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The Dynamics of International Exploitation

Jonathan F. Cogliano
(Economics Department, University of Massachusetts Boston)
Roberto Veneziani,
(School of Economics and Finance, Queen Mary University of London)
and
Naoki Yoshihara
(Department of Economics, University of Massachusetts Amherst,
Institute of Economic Research, Hitotsubashi University and
School of Management, Kochi University of Technology)

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Institute of Economic Research
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Jonathan F. Cogliano†, Roberto Veneziani‡, and Naoki Yoshihara§

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Abstract

This paper develops a theoretical and computational framework to analyse imperialistic international relations and the dynamics of international exploitation. A new measure of unequal exchange across borders – an exploitation intensity index – is proposed which can be used to characterise the structure of imperialistic international relations in the current global economy. It is shown that wealthy nations are net lenders and exploiters, whereas endowment-poor countries are net borrowers and suffer from exploitation. Capital flows transfer surplus from countries in the core of the global economy to those in the periphery. However, while international credit markets and wealth inequalities are sufficient to generate unequal exchange, they are proved to be insufficient for it to persist. Various possible factors are considered, including technical change and varying social norms, that may explain the persistence of international inequalities.

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†(Corresponding author) Economics Department, University of Massachusetts Boston, Wheatley Hall, 5th floor, 100 William T. Morrissey Blvd., Boston, MA 02125, U.S. (jonathan.cogliano@umb.edu)

‡School of Economics and Finance, Queen Mary University of London, Mile End Road, London E1 4NS, UK. (r.veneziani@qmul.ac.uk)

§Department of Economics, University of Massachusetts Amherst, Crotty Hall, 412 North Pleasant Street, Amherst, MA 01002, U.S.; The Institute of Economic Research, Hitotsubashi University, Naka 2-1, Kunitachi, Tokyo 186-8603, Japan; and School of Management, Kochi University of Technology, 2-22, Eikokuji-Chou, Kochi, Kochi, 780-8515, Japan. (nyoshihara@econs.umass.edu)

1 Introduction

The last four decades have witnessed the increasing integration of different national economies and the widespread adoption of neoliberal policies. This phenomenon, often labelled 'globalisation', has far-reaching economic, social, and political implications, and it has stimulated a vast debate (Rodrik [38]; Stiglitz[44]; Lechner and Boli [28]). Globalisation has significant effects *within* each economy, but special attention has been paid to its repercussions on the relations *between* countries. This is due to the economic stagnation of vast parts of the world and the large inequalities in income and standard of living among countries (Anand and Segal [2], Milanovic [32]), and the asymmetries in bargaining power in the international arena. But also to the qualitatively different role that international institutions and the use of force play in the global economy, according to various scholars, as compared to previous historical periods.

Different, if not opposite, analyses have been proposed, even outside of the neoclassical camp. Some authors argue that 'globalisation' is just a new name for old imperialistic practices by wealthy countries, including the use of force (Amin [1]; Petras and Veltmeyer [34]). According to others, a new world is taking shape, in which traditional imperialistic practices play no role, and the classical concept of imperialism is not useful to understand the global economy (Hardt and Negri [20]).

While admitting that classical approaches may be outdated, this paper defends the theoretical and empirical relevance of the concept of imperialism to analyse current international relations.

Based on Roemer's [39] theory of exploitation, a theoretical (albeit not historical) distinction can be drawn between a notion of *feudal* imperialism, in which the use of force and non-competitive distortions play a definitional role – as in 'classical' (Lenin [29]; Luxemburg [30]; Hobson [21]) and neoclassical (Schumpeter [41]) theories of imperialism; and neo-Marxist theories of dependency (Baran [3] and Frank [18]).[1] And a notion of *capitalist* imperialism, in which exploitation and mutual gains from trade may in principle coexist. Capitalist imperialism is thus related to Hobson's [21] "internationalism" and to the concept of "informal imperialism" (Griffin and Gurley [19], p.1092ff), in that power relations between states and exploitation are primarily the product of economic activities, rather than extra-economic coercion (see also Willoughby [52]).

More precisely, in this paper capitalist imperialism is conceived of as a system "based on the export of capital from advanced countries to less developed regions ... accompanied by the utilization of political and military resources to protect and maintain the means of production over which control has been acquired" (Evans [14], p.16), and by segmented labour markets. Empirically, this allows us to incorporate two crucial features of the contemporary global economy, namely capital mobility and restrictions to labour movement. Theoretically, this makes our approach conceptually close to theories of unequal exchange (Emmanuel [13]; Roemer [40]).

This paper aims to show that, even granting that the feudal aspects of colonial relations

[1] For a discussion of the literature, see Griffin and Gurley [19], Howard and King [22], and Kvangraven [24]. Observe that the qualifier 'feudal' refers to the nature of the relations *between* countries and not to the presence of feudal elements *within* poorer countries which is sometimes stressed in the literature (Kvangraven [24], p.84).

may have become less significant, the concept of capitalist imperialism is still relevant to analyse the global economy. First, we propose a new measure of unequal exchange across borders based on the theory of exploitation – *an exploitation intensity index*. Contrary to the received view – both in the mainstream and in heterodox quarters, – this measure is theoretically robust and logically consistent. Indeed, it can be used to precisely define the concept of capitalist imperialism and to provide a rigorous definition of the notions of *core* and *periphery* of the global economy that are central in dependency theory.

Further, far from being metaphysical, our exploitation index is empirically measurable based on widely available data. We calibrate our model to analyse the exploitation status of all countries in 2017, taking into account differences in the quantity *and* quality of the labour force, in addition to capital, and use the exploitation index to characterise the full structure of Imperialistic International Relations (henceforth, IIR).

Indeed, unlike in post-modern approaches to globalisation, such as Hardt and Negri [20], which depict IIR as immaterial and deterritorialised, the economic and geographic structure of imperialism can be identified, whereby wealthy nations gain, and endowment-poor countries lose from unequal exchange, as surplus is transferred *from* the latter *to* the former.

The second contribution of the paper is the analysis of the mechanism that allows such surplus transfer to occur. Unlike in classical approaches, where "characteristic of [imperialism] are: lending abroad, railroad constructions, revolutions, and wars" (Luxemburg [30], p.419), the role of capital movements is emphasised. Competitive markets, profit-seeking, and international wealth inequalities are central in generating IIR. The exploitative nature of IIR can be understood focusing on credit relations and international capital flows: wealthy nations are net lenders and exploiters, and form the core of the global economy, whereas endowment-poor countries are net borrowers and suffer from exploitation, and are relegated to the periphery.

Crucially, IIR can be explained without any controversial assumptions on the existence of some inherent contradiction of capitalism that "spurs capital on to a continual extension of the market" (Luxemburg [30], p.347), such as realisation problems in accumulating economies.[2] Accumulation is unnecessary to understand capitalist imperialism as an exploitative system of international relations. Indeed, we show that, under certain conditions, accumulation is *inconsistent* with the persistence of IIR. More generally, as argued by Howard and King [23], countries in the core have an incentive to exploit those in the periphery independently of accumulation needs: the incessant quest for profits.

As our analysis of the structure of imperialistic relations and the proposal of an index to measure international labour transfers involves the construction of a formal model, we shall briefly discuss some methodological aspects of our research.[3] This will also allow us to discuss some extensions of our main results.

[2]See also Lenin [29] and Hobson [21]. For a more recent formulation, see Latouche [25].

[3]Formally, the model presented in this paper builds on Roemer [39, 40] and can be viewed as an extension of the framework developed by Cogliano, Veneziani, and Yoshihara [7, 8] to the international context.

1.1 Methodology

A detailed historical and institutional analysis is certainly crucial for a thorough understanding of imperialism. In this paper, we use theoretical abstraction – and specifically, mathematical formalism – for various reasons.

One of the key contributions of the paper is the proposal of a measure of surplus transfers across countries, and all measurement is theory-specific. We set up a theoretical framework using mathematical formalism in order to define an exploitation index that can be used in the empirical analysis of international relations.

While mathematical-deductivist methods are inappropriate in the causal-explanatory analysis of open systems (Lawson [26, 27]), our purpose here is different. Our aim is not to identify causal laws (or even tendencies) within a predictionist perspective (Lawson [26], p. 60). Rather, ours is an exercise in scientific ontology and, as Veneziani and Yoshihara [50] have argued, mathematical tools are appropriate when addressing the issue of measurement of certain social phenomena with a quantitative dimension. The use of formalism to derive a well-defined exploitation index is particularly important given the widespread scepticism surrounding exploitation theory in *both* mainstream *and* heterodox quarters.

We also aim to contribute to theoretical debates on the fundamental features of imperialistic relations, and examine some simplified, counterfactual scenarios for three purposes. First, in order to investigate the nature and structure of IIR, we use theoretical abstraction in order to isolate some key characteristics of the global economy. It is remarkable, from this perspective, that an exploitation phenomenon and IIR can clearly emerge even in the absence of a number of features of real economies that play a central role in various strands of the literature, such as noncompetitive distortions, international wage and interest rate differentials, unequal access to technologies, differences in structure of production, and even price/value discrepancies. Without denying the relevance of these factors, our analysis forcefully brings to the fore the role of credit markets, the constraints that limited wealth imposes on countries in the periphery, and their "financial dependence" (Kvangraven [24]) on core countries.

Second, the counterfactual analysis points to an explanatory gap by showing that competitive markets and inequalities in wealth and development are crucial in *generating* IIR; but they are not sufficient to make them *persistent*. Lacking any countervailing tendencies, accumulation eventually makes capital abundant, leading to the disappearance of exploitation from the international arena. This result is in stark contrast with the reality of the global economy, and it raises the issue of the possible mechanisms guaranteeing the persistence of exploitative relations. In this paper, we consider endogenous technical change and adaptive consumption norms, but we see it as a first, preliminary step in the direction indicated by our simulations.

Third, although we do not address normative issues explicitly in this paper, our analysis may be interpreted as showing that IIR can be condemned independently of the noncompetitive and violent forms they may take. The model provides the foundations for a condemnation of imperialism by specifying the theoretical counterfactual against which IIR should be evaluated – a desirable property of a theory of imperialism, as forcefully argued by Brewer [5]. The counterfactual is given by the economy in which international disparities in wealth are annihilated. Indeed, in the global economy wealth inequalities do seem

to be morally arbitrary, as often primitive accumulation in the core has taken place – at least partly – at the expense of the periphery, as argued in chapter 31 of *Capital* I, where Marx ([31], p.926) famously refers to colonialism as robbery, looting, and plunder, such that "capital comes dripping ... from every pore, with blood and dirt."

The paper is organised as follows. The framework is laid out in section 2. Section 3 considers the basic economy with stationary population, technology and consumption norms. Section 4 discusses the notions of exploitation and class and section 5 introduces the exploitation intensity index. Section 6 presents the results of the calibration of the basic model, and the simulations of its dynamics. Section 7 extends the model, and the simulations, to include endogenous technical change and consumption norms. Section 8 briefly discusses the robustness checks, which are presented in detail in the Addendum.

2 The framework

Consider a dynamic extension of Roemer's [39] accumulating economy with a credit market and only one good produced and consumed.[4] There exists a set $\mathcal{N} = \{1, \ldots, N\}$ of countries that compete in the world economy for T periods, where T could be either finite or infinite. A country is generically denoted as $\nu \in \mathcal{N}$.[5] At the beginning of each production period t, $t = 0, 1, \ldots, T$, there is a finite set, $\mathcal{P}_t$, of *Leontief production techniques* (A_t, L_t), where $0 < A_t < 1$ and $L_t > 0$ denote the amount of the produced good and direct labour necessary to produce one unit of the final good. The set $\mathcal{P}_t$ need not be constant: it may vary, for example, if new production techniques are discovered. As argued in section 1.1 however, we are interested in analysing unequal exchange and IIR abstracting from all sorts of noncompetitive distortions and differences in the structure of production, and therefore assume that all countries have access to all of the techniques in $\mathcal{P}_t$.

In every period t, countries have potentially different endowments of labour, l^ν_{t-1}, and capital, $\omega^\nu_{t-1} \geq 0$, inherited from previous periods. The labour endowment is made up of two parts: $l^\nu_{t-1} = \ell^\nu_{t-1} s^\nu_{t-1}$ where $\ell^\nu_{t-1} > 0$ is country ν's labour force and $s^\nu_{t-1} > 0$ is ν's skill level, or human capital, so that l^ν_{t-1} represents ν's endowment of *effective* labour.

