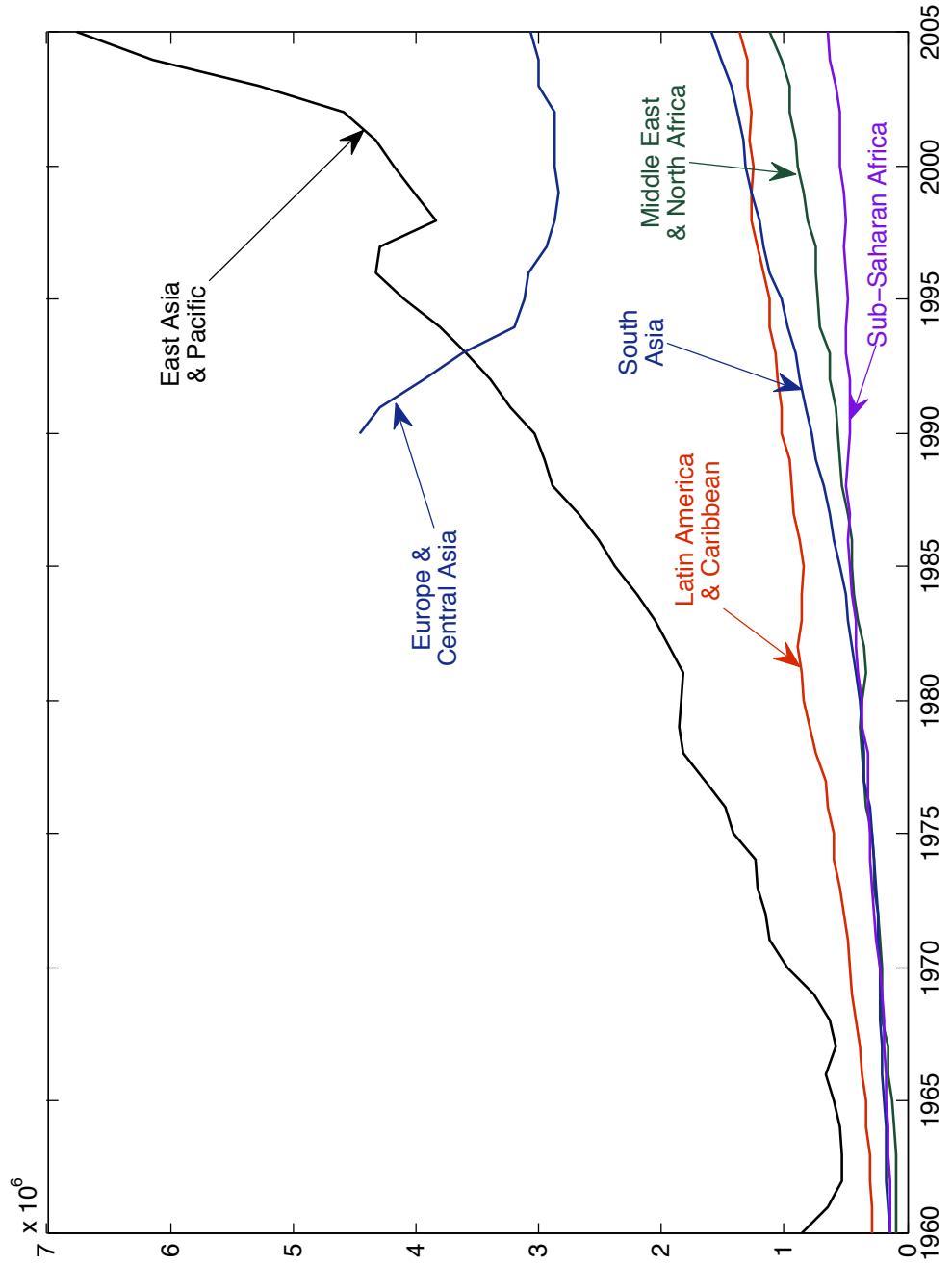

Figure 9: CO_2 Emissions in kilotons

To answer this question, I begin by distinguishing between industry and manufacturing, the former including not only the latter, but also activities such as mining, construction, electricity generation, etc. I would like to argue that it is possible for the region to pursue an industrial policy in the sense of increasing its share of manufacturing in output and trade, while minimizing the adverse impact on the region's carbon footprint.

