

Sustainable economic development in energy rich economies: A regional approach

By

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There is an extensive literature on, or relating to, development issues of energy rich economies – particularly those in the developing world. While national-level studies abound, the analyses of these economies at a regional level, or with a regional and spatial perspective, are scarce. Generally, a bottom up regional approach to development and the value of insights that regional models and comparative regional studies provide have not received deserved attention in the field of development economics. Analyzing development sustainability in energy-based economies at a regional scale may provide insights not otherwise possible. National scale studies and models are mostly sectoral and ignore interesting development issues arising from spatial organization of production, distribution of physical and human capital over space, and spatial factors affecting the diversification of capital base. These studies mostly focus on developing economies while a regional perspective can cut across all energy rich economies in both the developing and developed world. A regional perspective can open doors to contributions from multidisciplinary spatial scientists from a wide range of fields including geography, planning, regional science and regional economics. Finally, using sub-national regions as units of analysis provides a richer picture of development at national scale and can shed light on important global sustainable development concerns. This paper outlines a general development framework based on constancy of total capital stock and outlines a comprehensive knowledge base for *energy rich regions* that can be used to derive patterns of development and can serve as a basis for qualitative and quantitative analyses of sustainable development in these regions within a global context.

1. Energy Rich Regions

Energy rich regions (ERRs) are regions endowed with substantial reserves of exhaustible energy resources - our focus here is on oil and gas¹. Both onshore and the closest offshore reserves are included in energy resource endowments of a region. The exploitation of energy resources has played an important role in the development of ERRs and many of these regions depend primarily on the extraction of exhaustible resources for their economic wellbeing. ERRs are very diverse and are located in clusters across the globe. Geographically they spread from the arctic to the tropics, from extremely cold areas of Siberia and Alaska to hot deserts of Saudi Arabia. They fall under a wide spectrum of economic systems from planned to market economy, and their reserve size varies as does their level of dependence on resource revenues.

There are two features that distinguish the ERRs from other regions. First, no other commodity has the importance that these energy resources have in the global economy. The strategic and heavy dependence of the world on petroleum has created a market advantage that exporters of no other commodity enjoy. Of course, the development of a cheaper and more efficient renewable source of energy may quickly replace the oil and gas as the world's foremost sources of energy, as in the past oil did to coal. Second, and more important, oil and gas are *exhaustible* resources, i.e. these regions cannot consider resource revenues as a permanent stream of income.

Therefore, while there is great variation among these regions, they all enjoy a finite resource with a strong world market demand and all have the common problem of

¹ We use petroleum to refer to oil, gas, and condensates together.

converting their natural capital into reproducible capital in pursuit of an economic and environmentally sustainable development.

There is an extensive literature on or relating to development issues of energy rich economies – particularly those in the developing world – but most of this literature focuses on national economies. Examples include Gelb (1981 and 1988), Chichilnsky and Heal (1991), Sachs and Warner (1995, 1999, 2001), Gylfason (2000, 2001), Askari (2006), and Lederman and Maloney, eds (2007) on economic performance and resource curse; Corden (1984), Benjamin, Devarajan, and Weiner (1989) on Dutch Disease; Hartwick (1990), Repetto (1992, 1996), Uno and Bartelmus (1998), Hamilton and Clemens (1999) on “green” national accounts – properly valuing resource depletion; and Blitzer and Eckaus (1986), Jorgensen and Wilcoxon (1990, 1991), Manne and Rutherford (1994), Bohringer and Rutherford (1997) on energy-environment-economy interactions. But as national level studies about the analyses of these economies at a regional scale or with a regional and spatial perspective are scarce. A bottom up regional approach to development and the value of insights that regional models and comparative regional studies provide have not received the attention they deserve in the field of development economics. There are signs this may be changing. For example, the *2009 World Development Report*, the influential annual World Bank publication, focuses on spatial disparities and development policies. The report underscores the significance of economic geography and documents how this is changing through three dimensions of ‘the increase in *density* of economic activity, the decline of *distance* between economic agents and markets, and the persistence of

division between and within countries due to natural, cultural and policy-related barriers.²

