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# Resource rents, savings behavior, and scenarios of economic development

Elkhan Richard Sadik-Zada [a,b,c,d]

[a] Institute of Development Research and Development Policy, Ruhr-University Bochum (RUB), Germany
[b] Center for Environmental Management, Resources and Energy (CURE), Faculty of Management and Economics, Ruhr-University Bochum, Bochum, Germany
[c] Centre for Studies on European Economy, Azerbaijan State University of Economics (UNEC), Baku, Azerbaijan
[d] South African-German Centre for Development Research, University of the Western Cape (UWC), Cape Town, South Africa

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ABSTRACT

The paper revisits the nexus between natural resources and economic growth from the lens of development economics. It augments the traditional dual-sector economy model by the assumption that in addition to capitalists, also workers contribute to the capital accumulation through private savings out of their wage income. The proposed differential game theory model of the interaction between the public and the elites identifies two realistic open loop Nash and three Stackelberg scenarios for the management of the commodity driven budget surplus. Based on the conventional transversality conditions, the model detects a progressing decay of social cohesion and institutional quality. It shows that at the early stages of the exploitation of the natural resource riches, both the public and elites enable a rather modernization-friendly scenaros. At the rather advanced stages of the exploitation of natural resources both groups try to maximize their short-term private benefits and by doing so protract or even inhibit the process of economic modernization. The study finds that the savings behavior of the workers has a positive modernization effect. Nevertheless, workers' savings cannot fully offset the negative modernization effects of the inferior management of natural resource revenues.

## 1. Introduction

Since the very onset of the modern scholarly discussion on the socio-economic dualism that was proposed in the works of Dutch sociologist and economist Julius Herman Boeke (1953), the protagonists of dualism overlooked the distinctive role of the natural resources in their elaborations on the development of former colonies (Itagaki, 1968). Just two of them, Eckhaus (1955) and Higgins (1956) referred to the potential role of natural resources in the context of economic duality, and this in a rather superficial way.

Julius Boecke writes, '*… social dualism is the clashing of an imported social system, usually high capitalism, against an indigenous one*' (Boeke, 1953: 4). For a long time, it was a prevailing view that social dualism, epitomized in the unbridgeable cultural differences between the traditional indigenous population and modern colonial settlers was the central and durable cause of underdevelopment and the primary cause of the failure of the purely economic modernization approaches (Clement, 2015). In contemporary economics and sociology, dualism is still deemed to be one of the root causes of the underdevelopment of developing countries with colonial heritage (Myint, 1958; Myrdal, 1968).

Within the mentioned strand of literature, the authors juxtapose the traditionalist socio-economic systems with the modern ones. Traditional systems are organized around communitarianism epitomized by kinship ties, which exhibit a low level of labor division and negligible incentives for investing. Output in the traditional economy is not determined by market forces and competitive price building but rather by the stationary needs of the community (Clement, 2015). *"Not exchange but rather self-maintenance is the basis of existence; individual self-sufficiency is the dominant idea, the unit being the family"* (Boeke, 1953, p. 40).

Sir Arthur Lewis decisively shaped the discussion on the role of dualism in economic development, and at the same time changed the focus from the time-invariant cultural factors and foregrounded the dynamically evolving purely economic forces (Lewis, 1954). By doing so, he negated culture as the sole and fundamental cause of underdevelopment and turned an entirely new page by proposing a rather optimistic and nondiscriminatory page in the discussion on development and underdevelopment.

The mainstream economics literature, which focuses on the role of the resources-growth nexus, ignores duality and is in most cases are highly aggregated empirical studies with neoclassical underpinnings. It validates the resource curse conjecture in the context of developing and

*E-mail address:* Elkhan.R.Sadik-Zada@ruhr-uni-bochum.de.

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transition economies (Auty, 1990; Gelb, 1988). On contrary, the Lewis-type models analyze the process of economic growth of the less developed countries not from the perspective of neoclassical economics, but rather through the lens of development economics (Loewenstein and Bender, 2017).

In most of his works, Lewis mentioned explicitly the favorable and strategic role of natural resource endowments in economic development (Lewis, 1938, 1944, 1950, 1958, 1966, 1972). Especially, in his *Reflections on Nigeria's Economic Growth*, Lewis picks out commodity exports as a central theme of Nigerian economic growth (Kofi, 1980).

In his path-breaking paper, published in 1954 in *Manchester School*, he, however, explicitly ignored the role of natural resources (Lewis, 1954). Interestingly, the same holds also for countless studies, which draw on and augment Lewis' dual economy model (Fei and Ranis, 1964; 1964, 1965; Jorgensen, 1961; Stiglitz, 1974; Ros, 1999; Wang and Piesse, 2009). In my opinion, the lacking focus on the role and management options of natural resource revenues in developing areas is the central research gap of development economics. Because, in many instances, natural resources alongside low labor costs have been two major drivers of economic growth in the overwhelming majority of developing economies at the early stages of economic development of both developing and industrialized countries (Sadik-Zada, 2019).

Against the backdrop of the relevance of socioeconomic dualism for economic growth in developing countries, groundless abstracting away from it is a serious shortcoming. Hence, this survey attempts to contribute to the theory of economic development by revisiting the resource curse conjecture from the lens of development economics. The second contribution comes to its own in the endogenous derivation of the admissible equilibria, i.e. scenarios, of the commodity revenue management. Furthermore, the study augments Lewis' dual economy model by worker's savings behavior and accommodates the derived equilibria into it. There is no single study, where, it is assumed that workers in the modern sector not only consume but also save some share of their wage income.

In what follows, I present briefly two strands of the literature in section 2. These are the structuralist works on economic development that elaborate on the metamorphosis of the developing areas into modern societies, and the literature on the nexus between natural resources and economic growth. **Section 3** presents the traditional the dual economy model. **Section 4** augments the dual economy model by the extractives sector. **Section 5** analyzes the effects of the savings behavior on economic modernization within the extended framework. In **Section 6**, within a differential game theory model the study derives endogenously the scenarios of surplus management and based on meaningful transversality condition determines their sequencing. Section 7 proposes a theoretical framework for the analysis of different bargaining spectra. Section 8 discusses the findings and concludes.

## 2. Literature review

The modern debate on the role of natural resources in economic development of contemporary economies dates back to the evolutionary modernization paradigm of Harvard sociologist Talcott Parsons (1960, 1964). His sociological theory is widely known as the structural-functionalist approach, where the focus is on the evolution of societies from traditional to modern forms (Hout, 2016). Following this paradigm, Lerner (1958), Rostow (1960), and Levy (1965) sketched out models of modernization, which they believed to have a general validity (Gurminder, 2014a, 2014b). Within this homogenizing approach, modernization is shaping all the social contexts, indigenous, traditional, and less traditional *"patterns always change. In the direction of the some of the patterns of the relatively modernized society"* (Levy, 1965, p.30).

In his grand theory of economic modernization, neoliberal development economist Walter W. Rostow (1960) followed Hla Myint's (1958) *"vent-for-surplus"* approach and referred explicitly to the role of natural resources as the central driver of economic growth and development. Rostow's generalization of the modernization perspectives of the nascent nations was predicated on the modernization stories of Europe, North America, and Australia, within his theoretical framework, he regarded the availability of natural resources as a compulsory precondition for the modernization "take-off" (Rostow, 1960; 1960). For the critics of Walter Rostow's grand theory this approach is deeply rooted in the development and industrialization history of the West, and hence, Rostow's approach in its essence is deemed to be deeply anachronistic (Frank, 1969; Nisbet, 1969; Pieterse, 2010; Rosser, 2009; Demissie, 2014).

In accordance with grand theory, natural-resource abundant developing nations have better preconditions for economic growth than those without abundant natural resource endowments: natural resource exports provide a financial leeway for the import of capital goods from advanced areas and propel industrialization (Rostow, 1960). Prominent neoclassical economists, such as Bela Balassa (1971), Peter Drake (1972), and Anne Krueger (1980) argued that the wealth of natural resource revenues fuels economic growth over the generation of domestic savings, a greater fiscal resilience, and extension of domestic markets.

Based on a comprehensive review of development theories and modernization literature, Mwinuka (2015) concludes that also in the context of colonies and post-colonial settings, natural resources played a significant role in triggering socioeconomic modernization. Baldwin (1956, 1963) claims that mineral resources have a greater impact on the attraction of foreign direct investments than the abundance of cheap labor supply. Recent empirical studies as well confirm the primacy of mineral wealth in the attraction of FDI in developing countries (UNCTAD, 2019).