Given that the region has already invested heavily in infrastructure construction over the past three decades, a fact that is commonly advertised in the region's industrial policy literatures, it may be possible that increasing manufacturing value added as a percentage of total output is feasible without proportional growth in industrial value added. In other words, the regional industrialization policies for the next decade or two may involve substitution of some other elements of industrial value added toward manufacturing. Whether or not this substitution can provide the desired outcome without increasing the region's carbon footprint significantly is an empirical issue to which we now turn.

It is perhaps worthwhile mentioning here the large literature on an environmental Kuznets curve (EKC) that was inspired by the seminal paper of Grossman and Krueger (1991, 1995). The early literature suggested that per-capita pollutant emissions followed an inverted U-shape (i.e. increased and then decreased) as a function of per capita GDP. The early literature estimated polynomial (originally cubic) regressions for per-capita pollution as a function of per-capita GDP using cross-country panel data. Later studies added more explanatory variables to the analysis, continuing to find evidence for an EKC in various pollutants and various countries.

An excellent survey of the early history of "the rise and fall of the environmental Kuznets curve" is provided in Stern (2004). The (polynomial) parametric specification of the early literature was rejected on theoretical econometric grounds (statistical theory for panel estimation with powers of integrated random variables was not yet developed), and the parametric specification was also rejected against nonparametric alternatives, c.f. Millimet et al (2003). Recent

studies that use nonparametric methods to test for the shape of the relationship between per-capita pollution and per-capita GDP have failed to reject linearity of the relationship (i.e. non-existence of a Kuznets curve) for CO_2 emissions in particular, c.f. Azomahu et al (2006).

In this paper, I will not dwell on nonlinear model specification or sophisticated non-parametric and semiparametric estimation methods, but simply use a linear panel regression analysis to estimate partial correlations between growth in CO_2 emissions and various components of GDP, aiming to focus mainly on the relationship between growth in manufacturing output and CO_2 emissions. The brief review in the preceding paragraphs suggests that this simple linear specification is not unreasonable, especially as Bertineli and Strobl (2005) have failed to reject linearity in the ostensible EKC relationship. For the sake of internal consistency and accounting uniformity, I used only data from the World Bank's *World Development Indicators* (WDI) database, which contains data on carbon dioxide emissions as well as a number of directly relevant economic activities, including manufacturing and industrial value added. I used all available annual country-level data on the levels of CO_2 emissions in kilotons as the relevant variable of interest, constructing a sample that spanned the years 1969 to 2008.

For explanatory variables, I used lagged levels of CO_2 emissions growth, hence making the model dynamic, as well as growth in electric power consumption, GDP, industrial value added, manufacturing value added, and urban population. The panel dataset is unbalanced in the sense that data was not available for all periods for all countries, but missing data do not affect the moment conditions used for GMM estimation. The dynamic panel-data model was estimated using the 2-stage GMM estimator of Arellano and Bond, for $i = 1, \ldots, 118$ and $t = 1970, \ldots, 2008$:[13]

$$\text{CO}_2\text{Emit GR}_{it} = \beta_0 + \beta_1\ \text{CO}_2\text{Emit GR}_{i(t-1)} + \beta_2\ \text{Elect GR}_{it} + \beta_3\ \text{GDP GR}$$

$$+\beta_4\ \text{Industr VA GR}_{it} + \beta_5\ \text{Manuf VA GR}_{it} + \beta_6\ \text{Urban Pop GR}_{it} + u_i + \epsilon_{it}$$

[13] Arellano, M. and S. Bond, *Review of Economic Studies* 58(2), 1991.

The fixed effects u_i vanish after first differencing. The sample was nominally balanced, but with many missing observations for many countries. The minimum number of observations for a country in the sample was 1, and the largest was 34, with an average country time-series sample size of 20. With up to three lags allowed, the total number of instruments in GMM estimation was 111. The reported results are for two-step GMM estimation using the Arellano and Bond method, and reporting the White heteroscedasticity-robust standard errors for parameter estimates, where the covariances of the moment conditions are estimated using the first-order estimation residuals. The results of the 2-step estimation are shown in Table 1.

Table 1: GMM 2-Stage Estimation Results for Dynamic Panel Model. *Data Source*: World Bank, World Development Indicators, 2009.

