Ground Rent in the Labor Theory of Value

The impact of extraction rent on price-value deviations in 44 countries, 1995-2022

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1 Introduction

The Marxist theory of value revolves around the social division of labor following dynamics of capital accumulation. At its core stands the labor theory of value, which expresses regularities in the relationship between market prices, the general profit rate, and socially necessary labor time. (Tsoulfidis 2021) Socially necessary labor time in the production of commodities as well as capital inputs to production creates exchange value, competition between capitals creates an equalizing general profit rate which is added and gives production prices, and market prices move turbulently around these, like gravitational centers.
The law of value is modified where the social division of labor is changed by capital's historical form. (Rubin 1973) In this paper we trace landed property in Marx's theory of value and estimate price-value deviations due to ground rent in a large multi-regional input-output model. We locate the role of ground rent in capital accumulation and discuss its role in the context of the metabolic rift (Foster 2000; Lukács, Livingstone, and Lukács 2013) as well as environmental crisis.

Landed property is a fundamental aspect of capital, it stems from the monopolization of land use in enclosure and colonialism. It is economically fundamental in food production, mining of metals and rare earths as well as fossil fuel extraction. Ground rent is also a significant factor in housing and tourism. (Basu 2018, 22) In landed property, non-human nature moderates capital accumulation (Vlachou 2002) as its use values are reduced to their usefulness for exchange value production (Marx 1990, 3:1019–31). In Capital, Marx argues that this leads to an "*irreparable rift in the interdependent social metabolisms*" (Marx 1991, 949) between humans and nature (Marx 1990, 3:283).

Modern empirical evaluations of the labor theory of value argue that the regularities between market prices, production prices, and vertically integrated labor values are the empirical expression of the law of value's function of regulating the social division of labor under capitalism. (G. Işıkara and Mokre 2022; Shaikh 1984, 2012; Ochoa 1989; Tsoulfidis and Mariolis 2007; Cheng and Li 2019) We furthermore argue that the law of value is modified when the social division of labor is changed without eliminating the gravitational role of production prices on market prices, profits and capital accumulation as well as employment. (Schoeller 1976; Basu 2018, 7) Ground rent, capitalized production on landed property and superprofits through capital exports modify the law of value. Empirically this is expressed by regularities in price-value deviations.

Superprofits on landed property are developed in Marx's Capital, Volume 3, as ground rent. Ground rent above the normal profit rate is paid out of social surplus (ie. from the profits of other capitals) and expressed in positive price-value deviations (market prices are higher than production prices). Ground rent is composed of absolute rent (AR), differential rent of the first (DR1) and second type (DR2) as well as monopoly rent. AR, DR1 and DR2 express different competitive relationships, but on the sectoral level are tied to the same physical features (land size and capitalization).

2 Ground Rent in Marxist Political Economics

In Marxist theory, rent is a key factor to understand the economics of ecological exploitation. Rent is paid out of profits, out of social surplus labor, and appropriated privately by landowners. With increasing capitalist development, rentiers behave like capitalists, profit-seeking and capital accumulating entrepreneurs, without necessarily exploiting labor themselves. Increasingly, the role of capitalist and landowner are expressed by the same persons and firms. In global capitalist production, land is used and accumulated like capital, and rent is treated like profit. At the same time, rent appropriated by landlords in agriculture, fossil extraction, mining, real estate and other industries is not a monetary expression of surplus values performed in those industries. Landlords appropriate profits according to the industrial prices of production (and the general profit rate), and then parts of social profits as rent on top of it as surplus profits. Insofar as rent extracting activities contribute to the ecological breakdown, surplus profits from rent accelerate ecological destruction.

Under the capitalist mode of production, the distinctive use value of land is its utilization in the creation surplus value. In rent-extracting industries, nature plays a role beyond the mediation of production as such: it is used as capital, with the help of which commodities are produced and surplus value is created by human labor. This transformation of land into capital brought about additional and historically specific use values of land. The most important is the separation of producers (peasants and workers) from their conditions and means of production, thereby transforming them into wage laborers. By expropriating the right to using the land from what would become the working class, the enclosures foundational to English capitalism, granted this monopolized right to landowners. The monopoly right granted to certain people "[...] of disposing of particular portions of the globe as exclusive spheres of their private will to the exclusion of all others" (Marx 1991, 752) is "[...] a historical precondition for the capitalist mode of production and remains its permanent foundation [...]" (Marx 1991, 754).