Analyzing sustainability of development in energy-based economies at a regional scale may provide insights that are not otherwise possible. National scale studies and models are mostly sectoral and ignore interesting development issues arising from spatial organization of production, distribution of physical and human capital over space, and spatial factors affecting the diversification of capital base. These studies mostly focus on developing economies while a regional approach can cut across all energy rich economies in both the developing and developed world. A regional perspective can open doors to contributions from multidisciplinary spatial scientists from a wide range of fields including geography, planning, regional science and regional economics. Finally, using sub-national regions as units of analysis provides a richer picture of development at national scale—illuminating important issues that may be lost at the national level-- and can shed light on important global sustainable development concerns.

The International Energy Agency (IEA) estimates \$26 trillion in new infrastructure will be needed over the next twenty-five years to ensure that sufficient energy is available to satisfy anticipated worldwide demand. Clearly, regions endowed with energy resources will get these investments. Which resource rich regions will attract these megaprojects? How is the size and production stage of the reserve related to the magnitude of megaprojects? How will these investments change the structure of the regional economy and the composition of its physical and human capital? Can these

² <http://siteresources.worldbank.org/INTWDR2009/Resources/Outline.pdf>

investments bring sustainable development to the resource rich region? What can newly developed resource regions learn from the experience of regions that have already received trillions of dollars over the past 150 year history of the commercial energy industry? Can ERRs in the developing world learn from the experience of those in developed countries? For example, can we apply what we learn from the experience of Texas, Alaska, Calgary, and the North Sea to the Asalouye region in the south of Iran?

To answer some of these questions the next sections present a general framework for sustainable development in energy rich regions and, given the diversity of such regions, outline a foundation to derive patterns of development and to analyze sustainability issues in these regions within a global context.

2. Sustainable development in ERRs

An issue central to sustainability is achieving an equitable balance between present and future generations. Solow (1974) is among pioneering works that formally analyzes intergenerational equity issues of exhaustible resources. Hartwick (1977) states that to ensure intergenerational fairness, i.e. constant flow of consumption over time, it is necessary to invest the entire economic rent from an exhaustible resource in reproducible capital. Solow (1986) shows that Hartwick's rule can be interpreted as one of holding a total stock of capital constant over time as a condition for intergenerational equity in the case of exhaustible resources. More recently, Hamilton and Hartwick (2005) build on previous works and link investing exhaustible resource rents to growth in a model of optimal savings. In essence this literature suggests that an energy rich

economy should at least maintain a non-decreasing stock of total capital and be able to diversify its capital base to compensate for depletion of its oil and gas resources.

Recent World Bank studies have suggested a broad framework for valuation of natural, physical and human capital, thus providing a better understanding of sustainable – or unsustainable – development in an economy (World Bank 2006). With these efforts sustainable development has become more comprehensive and measurable. The World Bank study defines sustainable development as “a process of managing a portfolio of assets to preserve and enhance the opportunities people face.” The assets in this definition include physical capital, also called *produced capital*, *natural capital*, and *intangible capital* which broadly includes human capital and the quality of formal and informal institutions³. The condition, therefore, for sustainable development is that all these assets grow over time – or at least do not decrease. This is similar to the concept of constancy of total capital stock, above, more comprehensively offering a new statistical indicator “genuine saving rate” or “genuine investment rate” as the main indicator for sustainable (or unsustainable) development. The genuine saving (investment) rate improves standard measures of wealth accumulation by adjusting the traditional saving rate downward by an estimate of natural resource depletion and pollution damages, and upward by growth in the value of human capital. This rate ‘has become a central focus in the measurement of the sustainability of an economy’ (Hamilton and Hartwick 2005). Precursor to “genuine saving rate”, an early theoretical framework for properly calculating national product for an exhaustible resource based

³ Some authors adding social and organizational capital as a separate category have suggested wealth creation as “the process of using the four types of capital in combination to give rise to flows of goods and services which people want, in such a way that the capital stocks and the non-monetary flows of services from natural capital, are maintained or enhanced in quantity or quality.” (Ekins et al. 2003)

economy was formulated using the concept of Net National Production (Askari 1990). This index properly accounts for investment activities in a dynamic economy and most commonly it is interpreted as the largest “permanently maintainable amount of consumption”. Askari (1997) offers what may be called as “true” or comparable (to the standard measure of NNP) Net National Production calculations for the oil rich Gulf Cooperation Council (GCC) member countries including Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Qatar, and Oman.