On the contrary, especially during the first two decades in the aftermath of World War II, despite extensive engagement in international trade, commodity-exporting developing and especially Latin American countries mostly failed in terms of economic growth and modernization. Meanwhile, the negative association between natural resource abundance and the pace of economic growth, institutional quality, and human development belongs to one of the unabated stylized facts in economics (Gelb, 1988; Havranek et al., 2016).

There are purely economic and institutional theories the resource curse conjecture (Sadik-Zada, 2016; Sadik-Zada et al., 2019). Purely economic theories are the Prebisch-Singer hypothesis, the Enclave industry conjecture, and Dutch disease. Rentier state theory explains the growth failure of the commodity-exporting states by the prioritization of rather allocative and not productive economic activities (Mahdavy, 1970).

Raúl Prebisch's (1950) and Hans critique of the natural resources-based economic growth, gave birth to the *Dependency Theory*. This theory is an antipode of the evolutionary modernization approach, whereby natural resource abundance, is regarded as the major driver of economic modernization (Demissie, 2014; Hout, 2016). This approach is very well-known known as the Prebisch-Singer hypothesis and argues that in the long run, greater income elasticity of manufactured goods in comparison to that of raw materials causes substantial deterioration of the terms-of-trade of the natural resource exporters, and consequently to unequal exchange (Singer, 1950; Prebisch, 1950).

Notwithstanding its immense influence in polity and academia, Prebisch-Singer-hypothesis has not been proven in the overwhelming majority of empirical studies (Sadik-Zada, 2016). In contrast to the Marxist wing of the dependency approach, its reformist wing represented by Cardoso (1972) and Cardoso and Faletto (1979) considers natural resource dependence as the lesser evil and sees even substantial positive development impulses, which emanate from transnational corporations to the natural resource-dependent developing countries (Hout, 2016).

The second theoretical reflection of the growth and development failure of the commodity-reliant developing economies is the enclave economy hypothesis proposed by Alfred Hirschman (1958). This theory

explains the failure in the translation of natural resource wealth into economic growth by the insufficient backward and forward production linkages of the extractive industries (Hirschman, 1958, 2012). Consequently, the envisaged sparking of local industrialization does not come to its own. The empirical inquiries of the linkage effects by means of input-output and general equilibrium modeling have been systematically validating Hirschmann's enclave industry conjecture (Sadik-Zada et al., 2019).

Dutch disease is the third theory elaborating on the growth and development failures of the natural resource-abundant developing countries. The term was coined in 1979 by Economist for the description of the declining manufacturing in the Netherlands in the aftermath of the discovery of large natural gas fields in Groningen. The theory has been proposed by Meade and Russel (1957) and popularized through Corden and Neary (1982). Within this theory exchanging the growing commodity revenues in foreign currencies into domestic currencies leads to the appreciation of the domestic currencies. As a result, costs of domestic manufacturing, especially wages increase. The countries without commodity exports enjoy unabatedly low wage levels and acquire absolute cost advantages on international markets (Wheeler, 1984; Sachs and Warner, 1995). This mechanism was also known to Sir Arthur Lewis: In his elaborations on the economy of the Caribbean and Jamaica, he extensively discussed the problems that emanate from the appreciation of the domestic currencies and even suggested policies to reduce wages, profits, rents, and other incomes for the sake of growth and job creation (Lewis, 1944). Hence, he also is one of the first economists in the twentieth century, who implicitly referred to the issue of detrimental effects of domestic currency appreciation as a result of the growing commodity export revenues.

Despite these concerns, Sir Arthur Lewis considered the mineral endowment as the central factor of economic development in the British West Indies and Jamaica. He endorsed a supply-based industrialization, i.e. the establishment and development of the industries, for which the British West Indies have had a sufficient natural resources base (Lewis, 1938; 1944). Interestingly enough, he explicitly excluded natural resource-abundant settings from the scope of his pathbreaking model.

The same holds, also for the extension of the dual economy model proposed by Gustav Ranis and John Fei in 1961. The authors follow the same contextual demarcation and state at the very beginning after complaining on the challenge of generalization of the notion of underdevelopment that in their paper concerns *"with the labor-surplus, resource-poor variety in which the vast majority of the population is typically engaged in agriculture amidst widespread disguised unemployment and high rates of population growth* (Ranis and Fei, 1961, p. 533). Dale W. Jorgensen, who tries to bridge the gap between theories of growth and theories of development by presenting his version of the theory of the development of a dual economy, refers directly to the extraction of natural resources (Jorgensen, 1961). In one of the footnotes he puts it as follows:

> *"In the primary-producing countries of South-East Asia the advanced sector is plantation agriculture, mining and extraction of petroleum"* (p. 311).

Based on the in-depth scrutiny of the works of Sir Arthur Lewis, Gustav Ranis, and John Fei, the study identifies two possible explanations for the lacking elaborations on the repercussions of natural resources in their seminal works. These are, first, the focus on the overpopulated economies, which are dominated by subsistence agriculture. The abundance in natural resources and their exports lessen the Malthusian pressure and the central element of Lewis' model - the push factors for the migration from rural to urban regions (Gollin, 2014).

The augmentation of Lewis' dual sector economy model in Sadik-Zada (2016, 2019, 2020) shows both on the theoretical and empirical levels that commodity revenues could lead to a substantial slowdown of economic modernization in the labor surplus economies with inferior institutional quality. Sadik-Zada (2019) derives three possible commodity revenue distribution Nash open-loop scenarios that are based on the differential game-theoretical analysis. Within the framework of this project, we extend the game-theoretical analysis by the analysis of the Stackelberg-based open-loop scenarios.

Furthermore, the mentioned studies assume that reinvestment of the growing modern sector profits os the sole source of modernization. In contrast to all these studies, this paper analyzes a more realistic situation whereby the workers in the modern sector save a certain share of their wage income. This augmentation shows that the increasing level of wages and savings behavior of the workers could partially offset the negative modernization effects of nonproductive use of natural resource revenues.

## 3. Dual economy

The notion of economic dualism implies that there exist two dimensions of economic relations within one economic system. The difference between these two types comes to their own in the asymmetry of the proportions of the employed factors of production for the generation of the sector-specific output (Jorgensen, 1961). This asymmetry is expressed in the following features: *a.* modern sector is a labor shortage and the traditional sector is a labor surplus economy; *b.* the modern sector employs capital as an essential factor of production and the traditional sector employs no or negligible amount of capital such as primitive tools; *and c.* modern sector operates at a relatively high and the traditional sector at a relatively low technological level.

### 3.1. Moral economy

To substantiate the labor surplus character of the traditional sector, Lewis assumes that traditional sector in southeastern Europe, Egypt, and Asia, are dominated by subsistence agriculture and are characterized by disguised unemployment. Lewis defines disguised unemployment as the difference between factually employed and required labor force. Lewis's assumption of disguised unemployment is predicated on the works of Buck (1930) and Warriner (1939) and the methodological inquiry on the "indirect measurement" of the disguised unemployment in Kao et al. (1964).

Before the modernization take-off, the economy is overwhelmingly a single-sector economy. Hierbei this single sector is subsistence farming and related services. Subsistence farming relies on of primitive means of production and unskilled labor as the central factors of production (Acar et al., 2018). Labor and land are two essential factors of production. The labor force is utilized in combination with land. It is assumed that the agriculturally available territory measured in real hectares is fixed.

The amount of labor force working on the agricultural territory is many times higher than the necessary amount, which is required to produce the maximal output. This kind of state of the labor market corresponds with the existence of disguised unemployment (Rosenstein-Rodan, 1943). Following the ideas of Paul N. Rosenstein-Rodan (1943) and Ragnar Nurske (1953) on disguised unemployment, Sir Arthur Lewis dubbed the dual economies as the economies with the unlimited labor supply (Lewis, 1954). Whereby, the notion of the unlimited labor supply is rather confusing. To provide clarity Lewis makes clear that the labor supply is unlimited *"… as long as the supply of labour at a socially determined price exceeds the demand"* (Lewis, 1954). To avoid confusion, in his later works, Lewis (1966, 1979, 1984) replaced the usage of the notion of *the "unlimited supply of labour"* by the *"infinitely elastic supply of labour to the modern sector at the current wage"* (cf. Clement, 2015).