Marx's detailed discussions of rent are confined to the application of capital in agriculture, leaving aside other capitalist uses of land (Marx 1991, 751–52). The latter can better be understood through the distinction between land actively used for production and extraction, on the one hand, and land simply used as space, on the other. Use values contained in land, such as minerals, can be extracted, mobilized as productive forces of nature (hydropower, for instance), or utilized as the basis for continuous reproduction (agriculture, forestry). As Harvey (2018, 334) argues, the first two sets of use values can be designated as conditions or elements of production, while in the special case of agriculture in the third set, land is also an instrument or means of production insofar as it contains the very production process within the soil, rather than serving merely as a reservoir of nutrients, seeds, and so forth.

Since the price of land is not regulated by the socially necessary labor time required to reproduce the latter, this price reflects a social relation distinct from the production relation linking commodity producers with one another. The appearance in the form of exchange is the same, albeit with a different content. Free mobility of capital undermines profit rate differentials and drives the tendential equalization of profit rates across industries. In agriculture, this fundamental capitalist law is modified by the fact that accumulation depends not only on the profitability of capitalist farming, but also the obligation to pay rent to the landowner. Landed property, hence, acts as a barrier to investment into agriculture as well as accumulation within the industry by creating the conditions of permanence of surplus profits. This does not mean, however, that the tendency to the equalization of profit rates within and between industries is eliminated. It keeps exerting its force as a deep drift, albeit in a modified form.

Rent relates to both distribution and accumulation, or, both circulation and production. Under capitalism, these spheres are linked through the empirically observable form of money prices, which are a manifestation of the underlying value relation, as detailed above in chapter 2. Production on landed property is partially insulated from the economic dynamics of inter-industrial competition, as the social form of landed property inhibits free investment (Murray 1977, 119), and especially since the reproduction of the most profitable conditions of production is not possible. This does not change the fact that the capitalist form of landed property is a product of the capital relation, and contained in the latter as a historic component. This relative insulation is the cause of the modification of the law of value in the context of non-renewable or non-reproducible resources. This does not negate the law of value. It rather constitutes its frontiers, which are still contained in it.

Landed capitals in extractive industries appropriate absolute rent as well as differential rent of the first and second kind. Absolute rent corresponds to the non-reproducible character of landed property in general (eg. the fact that grain can be grown there but not on other plots of land), differential rent of the first kind to differences in fertility (or the ease of reaching mining materials), while differential rent of the second kind corresponds to productivity differentials due to capitalization. Differential rent of the second kind can be negative, if capitalization deteriorates the conditions of extraction, eg. through soil over-fertilization or ground instability. The regulating profit rate in these industries, which participates in turbulent equalization and general profit rate formation, includes absolute rent but no differential rent. Capitals in those sectors appropriate differential rents of the first and second kind from capitals which buy their products as input and capital goods, as well as consumers who buy consumption commodities.

In industries with landed property, all producers realize absolute rent, a share of other industries' profits. Some producers realize relative rent, a higher rate of return than their within-industry competitors. They realize both profits (the money expression of labor exploited in working the landed property) and rent (a transfer from other industries' profits due to the non-reproducibility of their production technology). Landed property industries realize above-average rates of returns, and charge prices above prices of production. They seek to increase both absolute rent, relative rent and profits, which induces mechanization and strategic competition (rather than static oligopoly) just like in other industries.

The rent to these industries is paid by customer-capitals and customer-consumers. If the payment through customer-capitals is the sole rent mechanism, then direct customer-capitals of the landed property industry realize a large negative price-value differential, which they hand down proportionally to their own customer-capitals, who again hand it down, in the same fashion as with vertically integrated labor cost. However, the share of rent they are able to hand down depends on competition, specifically the ability of their buyers to substitute input goods. Processing plants for fossil fuel might be able to hand down a large share of rent until grain fuels reach a comparable price point, while electricity producers from natural gas might be forced to absorb a large share of rent payments due to the competition from nuclear power plants.

