Acta Oeconomica 72 (2022) S1, 51–79
DOI: 10.1556/032.2022.00019

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Putting labour values to work

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Received: January 23, 2022 • Revised manuscript received: April 8, 2022 • Accepted: May 9, 2022

ABSTRACT

Conventional wisdom has it that Marxian value theory, and labour values themselves, are logically inconsistent, theoretically shaky, and empirically irrelevant. In this paper, we discuss recent research showing that this conclusion is not warranted. While past debates have definitively proved that labour values, or employment multipliers, cannot be used to explain equilibrium prices, this does not mean that a sound, empirically oriented Marxian approach cannot be built which assigns a central role to labour values. To be specific, we argue that they can be used to understand certain fundamental laws of capitalist economies – in particular the relation between profitability, technical progress, and accumulation – and also to construct normatively interesting indices capturing certain inequalities in well-being freedom.

KEYWORDS

exploitation, labour theory of value, labour values, Marx, Marxian value theory

JEL CLASSIFICATION INDICES

B51, C67, D24, D46, D63

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1. INTRODUCTION

For the classical economists – notably Adam Smith, David Ricardo – and Karl Marx, observable economic magnitudes and events are more often than not mere epiphenomena of deeper structural features, and a focus on market outcomes would yield at best a preliminary, superficial understanding of economic processes. This is not to deny their relevance in everyday economic life. Market prices, for example, are important magnitudes in determining agents' decisions, the survival of firms, government policies, and so on. However, according to the classicals and Marx, a thorough understanding of the deep underlying structures of capitalist economies requires conceptual tools that allow researchers to look beneath the surface of observable economic relations. In classical-Marxian political economy, the notion of *labour value* is one such conceptual tool.

In market economies, the notions of price and profit are central. In neoclassical theory, price and value magnitudes are essentially indistinguishable and both emerge in competitive markets from the interaction of optimising agents, within a subjectivist theory of value. In the classical and Marxian tradition, value magnitudes are distinct from monetary magnitudes; and only labour creates value. Such a labour theory of value (henceforth, LTV) is objective, and labour values are defined as the amount of labour time socially necessary to produce – or embodied in – each commodity.

The standard view is that labour values *determine* production prices – the equilibrium prices of classical-Marxian economics – which are long-run centres of gravity around which market prices fluctuate. From this perspective, labour values are the deep, structural variables that determine the dynamics of observed prices. This standard view has been the target of intense criticism, beginning shortly after Marx's death, and the relation between labour values and long-run prices is the content of what has become known as the "transformation problem". Discussions of the transformation problem make cyclical appearances in the literature, with long periods of relative inactivity punctuated by spurts of heated debate.

The outcome of the last wave of major debates in the 1960s and 1970s has led to the widespread view that the classical-Marxian LTV is logically inconsistent and so irremediably flawed. For it has been shown that, even in the simplest linear economies, labour values cannot be thought of as determining (relative, equilibrium) prices in any meaningful sense. Profit rate equalisation across sectors – the key characteristics of classical production prices – is incompatible with labour value pricing. Further, critics have argued that price/value deviations have no systematic pattern either at the sectoral or at the aggregate level, and therefore it is unclear that value magnitudes determine price magnitudes at the meso- or macroeconomic level either. As Paul Samuelson (1971) famously put it in his "blackboard theorem", price magnitudes and value magnitudes are simply independent of each other, with a relation of mutual irrelevance.

A similar negative judgement was shared also by commentators who were less hostile to Marxist theory in general. Joan Robinson famously argued, for example, that value theory "provides a typical example of the way metaphysical ideas operate. Logically it is a mere rigmarole of words, but for Marx it was a flood of illumination and for latter-day Marxists, a source of inspiration" (Robinson 1964: 39).

Given the central role of value theory in Marxian economics, these conclusions have led many commentators to consider the whole of Marx's theory as dead. For example, a widespread view –at least in economics, both in the mainstream and for most heterodox scholars – is that

the Marxian concept of exploitation cannot be defined coherently because of the logical flaws in the LTV.