Hence, the marginal productivity of labor in the traditional sector is *"negligible, zero, or even negative"* (Lewis, 1954). The difference between the number of the factually employed and the necessary number of peasants to maximize the output with the existing technology and supply of non-labor inputs yields the stock of the surplus labor (Wellisz, 1968).

Due to the moral imperatives and conventions in the traditional societies, peasants in the traditional sector are rewarded not with the marginal but rather with the average product of their labor (APL). This implies that both the productive and non-productive share of labor force with zero or negligible marginal product of labor (MPL) get the same subsistence wage, i.e. APL, in the traditional sector (Lewis, 1954; Scott, 1976). Stanislaw Wellisz (1968, p. 23) describes this kind of traditional sector setting as a society where "… a share-alike ethic prevails". For Schäfer (1983) this remuneration and distribution system is a kind of "… *precapitalistic social contract*", which is based rather on moral imperatives than on market forces (Scott, 1976; Ranis and Fei, 1961).

This logic is by no means confined to subsistence agriculture. Wellisz (1968) argues that such a sharing-alike culture of sharing is also present in *"cities when profit-maximizing entrepreneurs are forced to hire a greater-than-optimum number of workers"* (p.28). In a recent study, Braithwaite (2019) validates the cross-sectoral omnipresence of the disguised unemployment in the contemporary developing economies. The same or similar logic holds in many instances also for the widely proliferated disguised unemployment in the public sectors of a number of post-communist natural resource-abundant developing and transition countries too (Vogler-Ludwig, 1990; Auty, 1999; Eifert et al., 2002). This is a modified version of socio-economic dualism. Furthermore, a dual economy is not an anachronism, which was characteristic for the former European colonies in Africa and Asia. Dualism is still a substantial feature of the great majority of least developed and non-EU transition economies (Bonatti and Haiduk, 2014; Sadik-Zada, 2016; Loewenstein and Bender, 2017).

### 3.2. A basic model of a dual economy

In contrast to traditional sector, modern sector operations are predicated on two essential factors of production, labor force, $L_m$, and capital $K_m$. Besides these two production factors, manufacturing sector is also dependent on exogenous technical progress. Hence, the production technology of the manufacturing sector corresponds with the following function al form:

$$X_m(t) = F(A\ (t), K(t), L(t)) \tag{1}$$

whereby $X_m$ is gross output of the modern manufacturing. Following Dale Jorgensen it is assumed that the underlying production function exhibits constant returns to scale. This implies that manufacturing output is exhausted by payments to workers and capitalists (Jorgensen, 1961). The assumptions of constant factor shares and Hicks-neutral technological progress allow the representation of the production function in the following form:

$$X_m(t) = A(t)L_m^{1-\sigma}(t)K^{\sigma}(t) \tag{2}$$

whereby $\sigma$ indicates the share of capital and $A(t)$ is technological progress. It is assumed that the level of technological progress, grows at a constant and exogenouslyy given rate, $\lambda$, whereby:

$$\lambda = \frac{\dot{A}}{A} \tag{3}$$

Equation (3) can be rearranged as $\dot{A} = \lambda A$ and solved as a differential Equation (4)

$$A(t) = e^{\lambda t}A(0) \tag{4}$$

Hence, production technology of the modern sector takes the following form:

$$X_m(t) = e^{\lambda t}A(0)L_m^{1-\sigma}(t)K^{\sigma}(t) \tag{5}$$

To attract labor force from the traditional sector, the management of the modern sector has to offer greater wages that those in subsistence agriculture. The wage gap between two sectors has to compensate for the differences in the living costs, psychological costs of relocation, and the shortage of social capital in the urban settings. The lack of the social capital can be abridged by health insurance, provision of social security, pension deposits, and funeral insurance (Sadik-Zada et al., 2019). These are the costs that can be attributed to the difference between Gesellschaft in the urban and Gemeinschaft in the rural settings (Nisbet, 1969). Besides subsistence income, traditional communities provide different types of social insurance. Thus, the modern sector wages must compensate also for the amenities of the moral economies. Nicholas Kaldor (1969) attributes the wage differential also to a greater calorie intake requirements of the full-time employees in manufacturing sector.

Modern sector enterprises keep on hirings long as the marginal productivity of the newcomers is greater than the sector wages. It offers a unified level wages, i.e. there is not wage differentiation. To determine the marginal productivity of labor, in Equation (6) the production function of the manufacturing labor is differentiated with regards to labor.

$$MPL = \frac{\partial X_m}{\partial L_m} = (1-\sigma)^{\sigma}_{\ e^{\lambda t}A(0)\left(\frac{K_m}{L_m}\right)} \tag{6}$$

The effectively demanded labor in the modern sector, $L_m^D$, can be determined by equating the right-hand side of equation (6) to the wage level in the modern sector, $w_2$. This yields the labor demand, $L_m^D$, in equation (7).

$$L_m^D = \left[\frac{e^{\lambda t}A(0)(1-\sigma)}{w_2}\right]^{1/\sigma} K_m \tag{7}$$

Being the function of the wage rate, the labor demand function of the modern sector, $L_m^D$, is a downward-sloped and asymptotically shaped curve, $D_i(K_m)$ (Fig. 1). The labor supply of modern manufacturing, $L_s$, is depicted by the green-colored curve.

Equation (7) shows that in the settings with surplus labor, the low of diminishing returns of the employed do not hold. There is a positive and linear relationship between employed capital and labor demand. A greater level of technology have also a linear and wage rate in the modern sector a disproportionate impact on labor demand. As long as the economy is predominantly a labor surplus economy, additional labor demand does not lead to variations in the wage level. The graphical implication of this assumption is the infinitely inelastic, i.e. horizontal labor supply curve in the underdeveloped economies: as long as the economy disposes over substantial surplus labor, i.e. disguised unemployment over the interval $[0, L_s]$, the labor surplus is infinitely inelastic.

In Fig. 1, labor demand is depicted by blue colored curves $L_i^D(K_i)$. $K_m$ is the quantity of capital employed in the modern sector. In the initial period $t = 1$, the initial capital accumulation, i.e. investment of $K_1$, and establishment of the modern sector within the underdeveloped economy leads to the labor demand $L_1^D(K_1)$, which is determined in accordance with equation (8). The intersection of $L_1^D(K_1)$ and $L_s$ indicates the labor demand of the modern sector, $L_1$, gross manufacturing output $0P_1E_1L_1$. Total manufacturing output is divided between capitalists and workers: $0w_1E_1L_1$ squares with the sum of the paid wages and $w_MP_1E_1$ with profits. This inquiry does not delve into the black box of the nexus between labor demand and capital accumulation. The same holds for technological progress' impact on labor demand.

Like in Harrod-Domar model, the precursor to the Lewis model, capital accumulation is the major driver of economic growth of the underdeveloped economies (Domar, 1946). Both in Lewis (1954) and Ranis and Fei (1961) workers barely save from their income. This is why, reinvestment of profits is deemed to be the only source of capital accumulation in the manufacturing sector. In subsection 4, I show based on the analysis of empirical literature on savings behavior of labor migrants that exclusion of workers as a potential source of capital accumulation is not justified. To account for the mentioned limitation, section 6 extends the analytical framework by the analysis of the

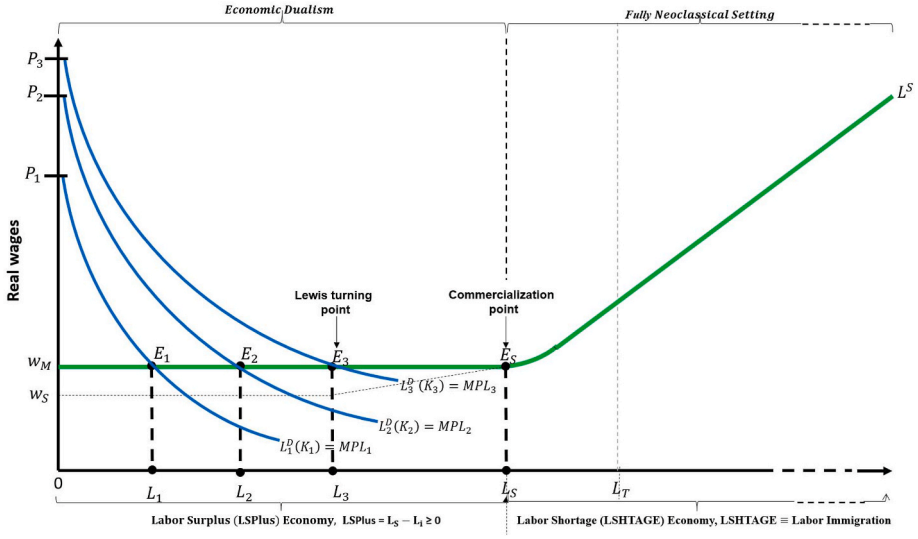


**Fig. 1.** Manufacturing sector labor market demand and supply. Adopted from Basu (1984), p. 184 and Sadik-Zada et al. (2019), p. 9.

repercussions of savings of labor migrants.