Non-human natures possess a variety of use values. A river, for instance, is useful for recreation, for swimmers' daily exercise, peace of mind for people who like to stare at moving waters, for a cool breeze on a hot summer evening. From a broader ecological perspective, a river is home to countless populations of plants, fish, insects, and other organisms, making it a crucial component of freshwater ecosystems. A river is also useful in capital accumulation, for the transport of commodities, the extraction of hydroelectrical power, or as cooling water for factory plants. It is through a social process that the river is turned into a 'natural resource'. The reduction of use values under nature's usefulness for capital accumulation escalates the contradiction between capital cycles and natural cycles of depletion and replenishment - logically, temporarily and spatially.

The metabolic rift is located on three levels, (1) the material disruption of cyclical processes under the regime of capital, (2) the antagonistic spatial relationship between town and country, and (3) a temporal rift between slower natural replenishment and faster capital accumulation cycles. To circumvent the negative consequences of metabolic rifts for capital accumulation, capital employs technological and social re-organizations of the labor process, albeit only to create new contradictions. These metabolic rifts can again be presented in three categories: (1) technological shifts to substitute the use of destroyed use-values, (2) the shift of the town-country contradiction onto the global level, and (3) the conscious use of a temporal shift to extract profits before deteriorating ecological conditions materialize (Saitō 2022).

Rent brings about a modification of the law of value and prevalent accumulation patterns. The modification is manifested in three major ways:

(1) the presence of rent fuels the capitalization of the sector at stake. Investment accelerates beyond the speed corresponding to a normal profit rate, as capitalists can earn (but have to share with landlords) both the normal profit rate and DR-II.

(2) Ceaseless expropriation and expanding privatization of land creates an exceptionally sharp class divide in the countryside. The expropriation of subsistence and small farmers pushes masses of people into the lowest-paid segments of the working class. At the same time, labor in agriculture is paid below-average wages in many parts of the world. Oftentimes groups with precarious status like non-citizens,

seasonal and migrant workers are over-exploited in agriculture, but also in mining in many countries of the Global South. The increased rate of exploitation allows for surplus profits in these sectors.

(3) The extraction of natural resources as input commodities for the production process governed by the imperative of accumulation creates a temporal contradiction between the replenishment of non-human natures and the accelerating turnover time of capital. Capital tends to subjugate all use value to the extraction of surplus value and accumulation, resulting in biophysical disruptions, something that will be discussed in detail in this chapter to uncover the relationship between value, ground rent, and ecological breakdown.

In this paper, we try to show that landed property does indeed realize above-normal profit rates, and positive price-value deviations. This illustrates the structural dynamic to over-capitalization on capitalized natural lands, which escalates the metabolic rift. In the following Section @ref(.cplv-05-model) we construct simple estimations of direct prices, production prices, market prices and land use.

3 Prices, Values and Land Rent

We use the EXIOBASE 3 multi-regional input output model (Stadler et al. 2018) and Södersten et.al.'s estimation of fixed capital stock flows (Södersten, Wood, and Hertwich 2018) to estimate labor values and production prices (Ochoa 1989; Shaikh 2012) and rent for 15 categories of land as well as the extraction of 12 metal ores, eight minerals and nine fossil fuels. Consistent with (B. G. Işıkara and Mokre 2020), we find a cluster of positive price-value deviations in extractive industries, and estimated rents to explain 45 % of positive price-value deviations in these sectors. We furthermore estimate direct land use and resource extraction as indicators of land rent, as well as direct use and vertically integrated use from the same source. For prices, land use and resource extraction, we apply vertical integration to global supply chains (ie. the full multi-regional input output table). However, we normalize relative prices within countries, and use estimates for the normal (average) profit rate as well as the normal (average) wage rate within countries. When we normalize land use and resource extraction, we normalize to shares in global use/extraction.

We remove the usual industries from the analysis - financial, real estate and insurance operations as well as recycling and waste removal operations and non-profit sectors or private households - after estimating prices, but before estimating price deviations. Thereby, we eliminate the unusual price-value patterns, but keep the flow of embodied labor from these sectors in the analysis.