The formal results derived in the debates on the transformation problem are mathematically true, and in a sense, they set the parameters of the discussion, becoming the point of reference – positive or negative – for most of the subsequent contributions. Some authors have denied the relevance of these results arguing that they focus on the wrong price or value magnitudes, and that appropriately defined values do determine appropriately defined prices.[1] More persuasively, other authors have interpreted these results as the starting point for a reconsideration of the role of value theory within Marxian economics.[2] The LTV may be inadequate to explain relative prices,[3] but this does not mean that labour accounts, and labour values, are irrelevant for both positive and normative purposes.

In this paper, we discuss some recent developments in value theory and present some novel empirical evidence that cast significant doubts on the received wisdom: labour values can, and in our view should be used to analyse advanced capitalist economies.

The key point to note is that there is no single, natural interpretation of Marxian value theory.[4] The standard view is that the main aim of the LTV is *predictive*: labour values are meant to predict (relative, equilibrium) prices. Yet even within a predictive interpretation, labour magnitudes may be relevant to explain other phenomena of capitalist economies. For example, one may argue that the LTV establishes a relation between exploitative relations and profits, thus allowing one to explain investment and growth, without being a theory of equilibrium prices. More generally, however, it is not clear that Marxian value theory can only be interpreted as a predictive exercise. For "there are at least three distinct non-metaphysical interpretations of the labour theory of value, viz. (i) descriptive, (ii) predictive and (iii) normative" (Sen 1978: 175).

One *descriptive* interpretation of the LTV is that of capturing the process of formation of equilibrium prices in capitalist economies, as in the standard view. But this is certainly not the only possibility. One may argue that in the LTV "it is the *activity* of production that is being described. . . [with a focus] on 'personal participation' " (Sen 1978: 177). In Section 2 of our paper, we explore yet another interpretation and show that labour values are relevant to measure and understand some important characteristics of capitalist economies – such as the dynamics of productivity and profitability, or the implications of technical progress – that are not immediately visible by focusing on monetary magnitudes.

But the LTV can also be interpreted as providing the foundations for a *normative*, evaluative exercise and an indictment of capitalist relations of production. For example, one may argue that it explains the origin of profits as accruing from the exploitation of workers and therefore shows

[1]See e.g., Chilcote (2004); Cockshott – Cottrell (1997); Fröhlich (2013); Işikara – Mokre (2022); Itoh (2021); Ochoa (1989); Sasaki (2021); Shaikh (1998, 2016); Tsoulfidis – Maniatis (2002).

[2]See e.g., Duménil (1980, 1984); Cogliano (2018, 2021); Cogliano et al. (2018); Foley (1982, 2000, 2011, 2016); Mohun (1994, 2004); Yoshihara (2021).

[3]It is worth noting, however, that a second important, albeit often neglected, set of results proved the existence of a relation between value and price magnitudes. See, for example, Morishima (1973, 1974) and Roemer (1981). For a comprehensive discussion of the literature see Desai (1988).

[4]For a detailed analysis of the variety of interpretations of Marxian value theory and a novel axiomatic interpretation of the LTV see Mohun – Veneziani (2017).

the illegitimacy of capitalist income, and the source of significant inequalities of well-being. Or it may be taken as providing the foundations of a distributive approach based on contribution and effort. In Section 3, we explore this normative interpretation and show that labour values can be used, among other things, to build a robust framework for the analysis of unfairness in international relations.

None of the interpretations presented in this paper are metaphysical, and none of them are affected by the standard criticisms levelled against Marxian value theory based on the transformation problem.

2. LABOUR VALUES AND PRODUCTIVITY

The starting point of our analysis is the description of capitalist economies as complex systems characterised by a high degree of social interdependence and by the interconnected role of production and circulation of commodities. In a Marxian perspective, a theoretical analysis of capitalism requires the development of a conceptual apparatus that allows one to capture real phenomena, and especially production relations and production processes, beneath the surface of market interactions. Classical input-output (IO) theory is, in our view, uniquely placed to provide the tools for this theoretical endeavour.