Constancy of total capital stock and the World Bank notion of development as a “process of portfolio management” provide a broad framework to study the economic development in an ERR where its most valuable assets are exhaustible natural resources. Sustainable development in an ERR crucially depends on managing its finite resources and its ability to transform its natural capital into reproducible physical and human capital - in the broad sense of intangible capital. Tracking the interplay of these three forms of capital overtime and finding their optimal size provides important insights about the nature of development in ERRs. Ghadimi (2007) presents an optimal depletion computable general equilibrium (CGE) model as a quantitative analytical framework to study oil economies and Ghadimi (2008) outlines application of this model at regional level to analyze three forms of capital. In the next section we present a regional approach to place the sustainable development of an ERR in a broader context of the development pattern of such regions around the world.

3. A multiregional global context

ERRs, although diverse in size and energy resource endowment, have the common problem of converting valuable but exhaustible natural capital to other forms of reproducible capital. Their location with respect to major consuming regions and thus distance and mode of transportation and the required infrastructure varies widely. ERRs experience different stage of growth and fall under very diverse political/institutional frameworks. This diversity clearly shows the multifaceted nature of development in ERRs and the need for a multiregional global context and a systems approach to go beyond economic factors to include geographical and socio-political dimensions to provide an appropriate framework to study sustainability issues in these regions. Such a framework and a comprehensive compendium of information on ERRs around the world not only helps in launching development programs in a particular region but can also profoundly facilitate a learning process among these regions. Storper (1995) discusses issues of territorial development in the context of a global learning economy and Florida (1995) maintains that the regions that grew by extracting natural resources and mass produced commodities now must harness knowledge and ideas and in effect become *learning regions* to keep economic advantage⁴. ERRs at early stages of development can learn from the experience of those that have successfully moved from dependence on exporting a primary resource to a more diversified economy based on reproducible physical and human capital.

⁴ See Capella and Nijkamp (2009) for a comprehensive survey of regional growth and development theories including the field of endogenous growth with emphasis on knowledge and human capital.

Development economists have long searched for **patterns** that relate successful **development**⁵ to structure and policy at the national level. Numerous studies have drawn stylized facts and patterns of development at national level. These patterns are very helpful in policy making for a particular group of countries or to put development issues of a single country in a broader context. See for example Chenery and Syrquin (1975) and Branson, Guerrero, and Gunter (1998). But no such work has been done at a regional level. In a similar vein we suggest using regions as units of analysis to derive 'patterns of development' and appropriate 'development metrics' in a multiregional approach to sustainable development in ERRs. The national level studies primarily have focused on a detailed economic structure defined by a number of macroeconomic indicators such as sectoral shares of GDP, trade intensity, or financial market development. In our regional approach we extend the framework to include important geologic, geographic and geopolitical dimensions in addition to economic factors. For this purpose, at the Regional Research Institute we have used ERRs as a flexible regional scale to construct a comprehensive knowledge base⁶. This knowledge base combines both spatial and non-spatial data and information related to ERRs under three main sets of indicators: *geologic, geo-economics, and geopolitics*. This regional/spatial knowledge base is used to derive stylized facts and a pattern of development in ERRs

⁵ The classic work of Chenery and Syrquin (1975) points out "a development pattern may be defined as a systematic variation in any significant aspect of the economic or social structure associated with a rising level of income or other index of development."

⁶ The general features and components of this knowledge base is described in RRI working paper # 12: Development Patterns of Energy Rich Regions.

and lays the foundation for further quantitative and qualitative analyses. Next sections describe these three sets of indicators and the way they relate to three capital forms.