In an input output table, elements z_{ij} in an industry-by-industry square matrix $Z = \{z_{ij}\}$ represent outputs from industry i used as circulating capital in industry j, and a corresponding payment flow in the opposite direction. In a flow matrix, column sums express the sum of productive inputs in industrial production, while row sums express the sum of productive outputs. Further rows express value added categories (taxes minus subsidies, compensation of employees, profits and rent), further columns record final demand from households, government and for capital formation. The sum of productive inputs and value added give a gross output vector $X = \{x_j\}$, from which we derive the gross output diagonal matrix$\hat{X} = \text{diag}\,(x_j)$. Normalizing Z by $\hat{X}$ gives a normalized flow (technical production coefficients) matrix $A = Z\hat{X}^{-1}$, where a_{ij} records the amount of industry i output used in the production of one USD worth of industry j's output.

We construct a direct labor vector l to represent industrial labor cost. To account for differential skill mixes between industries, we normalize the labor vector by the national average wage ($\bar{w} = W/L$ with W the sum of employment costs and L the sum of employees. Equation (**??**) gives skill-adjusted labor vectors for industries $j \in I$, where W_j is the aggreagte wage bill and X_j aggregate output of industry j, while $w_j/\bar{w}$ the approximate skill-adjustment.

$$l'_j = \frac{1}{\bar{w}} \times \frac{W_j}{X_j} = \frac{w_j}{\bar{w}} \times \frac{L_j}{X_j} \tag{1}$$

Vertical integration of the skill-adjusted labor vector with the technical coefficient matrix A gives a vector of labor hours embodied per USD of industrial output, v_j as in equation (**??**), which is expressed in labor hours or full-time employment (depending on the data source).

$$\begin{aligned} v &= l' + vA \\ v(I - A) &= l' \\ v &= l'(I - A)^{-1} \end{aligned} \tag{2}$$

To compare direct prices with production and market prices, we transform it into monetary terms rather than labor hours. We normalize v by the national average labor value of one dollar output to derive direct prices p_d in Equation (**??**).

The Marxist concept of prices of production refers to vertically integrated labor requirements and cost evaluated at the normal profit rate r. Both direct labor cost as well as vertically integrated labor requirements in circulating capital are evaluated at $(1+r)$. Following (Tsoulfidis and Tsaliki 2019, 169–70), in production prices per unit output, we can express the wage rate w and profit rate r as shares in the maximum profit rate, which is the profit rate with w going to 0, or value added over the sum of industrial inputs, such that $r' = r/R$ and $(1 + r)w = (1 - r/R)$. The construction of prices of production (per unit output) is given in Equation (**??**)

$$\begin{aligned} H = A(I - A)^{-1} \quad v = l' \times (I - A)^{-1} \\ p &= wl' + p + p_p rA \\ p &= wv(I - rH)^{-1} \\ p &= (1 - r')v(I - r'RH)^{-1} \end{aligned} \tag{3}$$

Both labor values v (Equation (**??**)) and relative production prices p (Equation (**??**)) are expressed in labor time. At the same time, market prices in input output tables are given in terms of total output, such that $X = mX$ with m the unity vector (as the number of units output Q is not recorded, and would be inconsistent with the industry production assumption of an industry-by-industry Leontief price system).
To investigate the relationship between direct, production and market prices, we normalize labor values and production prices by the sum of total output. This expresses direct prices p_d and production prices p_p in the monetary terms of market prices. (Tsoulfidis and Tsaliki 2019, 138; Ochoa 1989, 417; Shaikh 2016, 389ff)

We adopt the normalization method in Ochoa and Tsoulfidis, and choose to normalize over the sum of prices over all industries $j \in J$ within one year t and country c. For the normalization of labor cost in Equation (**??**) and the normal profit rate in Equation (**??**) we choose to normalize within one country and year. As the labor theory of value is primarily concerned with the social division of labor (and thereby investment), we treat the national state as the first reference frame for profit and wage rate equalization. (Mokre and Rehm 2020) It is also possible to extend the model towards international competition (at least in some sectors) and international value capture, but we refrain from this as to center in on the role of ground rent in this paper. At the same time, the maximum profit rate is a property of observed production with given technologies, rather than between-industrial competition. We therefore estimate R on the global level (within one year), as the dominant Eigenvalue of the H matrix (Shaikh 2012, 90).