## 4. Modernization dynamics with mineral commodity export revenues

In the following, the study focuses mostly on the of natural resource revenues on economic modernization because of the risks that emanate for the entire incentive structure of relevant actors and the risks of protracted industrialization and/or premature deindustrialization in this context. Sadik-Zada (2016) and in the subsequent study Sadik-Zada and Loewenstein (2018) show that in contrast to the renewable natural resources, such as agricultural export revenues, nonrenewable commodities, have a potential for the deterioration of the incentive structure of the ruling elites. One of the central concomitants of the deterioration of institutional quality is the so-called distributional bargaining, whereby the state elites spread the natural resource revenues among the public for the sake of a longer tenure or appropriation of more wealth.

To delineate the repercussions of the commodity export revenues into the economy of a rather underdeveloped economy and inferior institutional quality the study makes use of graphical juxtaposition of the scenarios with and without natural resource influx and the respective increase of the income within the resource-rich economy in Fig. 2. Increasing export revenues could, and in most cases, as will be shown in the next sections, definitely lead to an increasing level of income in the noncapitalist sector. Of course, under different political and economic constellations distribution of the resource export revenues are differently distributed among different social groups in the respective countries.

In the following, I scrutinize roughly the modernization effect of the commodity export revenues in a hypothetical developing economy, which is dominated by subsistence farming and related services. It is assumed that the level of income in the traditional sector after commensuration of commodity exports, $w'_S$, increases and is $\psi$ times greater than before the respective boom. It is assumed that $q$ is constant and does not change as the result of the increasing level of income in the subsistence economy. Under such conditions, the wages in the modern sector, $w'_m$, automatically increase and equal now $qw'_S$.

Prior to the commensuration of the commodity exports, the total output of the modern sector squares with $0P_1E_1L$, the area under the

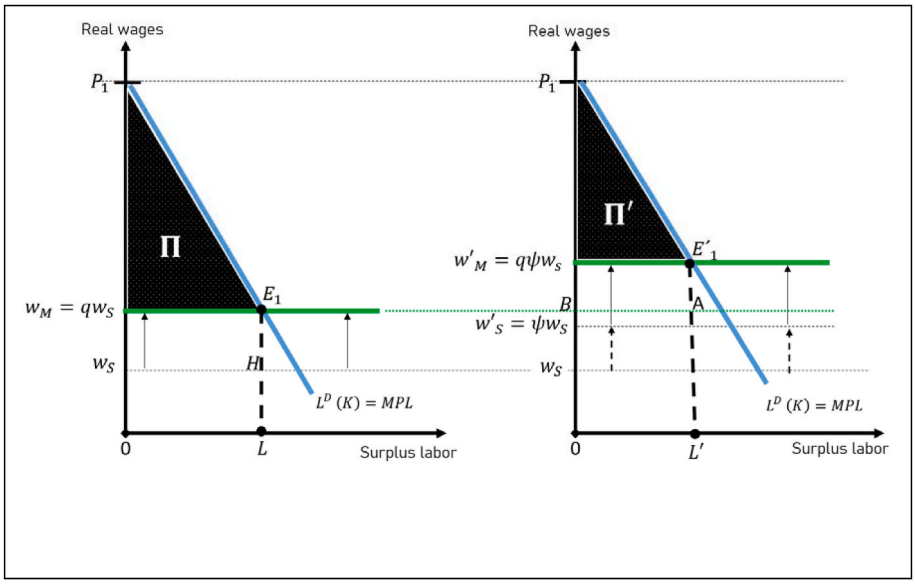


**Fig. 2.** Bargaining and capital accumulation.

labor demand curve, $L^D(K)$, limited by the intersection point of this labor demand and the horizontally shaped labor supply curve, $E_1$. As a result of the increasing wages the labor demand of the manufacturing sector falls from $L$ to $L^{'}$. The area between the labor demand and labor supply curves, the triangle $w_M P_1 E_1$ is the difference between gross output and wage costs and commensurate with the profits of capitalists, Π. As can be easily captured from Fig. 2 with the naked eye, the increasing wages in the manufacturing sector lead to the contraction of the profits of the of the modern sector. The profits shrink from $\Pi = w_M P_1 E_1$ to $\Pi^{'} = w^{'}{}_M P_1 E^{'}{}_1$.

Following the original model in Lewis (1954) and all the follow-up studies of the last seven decades, it is assumed that the wage income is completely consumed. Hence, increasing subsistence income and/or wage bill do not correspond with increasing savings subsistence farmers and/or workers. Under these conditions increasing level of subsistence income and wages in the modern sector corresponds with a lower rate of modern sector profits. Within Lewis' dual sector economy model this leads to a slower pace of the surplus labor absorption by the nascent modern sector. For mathematical proof of this protraction hypothesis see Sadik-Zada (2019, 2020). In the following subsection, we analyze the scenario whereby the workers of the modern sector are capable to save a certain proportion of their wage income and the modernization effects of saving behavior.

## 5. Savings behavior of workers

There is a sizeable literature, which addresses the savings-behavior of the labor migrants. This literature can be divided into the contributions that address the saving behavior of those who migrated from rural to urban areas within the same country (Acharya and Leon-Gonzalez, 2014) and the studies that analyze saving behavior of international migrants (Bauer and Sinnig, 2001). The assumption within the dual economy models that migrant workers entirely consume their wages and do not save anything does not square with the empirical evidence (Chen, 2017). Empirical studies on the rural-urban migration indicate that migrant households if they have temporary jobs consume less than the locals (Fang and Sakellariou, 2015).

The studies on international migration indicate that labor migrants save during the initial years of their stay more and consume less than their local counterparts because of a higher probability of remigration (Galor and Stark, 1990). This is in line with the permanent income hypothesis proposed by Milton Friedman, which shows that households determine their current level of consumption not just in accordance with current income but also expected income in the future years (Friedman, 1957; Dustman and Görlach, 2016). In addition, a higher risk of remigration or higher income risk of the migrants during the initial phase of migration leads also to a greater level of remittances in their countries of origin (Amuedo-Dorantes and Pozo, 2004). There is, nevertheless, no evidence, whether migrants transfer remittances predominantly for investment or consumptive targets (Bauer and Sinnig, 2001). Country case studies, nevertheless, indicate that remittances correspond with both greater consumption and investments in the receiving countries (Dhakal and Oli, 2020). Hence, in the following, the study extends the analysis of the dual economy by scrutinizing scenarios, whereby the workers can both consume and/or save their earnings.

Kevin Lancaster (1973) addresses hypothetically the issue of the savings behavior of the workers and deems this kind of behavior as favorable in terms of the long-run level of consumption of workers. Savings of the workers is equivalent to anstinence, wich leads to a long-term increase of workers' consumption levels if we deal with capitalists, especially financial instititions, which operate as agents for capital accumulation. Although the workers do not invest directly in productive activities, their savings are *"… equivalent to voluntary handling over part of their income to the capitalists in the hope or belief … that the capitaists will use it for true capital investment and will not use the proceeds of new stock issues merely to* support *their mistresses or buy larger car."* (Lancaster, 1973, p. 1094).

To evaluate the impact of savings behavior of workers on capital accumulation, in Fig. 3, the study considers the same comparative analysis that has been scrutinized in the previous subsection and in addition assume that the modern sector employees save the wage differential between their urban wages and subsistence level wages. This is of course a theoretical extreme case. The level of savings depends on individual preferences and differs from case to case and most probably less than the respective wage differential because of the higher living costs in the urban areas. This assumption, however, simplifies the graphical analysis without any loss for generality.