Following Roemer [39], we assume that production takes time and current choices are constrained by past events: every country must be able to lay out in advance the operating costs for the activities it operates. A country ν endowed with $\left(l^\nu_{t-1}, \omega^\nu_{t-1}\right)$ can either use its own capital to operate $(A_t, L_t) \in \mathcal{P}_t$ at the level $x^\nu_t \geq 0$, or it can borrow capital on international credit markets in order to operate $(A_t, L_t) \in \mathcal{P}_t$ at the level $y^\nu_t \geq 0$. Alternatively, it can lend its capital abroad, $z^\nu_t \geq 0$. Countries can borrow or lend at a market rate r_t.

Letting p_{t-1} denote the price of the produced commodity at the end of $t-1$ and beginning of t, the market value of country ν's endowment – its wealth – is $W^\nu_{t-1} = p_{t-1}\omega^\nu_{t-1}$. The

[4] The one-good assumption allows us to abstract from price/value disparities that are central in much of the literature on unequal exchange (for a discussion see Ricci [36] and the literature therein). More generally, given our focus on the dynamics of exploitation, the one-good assumption yields no loss of generality. The model can be extended to include n commodities, albeit at the cost of a significant increase in technicalities and computational intensity.

[5] Following Roemer [39, 40], in order to focus on *international* exploitation, we consider countries as black boxes and do not explicitly consider heterogeneity *within* each country.

wealth that is not used for production activities, and is not lent abroad, can be saved and sold on international markets at the end of the period, $\delta_t^\nu \geq 0$.

We assume that countries can be thought of as maximising the wealth of their citizens subject to consuming $b_t > 0$ per unit of labour performed, $\Lambda_t^\nu \equiv L_t x_t^\nu + L_t y_t^\nu$. Within every period t, we consider b_t as a constant parameter, but we do allow for the possibility that b_t changes endogenously over time (more on this in section 7 below). This assumption is motivated by our focus on the dynamics of exploitation in a global economies characterised by a drive to accumulate, rather than on consumer choices. Theoretically, it is consistent with the classical-Marxian tradition where consumption is largely the product of social norms, rather than utility-maximising behaviour, and it allows us to analyse the international structure of exploitation and class abstracting from heterogeneous consumption behaviour.[6]

Finally, we assume that technology is sufficiently advanced to allow for the production of a surplus: at all t, for all techniques $(A_t, L_t) \in \mathcal{P}_t$,[7] $1 - v_t b_t > 0$, where $v_t = L_t(1 - A_t)^{-1}$ denotes the embodied labour value.

3 The basic economy

In this section, we analyse the *basic economy*, which is characterised by constant population, technology, consumption norms, and human capital.[8] The basic economy provides a theoretical benchmark and a natural starting point for our analysis, but the framework, concepts, and definitions presented in this section, and in the next one, can be easily extended and the results derived continue to hold in more general economies (as confirmed also by the simulations).

In every t, given (p_t, r_t), every country ν chooses $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu)$ to maximise its wealth subject to consuming b per unit of labour performed (1) and to the constraints set by its capital (2) and labour (3) endowments. Formally, every ν solves the following programme:[9]

$$(MP_t^\nu) \max_{(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu)} p_t \omega_t^\nu$$

subject to

$$\begin{aligned} p_t x_t^\nu + [p_t - (1+r_t)p_{t-1}A]\, y_t^\nu + (1+r_t) z_t^\nu + p_t \delta_t^\nu &= p_t b \Lambda_t^\nu + p_t \omega_t^\nu & (1)\\ p_{t-1} A x_t^\nu + z_t^\nu + p_{t-1}\delta_t^\nu &= p_{t-1}\omega_{t-1}^\nu, & (2)\\ L x_t^\nu + L y_t^\nu &\leqq l^\nu. & (3) \end{aligned}$$

[6] Unlike in many accumulation models in the Marxian tradition, however, the introduction of an (endogenously determined) subsistence bundle raises some interesting theoretical and technical issues, as it imposes a relevant and oft-neglected constraint on the set of equilibria.

[7] This condition is equivalent to $(1 - b_t L_t) > A_t$: it implies that if $A_t x_t$ units of capital are invested in the production process, gross output x_t is sufficient for necessary consumption $b_t L_t$ and to replace capital used up in production, or $x_t > b_t L_t x_t + A_t x_t$.

[8] Formally, $\mathcal{P}_t = \mathcal{P} = \{(A, L)\}$, $b_t = b$, and $\left(l_{t-1}^\nu\right)_{\nu \in \mathcal{N}} = \left(l^\nu\right)_{\nu \in \mathcal{N}}$ for all t.

[9] Although we are focusing on an one-good economy, we provide a general formulation of programme MP_t^ν, and of the rest of the economy, in order to point the reader to the n-good extension of our analysis. Observe that if $\mathcal{P}$ is not a singleton, as in the model of section 7 below, then countries also choose A, L optimally.

The *basic economy* is defined by the set of countries, $\mathcal{N}$, technology, (A, L), consumption bundle, b, labour endowments, $(l^\nu)_{\nu\in\mathcal{N}}$, and initial capital endowments, $(\omega_0^\nu)_{\nu\in\mathcal{N}}$; and is denoted as $E(\mathcal{N}, (A, L), b, (l^\nu)_{\nu\in\mathcal{N}}, (\omega_0^\nu)_{\nu\in\mathcal{N}})$. Let $x_t \equiv \sum_{\nu\in\mathcal{N}} x_t^\nu$, and likewise for y_t, z_t, δ_t, ω_t, Λ_t, and l. Based on Roemer [39], the concept of reproducible solution can be defined.

Definition 1: A *reproducible solution* (RS) for $E(\mathcal{N}, (A, L), b, (l^\nu)_{\nu\in\mathcal{N}}, (\omega_0^\nu)_{\nu\in\mathcal{N}})$ is a sequence of vectors (p_t, r_t) and associated actions $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu)_{\nu\in\mathcal{N}}$, such that at all t:

(a) $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu)$ solves MP_t^ν for all $\nu \in \mathcal{N}$ (optimality);

(b) $A(x_t + y_t) + \delta_t \leqq \omega_{t-1}$ (feasibility of production);

(c) $p_{t-1}Ay_t = z_t$ (credit market);

(d) $(x_t + y_t) + \delta_t \geqq b\Lambda_t + \omega_t$ (goods market).

At a RS, in every period (a) all countries maximise their wealth; (b) aggregate capital is sufficient for production (and speculative saving) plans; (c) the credit market clears; (d) aggregate supply is sufficient for consumption and accumulation plans.[10]

For any (p_{t-1}, p_t, r_t), $w_t = \frac{p_t - (1+r_t)p_{t-1}A}{L}$ is the wage rate that implicitly obtains in each country at t. In contrast with some of the classic contributions in dependency theory, as all countries have access to the same technology, and international commodity and credit markets are competitive, factor price equalisation obtains even in the absence of an international labour market, as is well known in international economics.

Given the structure of the one-good economy, we shall focus on RS's with strictly positive prices without loss of generality,[11] and we can take the produced commodity as the numéraire, setting $p_t = 1$, all t.[12] This implicitly defines a real wage rate $\widehat{w}_t$ at any t. It is immediate to prove that at any nontrivial RS, the real wage is at least enough to cover subsistence and the interest rate is nonnegative.[13]

Given the previous observations, by constraints (1)-(2), it follows that at any RS, for all countries ν, the following equation must hold in every period t

$$\omega_t^\nu = \omega_{t-1}^\nu + r_t\left(Ax_t^\nu + z_t^\nu\right) + \left(\widehat{w}_t - b\right)L\left(x_t^\nu + y_t^\nu\right). \tag{4}$$

Equation (4) implies that for all countries at the solution to MP_t^ν, if the interest rate is strictly positive, then no wealth is used for speculative savings ($\delta_t^\nu = 0$ all ν), and if the wage rate is above subsistence, then the labour constraint (3) binds.

It is not difficult to show that this has some implications for the set of RS's: the interest rate and the real wage rate can both be strictly positive only if the aggregate (effective) labour and capital endowments satisfy the knife-edge condition $l = LA^{-1}\omega_{t-1}$. If capital (labour) is abundant, the interest rate (the real wage rate) drops to zero (the subsistence

[10]The economy can thus be interpreted either as a sequence of generations living for one period or as a single generation in a sequence of temporary equilibria.

[11]Formally, $p_t = p_{t-1} > 0$ all t. Observe that from MP_t^ν it immediately follows that if there is some t' such that $p_{t'} = 0$, then at any RS it must be $p_t = 0$ for all $t > t'$.

[12]Given the commodity as the numéraire, r_t should be considered to represent the *real* interest rate at period t, which is defined by the *nominal* interest rate minus the inflation rate. Therefore one will invest lend (rather than storing the good) provided $r_t \geqq 0$.

[13]Formally, if $\omega_{t-1} > 0$, then $\widehat{w}_t \geqq b$ and $r_t \geqq 0$, all t. For a proof, see Lemma 1 in the Addendum.

level). This observation provides the foundations for the analysis of the dynamics of the global economy in the simulations below.[14]

From equation (4), one can also derive, for every country ν the maximum wealth accumulated, $V_t^\nu\left(W_{t-1}^\nu;(1,r_t)\right)$, and the growth rate of capital, g_t^ν, in period t:[15]

$$V_t^\nu\left(W_{t-1}^\nu,\Lambda_t^\nu;(1,r_t)\right)=(1+r_t)\,\omega_{t-1}^\nu+(\widehat{w}_t-b)\,\Lambda_t^\nu, \tag{5}$$

$$g_t^\nu=r_t+(\widehat{w}_t-b)\,\frac{\Lambda_t^\nu}{\omega_{t-1}^\nu}. \tag{6}$$

4 Exploitation and Class

Having laid out the basic framework of our investigation, we can turn to the analysis of capitalist imperialism. What constitutes *imperialistic* international relations? Two structural aspects of the global economy arguably characterise IIR: first, the presence of some form of unequal exchange in which certain countries benefit disproportionately from interaction in the global economy compared to others. And, second, a stratification of countries into a core and a periphery – based on their position in international markets – which highlights the mechanisms that allow the former to gain at the expense of the latter. We capture the former aspect of IIR focusing on the concept of *exploitation*; and the latter by identifying *classes* of countries based on their position in the global credit market.

Consider first the concept of exploitation. The key point to note is that focusing on *actual* consumption would be highly misleading as both poor and rich countries consume b per unit of labour expended, but their *potential* consumption is very different. In order to define potential consumption, for all countries $\nu\in\mathcal{N}$ and all (p_t,r_t), let c_t^ν satisfy

$$p_t c_t^\nu=V_t^\nu\left(W_{t-1}^\nu,\Lambda_t^\nu;(p_t,r_t)\right)+p_t b\Lambda_t^\nu-p_t\omega_{t-1}^\nu. \tag{7}$$

Equation (7) defines a country's maximum potential consumption given its initial wealth, market prices, and interest rate. Definition 2 identifies exploitation status in terms of a country's potential consumption.[16]

Definition 2 [Roemer [39]]: Country ν is *exploited* at t if and only if $\Lambda_t^\nu>vc_t^\nu$; it is an *exploiter* if and only if $\Lambda_t^\nu<vc_t^\nu$.

By plugging equation (5) into equation (7), and recalling that $p_t=p_{t-1}=1$ and so $W_{t-1}^\nu=\omega_{t-1}^\nu$, it follows that at any RS, in every period t, if $r_t>0$ then the exploitation status of each country is determined by its wealth per unit of labour performed:[17]

$$\text{country } \nu \text{ is an exploiter if and only if } \frac{W_{t-1}^\nu}{\Lambda_t^\nu}>\frac{1}{r_t}\frac{[1-\widehat{w}_t v]}{v};$$
$$\text{country } \nu \text{ is exploited if and only if } \frac{W_{t-1}^\nu}{\Lambda_t^\nu}<\frac{1}{r_t}\frac{[1-\widehat{w}_t v]}{v}.$$

[14]For a precise characterisation of the set of RS's, see Theorem 1 in the Addendum.

[15]Recall that $W_{t-1}^\nu=p_{t-1}\omega_{t-1}^\nu$, that $\widehat{w}_t=\frac{w_t}{p_t}$ and that we are setting $p_t=p_{t-1}=1$. From equation (6) it follows that, at all t, the aggregate growth rate of the economy is $g_{_t}=r_t+(\widehat{w}_t-b)\,\frac{l}{\omega_{t-1}}$.

[16]In what follows, exploitation and class status are defined in every period t: this is a natural assumption if the model describes a series of one-period economies, otherwise it reflects a focus on *within period* exploitation. For a discussion of *within period* and *whole life* exploitation, see Veneziani [46, 47].

[17]For a formal statement and a complete proof, see Theorem 2 in the Addendum.