Geologic Indicators: Reserve size

Petroleum geologist Walter Youngquist (1997) in his book, *Geo Destinies*, writes “The destinies of all nations and all people are in many ways bound up with the mineral and energy mineral resources of the Earth. Events of the geologic past have richly endowed some nations with valuable Earth resources, whereas others have very few. The result is markedly different destinies for different nations.” The Earth's mineral riches are distributed unevenly over the globe and this has provided different regions with opportunity to achieve great power and affluence with the development of their resources. Geologic factors play a crucial role in the development process of an ERR. The most important factor is the size of a reserve, which determines the scale of initial investments and the duration of resource age. The longer the period of resource exploitation, more enduring is the impact on the regional economic structure and its development. Often in the case of smaller reserves energy boomtowns have turned into ghost towns soon after the resources are depleted. The other geological factors such as depth, age, dominant resource whether oil, gas, or condensate and share of each resource in total reserves, and chemical qualities generally characterize the most important *natural capital* of the region. The size of reserves and other geological factors have direct bearing on the amount and qualities of physical and human capital needed to exploit the resource and determine the duration of resource depletion in the region.

Geo-economic Indicators

All regions around the world have energy needs and some like ERRs also supply energy. The two distinct groups of regions with crucial significance to global energy dynamics are the major *energy producing* (net energy exporters) and the dominant *energy consuming* regions (net energy importers). The most common flows between producing and consuming regions are energy, either in crude or refined form, in one direction and investments and technology in the other (Figure 1). Our focus is on a subset of energy producing regions endowed with significant reserves of two exhaustible resources - oil and gas. The oil and gas reserves often coexist and are concentrated in a small region of the world showing a very different geography than that of other energy sources like coal. Distinctively separating energy producing and energy using regions, oil and gas have a volatile trading system and pose more urgent challenges than coal that is abundantly found in the major energy consuming regions of the world. Oil and gas are the dominant energy sources of the world; the existing energy transportation and transfer infrastructure, largely shaped by the requirements of these resources, links ERRs and consuming regions. Distance, proximity, and spatial layout of energy transportation infrastructure – whether pipelines or shipping lines – are important factors that are captured and measured in the geographical dimension of ERR knowledge base and analytic framework.

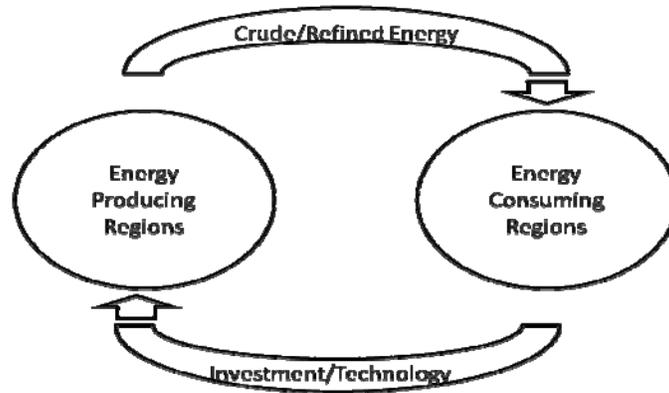


Figure 1 – Flows between energy producing and consuming regions

ERRs not only have different geographies but each region depending on the date of resource exploration falls at a different stage of economic development. Rostow (1960) in his well known theory of growth identifies a sequence of well-defined stages that a national economy passes through in its economic development process. These stages include traditional society, precondition for take-off, take-off to sustained growth, drive to maturity, and age of high mass consumption. Parr (2001) explores Rostow's stages of economic growth thesis in regional terms with three distinct perspectives of *regional*, *multiregional*, and *interregional*. Our focus here is on a regional perspective with no direct reference to national economy or other regions within a nation. The stages theory focuses on national economy and generalizes the sequence that any economy in modern history follows. But in the case of ERRs a certain and measurable pattern of resource exploitation strongly shapes and influences the production level and thus the economic growth of the region. We consider this common path of resource depletion and, similar to Rostow's theory, impose a five stage economic growth sequence to an energy resource based region (Figure 2). In this case the leading sector is energy

resource but often with initially very weak forward and backward linkages with other sectors of the regional economy.