In the case with no distributional bargaining, the wage level of the manufacturing sector workers equals $w_M$. This wage level corresponds with the labor demand of L in the modern sector. Each of L workers work for the wage level, which is grater than the traditional sector wages by $(w_M - w_S)$. This imply a gross wage differential of $(w_M - w_S)L$. This amount corresponds with $w_S w_M E_1 B$. It is assumed that savings and profits are fully reinvested in the modern sector. This means that gross capital accumulation in the natural resource-poor economy corresponds with the area $w_S P_1 E_1 B$, i.e. the whole back area in Fig. 3a This area corresponds with the sum of the original profits, $\Pi_0$, plus gross savings, ΔS. Hence, capital accumulation in t can be expressed as follows:

$$\Delta K = \Pi_0 + \Delta S \tag{9}$$

Hence, in the following, the study scrutinizes a simplified hypothetical case, whereby the workers in the modern sector are saving the wage differential between subsistence and modern sectors and by doing so contribute to the capital accumulation in the modern sector. To this end, we first scrutinize the case of the workers, who save their income above the subsistence level and by doing so enable reinvestment of these savings by the modern sector capitalists (Lancaster, 1973). In Fig. 2a the mentioned amount corresponds with $[(w_M - w_S) \bullet L]$. Geometrically this savings correspond with the area $w_S w_M E_1 B$ on Fig. 2a. This implies that in total the area $w_S P_1 E_1 B$ will be reinvested into manufacturing sector. In the case with distributional bargaining, which is depicted in Fig. 2b, the workers save an amount, which equals $[(w^{'}{}_M - w_S) \bullet L^{'}]$.

Here we assess the impact of bargaining on the effective labor demand and then on the relationship between ΔΠ and $\Delta\Pi^{'}$. For this I make use of equation (8). First, let me quantify the labor demand in the face of distributional bargaining.

$$L^{'} = \left[\frac{e^{\lambda t} A(0)(1-\sigma)}{w_2 \psi}\right]^{1/\sigma} K_m \tag{10}$$

The savings in the case with bargaining equal then the product of the adjusted labor demand, $L^{'}$, and the adjusted wage level in the manufacturing sector, $w_2\psi$. This yields

$$S^{'} = \left[\frac{e^{\lambda t} A(0)(1-\sigma)}{w_2 \psi}\right]^{1/\sigma} \bullet K_M w_2 \psi = \left[\frac{e^{\lambda t} A(0)(1-\sigma)}{\psi}\right]^{\frac{1}{\sigma}} K_M \psi {w_2}^{1-\frac{1}{\sigma}} = \left(e^{\lambda t} A(0)(1-\sigma)\right)^{1/\sigma} \psi^{1-\frac{1}{\sigma}} {w_2}^{1-\frac{1}{\sigma}} K_M$$

$$S = \left[\frac{e^{\lambda t} A(0)(1-\sigma)}{w_2}\right]^{1/\sigma} K_m w_2 = \left(e^{\lambda t} A(0)(1-\sigma)\right)^{1/\sigma} {w_2}^{1-\frac{1}{\sigma}} K_M$$

$$\frac{S^{'}}{S} = \psi^{1-\frac{1}{\sigma}} \tag{11}$$

If $\sigma \to 1$ then $\frac{S^{'}}{S} = 1 > \to$ No difference. This is an unrealistic case with no labor input. In accordance with Inada conditions such a scenario corresponds with $Y_m = 0$.

If $\sigma > 1$ then $\frac{S^{'}}{S} > 1 \to$ Not feasible in the case of a linear-limitational Cobb-Douglas production function.

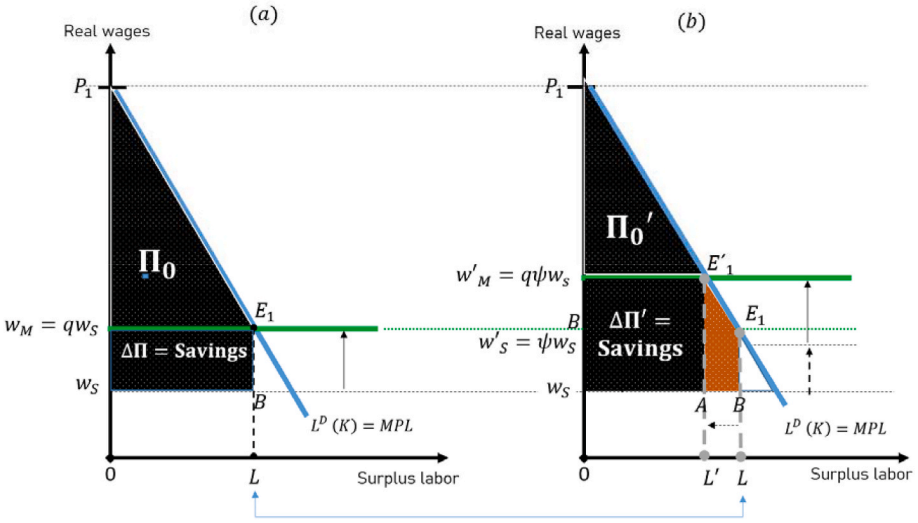


**Fig. 3.** Savings behavior of workers without (a) and with (b) distributional bargaining.

If $\sigma < 1$ then $\frac{S'}{S} < 1 \rightarrow$ Less savings. This is the only realistic case and it implies that distributional bargaining leads to a lower level of private savings.

To illustrate this effect geometrically, we juxtapose the total amount of reinvestment for the cases with and without distributional bargaining. The sum of profits and savings for the case without bargaining commensurate with the following definite integral:

$$\Pi + S = \int_0^L \left[(1-\sigma)e^{\lambda t}A(0)\left(\frac{K}{L}\right)^{\sigma} - w_S L\right]dL = X_M - w_s L \equiv w_S P_1 E_1 B \qquad (12)$$

whereby the area under the labor demand curve corresponds with the first term of the definite integral. It is assumed that gross profits and the difference between manufacturing and traditional sector wages are reinvested. Hence the gross manufacturing sector output less subsistence wage level is assumed to square with the gross capital accumulation in the economy. In Fig. 3 the sum of reinvestment corresponds with the area $w_S P_1 E_1 B$ and the sum of the consumed income of the manufacturing sector wages correspond with $w_s L$ and the area $w_S w_M E_1 B$.

In the case with distributional bargaining the profits can be determined with an analogous definite integral. The only difference is related to the upper bound of the integral. In the case with distributional bargaining it is no more $L$, but $L'$.

$$\Pi' + S' = \int_0^{L'} \left[(1-\sigma)e^{\lambda t}A(0)\left(\frac{K}{L}\right)^{\sigma} - w_S L\right]dL = X'_M - w_s L' \qquad (13)$$

Gross manufacturing output in the case with bargaining corresponds with the first term of the definite integral. In Fig. 3, gross manufacturing sector output corresponds with area $OP_1E'_1L'$. This area is less than manufacturing sector output with no distributional bargaining. This difference corresponds with the area $L''_1E_1L$.

The sum of reinvestments, i.e. gross profits plus savings, correspond with area $w_S P_1 E'_1 L'$. This area is less than in the case with no bargaining, i.e. under conditions of distributional bargaining, the sum of reinvestment is less by the area $AE'_1E_1B$.

Assessment of the case with savings behavior shows that savings of the workers could serve as an additional source of the growth of the manufacturing sector. Furthermore, our analysis shows that in the case of distributional bargaining workers could save both individually and in aggregate terms more than in the case without commodity revenues and bargaining. Nevertheless, it has also been shown that despite greater savings potential, bargaining corresponds with less gross reinvestment and capital accumulation in the manufacturing sector.

## 6. Differential game-based derivation of the bargaining scenarios

In the previous subsection, I have scrutinized the repercussions of the commodity revenue inflows on the wages bill and the pace of economic modernization, whereby the issue of the magnitude of the increasing levels of income in the manufacturing sector has been deemed as exogenously given. In this subsection, I am endogenizing the process and the repercussions of the distribution of commodity revenues among different stakeholders. To this end, I make use of differential game theory and derive possible scenarios for the distribution of the surplus within the dual economies, whereby the budget surplus emerges as a result of the commensuration of exports of the natural resources and the influx of substantial revenues. The study presents the noncooperative Nash and Stackelberg equilibria. With regards to the information structure, the analysis is confined to open loop structures, whereby controls depend on time, $t$, and the initial state $S(0)$, $u^i = u^i(t, x_0)$ structure (Başar and Olsder, 1982a,b; Feichtinger and Hartl, 1986).[1]

Employment of the noncooperative Nash strategies yields absolutely sense in the situations whereby the players have symmetric roles and none of the players can enforce her strategy to the rival or opponent. Within the Nash strategy, it is assumed that all the players know each other's performance functions, and the applied strategies are communicated simultaneously (Simaan and Cruz, 1973).