This generalises analogous results by Roemer [39], as it characterises the exploitation status of all countries even in the presence of unemployed labour. More precisely, if full employment obtains at t then $\Lambda_t^\nu = l^\nu$, all ν, and so exploitation status is determined by the ratio of capital and labour *endowments* as in Roemer [39]. However, if labour is not fully employed world-wide,then $\Lambda_t^\nu < l^\nu$ for at least some ν, and exploitation status is determined by the ratio of the capital endowment *and labour performed*.

Observe that the previous conclusions hold if $r_t > 0$. If $r_t = 0$ then $\widehat{w}_t = (1/v) > b$ and $\Lambda_t^\nu = vc_t^\nu$ for all ν and no exploitation exists in the economy. This correspondence between profits and exploitation is a standard result in Marxian theory (Veneziani and Yoshihara [48]).

Definition 2 provides the foundations for the analysis of the unequal exchange involved in IIR, whereby some countries gain at the expenses of others: some countries exploit, while others are exploited. However, while it permits us to identify the winners and losers of globalisation, it does not tell us much about the structural features of IIR that allow exploitation to emerge. For that purpose, we shall introduce a concept that identifies a clear stratification of countries based on their position in international markets.

To be specific, following Roemer [39], *classes* can be defined based on the countries' position in the credit market.[18] Let (a_1, a_2, a_3) be a vector where $a_i \in \{+, 0\}$, $i = 1, 2, 3$, where '+' means a positive entry. Country ν is said to be a member of class (a_1, a_2, a_3), if there is an optimal vector $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu)$ such that $(x_t^\nu, y_t^\nu, z_t^\nu)$ has the form (a_1, a_2, a_3). The notation $(+, +, 0)$ implies, for instance, that a country activates production using both its own capital and borrowed capital; $(+, 0, +)$ implies that the country uses part of its capital to activate production and lends the rest; and so on. Although there are eight conceivable classes, only the following four will be shown to be *theoretically* relevant.[19]

$$
\begin{aligned}
C_t^1 &= \{\nu \in \mathcal{N} \mid \nu \text{ is a member of class } (+,0,+) \text{ but not of class } (+,0,0)\}, \\
C_t^2 &= \{\nu \in \mathcal{N} \mid \nu \text{ is a member of class } (+,0,0)\}, \\
C_t^3 &= \{\nu \in \mathcal{N} \mid \nu \text{ is a member of class } (+,+,0) \text{ but not of class } (+,0,0)\}, \\
C_t^4 &= \{\nu \in \mathcal{N} \mid \text{ is a member of class } (0,+,0)\}.
\end{aligned}
$$

It is possible to show that at any RS, in every period t, if the interest rate is positive, the set of countries can be exactly partitioned into the four classes above: all countries belong to one, and exactly one, of $C_t^1 - C_t^4$. To be precise:[20]

$$
\begin{aligned}
C_t^1 &\text{ is the set of countries such that } Ay_t^\nu < z_t^\nu \text{ at all optimal solutions to } MP_t^\nu; \\
C_t^2 &\text{ is the set of countries such that } Ay_t^\nu = z_t^\nu \text{ at an optimal solution to } MP_t^\nu; \\
C_t^3 &\text{ is the set of countries such that } Ay_t^\nu > z_t^\nu \text{ at all optimal solutions to } MP_t^\nu; \\
C_t^4 &\text{ is the set of countries such that } W_{t-1}^\nu = 0
\end{aligned}
$$

[18] Again, observe that we focus on *within period* classes (Veneziani [46, 47]).

[19] Of course, *empirically*, only $C_t^1 - -C_t^3$ matter, as shown by our simulations: C_t^4 is empty because there is no country with zero wealth and producing *only* using borrowed capital.

[20] For a formal statement and a complete proof, see Theorem 3 and Corollary 1 in the Addendum.

In other words, a precise stratification emerges in the world economy whereby countries can be sorted into classes based on their status in the international credit market, which is in turn related to their productive endowments: countries with higher (lower) wealth per capita belong to the higher (lower) echelons of the class hierarchy.

As both class and exploitation status depend on per capita wealth, it is legitimate to wonder whether a country's position in the exploitation hierarchy and its position in the credit market are linked, as predicted in theories of unequal exchange, and also in some of the classical approaches to imperialism discussed in the Introduction.

The hypothesis that a tight relation exists between class positions and exploitation status is known as the *Class-Exploitation Correspondence Principle* (CECP, Roemer [39]), and it is possible to prove that indeed the CECP holds in the world economy: countries that enjoy a privileged position in the credit market are exploiters, while net borrowers are exploited. Formally, at any RS, at any period t, if the interest rate is strictly positive then: if $\nu \in C_t^1$ then ν is an exploiter and if $\nu \in C_t^3 \cup C_t^4$ then ν is exploited.[21]

In other words, based on the concepts of exploitation and class that we have proposed here, building on Roemer [39, 40], it is possible to show that IIR are clearly characterised by a hierarchical structure that emerges endogenously, and that, contrary to postmodern claims, has a clear economic and territorial dimension: wealthy countries are exploiters and poor countries are exploited. Further, contrary to classical theories, IIR emerge from the functioning of competitive markets: wealthy countries are net creditors, poor countries are net debtors, and it is the credit market that allows surplus to be transferred from the latter to the former. Thus, the previous analysis provides rigorous foundations to the concepts of *core* countries – which enjoy a privileged position in the credit market and exploit – and the *periphery* of the global economy – poor countries that need to borrow in order to activate production and reach subsistence, and are exploited.

5 An index of exploitation

The core/periphery structure that characterises IIR derived in the previous section provides some important insights on the structural injustices characterising the world economy, as Roemer [39] has forcefully argued. Yet, simply identifying the countries in the core and in the periphery of the global economy yields a rather partial, coarse picture of the structure of IIR: international economies with similar numbers of countries belonging to each class and each exploitation category may be very different. Based on Definition 2, the normative reach of the concept of exploitation can be extended to provide a finer and more comprehensive picture of IIR, moving beyond a purely aggregate analysis to explore the *intensity of exploitation*. For, it is certainly desirable to have a notion of exploitation that allows us to make statements such as "country A is more exploited than country B", or "IIR are becoming increasingly exploitative over time".

Definition 2 states that exploitation status is determined according to whether $\Lambda_t^\nu \gtrless vc_t^\nu$.

[21] The converse is also true if $\widehat{w}_t > b$. For a precise statement of CECP and a complete proof that it holds in the world economy, see section 1 in the Addendum.

Therefore a natural index of the intensity of exploitation of any country ν in period t is:

$$e_t^\nu = \frac{\Lambda_t^\nu}{vc_t^\nu},$$

and a country is an exploiter (exploited) if and only if $0 \leq e_t^\nu < 1$ ($e_t^\nu > 1$).

Three important features of the exploitation index e_t^ν should be emphasised. First, it has robust theoretical foundations. It is conceptually related to the so-called 'New Interpretation' of Duménil [10] and Foley [**?**]. It can be shown that a country is exploited if the share of labour it contributes to the global economy is higher than the share of income it receives, and vice versa if it is an exploiter (Veneziani and Yoshihara [51]). It can also be proved that Definition 2, upon which the index is based, is the only definition of exploitation that satisfies the core insights of exploitation theory (Veneziani and Yoshihara [50, 51]).

Second, the exploitation index embodies some intuitive normative views. For e_t^ν can be interpreted as the rate of (effective) labour supplied relative to the labour necessary to obtain one unit of consumption and exploitative relations are equivalent to inequalities in labour hours supplied to earn one unit of income (measured in the labour numéraire). From this perspective, exploited countries need to work more than exploiters in order to secure an analogous standard of living, and the additional labour they contribute by to the global economy is transferred to the latter. In IIR, exploitation represents an unreciprocated transfer of labour from the periphery to the core, and the higher the amount of labour transferred from a country in the periphery, the higher e_t^ν.

Unlike most empirical measures of unequal exchange, the exploitation index does not capture price-value deviations, whose normative content is unclear (Schweickart [42]). Nor does it crucially rely on the existence of market imperfections and international wage differentials: although differences in the remuneration of labour across countries are of great relevance, the unfairness of international relations is not reducible to them, and a global economy with complete wage equalisation might still be highly unjust.[22]

Finally, and perhaps more importantly for our purposes, contrary to a widespread view, the exploitation index is all but metaphysical: it is entirely based on empirically measurable magnitudes, an arguably important quality (Mohun [33]). Country ν is exploited (and exploiter) if and only if $e_t^\nu > 1$ ($e_t^\nu < 1$), but, assuming e_t^ν to be a meaningful cardinal and interpersonally comparable measure, a much richer analysis of IIR is possible. For example, one can say that the greater e_t^ν the more exploited ν is and, for any two countries ν,μ in the periphery, if $e_t^\nu > e_t^\mu > 1$ then ν is more exploited than μ. And similarly for countries in the core. We can also analyse the dynamics of the distribution of e_t^ν, and ask a number of questions about the structure of IIR. A more polarised distribution of e_t^ν, for instance, suggests a worsening of IIR. More generally, the measurement of some aggregate degree of exploitation raises similar issues as in the debate on the measurement of income or wealth inequalities.

[22] For a particularly sophisticated, recent empirical analysis of unequal exchange focusing on wage differentials and price value deviations, and a comprehensive discussion of the related literature, see Ricci [36, 37].

6 The dynamics of the basic economy

This section analyses the basic economy computationally. The aim is to illustrate the relevance of the theoretical results derived above and to rigorously describe the dynamics of IIR, both in their exploitation and in their class dimensions, in the benchmark case. This section also provides the basic formal and computational framework for the analysis of more complex economies below.

The simulation begins with data on the various parameters of the model. The set of countries $\mathcal{N}$, and the distribution of capital and labour endowments are calibrated using 2017 data from the Penn World Table [15]. The Penn estimates of nations' capital stock at current PPPs (millions of 2011 U.S. dollars) are taken as ω_0^ν for each country ν. The values of l^ν are set by multiplying each country's population by the Penn estimates of average human capital attainment and scaling this figure up by 100,000 to ensure $l > LA^{-1}\omega_0$.[23] Countries for which there are no estimates of the capital stock or average human capital attainment are removed from the simulations, leaving $N = 144$.[24]

As for technology and consumption, we set: $A = 0.75$, $L = 0.5$, and $b = 0.44$, thus $v = 2$. It is worth stressing at the outset that the values chosen help to start the simulations far from the knife-edge condition $l = LA^{-1}\omega_{t-1}$ and ensure a reasonable initial value of r_t such that the dynamics of the simulation have room to play out before the simulation becomes labour constrained, but – as discussed in section 8 below – our key insights are robust to different choices of parameters.

For all countries and time periods, we restrict the computational analysis to solutions of MP_t^ν of the form $(0, y_t^\nu, z_t^\nu, \delta_t^\nu)$.[25] To be specific, at any t, we set $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu) = \left(0, \frac{A^{-1}\omega_{t-1}}{l} l^\nu, \omega_{t-1}^\nu, 0\right)$, $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu) = \left(0, L^{-1}l^\nu, \frac{l}{LA^{-1}\omega_{t-1}}\omega_{t-1}^\nu, \omega_{t-1}^\nu - z_t^\nu\right)$, or $(x_t^\nu, y_t^\nu, z_t^\nu, \delta_t^\nu) = \left(0, L^{-1}l^\nu, \omega_{t-1}^\nu, 0\right)$, for all ν, depending on whether the economy is capital constrained, labour constrained, or on the knife-edge. This specification of agents' optimal choices guarantees that the conditions in Definition 1 are always satisfied.[26]

The simulation runs for $T = 50$ periods. The simulation first checks whether the economy is capital constrained, labour constrained, or on the knife-edge and updates r_t accordingly. Given the choice of ω_0, the simulation begins with r_1 such that $\widehat{w}_1 = b$ and countries then

[23] In the PWT [15], capital stocks are estimated using a perpetual inventory method and include six assets: structures (residential and non-residential); transport equipment; computers; communication equipment; software; and other machinery and assets. The human capital index in the PWT [15] is based on average years of schooling, provided by Barro and Lee [4], and assumptions about the rate of return to education from Psacharopoulos [35]. The scaling by used in our simulations 100,000 is arbitrary but does not affect the position of any country relative to the others in terms of effective labour capacity. The scaling is necessary to ensure that the simulations always begin from a capital constrained state.

[24] Robustness checks are run using proxies for average human capital attainment, but the main results of the simulations are not altered by reintroducing these countries.

[25] Lemma 3 in the Addendum proves that this is without any loss of generality.