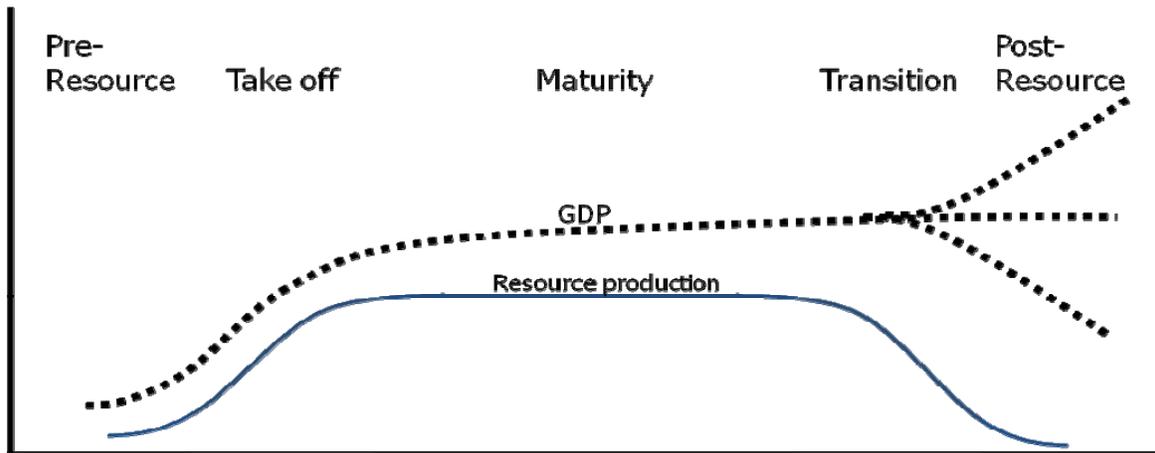


Figure 2 – Stages of resource depletion and regional growth

If we look at resource exploitation stages, once a reserve is explored a substantial investment in the form of megaprojects puts in place the required infrastructure – rigs, machinery, roads, pipelines, communication systems, and a whole host of supporting residential and non residential buildings – to start the production. This *take-off stage* is a transitional period from traditional *pre-resource* time where in addition to an accelerated creation of physical capital there is a large inflow of highly skilled labor from outside of the region. The investments continue to flow in until the full maximum production capacity of resource extraction is realized. After this short duration of take-off a longer *stage of maturity* starts where a plateau of resource production is reached. The duration of this maturity stage depends on the size of the reserve and the level of extraction and may last for decades. This is the crucial stage where the region pays off returns to investments made during take-off stage, maintains and expands resource

production capacity, and most importantly has the opportunity to convert its valuable natural resources into reproducible forms of physical and human capital to ensure a sustained growth after the resource is gone. After passing a peak (some argue that globally we are approaching or have passed this peak) resource production declines during a transition period to *post-resource stage*. At this transitional period, the fortunes of the region may continue steadily, fall precipitously, or even increase depending on the quality of region’s institutions, level of diversification, and the degree of success (or the extent of failure) in converting its exhaustible natural resource into reproducible capital during the maturity stage. The total accumulated reproducible capital has reached a threshold level if the economy can sustain its production level after the transition period and into post-resource stage. At this stage, with successful diversification of its export base to non-resource sectors the region loses its identity as a energy rich region and with long-term factor mobility becomes fully integrated into national and global markets.