The United Nations' System of National Accounts (SNA) originally developed by Richard Stone and his research group (United Nations 1968) is a rigorous classification system of production and exchange activities. It considers many complexities of capitalist economies, including joint production and fixed capital, and attempts to construct both stock and flow matrices to capture the dynamics of an economy, and real magnitudes like real GDP and labour productivity. The real magnitudes of the SNA are theoretical concepts which capture relevant economic phenomena that underlie nominal magnitudes. Thus, they are akin to the centres of gravity developed by the classicals and Marx, which identify a theoretical reference point for the analysis rather than an actual, attainable state.

From this perspective, Richard Stone's SNA is more classical than neoclassical in nature, in the sense that its concepts focus on average magnitudes rather than on marginal conditions in a perfectly competitive environment. Classical-Marxian prices of production exemplify this type of average magnitude, because competitive forces can yield a uniform profit rate only over a long period of time. They are centres of gravity around which market prices fluctuate in the presence of unfettered competition (Marx 1981). They identify an abstract reference point for analysis, rather than the actual position of an economy.

We interpret Marx's LTV as the other building block of the analysis of real phenomena. It aims to identify the real magnitudes behind nominal, market phenomena by focusing on the qualitative notion of 'abstract labour' and on its quantitative expression 'labour content'. From this perspective, labour content is the (average) labour time 'embodied' in a good, in the sense of full-cost accounting in terms of labour time spent (on average) in the production of commodities (Flaschel 1983, 2010). Labour values are thus an accounting construct simultaneously determined alongside prices of production.

One key role of labour values in this approach is as alternative indicators of labour productivity. This interpretation can be traced back to Marx (1976: 131): "In general, the greater the productivity of labour, the less the labour-time required to produce an article, the less the mass of labour crystallized in that article, and the less its value. Inversely, the less the productivity of

labour, the greater the labour-time necessary to produce an article, and the greater its value. The value of a commodity, therefore, varies directly as the quantity, and inversely as the productivity, of the labour which finds its realization within the commodity."

In an economy with n production sectors, estimating labour values requires constructing an $n\times n$ matrix of capital requirements, denoted by A, and a $1\times n$ vector of direct labour requirements, denoted by l. The elements of A, denoted by a_{ij}, capture the quantity of good i needed to produce a unit of good j. The elements of l, denoted by l_j, capture the quantity of labour needed to produce a unit of good j. Labour values $v = (v_1, \ldots, v_n)$ are then calculated from $(A,\ l)$ as:

$$v = vA + l = l(I - A)^{-1}, \tag{1}$$

where I is the n-dimensional identity matrix. The classical-Marxian indicators of labour productivity, π_j^m, are defined as the inverse of labour values: $\pi_j^m = \frac{1}{v_j}$.

Apart from the affinity between the SNA and classical-Marxian approach at the broad conceptual level highlighted earlier, the similarity between the SNA measurement of total labour costs in production and the classical-Marxian measures, π_j^m, is quite striking. To see this, consider technical change in a simple economy with circulating capital only. Let $(A,\ l)$, $(A^*,\ l^*)$ denote, respectively, technology in the base and in the current period, and let v, v^* be the associated vectors of labour values. Let x^* denote an $n\times 1$ vector of gross output producible with the new technology with element x_j^* . In the UN's SNA, the change in labor productivity between the two periods, Δv, is defined as follows (United Nations 1968: 69):

$$\Delta v = \frac{l(I - A)^{-1}\left(I - A^*\right)x^*}{l^*x^*} = \frac{v\left(I - A^*\right)x^*}{v^*\left(I - A^*\right)x^*}. \tag{2}$$