[26] The economy is capital constrained, labour constrained, or on the knife-edge depending on whether $l \gtreqless LA^{-1}\omega_{t-1}$. Suppose the economy is capital constrained with $l > LA^{-1}\omega_{t-1}$, some t. Then at any RS it must be $\widehat{w}_t = b$, so that $r_t > 0$ and labour performed does not produce any net income for accumulation. Thus, for all ν, any $(0; y_t^\nu; z_t^\nu; 0)$ with $z_t^\nu = \omega_{t-1}^\nu$ solves MP_t^ν. Therefore since $z_t = \omega_{t-1}$ and $l > LA^{-1}\omega_{t-1}$, we choose a suitable profile $(y_t^\nu)_{\nu\in\mathcal{N}}$ such that $Ay_t = z_t$ and all conditions of Definition 1 are satisfied at t. A similar logic holds in the other cases. See section 2 of the Addendum.

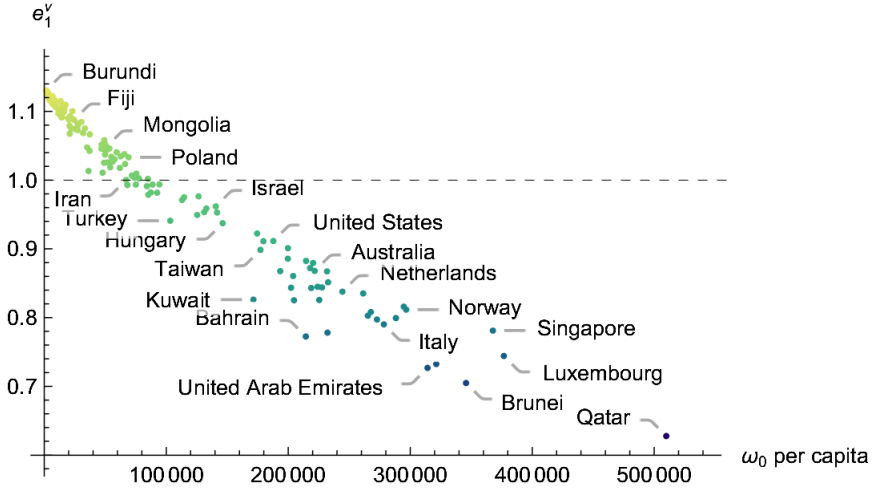
solve MP_t^ν. Endowments are updated according to equation (4) and the simulation then repeats as necessary.[27]

6.1 Exploitation in the world economy: a new empirical approach

What do international relations look like? Is it possible to detect a hierarchical structure in the global economy giving rise to systematic injustice in the form of unequal exchange, and a transfer of surplus across borders? The exploitation intensity index is designed to provide an answer to these questions, and in this section we derive its distribution across countries in 2017. It is worth stressing that the results presented in this section should not be taken as providing a comprehensive picture of IIR: they are primarily meant to illustrate the power of our measure of exploitation, while bearing in mind that ours is an imperfect calibration exercise in the context of a simplified one-good model.[28] With this caveat in mind, the results are rather striking indeed.

Two main conclusions can be drawn from the analysis of the distribution of the exploitation intensity index. First, figure 1 graphs e_t^ν for $t = 1$ against ω_0^ν per capita for all countries in the simulation, and it shows a strong, clear inverse relation between exploitation intensity and per capita wealth: a higher wealth is associated with lower levels of exploitation.[29]

Figure 1: Worldwide Exploitation Intensity - Basic economy



Second, based on Definition 2, it is possible to use the exploitation index in order to identify the "core" and the "periphery" of the global economy, consistent with theories of

[27] All simulations are done using *Mathematica* version 12. The simulation code is available at http://jonathancogliano.com.

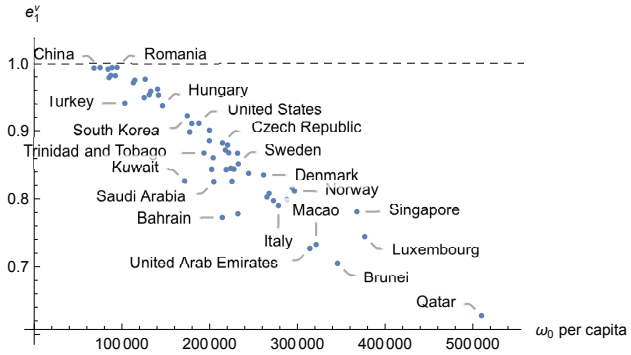
[28] This is particularly relevant for the measurement of the denominator of e_t^ν, while the numerator more or less accurately captures actual (effective) labour contributed to the world economy.

[29] Figure 1 uses initial wealth per capita – based on each country's total population – on the horizontal axis while e_t^ν is based on effective labour actually performed. This is a presentational choice only, since effective labour capacities are based on populations, and so that there is a fixed reference point across simulations. The same presentational choice is made for similar figures showing the exploitation intensity index.

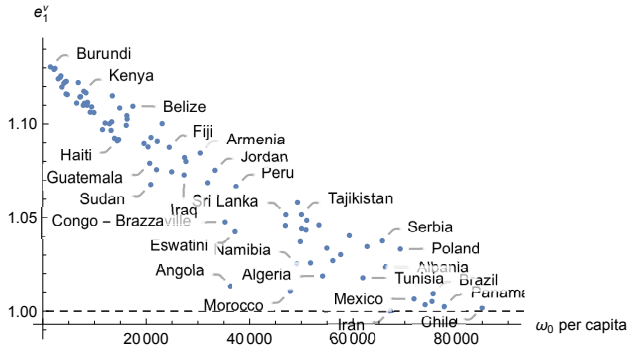
unequal exchange and uneven development. Using $e_1^\nu = 1$ as the relevant threshold, in figure 2 we cluster the countries into two clearly defined groups based on their exploitation status. The core consists of exploiter countries (figure 2(a)), whereas exploited countries are in the periphery of the global economy (figure 2(b)). Thus, figure 2 clearly shows the economic and geographic structure of IIR, and in particular the crucial relevance of wealth, and productive endowments in general, in determining a country's position within IIR.

Figure 2: Exploiter & Exploited Countries - Basic economy

(a) Exploiter Countries



(b) Exploited Countries



It is worth emphasising that, in spite of its simplicity, the exploitation intensity index portrays a picture of IIR that is strikingly in line with common intuitions. Tables 1 and 2 below show the complete listing of e_1^ν for all countries sorted by ω_0^ν per capita, with exploiter countries shown in table 1 and exploited countries in table 2. Apart from the Latin American members of the club, *all* of the OECD countries are in the core, with exploitation intensity index well below 1;[30] while nearly *all* of the African countries are exploited, including the twenty most exploited.[31] Further, among the main exploiters are oil-producing countries as well as countries at the core of the international financial system. Although its exploitation intensity index is too close to one to draw any definite conclusions, the classification of China as one of the exploiting countries is likely to reflect its increasing role in the world economy, which is moving it from the periphery to the core of IIR; and a similar point may be made about Indonesia (for an interesting discussion, see Kvangraven [24]).

6.2 Credit markets and the dynamics of exploitation

While the previous subsection derives some novel and interesting results, it provides only a partial picture of IIR. Although the analysis of the distribution of the exploitation intensity allows us to characterise the economic and geographic structure of unequal exchange at the global level, the mechanisms allowing for the transfer of surplus remain hidden. Second, Figures 1-2 provide a snapshot of exploitative relations in the international context. It

[30]Poland is the only exception, but its exploitation intensity index is only marginally above 1, which may be due to measurement error and/or the simplifying assumptions adopted in the calibration of our model.

[31]Two notable outliers are Trinidad and Tobago and, partly, Botswana. Although they have a small capital stock compared to OECD countries, they are categorised as exploiters largely due to their very small population and thus low effective labour capacity.

Table 1: Exploitation Intensity for Exploiter Countries at $t = 1$ - Basic economy

	e_1^ν		e_1^ν		e_1^ν
Indonesia	0.9928	South Korea	0.9223	Germany	0.8672
China	0.9935	Taiwan	0.8985	Portugal	0.7781
Venezuela	0.9912	Japan	0.9112	Sweden	0.8514
Mauritius	0.9788	United States	0.9114	Netherlands	0.8377
Uruguay	0.9820	Trinidad and Tobago	0.8675	Denmark	0.8352
Malaysia	0.9935	Finland	0.8857	Belgium	0.8027
Botswana	0.9816	United Kingdom	0.9010	Hong Kong	0.8081
Romania	0.9938	Cyprus	0.8435	Ireland	0.7972
Turkey	0.9409	Latvia	0.8605	Italy	0.7901
Lithuania	0.9711	Saudi Arabia	0.8252	Austria	0.7993
Russia	0.9750	Bahrain	0.7725	Switzerland	0.8159
Malta	0.9493	Czech Republic	0.8825	Norway	0.8116
Slovakia	0.9764	Slovenia	0.8720	United Arab Emirates	0.7268
New Zealand	0.9535	Greece	0.8431	Macao	0.7324
Croatia	0.9587	Canada	0.8794	Brunei	0.7048
Israel	0.9618	Australia	0.8679	Singapore	0.7811
Estonia	0.9529	France	0.8448	Luxembourg	0.7441
Hungary	0.9373	Spain	0.8256	Qatar	0.6277
Kuwait	0.8261	Iceland	0.8439		

Table 2: Exploitation Intensity for Exploited Countries at $t = 1$ - Basic economy

	e_1^ν		e_1^ν		e_1^ν
Burundi	1.1305	Kyrgyzstan	1.1150	Sri Lanka	1.0516
Congo - Kinshasa	1.1292	Tanzania	1.0923	Morocco	1.0108
Malawi	1.1297	Haiti	1.0910	Namibia	1.0253
Mali	1.1241	Lesotho	1.0916	Ukraine	1.0581
Sierra Leone	1.1249	Bolivia	1.1085	Colombia	1.0373
Liberia	1.1257	Honduras	1.0993	Tajikistan	1.0516
Mozambique	1.1197	Vietnam	1.1045	Gabon	1.0441
Central African Republic	1.1218	Egypt	1.1026	South Africa	1.0435
Madagascar	1.1224	Belize	1.1095	Mongolia	1.0485
Niger	1.1160	Nicaragua	1.0896	Maldives	1.0258
Rwanda	1.1228	El Salvador	1.0878	Argentina	1.0459
Burkina Faso	1.1157	Guatemala	1.0790	Algeria	1.0187
Ethiopia	1.1112	Sudan	1.0675	Dominican Republic	1.0337
Zimbabwe	1.1221	Syria	1.0927	Jamaica	1.0270
Togo	1.1144	Laos	1.0755	Ecuador	1.0303
Benin	1.1146	Zambia	1.0908	Bulgaria	1.0405
Gambia	1.1100	Moldova	1.1002	Tunisia	1.0177
Kenya	1.1175	Fiji	1.0876	Kazakhstan	1.0346
Yemen	1.1110	India	1.0744	Serbia	1.0377
Uganda	1.1167	Iraq	1.0727	Albania	1.0234
Nepal	1.1100	Philippines	1.0821	Iran	1.0002
Cambodia	1.1115	Paraguay	1.0799	Poland	1.0333
Ivory Coast	1.1063	Armenia	1.0845	Mexico	1.0066
Cameroon	1.1091	Ghana	1.0685	Thailand	1.0035
Pakistan	1.1061	Jordan	1.0752	Barbados	1.0052
Senegal	1.0970	Congo - Brazzaville	1.0475	Brazil	1.0094
Myanmar	1.1005	Angola	1.0133	Panama	1.0025
Nigeria	1.1001	Eswatini	1.0426	Chile	1.0018
Mauritania	1.0966	Peru	1.0665		
Bangladesh	1.1012	Costa Rica	1.0456		

forcefully illustrates one of the main insights of our framework: wealth inequalities determine the *emergence* of IIR, and the exploitation index provides a picture of the current world

economy that chimes with intuition.

But what determines exploitation? And what drives the dynamics of IIR? In this section, we answer both questions. We derive the entire class structure of the global economy, based on the definition in section 4, and we perform a counterfactual exercise. We ask: what would happen if the world economy behaved as in our model? Would exploitation *persist* in a competitive economy with significant wealth inequalities, and a drive to accumulate?

The results of the simulation over T can be found in figures 3-5. Figure 3 reports the relevant aggregate activity levels (y_t, z_t, δ_t), net output per capita $(1-A)\,y_t/N$, wealth W_{t-1}, the growth rate of capital g_t, $\widehat{w}_t$ and b, and r_t.[32] In all panels, the dashed vertical line denotes the period in which the economy becomes labour constrained.