$$p_{d,j,c,t} = v_{j,c,t} \times \frac{x_{j,c,t}}{\sum_{j \in J, c=c, t=t} v_{j,c,t} x_{j,c,t}} \tag{4}$$

$$p_{d,j,c,t} = p_{j,c,t} \times \frac{x_{j,c,t}}{\sum_{j \in J, c=c, t=t} p_{j,c,t} x_{j,c,t}} \tag{5}$$

For relative market prices, we use the gross output vector in flow matrix Z, x.

$$p_{m,j,c,t} = \frac{m_{j,c,t} X_{j,c,t}}{\sum_{j \in J, c=c, t=t} m_{j,c,t} X_{j,c,t}} = \frac{x_{j,c,t}}{\sum_{j \in J, c=c, t=t} x_{j,c,t}} \tag{6}$$

The notion of dimensionless and non-dimensionless measures of deviations, and the impact fo the choice of numeraire is prevalent in the literature on the price-value relationship (Steedman and Tomkins 1998; Shaikh 2016, 391; Tsoulfidis and Tsaliki 2019, 157; Basu and Moraitis 2023, 32) The normalization in Equations (**??**), (**??**) and (**??**) to the same unit is a necessary precondition for any of the proposed measures.

Finally we estimate land use and resource extraction indicators e, where e expresses use or extraction in physical units (square kilometres and metric tons). Rather than estimating absolute and differential rent, with the latter two properties of within-industry variation, we restrict the analysis to the physical bearers of landed property. For each category, we estimate (1) land use or extraction respectively e_0, (2) in direct production inputs used $e_1 = e_0 \times A$, and (3) in direct and indirect production inputs $e2 = e_0 \times (I - A)^{-1}$. The distinction is relevant to identify recipients and payers of ground rent in the distribution of social surplus. The calculation of e_1 and e_2 for crop land, pasture land, forest land, infrastructure land and other land use as well as coal, gas, oil, metal ores and non-metallic mineral extraction is described in equations (**??**) and (**??**). All indicators are normalized to the share of total global use/extraction in one year, ie. $e'_0 = e_0 / \sum_{j \in J, c \in C} e_0$, $e'_1 = e_1 / \sum_{j \in J, c \in C} e_1$ and $e'_2 = e_2 / \sum_{j \in J, c \in C} e_2$.

$$e_{1,j,c,t} = e_0 A \tag{7}$$

$$e_{2,j,c,t} = e_0 (I - A)^{-1} \tag{8}$$

4 Data

We apply environmentally extended multi regional input output (EEMRIO) data from EXIOBASE's 3.8.2 release. EXIOBASE 3 contains data on 44 countries and 5 rest-of-world regions, disaggregated to 163 industrial sectors and 200 product sectors in current EUR prices and 1090 environmental impact categories in physical units. EXIOBASE data is only recorded directly for the period of 1995-2011, while the period 2012-2022 is a mix of estimates and extensions. Furthermore, sectoral disaggregation to the 163×163 dimension relies on algorithmic projection and harmonization. We treat the long and disaggregated time series carefully by performing all analyses in the more aggregated WIOD sector classification and for the period 1995-2011 first.

We retrieve physical flow matrix Z and technical coefficient matrix A, gross output vector x and gross demand vector y, as well as employment (in hours and heads) and value added vectors directly from EXIOBASE to estimate market, production and direct prices. EXIOBASE 3.8.2 records employment separately between three skill levels, for men and women as well as between vulnerable- and non-vulnerable employment, which we aggregate to total hours, persons and compensation.

We use EXIOBASE 3.8.2's "factors of of production/stressors/impacts" extension to estimate land use and extraction intensity in crop, forest, pasture, infrastructure and other land use as well as gas, oil, metal and non-metallic mineral extraction. We divide an industry's physical land use or extraction by global use in this year, ie. we calculate an national industry's share in global use or extraction. In fossil fuel extraction, EXIOBASE only provides an aggregate "fossil fuel: total" category in direct extraction, but disaggregates unused domestic extraction (UDE) to 9 categories. Furthermore, supporting information file S5 in Stadler et al. (2018) [1] explains that the UDE is just domestic extraction discounted by a resource-specific factor. The share on global use or extraction will therefore be the same between UDE and domestic extraction.

[1] https://onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1111%2Fjiec.12715&file=jiec12715-sup-0005-SuppMat-5.pdf

Table 1: Regression analysis of market-production price relationship. Data: EXIOBASE 3.8.2, WIOD industry classification, 2000-2014.