In situations, whereby 1. one of the players is not aware of the performance function of another player; and 2. one of the payers is capable to announce her strategy prior to another's player, the Nash strategy is no more applicable (Simaan and Cruz, 1973). The mentioned constellations give one of the players the capability of enforcing her strategy to another player then Stackelberg strategy is more appropriate (Feichtinger and Hartl, 1986). Simaan and Cruz (1973) give mathematical proof that within the sequential strategy announcement framework, Stackelberg strategy will be employed because Nash strategy is inferior and Stackelberg is a superior strategy.

Within the Stackelberg solution, this is a game on two levels with a leader and a follower epitomized by the politically dominant elites and the rest of the population as the follower (Cruz, 1978). This is in line with the solution suggested by von Stackelberg, whereby, in contrast to

[1] For the juxtaposition of the open-loop, closed-loop and feedback information structures see Feichtinger and Hartl (1986), p. 534.

the non-cooperative mood of Nash and from the cooperative mood of Pareto, there is a clear leader-follower relationship, which is characteristic for most societies (Wishart and Olsder, 1979; Feichtinger and Hartl, 1986). The leader is referred to also as the *coordinator*. The followers adopt their rational reaction set by following open-loop Nash strategies. The coordinators employ their open-loop controls by incorporating the open-loop strategies of the followers in their calculus (Wishart and Olsder, 1979).

The assumption of the full absorption of surplus labor and resolution of the backward sector on the one hand, and establishment of the nascent neoclassical modern sector as the sole sector of economy allows the derivation of the sequencing of the Stackelberg equilibria with an open-loop information structure (Başar and Olsder, 1982a,b). As shown in Pohjola (1983) and Wishart and Olsder (1979) this is a pertinent question for the differential game model of capitalism, addressing scenarios with one of the groups dominating the game setting is a relevant question, at least on the theoretical level. The corresponding open-loop Nash solution of this problem has been elaborated in Sadik-Zada (2019). In the following, the study takes Kelvin Lancaster's (1973) open-loop Nash equilibrium and the corresponding open-loop Stackelberg solution of this game in Pohjola (1983) as the reference models.

### 6.1. A differential game model

It is assumed that the total stock of the tradable natural resources in $t_0$ equals $S(0)$. The quantity of the extracted natural resource in period $t$ is denoted by $R(t)$. $S(t)$, the remainder of the natural resource stock in period $t$ is the state variable in the model. It evolves in accordance with the following equation of motion:

$$\dot{S}(t) = -R(t) \tag{14}$$

For the sake of simplicity, the price of one unit of the natural resource is normalized to unity and it is assumed that there are no extraction costs. The extracted natural resources are completely exported overseas. Hence, in period $t$ public budget receives commodity revenues amounting to $R$ units of currency. The assumption that the resources are completely exported overseas without considering modern domestic processing is in line with Alfred Hirschman's enclave industry hypothesis.

There are two players in this game. The first player encompasses the majority of the population, persons that do not belong directly or indirectly to the state elites. These are subsistence farmers, street doctors, moneylenders, pottery-makers, open-air laundry tubes, employees of the public sector, small and middle-sized enterprises, petty traders, etc. (Lewis, 1954; Clement, 2015; Sadik-Zada, 2016). In the following, we refer to this player as *Player 1* or *Public* interchangeably. *Player 1* controls its share of consumption in the gross value added (GVA), i.e. the surplus of the economy. This share is denoted by $u_1(t)$ and GVA is determined in accordance with the following equation

$$GVA(t) = R(t) + A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t) \tag{15}$$

whereby $[A_2(t)K^{\sigma}L^{1-\sigma}]$ is the gross output of the modern sector. The quantity of the physical output commensurates with its value because for the sake of simplicity the price of one unit of modern sector output is normalized to unity, like in the case of the natural resource, $R(t)$. $[w_m L_m]$ is the wage bill of the modern sector, and $[\delta K(t)]$ is the value of the depreciation of the physical capital.

$u_1(t)$ is the control variable of the *Public* and ranges within institutional bounds $a$ and $b$, i.e. $u_1(t) \in [a,b]$, whereby $0 \le a \le u_1(t) \le b \le 1$, whereby $a$ is the lower and $b$ is the upper institutional bound. A greater $u_1(t)$ corresponds with a greater magnitude of redistribution of revenues among those in the traditional sector. *Player 2*, epitomized by the core state elite and the politically powerful groups controls the distribution of the GVA, whereby $u_2(t) \in [0,1]$ is the control variable of Player 2 and stands for the share of the remainder of the GVA after Public's consumption. In the following, the time reference $t$ will be omitted whenever this does not cause any misunderstanding. All symbols with dots over indicate derivatives with regards to the time of the respective variable.

It is assumed that the rest of the remainder, $[1-u_2]$, is illicitly appropriated and used in a nonproductive or allocative way by Player 2. It is assumed that the illicitly appropriated revenues leave the respective country for financial oases and do not have any impact on the domestic economy and manufacturing sector. This assumption is in line with Sadik-Zada (2016, 2020) and Sadik-Zada and Loewenstein (2018).

Hence, the basic relationships within this game can be represented as follows:

$$Public's\ (Player\ 1)\ Stake\ in\ Surplus = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right] \bullet u_1(t) \tag{16}$$

$$Elite's (Player 2)\ Stake = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right](1-u_1)(1-u_2) \tag{17}$$

$$\dot{K} = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right](1-u_1)u_2 \tag{18}$$

Following in Hoel (1978) and Sadik-Zada (2019) it is assumed that one unit of appropriation of the budget surplus translates into its one unit of utility. To account for the time value of the utilities we assume that both players discount utilities. $\rho_1$ and $\rho_2$ are the discount rates of the *Public* and *Elite* respectively.

Hence, the utility or payoff functions of Public, $J_1$, and the Elite, $J_2$, can be expressed as follows:

$$J_1 = \int_0^T e^{-\rho_1 t}\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right] \bullet u_1(t)dt \tag{19}$$

$$J_2 = \int_0^T e^{-\rho_2 t}\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right](1-u_1)(1-u_2)dt \tag{20}$$

The second state variable, capital accumulation, is determined by the following equation:

$$\dot{K}(t) = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right](1-u_1)u_2 \tag{21}$$

### 6.2. Non-cooperative Nash open-loop equilibrium

To solve the presented differential equation based on Pontryagin's maximum principle, the Hamiltonian functions of the players serve as the starting point. Hamiltonian function represents Public's (Player 1) current and future utilities and have the following form:

$$\begin{aligned} H_1 = {} & e^{-\rho_1 t}u_1(t)\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right] \\ & + \lambda_1(t)(1-u_1(t))u_2(t)\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]\right] \\ & - \mu_1(t)R(t) \end{aligned} \tag{22}$$

whereby $\lambda_1(t)$ and $\mu_1(t)$ are auxiliary variables: $\lambda_1(t)$ indicates the shadow value of the marginal increase of the capital stock and $\mu_1(t)$ indicates the shadow value of the marginal increase of extraction of the natural resource. The choice of the magnitude of $u_1(t)$ from the range of $[a,b]$, which determines the magnitude of distributional bargaining depends on the product of $\lambda_1(t)$ and $u_2(t)$. The optimality conditions for the open-loop Nash equilibrium correspond with the following relations:

$$u_1 = \left\{ \begin{matrix} a \\ b \end{matrix} \right\} \ if\ \lambda_1 u_2 e^{\rho_1 t} \left\{ \begin{matrix} > \\ < \end{matrix} \right\} 1 \tag{23}$$

The Hamiltonian function of the Elite (Player 2) has the following form

$$H_2 = e^{-\rho_2 t}\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right](1-u_1)(1-u_2) + \lambda_2(t)(1-u_1(t))u_2(t)\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right] - \mu_1(t)R(t)\right. \quad (24)$$