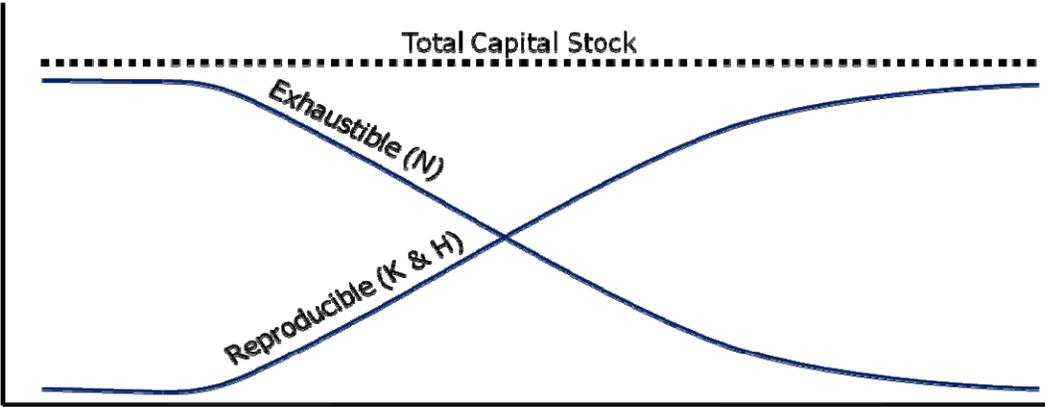


Figure 3 – Stages of capital stock conversion

Figure 3 schematically shows stocks of exhaustible natural capital (N) and reproducible physical (K) and human (H) capitals in different stages. The outcome of converting exhaustible into reproducible capitals determines the economic performance and sustainability of development in an ERR.

Regardless of their performance, the existing ERRs in advanced economies or in the developing world can be classified under these growth stages. For example, in North America Pennsylvania, Oklahoma, Texas, and Alaska fall in post-resource, transition, maturity, and take-off stages respectively. Similarly, in the Middle East, most regions like Khuzistan in Iran, Jobail in Eastern Saudi Arabia are in their maturity stage approaching the second transition stage. Areas like South Pars and Caspian Sea are in take-off stage and there are numerous smaller regions that have passed their resource age.

Geopolitical Indicators

Oil and gas have been an important concern of the world economy and geopolitics of our time. There is an extensive literature on whether natural resources are a curse rather than a blessing (For an overview see Sachs and Warner 2001, Gylfason 2001, or van der Ploeg 2008). A large part of this literature deals with the relationship between political corruption and economic performance in resource rich economies and suggests that resource rents lead to an increase in corruption depending on the quality of institutions (e.g., Leite and Weidmann, 2002; Sala-i-Martin and Subramanian, 2003; Isham et al., 2005). An important indicator showing the structure of power and the

nature of socio-political institutions in ERRs is where they fall on a bipolar economic spectrum (Figure 4). At one end of this scale are centrally planned economies based on the concept of socialism where resources are controlled and allocated by the state. This socialist economic structure is also known as a command economy. The other end of the scale is the free market economy based on capitalism where the ‘invisible hand’ of the price mechanism determines resource allocation. There is no purely planned or purely market economy, rather there is gradation of mixed economies each falling on this wide spectrum depending on its dominant economic structure and the share of public and private sectors in the economy.



Figure 4 – Economic structure spectrum

The relative position of an ERR in this spectrum implies distinct variation in the nature of governance and quality of institutions. The relationship with other regions, national economy, and the rest of the world, the role and dominance of international or national oil companies, and whether the energy sector in an ERR remains as an enclave or is integrated with other sectors of the economy varies with position on this spectrum.

Recent World Bank studies show that the share of physical (produced) capital in total wealth is constant across different country income groups but the share of natural

capital tends to fall with income while the share of intangible capital rises. The study also shows much higher genuine savings (investment) rates for market economies than formerly centrally planned and other resource dependent developing countries. These findings clearly indicate that rich market economies do better with their physical capital. In other words these economies are rich because of the skills of their population and quality of institutions supporting economic activity and transforming natural capital into intangible capital. Therefore, the position of an ERR on the planned-market spectrum has a lot to say about the quality of institutions and the role of governance in exploitation of the resource and the nature of transforming these transient revenues into other forms of reproducible capital. In addition, the level of integration of the energy resource sector with other sectors and with the national economy is also largely determined by the position of the ERR on planned-market spectrum.