	OLS Level	LSDV Level	OLS Log	LSDV Log	RE Log
(Intercept)	0.0024	0.0024	-0.1347	-0.1596	-0.137
(Intercept)	0.0001	0.0005	0.007	0.0171	0.0101
(Intercept)	***	***	***	***	***
pp	0.908	0.908	0.9686	0.9681	0.9681
pp	0.0024	0.0024	0.0016	0.0016	0.0016
pp	***	***	***	***	***
R^2	0.8488	0.8488	0.936	0.9375	0.9368
Adj. R^2	0.8488	0.8484	0.936	0.9373	0.9368

5 Results

We apply a unified regression approach to estimate the explanatory power of direct and production prices over relative market prices, as well as the impact of land rent on price-value deviations. The traditional approach to the market price-production price relationship is a log-log linear regression, where adjusted R^2 is taken as an indicator of explanatory power or small deviations. However, the approach is controversial, and subject to criticisms by Basu and Moraitis (2023) and Shaikh (2016). While the former prefers a linear level regression and Wald tests for a null intercept and a unity linear coefficient ($H_0 : \alpha_0 = 0 \& \alpha_1 = 1$), the latter proposes measures of deviation appropriate for non-dimensionless variables, the coefficient of variation CV, classical distance measure δc and mean average weighted deviation MAWD.

We perform log-log and level regressions in a workhorse estimation of (1) only market and production prices, (2) with factor controls for years and country and (3) in fixed effects and random effects panel regressions indexed for countries and year (but not industry). Coefficient estimates, standard errors and significance levels are consistent between the three setups. Table **??**

To analyze the impact of ground rent on price value deviations, we run a panel regression with percentual deviations between market and production prices as the dependent variable, $\Delta_{MP} = (p_m - p_p)/p_p$ in Equation (**??**) to estimate the impact of land use and resource extraction on deviations between market and production prices, with $j \in J$ industrial sectors, $c \in C$ countries and $t \in T$ years. We also run a least squares dummy variable (LSDV) OLS setup with factored controls for countries and years (Equation (**??**)), as well as a barebones OLS regression without controls (Equation (**??**)). We interpret e'_0 as a proxy for land rent, e'_1 as the share of land rent-bearing inputs in production by direct buyers, and e'_2 as the prevalence of land rent through circulating capital payment streams. We normalize all factors e by the global yearly sum of the same factor, such that a higher factor e implies a higher share in land rent. Corresponding with the idea that land rent is paid from social surplus and the profits of non-ground rent earning capitals, e'_0 coefficients would have positive, e'_1 positive or zero, and e'_2 negative or zero coefficients. [2]

$$log(\Delta_{MP}) = \alpha_{0,c,t} + \alpha_1 e' + epsilon_{j,c,t} \tag{9}$$

$$log(\Delta_{MP}) = \alpha_0 + \alpha_1 e' + \alpha_{2,c} COUNTRY + \alpha_{3,t} YEAR + epsilon_{j,c,t} \tag{10}$$

$$log(\Delta_{MP}) = \alpha_0 + \alpha_1 e' + epsilon_{j,c,t} \tag{11}$$

Table **??** compares the results of a fixed effects, random effects and least squares dummy variables regression. In general, the coefficient signs agree with the hypotheses of land rent - land rent bearing activities and their immediate buyers show positive signs, while vertically integrated use (after controlling for he first two) shows negative signs for forest land, crop land, coal, oil and metallic ores. Pasture land use and non-metallic mineal

[2] Note that for 9 categories of land use or resource extraction, e' is a vector with 3×9 length.

Table 2: Regression analysis of landed property production indicators on market-production price deviations. Data: EXIOBASE 3.8.2, WIOD industry classification, 2000-2014.