$H_2$ is maximized by the values of $u_2$ that satisfy the following conditions:

$$u_2 = \left\{ \begin{matrix} 0 \\ 1 \end{matrix} \right\} \text{ if } \lambda_2 e^{\rho t} \left\{ \begin{matrix} < \\ > \end{matrix} \right\} 1 \quad (25)$$

Based on optimality conditions for $u_1$ and $u_2$ in (23) and (24) there are four possible solutions for the optimization problem:

| | | | | | | |
|---|---|---|---|---|---|---|
| I. | $u_1 = a, u_2 = 0$ | whenever | $\lambda_1 u_2 e^{\rho_1 t} > 1$ | and | $\lambda_2 e^{\rho t} < 1$ | unfeasible mode |
| II. | $u_1 = b, u_2 = 0$ | whenever | $\lambda_1 u_2 e^{\rho_1 t} < 1$ | and | $\lambda_2 e^{\rho t} < 1$ | allocative mode |
| III. | $u_1 = a, u_2 = 1$ | whenever | $\lambda_1 u_2 e^{\rho_1 t} > 1$ | and | $\lambda_2 e^{\rho t} > 1$ | modernization mode |
| IV. | $u_1 = b, u_2 = 1$ | whenever | $\lambda_1 u_2 e^{\rho_1 t} < 1$ | and | $\lambda_2 e^{\rho t} > 1$ | antagonistic mode |

Whereby combination I is not feasible because of the incompatibility of $\lambda_1 u_2 e^{\rho_1 t} > 1$ and $u_2 = 0$. Hence in the following, the study scrutinizes only three equilibria. Solution II is a destructive mode, whereby the Public claims the highest possible stake for consumption and the Elite illicitly appropriate the remainder. Solution III is a productive mode, whereby the Public claims minimum for its own consumption and the Elite invests the rest. There is no illicit appropriation under this scenario. Solution IV is a solution with no illicit appropriation or allocative expenditure by the Elite and maximum consumption claims by the Public (Sadik-Zada, 2019). Based on Lancaster (1973) and Bender (2012), Sadik-Zada (2019) shows that the transversality conditions for a Lewis-type problem. Hereby the MPK equals zero. Against the backfrop of this kind of reduction of the MPK only two Nash equilibria, II and III are realistic. Solution III, corresponds with the initial, i.e. development or modernization, and solution II with the post-development phase with neoclassical remuneration. In the next subsection, I present in more detail the hierarchical open-loop Stackelberg solutions (Sadik-Zada, 2019).

### 6.3. Stackelberg open-loop solution with the public as a leader

Here, I analyze a setting, whereby the *Public* has a leading position in society and the *Elites* are the followers. This is a constellation with one leader and one follower. The open-loop Stackelberg solution of this game has been proposed in Wishart and Olsder (1979). Pohjola (1983) embedded Kevin Lancaster's capitalism game in the mentioned open-loop Stackelberg framework. We re-employ the same model in the context of the analysis of the interaction between the Public and the Elites. Within this setting, the follower, i.e. the Elites maximize their utility. The corresponding Hamiltonian function is formulated in Equation (26):

$$H_2 = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right](1-u_1)(1-u_2) + \lambda_2(t)\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right](1-u_1)u_2 \quad (26)$$

the corresponding optimality conditions are

$$\dot{\lambda}_2(t) = -\frac{\partial H_2}{\partial K} = -\left[\alpha A_2 K^{\sigma-1}L^{1-\sigma} - \delta\right][1-u_2-u_2\lambda_2][1-u_1], \lambda_2(T) = 0$$

Since,

$$u_2 = \begin{cases} 0 \text{ if } \lambda_2 > 1 \\ 1 \text{ if } \lambda_2 < 1 \end{cases}$$

This implies that commodity revenues will be invested at the maximum rate as long as the marginal value of the marginal increase of the capital stock is above unity. If the marginal value of an investment is below unity then it makes economically more sense to appropriate the surplus. Because it is assumed that one unit appropriated revenue squares with one unit of utility for the state elites (cf. Pohjola, 1983).

$\lambda_2(t)$ measures the shadow value of capital from the perspective of Player 2, i.e. the Elite. The Nash solution for the Elite is obtained by maximizing $H_2$ with respect to the control variable $u_2$. The necessary optimality conditions are presented in equations (19)–(21).

$$u_2 = \left\{ \begin{matrix} 0 \\ not\ defined \\ 1 \end{matrix} \right\} \text{ if } \lambda_2 \left\{ \begin{matrix} < \\ = \\ > \end{matrix} \right\} 1 \quad (26)$$

Equation (27) implies that the Elite invest the maximally feasible amount until they value the marginal increase of capital stock is greater than unity. If the marginal valuation of one additional unit of investment is unity then the Elite is indifferent between investment and illicit appropriation. If the marginal increase of the capital stock by one unit corresponds with its valuation below unity then the Elite illicitly appropriates the whole GVA.

$$\dot{\lambda}_2 = -\frac{\partial H_2}{\partial K} = -\left[\delta(1-u_1)(1-u_2) + \lambda_2(t)\delta(1-u_1)u_2\right] = -\delta(1-u_1)(1-u_2+\lambda_2 u_2) \quad (27)$$

$$\lambda_2(T) = 0 \quad (28)$$

By definition, within the framework of the Stackelberg solution the Public employs $u_1$ maximizes (1) subject to (3) and the adjoint reaction of the Elite in Equation (29), and the transversality condition expressed in the same equation. Hence, the optimal control problem of the leader, here Public, exhibits a Hamiltonian with $K$ and $\lambda_2$ as two state variables and have the following form

$$H_1 = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right]u_1 + \lambda_1\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right](1-u_1)u_2 - \mu_1\delta(1-u_1)(1-u_2+\lambda_2 u_2) \quad (29)$$

whereby $\lambda_1(t)$ and $\mu_1(t)$ are co-state variables of K and $\lambda_2$ respectively. The costate variable $\lambda_1$ differs from that of the Elite's costate variable $\lambda_2$ due to the differences in the valuation of the marginal utility of reinvestment for different groups.

The coefficient of $u_1$ in (29) is the leader's switching function (cf. Wishart and Olsder, 1979; Pohjola, 1983).

$$B(t) = \left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right] - \lambda_1 u_2\left[R(t) + \left(A_2(t)K^{\sigma}L^{1-\sigma} - w_m L_m - \delta K(t)\right] + \mu_1(1-u_2+\lambda_2 u_2) \quad (30)$$

The Hamiltonian function in connection with the maximum principle imply that

$$u_1(t) = \begin{cases} a & if \quad B(t) < 0 \\ b & if \quad B(t) > 0 \end{cases} \quad (31)$$

| | $t \in [0, \hat{t}_2)$ | $t \in [\hat{t}_2, \hat{t}_1)$ | $t \in [\hat{t}_1, T]$ |
|---|---|---|---|
| $\hat{u}_1(t)$ | a | a | b |
| $\hat{u}_2(t)$ | 1 | 0 | 0 |

The derived Stackelberg solution consists of three phases. In the first phase, both workers and capitalists consume at the minimal level. This corresponds with the maximum level of investment in the economy. In the second phase, the workers keep on consuming at the minimal level. Capitalists stop investing and consume at the maximum level. In the third phase, both groups maximize their consumption (Feichtinger and

Hartl, 1986). For the derivation of the switching instants, $\hat{t}_2$ and $\hat{t}_2$ see Pohjola (1983).

Over the whole planning horizon workers value investments greater or at least at the same level as the capitalists do, i.e. $\lambda_1(t) \geq \lambda_2(t)\ \forall[0,T]$. Over the interval $(\hat{t}_2, \hat{t}_1)$, the workers offer the share of the gross output, (a-b), to the capitalists as compensation for the extension of capitalists' investment activities from $\bar{t}$ to $\hat{t}_2 > \bar{t}$. As a result, the model economy accumulates more capital than in the case with Nash equilibrium (Feichtinger and Hartl, 1986). Pohjola (1983) analyzes also the open-loop Stackelberg solution for the case with the elite as the leader.