Conclusions

This paper claims no theoretical or methodological novelty, rather it provides a conceptual development framework based on the established theoretical literature and a systematic regional knowledge base as a broad context for applied quantitative and qualitative development analyses of energy rich regions. The development framework emphasizes sustainability based on constancy of total capital stock and the knowledge base builds on the extensive literature related to the multifaceted field of development in energy rich economies; and it proposes an integrated compendium of geologic, geographic, geoeconomics, and geopolitical data and information to derive development patterns and create a broad context to study sustainable development in ERRs. This

comprehensive knowledge base of energy rich economies at a regional scale provides a useful basis for studies of sustainable development with a new economic-spatial perspective. The knowledge base can be used for: i) classifying these regions using various schemes and identifying salient features of each sub-group of ERRs; ii) establishing simple stylized facts based on relationships between spatial and economic structure and the pattern of development in these economies; and iii) serving as a basis for qualitative and quantitative studies which in turn can further enrich the knowledge base. ERRs will receive substantial investments in the form of megaprojects in the next two decades. These investments will alter capital composition in these regions and the outcome will profoundly impact development at regional, national and even global scale. Case studies of ERRs with different positions on the planned-market spectrum experiencing a different stage of growth or with varying reserve size could provide invaluable insights into the development processes of these economies. Case studies and comparative analyses can facilitate exchange of experience for ERRs with varying economic structure, stage of development, and resource life. These qualitative studies can result in important policy lessons at regional, national, and global scales. The broader ERR development context suggested in this paper can be used to derive stylized facts and development pattern in ERRs. Those regions in earlier stages can learn from the extensive experience of regions that have passed – successfully or unsuccessfully – their resource dependence period.

References

- Askari, Hossein. 1990. "Saudi Arabia's Economy: Oil and the Search for Economic Development." JAI Press Inc. London.
- Askari, Hossein., V. Nowshirvani and M. Jaber. 1997. "Economic Development in the Countries of the GCC: The Curse and Blessing of Oil." JAI Press Inc London.
- Askari, Hossein. 2006. Middle East oil exporters: What happened to economic development? Edward Elgar Publishing Inc.
- Benjamin, N, S Devarajan, and R Weiner. 1989. "The Dutch Disease in a Developing Country: Oil Revenues in Cameroon." *Journal of Development Economics*, 30: 71-92.
- Blitzer CR, Eckaus RS.1986. "Energy-economy interactions in Mexico: A multiperiod general equilibrium model." *Journal of Development Economics*, 21 (2): 259-282.
- Bohringer C, and T Rutherford. 1997. "Carbon taxes with exemptions in an open economy: a general equilibrium analysis of the German tax initiative." *Journal of Environmental Economics and Management*, 32 (2): 189-203.
- Branson WH, I Guerrero, and BG Gunter. 1998. "Patterns of development 1970-1994." World Bank Working Paper. <http://siteresources.worldbank.org/WBI/Resources/wbi37132.pdf>
- Capello R, and P Nijkamp. Eds. 2009. Handbook of regional growth and development theories. Edward Elgar.
- Chenery, Hollis B. and M. Syrquin. 1975. Patterns of Development: 1950–1970. New York: Oxford University Press for the World Bank.
- Corden, W.M. (1984). "Boom Sector and Dutch Disease Economics: Survey and Consolidation." *Oxford Economic Papers*, 36: 362.
- Devarajan, S. 1988. "Natural resources and taxation in computable general equilibrium models of developing countries." *Journal of Policy Modeling*, 10 (4): 505-28.
- Ekins P., S. Sandrine, L. Deutsch, C. Folke, and R. De Groot. 2003. "A framework for the practical application of the concepts of critical natural capital and strong sustainability." *Ecological Economics*, 44: 165-185.
- Florida, R., 1995. "Towards the learning region." *Futures*, 27(5): 527-36.
- Ghadimi, Hodjat. 2007. Economic development planning in oil economies: A dynamic CGE analysis. VDM Verlag Dr. Mueller e.K.
- Ghadimi, Hodjat. 2008. "Energy in a resource-based regional economy: A dynamic general equilibrium analysis," Research Paper #2008-2 , Regional Research Institute, West Virginia University. Presented at 47th Annual Western Regional Science Association Meeting.
- Gelb, Alan H. 1988. Oil Windfalls: Blessing or Curse? A World Bank research publication. Oxford University Press.

Gylfason T. 2000. "Resources, agriculture, and economic growth in economies in transition." *Kyklos*, 53: 545–580.