Figure 3: Summary results - Basic economy

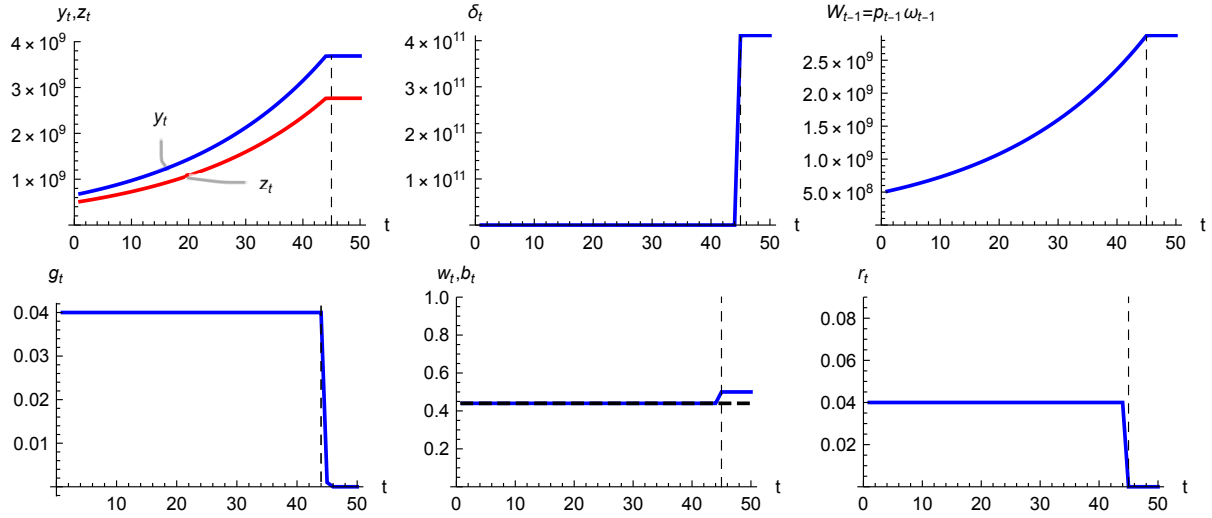


Figure 4(a) reports the dynamics of exploitation by providing a headcount of exploiting and exploited countries. The exploitation status is constant while the economy is capital constrained and exploitation ceases to exist once it becomes labour constrained.

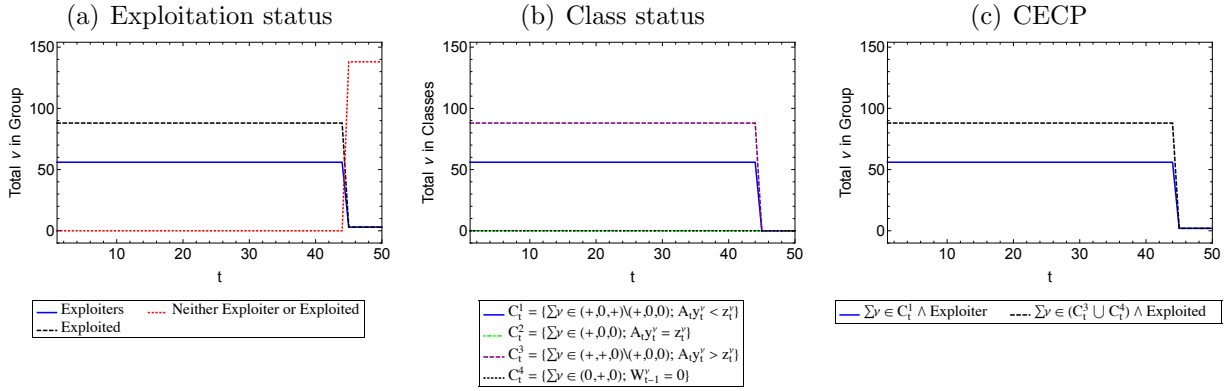
Figure 4(b) derives the entire class structure of the global economy based on each country's position in the international credit market captures, while figure 4(c) compares exploitation and class status. Together, they complete our depiction of IIR, and confirm common intuitions in dependency theory. For, wealthy countries are net creditors ($Ay_t^\nu < z_t^\nu$), belong to C_t^1, and are exploiters, while poor countries are net debtors ($Ay_t^\nu > z_t^\nu$), belong to C_t^3, and are exploited.[33] Surplus is transferred from poor to rich countries via global capital markets.

Figure 5 describes the dynamics of the distribution of the exploitation intensity index, e_t^ν, with countries sorted on the vertical axis by their initial per capita wealth (countries with the highest per capita wealth are at the top). In the first part of the simulation, the

[32] Aggregate x_t is not reported since $x_t = 0$, all t, due to the restriction placed on solutions to MP_t^ν. Supplementary summary results, including x_t, are provided in the Addendum.

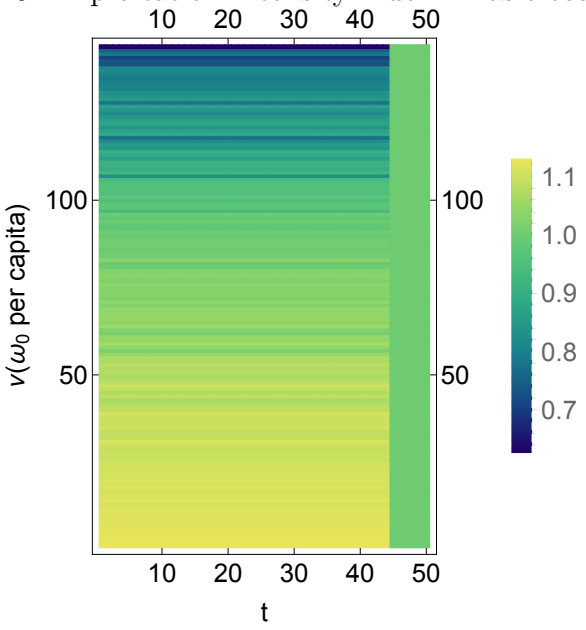
[33] In figure 4(b), and in all similar figures below, the class composition of the economy is shown only for the periods t with $r_t > 0$. For if the profit rate vanishes the definition of classes needs to be revised (see Theorem 3 in the Addendum). C_t^2 is actually empty in all simulations because no country satisfies the knife-edge condition $Ay_t^\nu = z_t^\nu$ exactly. This is a peculiarity of the one-good model and it can be shown that in more general economies some countries will indeed belong to C_t^2.

Figure 4: Class and exploitation status - Basic economy



distribution of e_t^ν is constant over time with a Gini coefficient of 0.0644787: there is no tendency for exploitation to diminish. Relatively poorer countries experience the highest intensity of exploitation, while the wealthiest countries are exploiters with $e_t^\nu < 1$ while the economy is capital constrained. When the economy becomes labour constrained, profits and exploitation disappear, and $e_t^\nu = 1$, all $\nu \in \mathcal{N}$.[34]

Figure 5: Exploitation intensity index - Basic economy



These results confirm and generalise an argument originally suggested by Devine and Dymski [9] and later proved by Veneziani and Yoshihara [49]: wealth inequalities and competitive markets are sufficient for exploitation, and IIR, to emerge, but not for them to per-

[34]The distribution of income remains stable over the simulation, with a Gini coefficient equal to 0.79634 while the economy is capital constrained and decreasing thereafter. The Gini coefficient of income is higher than standard estimates (see Milanovic [32]), but the difference is surprisingly small, given the simplifying assumptions underlying our analysis.

sist. Given the strong empirical evidence of persistent, if not widening, inequalities across borders, our simulation exercise suggests that something else is necessary to explain the dynamics of IIR. In the next section, we extend our analysis to incorporate some possible mechanisms to explain persistence of IIR, without having to assume the open use of force by core countries to stem the growth of those in the periphery.

7 Endogenising consumption and technical change

In this section we extend the basic economy to allow both the consumption bundle, b_t, and the production technology, (A_t, L_t), to be determined endogenously and change over time, and analyse their effect on IIR. This choice reflects both empirical and theoretical concerns. Empirically, the long-run evolution of capitalist economies has indeed been characterised by an increase in (average) consumption opportunities and by a tendential expansion of technical knowledge, leading to a progressive increase in labour productivity (Flaschel et al. [16] and Cogliano et al. [6]). Theoretically, a fundamental feature of capitalism as a dynamic system is its constant tendency to revolutionise production with a strong propensity, according to Marx, for labour-saving innovations.

To be specific, concerning consumption, we incorporate some Marxian insights on the social nature of consumption and assume that b_t is the product of social norms, by making it an increasing function of the general level of development of the economy, as proxied by aggregate capital, and of the history of consumption itself. To be specific, we assume:

$$b_t = b_{t-1} \cdot \left(1 + \phi \frac{\omega_{t-1} - \omega_{t-2}}{\omega_{t-2}}\right), \tag{8}$$

where the parameter ϕ captures the degree to which the development of the economy influences consumption norms.

Concerning technology, we follow Marx and assume that when the rate of return on capital falls beneath a certain threshold, capitalists increase their efforts to innovate and introduce new capital-using labour-saving techniques, thus leading $\mathcal{P}_t$ to change over time. In our model, given perfect competition, profitability is measured by the interest rate fetched on the international credit market. Therefore, in the simulations, we shall assume

$$\begin{aligned} (A_t, L_t) &= (A_{t-1}, L_{t-1}), \text{ if } r_{t-1} \geqq r^*, \\ (A_t, L_t) &= (A', L'), \text{ if } r_{t-1} < r^*, \end{aligned}$$

where r^* is the capitalist's minimum profitability benchmark, which depends on economic, institutional and even cultural factors. The new technique (A', L') is chosen such that $A' \geqq A_{t-1}$, $L' < L_{t-1}$, and $r' > r_{t-1}$, in order to capture the nature of profitable, Marx-biased technical change. This formulation of technical change is grounded theoretically in the Marxian and evolutionary tradition, as argued by Cogliano et al [7], and it has robust empirical support (see, for example, Tavani and Zamparelli [45]).

7.1 Persistent exploitation cycles

In our simulations, we set $r^* = 0.01$. Let $r^{(\widehat{w}_t;A_{t-1},L_{t-1})}$ be the interest rate given the real wage at t and the production technique adopted at $t-1$.[35] If $r^{(\widehat{w}_t;A_{t-1},L_{t-1})} \geq r^*$ then $(A_t, L_t) = (A_{t-1}, L_{t-1})$. When $r^{(\widehat{w}_t;A_{t-1},L_{t-1})} < r^*$, the new technique prevailing at t is identified by first selecting an interest rate, r', from the set of all previous interest rates $\{r_\tau\}_{\tau<t}$, such that $r_\tau > r^*$ and then randomly choosing an increase in A_{t-1} in the range $[0.01, 0.03]$ and setting $L_t = \frac{1-A_t-A_t r'}{\widehat{w}_t}$. To ensure that $A_t < 1$ a limit is set such that $A_{\max} = 0.991$. If r' and A_t entail a negative L_t, r' is adjusted downward by 0.02 so that $L_t > 0$.[36] These parameter values are chosen to ensure that new techniques restore a higher interest rate while not being so large as to preclude additional new innovations over the course of the simulation, i.e. these values allows us to examine the impact of a series of new techniques on exploitation and the core-periphery structure of the world. New techniques also provide the highest possible interest rate during any t. Given the persistently rising b_t, a new technique provides a higher interest rate than older techniques, thus there is no desire for any kind of reswitching.

The simulation occurs in the following order: (1) initialisation, $t = 1$; (2) subsistence b_t is updated; (3) $\widehat{w}_t$ and $r^{(\widehat{w}_t;A_{t-1},L_{t-1})}$ are determined depending on whether the economy is capital constrained or labour constrained;[37] (4) given $r^{(\widehat{w}_t;A_{t-1},L_{t-1})}$, A_t and L_t are updated if appropriate, leading r_t to be subsequently updated to reflect the new technology; (5) agents solve MP_t^ν;[38] and (6) the sequence (2)-(5) is repeated for all T periods.

The simulation runs for $T = 50$, with $A_0 = 0.5$, $L_0 = 1$, $b_0 = 0.3$, and $\phi = 1$. Parameters are chosen to allow the dynamics of technical change and evolving consumption norms to play out over T, and similar to section 6, $v_1 = 2$ and declines thereafter as a result of technical change. The effective labour endowments and the initial distribution of wealth are determined as in the basic model. The main results are depicted in figures 6-12.