### 6.4. Discussion of the scenarios

Despite principal differences between open-loop Nash and von Stackelberg solutions, the derived scenarios indicate analogous investment and bargaining behavior. Nevertheless, overall, Stackelberg solution corresponds with less bargaining and more investment. In both cases, the initial phases both in Nash and von Stackelberg equilibria correspond with maximized investment and minimized bargaining. The latest stage, i.e. phase 2 in Nash and phase 3 in Stackelberg, corresponds with maximum bargaining and zero investment. Phase 2 in von Stackelberg solution, with zero investment and minimum bargaining is the result of the strategic behavior of workers. In order to contribute to their employment security and general economic stability, workers commit themselves to minimize their distributional aspirations in the aftermath of the initial phase, even if the entrepreneurs drastically reduce investing in the manufacturing sector.

With the exception of phase 1 both within the open-loop Nash and open-loop Stackelberg solutions, none of the phases corresponds with growing manufacturing, i.e. economic modernization. In the subsequent phase(s), entrepreneurs stop investing. This means that this initial phase that provides the greatest opportunity for poverty alleviation, creation conditions for affluence, and establishment of a more coherent and less polarizes society with resilient middle class.

## 7. Bargaining and capital intensity spectra and economic modernization

Productive and altruistic modes are two extremes of the bargaining mode. This is why, in the following, the study elaborates only on the modernization dynamics within the bargaining mode without referring to its intensiveness. In bargaining mode, the export revenues are not entirely invested. The not invested share of the revenues are not used for the earmarked targets of socioeconomic development. Here, under investment, we define not only investment in physical or intangible capital accumulation, but also in human development. Hence, action against malnutrition, child mortality, health status of adolescent girls etc. are of an investment character.

Let's assume that $\theta \in [0,1]$ is the share of export revenue, which is used for unproductive purposes, whereby is the share of this unproductively used revenue that is illicitly appropriated by the political elites. The remainder of this revenue, i.e. $(1-\theta)R$, is invested. Hence, the APL in the nonmodern sector increases by $(1-\zeta)\theta R/L_S$, i.e. $w_S^R = w_S + (1-\zeta)\theta R/L_S$. It is assumed that the additional charge factor $q$ has not changes under different conditions. Based on the derived level of income in the nonmodern sector the relative increase of income in the nonmodern sector, $\psi$, is the ratio of the new and old level of incomes in this sector:

$$\psi = \frac{w_S + (1-\zeta)\theta R/L_S}{w_S} = \frac{w_S L_S + (1-\zeta)\theta R}{w_S L_S} \tag{32}$$

equation (32) indicates that the relative wage increase depends on the ratio of the redistributed commodity revenues, and the magnitude of the employment in the nonmodern sector, $L_S$. equation (32) makes also clear that $\psi$ is strictly greater than unity. A greater magnitude of export revenues, $R$, and a lower level of illicit appropriation, $\zeta$, leads to

The implications of the rising wage costs of the modern sector and the reinvestment of $(1-\theta)R$ are incorporated into the labor demand function by replacing the wages before redistribution, $(w_S)$ with $(\psi \bullet w_S)$; and adding $(1-\theta)R$ to the capital stock. This yields the adjusted labor demand, $L_m^R$ in Equation (33).

$$L_m^R = \left[\frac{(1-\sigma)}{q\psi w_S}\right]^{\frac{1}{\sigma}} \bullet [K_m + (1-\theta)R + S] \tag{33}$$

To highlight the effects of commodity exports driven redistribution and reinvestment, Equation (33) is rearranged to Equation (34).

$$L_m^R = \underbrace{\left(\left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} \cdot K_m}_{\equiv L_m} + \left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} [(1-\theta)R + S]\right) \cdot \left(\frac{1}{\psi^{1/\sigma}}\right) \tag{34}$$

The first term of Equation (34) on the RHS of the equation, $\left[\left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} \bullet K_m\right]$, is identical with the RHS of Equation (7). This is the labor demand without the influx of the natural resource revenues. The second term on the RHS of the equation, $\left[\left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} [(1-\theta)R + S]\right]$, is strictly positive. Its magnitude depends only on two parameters that could be steered by the politicians. These are the shre of the unproductively uses surplus, $\theta$; the value of commodity export revenue, $R$; and the value of private savings, $S$. This means that a greater share of productive use of resources and more commodity exports lead to a greater labor demand in the nascent modern sector. The third term, $\frac{1}{\psi^{\frac{1}{\sigma}}}$, is the direct effect of the increasing average wages in the nonmodern sector of the economy. Because $\psi$ and $\left[1/\sigma\right]$ are strictly greater than unity, multiplication of $\left(\left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} \bullet K_m + \left[\frac{(1-\sigma)}{qw_S}\right]^{\frac{1}{\sigma}} [(1-\theta)R]\right)$ by $\frac{1}{\psi^{\frac{1}{\sigma}}}$ leads to less labor demand in the modern sector. This effect is stronger if the modern sector is less capital-intensive. Conversely: labor surplus economies with a more capital-intensive modern sector are more resilient to the protraction effect of distributional bargaining. The relevance of the production technology in the context of modernization is an interesting finding that deserves a closer examination.

## 8. Discussion of the findings concluding remarks

In this study, we analyzed the nexus between natural resource

abundance and economic growth from the lens of socioeconomic dualism. For the first time the modernization effect of the inferior strategic behavior of elites in a commodity exporting dual economy setting has been augmented by the savings behavior of the modern sector employees. Against the backdrop of empirical evidence on strong saving propensity of labor migrants, consideration of the savings significantly contributes to the reality content of the model. The model shows on the theoretical level that savings behavior of workers in the nascent modern sector has the capacity of partial mitigation the allocative inefficiencies and the negative modernization effects that emanate from distributional bargaining behavior of the politically and economically powerful elite. However, even the maximized saving of worker's income cannot fully offset the negative effect of distributional bargaining on the pace of economic modernization.

The central difference between the existing literature and present study is a comprehensive differential game theory based endogenization of the distributional bargaining polidy dynamics. Both the open loop Nash and Stackelberg solutions indicate that there are two phases in terms of resource revenue policies. During the early stages of the exploitation of the natural resources the elites care more for economic development and try to keep the allocative inefficiencies at a relatively low level. At the advanced stages the elites maximize the share of the unproductively used budget resources. Accordig to Stackelberg solution, even under conditions of surging corruption the workers keep their wage demands at a relatively low level. Understanding of the importance of gross economic development for workers and probably the hope, that their constructive position elites could lead to the confinement of the rapacious course of the selfish elites is the possible explanation for the worker's conservatism in terms of wage demands. Both the open loop Nash and Stackelberg solutions converge, however, with regards to the advanced stages of the resource-based development in the nondemocratic settings: At the advanced stages of the resource-based development both workers and elites try to maximize their utility epitomized in wages and illicit appropriation respectively. In contrast to the initial years of the commodity export boom, at the advanced stages, both elites and workers follow a rent-seeking course which is detrimental to economic modernization. This shows that with progressing time, both the economy drifts out from the productive to the destructive mode. Hence, natural resource exporting autoctacies could develop disproportionately the tendencies that lead to the degradation of institutional quality and the level of socioeconomic development.

Assessment of the modernization effects of inferior institutional quality that is expressed in different intensities of autocratic bargaining has made clear that commodity revenues *per se* lead to the acceleration of the pace of economic modernization. Increasing wage levels in the modern sector corresponds with the protraction of modernization processes. The net effect of natural resource abundance depends among others also on the capital intensity of the modern sector of the economy. The finding, that more capital intensive manufacturing is more resilient to the inferior institutional quality contradicts the mainstream theory of international trade. Both Ricardian theory of comparative advantage and Heckscher-Ohlin paradigm predict for the labor surplus economies relatively labor intensive and capital scarce production patterns. Hence, the resilience effect of a more capital intensive modern sector on the pace of economic modernization to be taken with a pinch of salt. Because without a comprehensive integration of the presented model with the models of international trade, the findings of the augmented model of economic modernization with resources provides an incomplete picture.

This study is a substantial improvement of the previous models of the resources-growth nexus from the lens of development economics. But, it is still a birds' eye perspective on the problems of socio-economic and public governance issues in the natural resource exporting developing nations. Incorporation of the elements of this theoretical work into empirical works and their integration with more contextualized and detailed computable general equilibrium models could give us more robust analytical tools for the formulation of applied policy instruments to assure continued economic modernization and political upgrading.

## Authorship statement

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in the Resources Policy.

## Data availability

No data was used for the research described in the article.

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