Gylfason T. 2001. "Natural resources, education, and economic development." *European Economic Review*, 45: 847–859.

Hartwick, John M. 1977. "Intergenerational equity and investing of rents from exhaustible resources." *American Economic Review*. 66: 972-74.

Hamilton, K., and J. Hartwick. 2005. "Investing Exhaustible Resource Rents and the Path of Consumption", *Canadian Journal of Economics*, 38 (2): 615-21.

Hamilton, Kirk, and M. Clemens. 1999. "Genuine saving in developing countries," *World Bank Economic Review*, 13: 33–56.

Hartwick, John M. 1990. "Natural resources, national accounting and economic depreciation." *Journal of Public Economics*, 43(3): 291-304.

Heal, G., and G. Chichilnisky. 1991. Oil and the International Economy. Clarendon Press, Oxford, UK.

Isham, J., Pritchett, L., Woolcock, M., Busby, G., 2005. "The varieties of resource experience: natural resource export structures and the political economy of economic growth." *World Bank Economic Review*, 19, 141-174.

Jorgensen, Dale W. and Peter Wilcoxon. 1990. "Intertemporal modeling of US environmental regulation." *Journal of Policy Modeling*, 12:4, pp. 1-30.

Jorgensen, Dale W. and Peter Wilcoxon. 1991. "Global change, energy prices, and U.S. economic growth." *Structural Change and Economic Dynamics*, 3:1.

Lederman D, and W. Maloney (eds). 2007. Natural resource: Neither curse nor destiny. The World Bank – Stanford University Press. Washington DC.

Leite, C., Weidmann, J., 2002. "Does mother nature corrupt? Natural resources, corruption, and economic growth." In: Abed, G., Gupta, S. (Eds.), *Governance, Corruption, and Economic Performance*. IMF, Washington DC, pp. 159-196.

Manne, A.S. and T.F. Rutherford. 1994. "International trade in oil, gas and carbon emission rights: an intertemporal general equilibrium model." *The Energy Journal*, 15: 57-76.

Parr, John B. 2001. "On the regional dimension of Rostow's theory of growth." *Review of Urban and Regional Development Studies*, 13: 1, 2-19.

Ploeg F van der. 2008. "Challenges and Opportunities for Resource Rich Economies." Ox-Carre Research Paper 2008-05.

Repetto, Robert C. 1992. "Accounting for Environmental Assets", *Scientific American*.

Repetto, Robert C. 1996. "Wasting Assets: The Need for Natural Resource Accounting", R.L. Fischman, M. L. Lipeles and M. S. Quillace, *An Environmental Law Anthology*, Anderson Publishing, Cincinnati.

Rostow, W. W. 1960. The Stages of Economic Growth: A Non-Communist Manifesto. Cambridge: Cambridge University Press.

Sachs JD, Warner AM. 1995. "Natural resource abundance and economic growth." NBER Working Paper No. 5398, National Bureau of Economic Research, Cambridge, MA

Sachs JD, Warner AM. 1999. "The big push, natural resource booms and growth." *Journal of Development Economics*, 59: 43–76

Sachs JD, Warner AM (2001) "Natural resources and economic development: The curse of natural resources." *European Economic Review*, 45: 827–838.

Sala-i-Martin, X. and A. Subramanian. 2003. "Addressing the natural resource curse: An illustration from Nigeria," NBER Working Paper 9804, Cambridge, Mass.

Solow, Robert M, 1986. " On the Intergenerational Allocation of Natural Resources," *Scandinavian Journal of Economics*, 88 (1): 141-49.

Solow, R.M. 1974. "Intergenerational equity and exhaustible resources," *Review of Economic Studies*, symposium, 29–46

Storper, Michael. 1995. "Territorial development in the global learning economy: The challenge to developing countries." *Region et Development*, 1: 1-37.

Uno, K. and Bartelmus, P. (Editors), 1998. Environmental Accounting in Theory and Practice. Kluwer Academic Publishers, Dordrecht, Boston and London.

World Bank. 2006. Where is the wealth of nations? Measuring capital for the 21st Century. The World Bank, Washington DC.