Figure 6 reports the same information as figure 3 for the basic model. Some differences clearly emerge: aggregate production, lending, and wealth, all increase over time but their growth path is no longer a smooth exponential, and g_t exhibits a cyclical downward trend, without the economy reaching a stationary state. This is caused by the joint dynamics of distribution, consumption norms, and technical change. Initially, the economy is capital constrained, and $\widehat{w}_t = b_t$. As accumulation proceeds, the subsistence norm, b_t, increases, leading to a decrease in the interest rate, and thus in the growth rate of aggregate output, lending, and capital, even before the economy becomes labour constrained. As the rate of

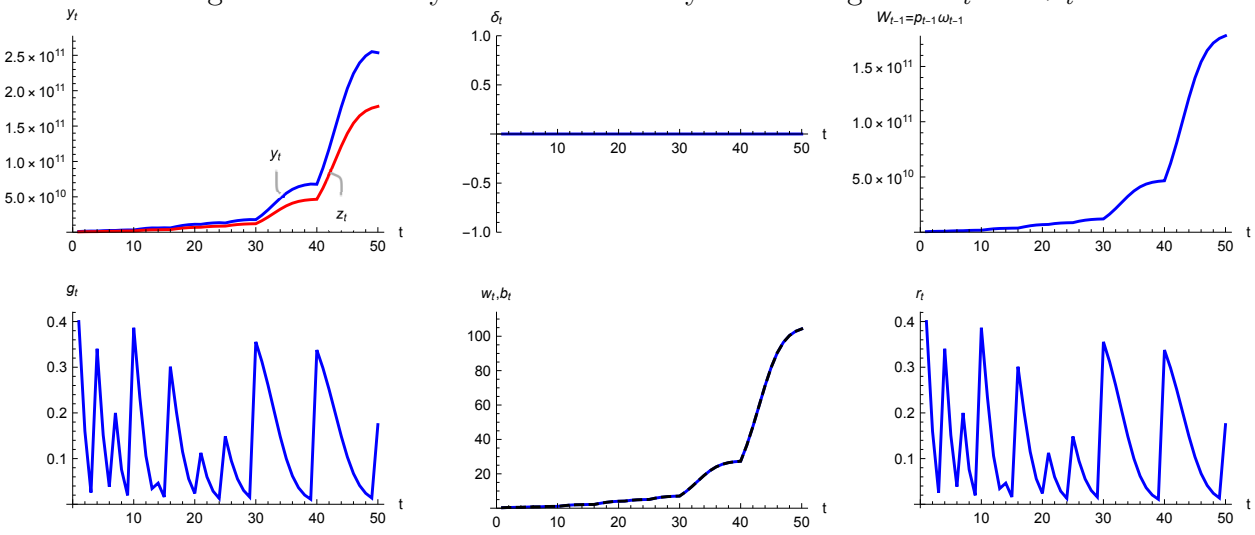
[35] Formally, $r^{(\widehat{w}_t;A_{t-1},L_{t-1})} \equiv \frac{1-A_{t-1}-\widehat{w}L_{t-1}}{A_{t-1}}$, where $\widehat{w}_t = b_t$ and b_t is given by the equation (8) when the economy is capital constrained at period t; while $\widehat{w}_t = \frac{1-A_{t-1}}{L_{t-1}}$ when it is labour constrained.

[36] The downward adjustment of r' by 0.02 is only to ensure that the simulations run smoothly and does not actually take place in the simulation results shown below. Similarly, the upper limit on A_t is not actually reached and new techniques in the simulation results fit the Marx-biased pattern described above.

[37] In principle, the global economy could also be on the knife-edge, in which case we would need to specify a rule to determine the distributive variables. However, the set of parameters giving rise to this configuration is of zero measure and we never encounter it in the simulations.

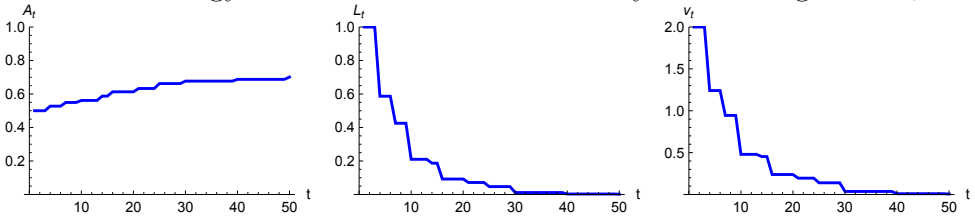
[38] This procedure also explains how to compute an equilibrium price at each and every period within the simulation, given that changes of consumption norms and technical changes may take place. Note that if market prices are under the disequilibrium, the consumption norms determined by the equation (8) may violate feasibility, which does not occur in our simulations.

Figure 6: Summary results - Economy with endogenous b_t and $\mathcal{P}_t$



return hits the critical threshold, however, capitalists manage to introduce an innovation that restores global profitability, lowers employment, and speeds up growth again, starting a new accumulation cycle. Throughout the cycles of accumulation and technical change the economy remains capital constrained, as recurrent Marx-biased technical change (cyclically) lowers labour demand and the labour embodied in the production good (Figure 7). Therefore there is a secular increase in $\widehat{w}_t = b_t$, while r_t oscillates between $r_0 = 0.4$ and r^*.

Figure 7: Technology and labour values - Economy with endogenous b_t and $\mathcal{P}_t$



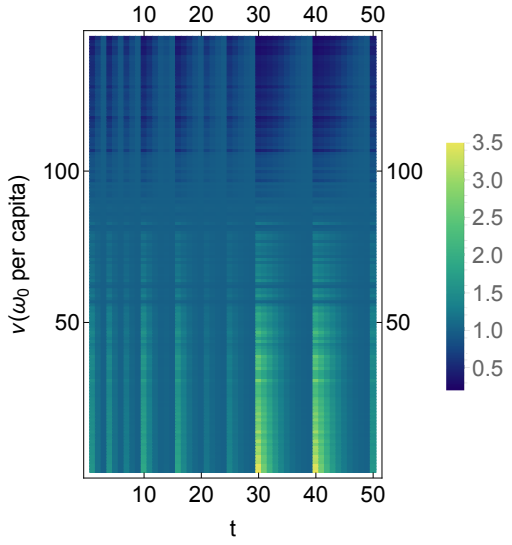
Note: $A_{\max} = 0.700997$, $L_{\min} = 0.00169562$, $v_{\min} = 0.00567092$

In light of the cyclical behaviour of g_t and r_t, the structure of IIR is remarkably stable. Throughout the simulation, fifty-six countries are exploiters and belong to C_t^1, and eighty-eight are exploited and belong to C_t^3, while C_t^2 and C_t^4 are empty. The core/periphery structure of the economy is stable and the CECP holds at all t.[39] However, the exploitation and class structure of the global economy draws only a partial picture of IIR. Under the surface of a seemingly unchanging pattern of exploitation, figures 8(a)-8(b) show that the addition of technical change induces an interesting phenomenon of "exploitation cycles" that trace the cycles in r_t. As accumulation progresses with a given technique (A_t, L_t), exploitation tends to decrease as e_t^ν tends to 1 for all ν. However, when a new technique is introduced, profitability and inequality in exploitation intensity are restored, and the pattern of accumulation and exploitation resumes until another innovation is introduced.

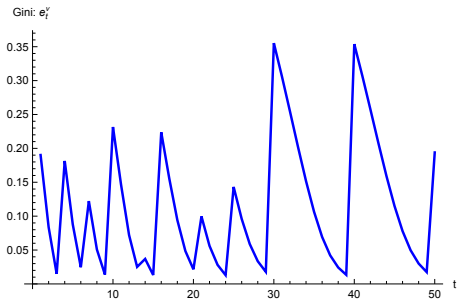
[39]These results are not shown for reasons of space. (See section 3.2 in the Addendum.)

Figure 8: Exploitation intensity index - Economy with endogenous b_t and $\mathcal{P}_t$

(a) Exploitation intensity across agents



(b) Gini coefficient of e_t^ν



The results support the claim that capital-using labour-saving technical change can help to explain the persistence of IIR – an intuition formulated within individual countries (Skillman [43]), which we extend here to the international context. In the global economy, international trade and development raise (norms, expectations and therefore) living standards, including for countries in the periphery, which increases their reservation wage and tends to reduce the rate of return on capital. What can countries in the core do in order to counter this tendency, and maintain exploitation, without recourse to war and coercion? The previous analysis suggests that Marx-biased technical change may do the job as it makes capital persistently scarce relative to labour, thus maintaining the advantage of capital-rich core countries over labour-abundant countries in the periphery. In a competitive setting, countries in the core cannot coordinate their innovation efforts and therefore technical change tends to occur occasionally, which leads to cycles that capture the varying degree to which core countries are able to exploit the periphery over time.

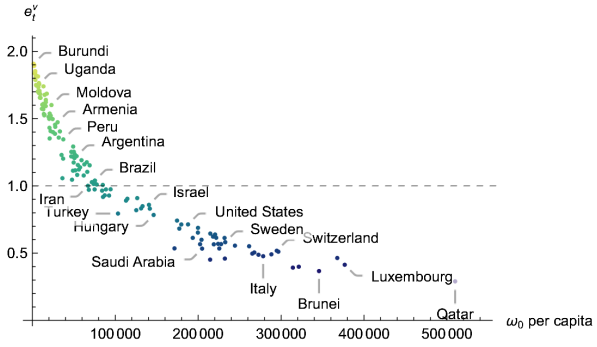
Figure 9 shows the global distribution of the exploitation intensity index against initial per capita wealth at select t. Unlike at $t = 1$, the distributions shown in figure 9 are counterfactuals: they show what the global distribution of e_t^ν would look like at different points in the cycles shown in figure 6.[40] Specifically, periods where exploitation is most intense for exploited countries – periods with high r_t ($t = 25, 40$)– have a wider dispersion of e_t^ν than periods at the bottom of a cycle with low r_t ($t = 10, 50$).

In closing this section, it is worth remarking that while the Gini of the exploitation intensity index fluctuates widely around a mildly increasing trend, the Gini coefficient of the distribution of wealth is constant at 0.8156 over t since all countries accumulate at the rate r_t. The distribution of income is also stable with only small variations in the Gini

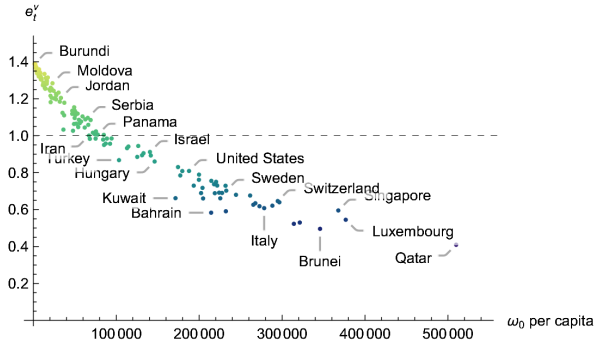
[40]The distribution of e_t^ν at $t = 1$ is qualitatively the same as in figure 1 and is therefore omitted. The full list of values can be found in table 4 in the Appendix.

Figure 9: Worldwide Exploitation Intensity - Economy with endogenous b_t and $\mathcal{P}_t$

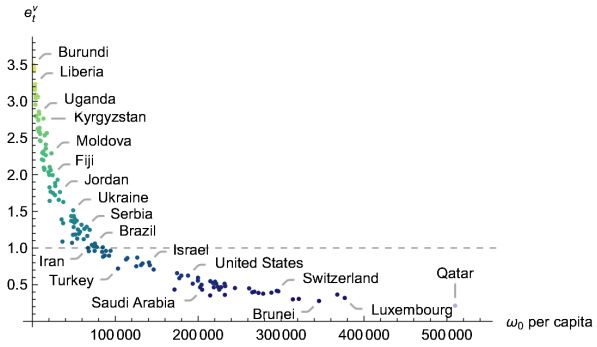
(a) $t = 10$



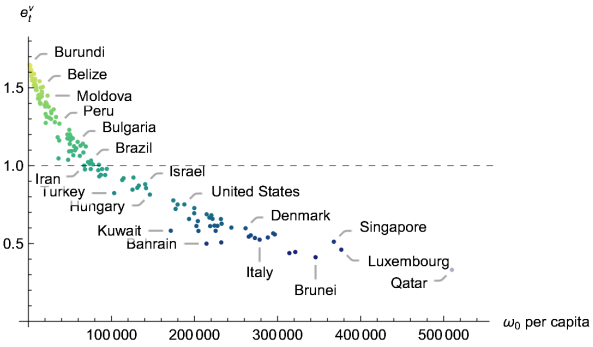
(b) $t = 25$



(c) $t = 40$



(d) $t = 50$



coefficient in the range [0.780087, 0.809].[41] This is an important point that was not evident in the basic economy: an analysis of international relations focusing on the concepts of exploitation and class is not reducible to the standard focus on income and wealth inequality (even though a strong relation exists between wealth inequalities and exploitation and class status, as argued above). The notions of exploitation and class identify the key economic and geographic structure of IIR in a way that international inequalities of income and wealth do not. Exploitative international relations, and the emergence in the global economy of a core and a periphery, cannot be captured by simply looking at conventional notions of income and wealth inequalities.