Equation (2) holds for any x^* and by definition the following relation holds between gross and net output $y : A^*x^* + y = x^*$. Therefore, setting $y = (1,\ 0,\ \ldots,\ 0)'$, x^* represents the activity vector that produces one unit of commodity 1 as net product and the SNA equation of the change in labor productivity becomes:

$$\Delta v = \frac{vy}{v^*y} = \frac{v_1}{v_1^*}. \tag{3}$$

This is just the relative change in Marx's index of labour productivity, $\frac{\pi_1^{m^*}}{\pi_1^m}$. The pragmatism of national accounting, when based on a sound IO methodology, thus leads to the Marxian measure of labor productivity, although this was not in the intentions of Stone and his research group in the 1950s and 1960s.

A thorough analysis of labour values as indicators of both sectoral and aggregate labour productivity has been developed by Flaschel et al. (2013), as well as Cogliano et al. (2018), for the case of Germany, and we adapt their method to data for the United States. Labour values are estimated using IO data on uses by industry and GDP by Industry from the Bureau of Economic Analysis (2017, 2021b) for the years 1997–2020. In each year the IO data provide a 14×14 table of the dollar amount of non-labour inputs used by each industry, as well as relevant data on industry-level value added and total industry output. For simplicity of notation, we forgo time subscripts t, but all of the calculations described below apply across each year available in the Bureau of Economic Analysis (BEA)'s IO data.

Let p be the $1\times n$ vector of prices with element p_i, and let X_{ij} denote the physical amount of good i used to produce good j. p_iX_{ij} is then the dollar value of good i used by industry j – these are the data available in the columns of the raw IO tables on uses by industry. The matrix A is generated by dividing the respective elements p_iX_{ij} by p_jx_j and multiplying by $\overline{p}_i/\overline{p}_j$, where $\overline{p}_i$ and $\overline{p}_j$ are price indices for intermediate goods from the BEA (2017) GDP by Industry data. This is the double deflation method used by Flaschel et al. (2013) and Cogliano et al. (2018) to construct the A matrix in real terms. The elements of A are then $a_{ij} = \frac{p_iX_{ij}}{p_jx_j}\frac{\overline{p}_i}{\overline{p}_j}$, with 2012 as the base year.

Labour requirements l_j are estimated from employment data from the BEA Employment by Industry data (2021a).[5] Available data provide the number of workers in an industry, which we denote by L_j. L_j are then scaled by p_jx_j and deflated by $\overline{p}_j$, thus $l_j = \frac{L_j}{p_jx_j}\frac{1}{\overline{p}_j}$, all j.

Labour values v are then calculated according to equation (1) for the 14 industries in the U.S. IO data from 1997 to 2020. Industries and their abbreviations are shown in Table 1.

Table 1. Industries in U.S. input-output data

j	Industry
(1)	Agriculture, forestry, fishing, and hunting
(2)	Mining
(3)	Utilities
(4)	Construction
(5)	Manufacturing
(6)	Wholesale trade
(7)	Retail trade
(8)	Transportation and warehousing (T&W)
(9)	Information
(10)	Finance, insurance, real estate, rental, and leasing (FIRE)
(11)	Professional and business services (PBS)
(12)	Educational services, health care, and social assistance (EHS)
(13)	Arts, entertainment, recreation, accommodation, and food services (AERAF)
(14)	Other services, except government (Other srvcs)

[5]The BEA's Employment by Industry data fits the industries of the IO data from 1998 onward. Employment data prior to 1998 does not cleanly map onto the industry structure of the IO tables. Employment data by industry for 1997 come from a data set compiled by Cogliano (2018) using data on non-farm employment from the Bureau of Labor Statistics's (BLS 2017) Employment, Hours, and Earnings data. For the case of the agriculture industry in 1997, the employment figure is available from the BEA Employment by Industry data and fits with the industrial classification of the IO tables.