	FE Level			RE Level			LSDV Level		
				0.1134	0.01	***	0.1115	0.0044	***
f0	0.5936	0.1011	***	0.5988	0.1011	***	0.649	0.1015	***
f1	0.2676	0.0562	***	0.2704	0.0562	***	0.297	0.0565	***
f2	-0.9373	0.1771	***	-0.9464	0.1771	***	-1.0335	0.1779	***
c0	0.3604	0.0936	***	0.3572	0.0935	***	0.3391	0.0938	***
c1	0.4773	0.1639	**	0.4723	0.1637	**	0.445	0.1644	**
c2	-1.2005	0.353	***	-1.1887	0.3523	***	-1.1235	0.3536	**
p0	-0.0545	0.0723		-0.0547	0.0722		-0.0654	0.0724	
p1	-0.0791	0.153		-0.0792	0.1528		-0.0964	0.1533	
p2	0.2112	0.3118		0.2125	0.3111		0.2597	0.3119	
coal0	0.1396	0.0215	***	0.1383	0.0214	***	0.1319	0.0215	***
coal1	0.3007	0.0543	***	0.2981	0.0542	***	0.283	0.0545	***
coal2	-0.7668	0.12	***	-0.7595	0.1199	***	-0.7236	0.1203	***
gas0	-0.0356	0.0145	*	-0.0342	0.0145	*	-0.0244	0.0143	.
gas1	-0.268	0.0788	***	-0.2611	0.0786	***	-0.2144	0.0782	**
gas2	0.5135	0.1662	**	0.4961	0.1657	**	0.3766	0.164	*
oil0	0.0568	0.015	***	0.0557	0.015	***	0.0467	0.015	**
oil1	0.2039	0.0769	**	0.1987	0.0769	**	0.161	0.077	*
oil2	-0.5991	0.1674	***	-0.5847	0.1671	***	-0.4686	0.1669	**
mo0	0.1054	0.0247	***	0.105	0.0247	***	0.0993	0.0247	***
mo1	0.1752	0.0612	**	0.174	0.0611	**	0.1627	0.0612	**
mo2	-0.5363	0.1484	***	-0.5326	0.1482	***	-0.4894	0.1479	***
nmo0	-0.0088	0.012		-0.008	0.012		0.0002	0.012	
nmo1	0.0108	0.0321		0.0125	0.0321		0.0249	0.0322	
nmo2	0.0735	0.071		0.0674	0.0709		0.0088	0.0708	
R^2	0.0269			R^2	0.0269		R^2	0.0261	
Adj. R^2	0.0238			Adj. R^2	0.0238		Adj. R^2	0.0252	

extraction have no significant effect, and natural gas has the opposite signs from what the hypothesis would imply. In random effects and LSDV estimation, we have significantly positive intercepts, and adjusted R^2 values between 0.024 and 0.025 suggest that the impact of land rent on price-value deviations is small but significant.

6 Interpretation

In this paper, we explored the relationship between ground rent and ecological breakdown in Marxist economics. The use of non-human nature in production on landed property allows capitalists to exploit its productivity-increasing role in capital accumulation. At the same time, the non-reproducibility of agricultural, mining and construction land (be it for physical or legal reasons) allows landowners to extract land rent from capitalists, on top of a normal profit rate. Landed capitalists extract the same land rent and realize above-normal profit rates. This absolute rent is paid out of the social surplus, and more precisely, capitalists who buy circulating capital goods from landed capitals, or direct consumers. Furthermore, landed capitalists extract differential rent if they produce on land with above-average fertility, or if they increase capitalization. Above-normal profit rates and fertility differentials create a structural dynamic towards in-

creased capitalization of rent-realizing sectors, and thereby increases the reduction of natural use values under capital accumulation. This escalates the metabolic rift between the cycles of capital accumulation and nature's depletion and replenishment.

All forms of rent are tied to the landed property and its capitalization. We calculated direct prices, production prices and market prices from EXIOBASE 3' database of 44 country and five rest-of-world regions in 163 industries. We furthermore estimated land use and resource extraction, direct downstream use of these products, and total use through the input-output table. We found that production on landed property as well as their direct downstream buyers experience significant positive price value deviations for farm land, construction land, coal, oil and metal ore extraction. We found the opposite for gas extraction and no significant coefficients for pasture lands and non-metallic mineral extraction. The overall regression is jointly significant, but explains only a small share of global price-value deviations, with an adjusted R^2 of 0.025 in the baseline regression.

Our paper illustrates the impact of land rent through global production chains, and confirms the Marxist argument that land rent is paid on top of normal profits, and out of social surplus. Further work is needed on the global inequalities between countries, and the distinction between commodities with a world market and one where turbulent profit rate equalization happens at the national level.

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