L.H.S. Variable = CO_2 Emissions (kT) growth		
R.H.S. Variable	**Coefficient**	**(Robust S.E.)**
Lagged CO_2 Emissions growth	-0.019*	(0.003)
Electric power consumption growth	-0.104	(0.115)
GDP growth	-0.189	(0.327)
Industry, value added growth	0.397*	(0.200)
Manufacturing, value added growth	-0.122	(0.152)
Urban population growth	1.931	(1.065)
Intercept	1.013	(2.794)
		* = Significant at 0.05
Number of Countries	118	
Time series for each country (where available)	1970–2008	
Total Number of Observations	2458	
$\chi^2_{(6)}$	232.47	p-value = 0.000
Specification Tests:		
Sargan Test of over-identifying Restrictions:	$\chi^2_{(103)}$ = 108.28,	p-value = 0.342
Arellano-Bond Test of zero AC (order 2)	z = -1.0631	P-value = 0.288

We first note that specification tests suggest that the model has significant explanatory power, with a very significant $\chi^2_{(5)}$ test rejecting that all coefficients are zero. Moreover, two specification tests of over-identifying restrictions (Sargan, obtained from estimation without

Table 2: Results without Industrial Value Added Growth in R.H.S.

L.H.S. Variable = CO_2 Emissions (kT) growth		
R.H.S. Variable	**Coefficient**	**(Robust S.E.)**
Lagged CO_2 Emissions growth	-0.019*	(0.003)
Electric power consumption growth	-0.094	(0.114)
GDP growth	0.169	(0.256)
Manufacturing, value added growth	-0.011	(0.128)
Urban population growth	1.805	(1.072)
Intercept	1.103	(2.536)
		* = Significant at 0.05
Number of Countries	119	
Time series for each country (where available)	1970–2008	
Total Number of Observations	2490	
$\chi^2_{(5)}$	182.14	p-value = 0.000

robust standard deviation) and the autocorrelation structure of residuals (the test suggested by Arellano and Bond for second order correlation, since first order correlation is induced by the differencing before estimation) fail to reject that the model is correctly specified.

Therefore, we can reasonably trust the results of our estimation in Table 1 as being based on correctly specified moment restrictions and having strong explanatory power. The most important result, which answers the question that we asked earlier in this section, is that the coefficient on manufacturing value added growth is statistically insignificant (and in fact numerically negative, suggesting virtually zero effect) once we condition on industrial value added growth, the coefficient of which is very significant. As shown in Table 2, even if we were not to condition on industrial value added growth, the coefficient on manufacturing value added growth is not statistically significant. This confirms our hypothesis that manufacturing is not the biggest contributor to CO_2 emissions, and that even a partial switch from other "industrial" activities to manufacturing can be accomplished in a carbon neutral manner.

In an earlier version of this paper, the levels of CO_2 emissions were used instead of growth rates thereof. The idea was to suggest that increased manufacturing output can be done in a

carbon neutral way if it replaces other industrial output (e.g. construction). The results were that with both industrial output growth and manufacturing output growth in the regression, manufacturing growth did not contribute to increased CO_2 emissions, but if we exclude industrial output, then it did have a positive effect on CO_2 emissions. Two anonymous referees pointed out that increased manufacturing will normally require increased industrial output of other types, and therefore the argument for carbon neutrality was inconclusive. They also suggested that it would be more reasonable (and in line with the literature) to show that CO_2 emissions would not grow at an accelerated rate because of the shift to manufacturing. Therefore, this revised version of the paper uses a specification in terms of the rate of growth of CO_2 emissions, and the results unequivocally show that acceleration of manufacturing output growth does not contribute to acceleration of CO_2 emissions, regardless of whether or not we control for acceleration of other industrial output; while acceleration of industrial output itself does in fact contribute to acceleration in CO_2 emissions.

In other words, if the Middle East agenda of trade and investment integration toward the goal of increased manufacturing proportion in output and trade were to be pursued, this may be possible without necessarily aggravating the region's carbon footprint and running afoul of increasing emphasis on environmental sustainability worldwide. Of course, the political and economic feasibility of this regional integration program may make it infeasible, and many hurdles, including some that were mentioned above, must be overcome in the process, but that is the topic of other ongoing research.

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