8 Robustness

We have analysed many variations of the two economies in order to assess the robustness of our results. In this section, we briefly summarise the main points.[42]

First, the empirical estimates of the global distribution of exploitation intensity in tables 1-2, and the partition of countries into exploiters and exploited, are robust to a number of perturbations. To be sure, alternative estimates of national wealth and consumption levels, or of the technological parameters A, L (and thus of embodied labour value v) may make a

[41] Figures for the distributions of wealth and income are omitted for space and available in the Addendum.

[42] A complete description of all robustness checks is available in the Addendum.

difference for countries that are very close to the threshold $e^{\nu} = 1$. But on the whole the picture of the international economy in 2017 derived in section 6.1 is quite robust.

We have also considered alternative determinations of each country's labour endowment, including (i) assigning a proxy value of one to those countries in the Penn World Table [15] that do not report human capital attainment, and then determining labour endowments following the formula specified in section 6; and (ii) using the Penn World Table [15] data on persons engaged by country to determine labour endowments rather than population.[43] In some respects, using persons engaged may yield preferable estimates of effective labour capacity, over those based on population, since persons engaged could ostensibly capture cultural and other differences across countries that determine different labour forces, even when populations are very similar. Option (i) expands N to 180 to include almost all countries in the world; while (ii) yields $N = 171$. All other initial parameters remain the same. In either scenario, the broader set of agents has no significant impact on the depiction of IIR.

Indeed, second, the different methods of estimating the countries' labour endowment have no impact on the simulation results of the basic economy and of the economy with endogenous technical change and consumption norms. The structures of accumulation, exploitation and class, and exploitation intensity are consistent across simulations.

Third, the key qualitative features of both economies are robust to a large number of perturbations of the initial conditions, production set, and, to a large extent, behavioural assumptions. The results obtained in section 7.1 remain unchanged for a range of values of the threshold interest rate $r*$ and of the parameter ϕ linking the growth of consumption norms to accumulation, and they continue to hold if more general formulations of technical change are considered.

Fourth, we have considered a mixed variant of the economy with endogenous consumption norms but *exogenous* labour-saving technical change that occurs at a pace sufficient to maintain a stable r_t for all t. In this economy, the class and exploitation structure and the distribution of e_t^{ν} remain stable and consistent with that of the basic economy, but the economy does not reach a non-exploitative stationary state consistent with the results in section 7.1.

Lastly, it may be argued that our conclusions in section 7 depend on the rather specific dynamics of consumption norms, which are assumed to grow at the same rate as the capital stock. Although we believe this assumption to be empirically plausible, we have also tested a host of alternative specifications of consumption behaviour that largely confirm our results, except when consumption of core countries is so high that they stop accumulating straight away and there is a mild tendency for exploitation inequality to decrease.

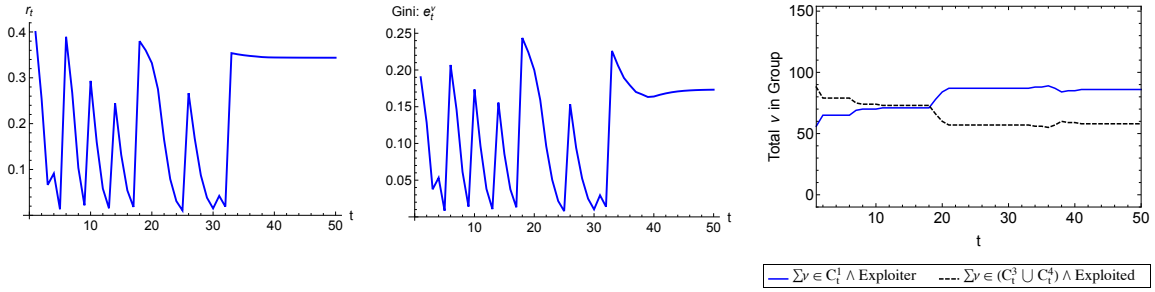
Specifically, we examined a series of economies with highly heterogeneous consumption based on differential standards of living, replacing $p_t b_t \Lambda_t^{\nu}$ in constraint (1) with $p_t D_t^{\nu}(b_t, r_t \omega_{t-1}^{\nu})$, where $D_t^{\nu}(\cdot)$ is an increasing function of consumption norms, as determined in section 7, and of a country's interest revenue – the intuition being that wealthy countries tend to consume more from interest revenue and accumulate less.

Figure 10 shows select results from one of these alternative specifications, which sum-

[43] We have then multiplied the value obtained by 1,000,000 in order to ensure the simulations begin from a capital constrained state.

Figure 10: Sample results - Example economy with standard of living consumption

(a) Cycles in r_t (b) Gini coefficient of e_t^ν (c) CECP



marises the main insights of this series of robustness tests. The economy displays similar cycles to those in section 7. As countries accumulate, they gradually shift toward consuming more interest income and their rate of accumulation slows. Yet, there seems to be no clear tendency for the Gini of e_t^ν to decrease, with the initial value very close to that at the end of the simulation. Overall, most of the initially exploited countries remain so, with some switching to become exploiters by the end of the simulation, but the general pattern is for a slight decrease in the intensity of exploitation over time; likewise, most of the initial exploiter countries keep exploiting, with many exploiting less intensely than at the start of the simulation, but some show notable increases in the intensity with which they exploit as time goes on. This pattern of exploitation intensity is particularly interesting since it occurs even as r_t and the Gini of e_t^ν show no clear tendency to decline. Further, the structure of the CECP shown in figure 10 is robust even as standard of living-based consumption is introduced, b_t grows with aggregate accumulation, various technical changes take place, and the global economy eventually reaches a stationary state around $t = 40$, after which e_t^ν is almost constant for all ν. Stated differently, the CECP persists even as the world economy switches from a capital accumulation regime to a stationary one, thus the structure of exploitation and class is robust to shifts in the stage of world development – further confirming the analysis in section 6.

9 Conclusions

In this paper, we have developed a rigorous conceptual framework to analyse the new guise that IIR have taken in the global economy. First, we have developed a formal model to derive a new measure of unequal exchange across borders – an exploitation intensity index. Contrary to the received view, this measure is theoretically robust and logically consistent, and it can be taken to the data: we have derived the full structure of IIR within the framework of our model and derived a number of novel and interesting insights.

Unlike in post-modern approaches to globalisation, which depict IIR as immaterial and deterritorialised, the economic and geographic structure of imperialism can be identified, whereby wealthy nations are net lenders and exploiters, whereas endowment-poor countries are net borrowers and suffer from exploitation. In line with dependency theory, our model identifies a set of countries in the core of the global economy, and those in the periphery

based on their position in the class and exploitation structure.

We have also shown that unlike in classical theories, competitive markets, profit-seeking, and international inequalities in development and wealth are central in generating IIR. The exploitative nature of IIR can be understood focusing on credit relations, which transfer surplus from the periphery to the core of the global economy. Capital movements – and restrictions to the movements of labour – are key ingredients of current disparities among countries.

While international credit markets and wealth inequalities are sufficient to generate an exploitation phenomenon, we show that they are not sufficient for it to persist – a point made by various authors in the literature. We have therefore explored some mechanisms to guarantee the persistence of IIR – without assuming the sheer use of force from core countries. Consistent with a classic Marxian intuition, we show that capital-using labour-saving technical change introduced by profit-seeking capitalists may play this role.

Indeed, if one adopts an evolutionary model of the creation and adoption of technical innovations, it is possible to show that the world economy displays endogenous fluctuations in the growth rate of output, as well as profitability and exploitation. Although ours is an exercise in scientific ontology – trying to identify the nature of IIR and an appropriate index to measure exploitative relations – these results suggest a possible explanation of the turbulent dynamics of the global economy. We leave this issue for further research.

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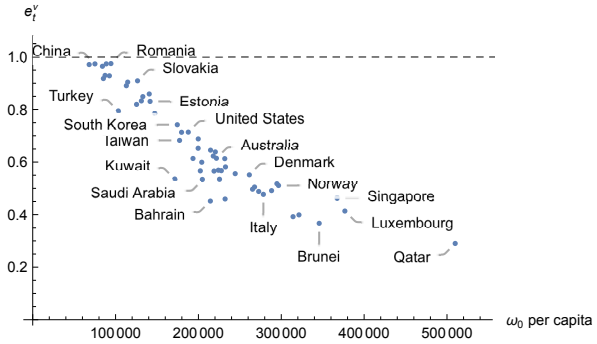
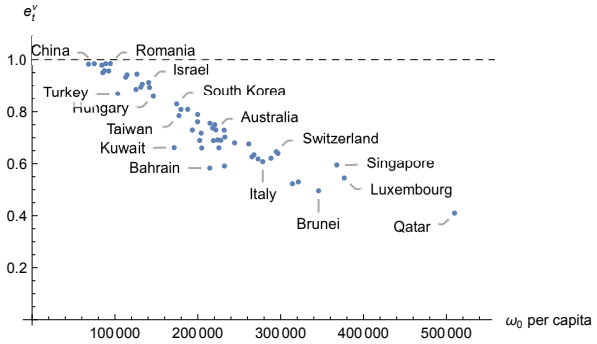
A Appendix

Figure 11: Exploiter Countries - Economy with endogenous b_t and $\mathcal{P}_t$

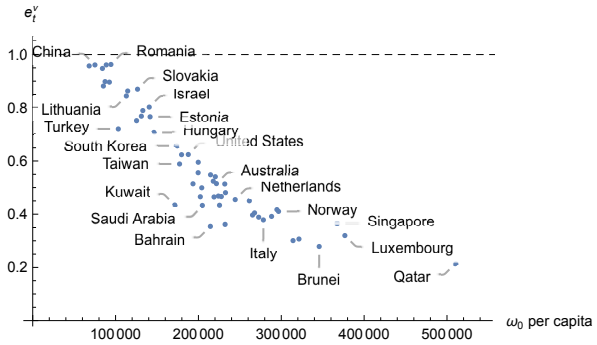
(a) $t = 10$



(b) $t = 25$



(c) $t = 40$



(d) $t = 50$

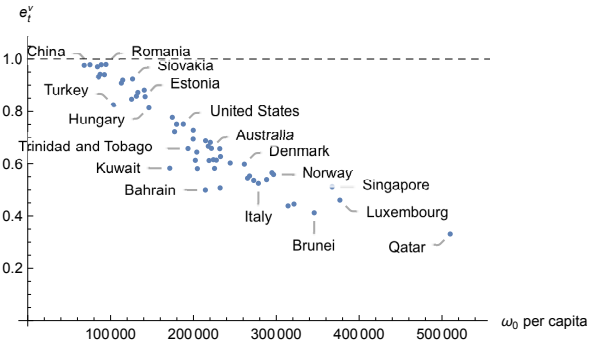
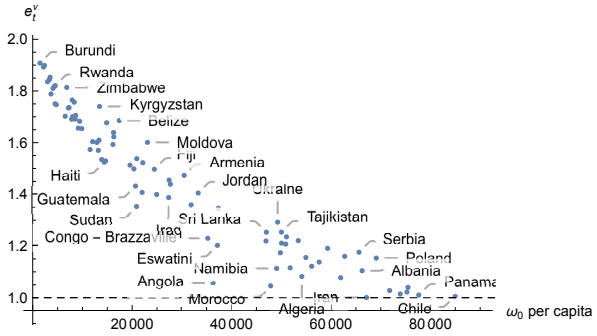
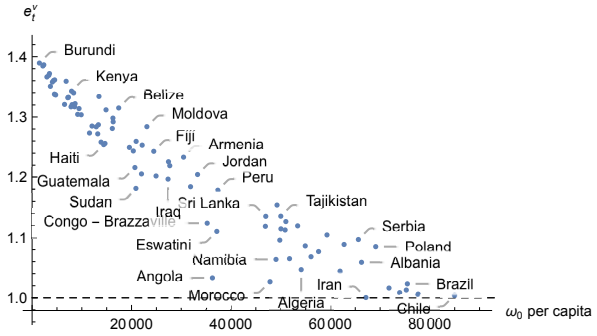


Figure 12: Exploited Countries - Economy with endogenous b_t and $\mathcal{P}_t$

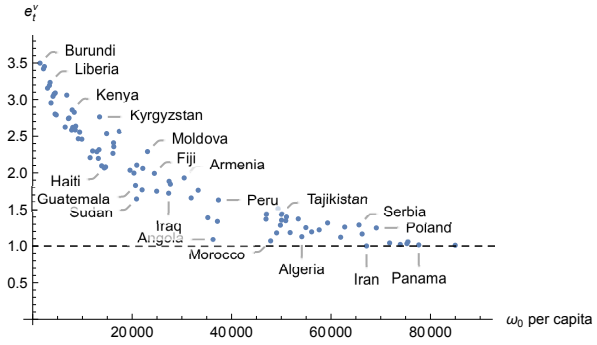
(a) $t = 10$



(b) $t = 25$



(c) $t = 40$



(d) $t = 50$

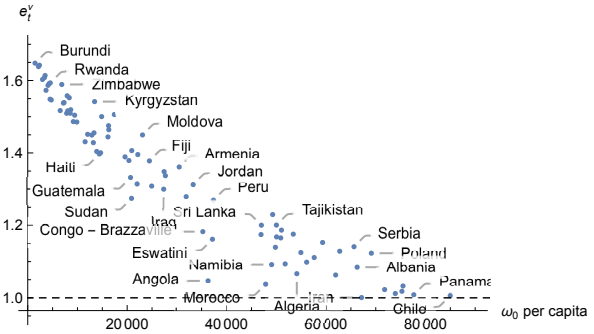


Table 3: Exploitation Intensity for Exploiter Countries at select t with countries sorted by initial per capita wealth - Economy with endogenous b_t and $\mathcal{P}_t$

	e_1^ν	e_{10}^ν	e_{25}^ν	e_{40}^ν	e_{50}^ν
Indonesia	0.9765	0.9983	0.9686	0.9591	0.9980
China	0.9786	0.9985	0.9714	0.9627	0.9982
Venezuela	0.9712	0.9979	0.9615	0.9499	0.9975
Mauritius	0.9325	0.9949	0.9110	0.8861	0.9940
Uruguay	0.9426	0.9957	0.9240	0.9023	0.9949
Malaysia	0.9787	0.9985	0.9715	0.9628	0.9982
Botswana	0.9413	0.9956	0.9224	0.9002	0.9948
Romania	0.9796	0.9985	0.9727	0.9643	0.9983
Turkey	0.8270	0.9854	0.7798	0.7289	0.9828
Lithuania	0.9097	0.9930	0.8818	0.8500	0.9918
Russia	0.9212	0.9940	0.8965	0.8680	0.9929
Malta	0.8488	0.9876	0.8062	0.7595	0.9853
Slovakia	0.9253	0.9943	0.9018	0.8746	0.9933
New Zealand	0.8602	0.9886	0.8201	0.7759	0.9866
Croatia	0.8744	0.9899	0.8376	0.7966	0.9881
Israel	0.8830	0.9907	0.8483	0.8094	0.9890
Estonia	0.8586	0.9885	0.8181	0.7736	0.9864
Hungary	0.8177	0.9845	0.7687	0.7162	0.9817
Kuwait	0.5876	0.9527	0.5136	0.4450	0.9446
South Korea	0.7807	0.9805	0.7251	0.6670	0.9770
Taiwan	0.7265	0.9741	0.6631	0.5992	0.9695
Japan	0.7548	0.9775	0.6952	0.6339	0.9735
United States	0.7553	0.9776	0.6957	0.6346	0.9736
Trinidad and Tobago	0.6627	0.9652	0.5928	0.5250	0.9592
Finland	0.6991	0.9704	0.6326	0.5666	0.9653
United Kingdom	0.7318	0.9747	0.6691	0.6056	0.9703
Cyprus	0.6178	0.9581	0.5450	0.4763	0.9508
Latvia	0.6491	0.9632	0.5782	0.5100	0.9567
Saudi Arabia	0.5861	0.9524	0.5120	0.4434	0.9442
Bahrain	0.5046	0.9350	0.4301	0.3643	0.9241
Czech Republic	0.6925	0.9695	0.6253	0.5589	0.9642
Slovenia	0.6714	0.9665	0.6022	0.5348	0.9607
Greece	0.6171	0.9579	0.5442	0.4755	0.9507
Canada	0.6862	0.9687	0.6184	0.5517	0.9632
Australia	0.6634	0.9653	0.5935	0.5258	0.9593
France	0.6202	0.9585	0.5475	0.4789	0.9513
Spain	0.5869	0.9525	0.5128	0.4442	0.9444
Iceland	0.6185	0.9582	0.5457	0.4771	0.9510
Germany	0.6621	0.9651	0.5921	0.5244	0.9591
Portugal	0.5127	0.9370	0.4380	0.3718	0.9264
Sweden	0.6322	0.9605	0.5601	0.4916	0.9536
Netherlands	0.6076	0.9563	0.5343	0.4656	0.9488
Denmark	0.6032	0.9555	0.5297	0.4610	0.9479
Belgium	0.5496	0.9452	0.4748	0.4071	0.9359
Hong Kong	0.5582	0.9470	0.4835	0.4155	0.9379
Ireland	0.5412	0.9434	0.4663	0.3989	0.9338
Italy	0.5303	0.9410	0.4555	0.3885	0.9310
Austria	0.5443	0.9441	0.4695	0.4019	0.9346
Switzerland	0.5707	0.9495	0.4962	0.4279	0.9408
Norway	0.5637	0.9481	0.4891	0.4209	0.9392
United Arab Emirates	0.4439	0.9186	0.3716	0.3099	0.9051
Macao	0.4509	0.9207	0.3783	0.3160	0.9076
Brunei	0.4173	0.9101	0.3467	0.2872	0.8954
Singapore	0.5171	0.9380	0.4424	0.3759	0.9275
Luxembourg	0.4659	0.9250	0.3926	0.3293	0.9125
Qatar	0.3359	0.8773	0.2726	0.2215	0.8581

Table 4: Exploitation Intensity for Exploited Countries at select t with countries sorted by initial per capita wealth - Economy with endogenous b_t and $\mathcal{P}_t$

	e^{ν}_{1}	e^{ν}_{10}	e^{ν}_{25}	e^{ν}_{40}	e^{ν}_{50}		e^{ν}_{1}	e^{ν}_{10}	e^{ν}_{25}	e^{ν}_{40}	e^{ν}_{50}
Burundi	1.6254	1.0280	2.0804	3.1628	1.0332	Laos	1.3056	1.0168	1.4618	1.7123	1.0200
Congo - Kinshasa	1.6163	1.0277	2.0603	3.1024	1.0329	Zambia	1.3838	1.0200	1.5984	1.9722	1.0237
Malawi	1.6199	1.0278	2.0683	3.1263	1.0331	Moldova	1.4359	1.0220	1.6941	2.1716	1.0260
Mali	1.5824	1.0267	1.9872	2.8915	1.0318	Fiji	1.3669	1.0194	1.5682	1.9124	1.0230
Sierra Leone	1.5874	1.0269	1.9977	2.9209	1.0319	India	1.3000	1.0166	1.4524	1.6954	1.0197
Liberia	1.5929	1.0270	2.0095	2.9543	1.0321	Iraq	1.2917	1.0162	1.4384	1.6704	1.0192
Mozambique	1.5538	1.0259	1.9271	2.7284	1.0307	Philippines	1.3384	1.0182	1.5181	1.8161	1.0216
Central African Republic	1.5670	1.0263	1.9546	2.8018	1.0312	Paraguay	1.3276	1.0178	1.4994	1.7812	1.0211
Madagascar	1.5714	1.0264	1.9638	2.8270	1.0314	Armenia	1.3508	1.0187	1.5398	1.8573	1.0222
Niger	1.5304	1.0251	1.8789	2.6039	1.0299	Ghana	1.2716	1.0153	1.4051	1.6120	1.0182
Rwanda	1.5734	1.0265	1.9681	2.8387	1.0314	Jordan	1.3040	1.0168	1.4591	1.7074	1.0199
Burkina Faso	1.5285	1.0251	1.8750	2.5940	1.0298	Congo - Brazzaville	1.1781	1.0108	1.2563	1.3674	1.0128
Ethiopia	1.5004	1.0242	1.8186	2.4554	1.0287	Angola	1.0457	1.0031	1.0626	1.0841	1.0037
Zimbabwe	1.5692	1.0263	1.9593	2.8145	1.0313	Eswatini	1.1577	1.0097	1.2252	1.3194	1.0115
Togo	1.5202	1.0248	1.8583	2.5522	1.0295	Peru	1.2624	1.0149	1.3900	1.5859	1.0177
Benin	1.5216	1.0249	1.8612	2.5593	1.0295	Costa Rica	1.1703	1.0104	1.2444	1.3489	1.0123
Gambia	1.4932	1.0239	1.8045	2.4216	1.0284	Sri Lanka	1.1954	1.0117	1.2830	1.4094	1.0139
Kenya	1.5394	1.0254	1.8973	2.6507	1.0302	Morocco	1.0369	1.0025	1.0504	1.0675	1.0030
Yemen	1.4996	1.0241	1.8172	2.4518	1.0287	Namibia	1.0896	1.0059	1.1248	1.1711	1.0069
Uganda	1.5342	1.0253	1.8868	2.6239	1.0300	Ukraine	1.2240	1.0131	1.3280	1.4820	1.0155
Nepal	1.4933	1.0239	1.8047	2.4222	1.0284	Colombia	1.1361	1.0085	1.1929	1.2705	1.0101
Cambodia	1.5026	1.0242	1.8230	2.4659	1.0288	Tajikistan	1.1957	1.0117	1.2835	1.4102	1.0139
Ivory Coast	1.4712	1.0232	1.7615	2.3215	1.0275	Gabon	1.1640	1.0101	1.2348	1.3341	1.0119
Cameroon	1.4881	1.0238	1.7944	2.3977	1.0282	South Africa	1.1612	1.0099	1.2307	1.3277	1.0118
Pakistan	1.4701	1.0232	1.7594	2.3167	1.0275	Mongolia	1.1822	1.0110	1.2626	1.3772	1.0131
Senegal	1.4178	1.0213	1.6604	2.0996	1.0253	Maldives	1.0914	1.0060	1.1274	1.1748	1.0071
Myanmar	1.4376	1.0220	1.6973	2.1786	1.0261	Argentina	1.1714	1.0105	1.2461	1.3515	1.0124
Nigeria	1.4355	1.0219	1.6935	2.1702	1.0260	Algeria	1.0652	1.0043	1.0900	1.1220	1.0051
Mauritania	1.4154	1.0212	1.6561	2.0905	1.0252	Dominican Republic	1.1221	1.0078	1.1721	1.2397	1.0092
Bangladesh	1.4413	1.0221	1.7044	2.1940	1.0263	Jamaica	1.0961	1.0062	1.1342	1.1845	1.0074
Kyrgyzstan	1.5241	1.0249	1.8661	2.5718	1.0296	Ecuador	1.1085	1.0070	1.1523	1.2107	1.0083
Tanzania	1.3921	1.0203	1.6134	2.0025	1.0241	Bulgaria	1.1490	1.0093	1.2122	1.2995	1.0110
Haiti	1.3854	1.0201	1.6012	1.9778	1.0238	Tunisia	1.0616	1.0041	1.0850	1.1150	1.0049
Lesotho	1.3885	1.0202	1.6068	1.9892	1.0240	Kazakhstan	1.1255	1.0080	1.1772	1.2472	1.0094
Bolivia	1.4844	1.0236	1.7872	2.3810	1.0281	Serbia	1.1377	1.0086	1.1952	1.2740	1.0102
Honduras	1.4306	1.0218	1.6843	2.1504	1.0258	Albania	1.0827	1.0054	1.1149	1.1570	1.0064
Vietnam	1.4604	1.0228	1.7407	2.2743	1.0271	Iran	1.0007	1.0000	1.0009	1.0012	1.0001
Egypt	1.4497	1.0224	1.7203	2.2288	1.0266	Poland	1.1202	1.0077	1.1694	1.2357	1.0091
Belize	1.4900	1.0238	1.7981	2.4066	1.0283	Mexico	1.0223	1.0015	1.0304	1.0404	1.0018
Nicaragua	1.3777	1.0198	1.5873	1.9502	1.0235	Thailand	1.0117	1.0008	1.0158	1.0209	1.0010
El Salvador	1.3679	1.0194	1.5699	1.9158	1.0230	Barbados	1.0177	1.0012	1.0240	1.0319	1.0015
Guatemala	1.3226	1.0176	1.4909	1.7654	1.0208	Brazil	1.0321	1.0022	1.0438	1.0584	1.0026
Sudan	1.2672	1.0151	1.3978	1.5993	1.0179	Panama	1.0083	1.0006	1.0113	1.0149	1.0007
Syria	1.3943	1.0204	1.6173	2.0105	1.0242	Chile	1.0059	1.0004	1.0080	1.0105	1.0005