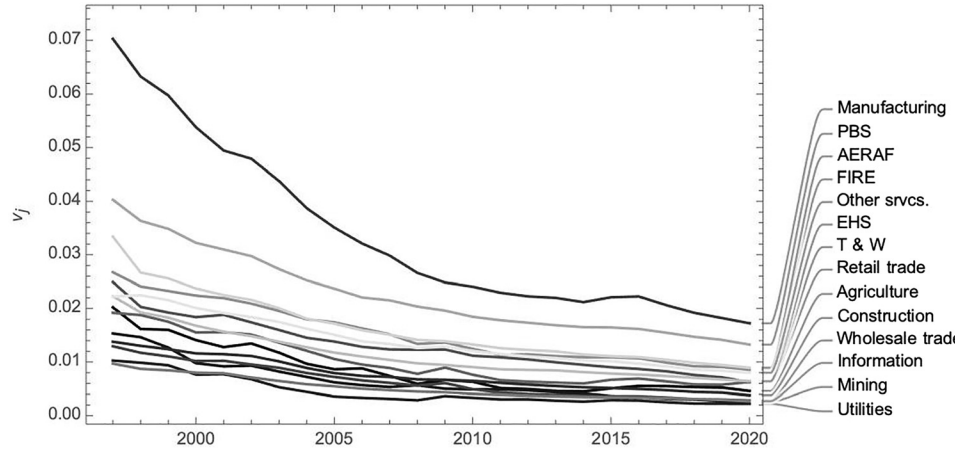

Fig. 1. Decreasing labour content of commodities

A central argument of Marx (1976) is that the onward march of technological progress will persistently introduce new techniques of production that reduce the labour requirements of production. This is the *law of decreasing labour content* (LDLC) originally formulated by Farjoun – Machover (1983) within their probabilistic approach and recently formalised by Flaschel et al. (2013) and Cogliano et al. (2018) in a deterministic setting. Figure 1 shows the downward trend of labour content of commodities by plotting v_j for all $j = 1, \ldots, 14$ listed in Table 1, while Figure 2 illustrates the dramatic *cumulative* impact of the LDLC.

Figures 1 and 2 present an arguably crucial stylised fact about the US economy, and confirm empirically the relevance of the LDLC. Two questions immediately arise. What are the

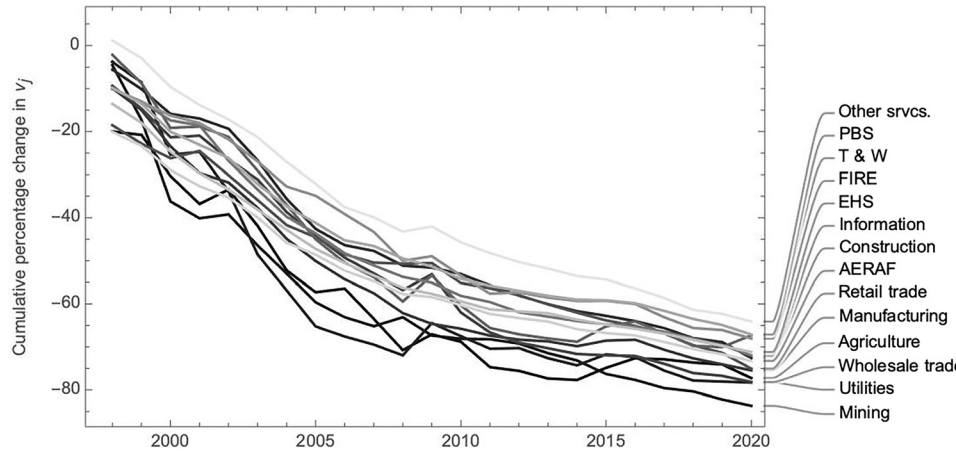

Fig. 2. Cumulative percentage change in the labour content of commodities

mechanisms underlying the long-run dynamics of labour content? And can this phenomenon not be explained also in the standard neoclassical approach?

As for the former question, Flaschel et al. (2013) and Cogliano et al. (2018) use a classical-Marxian framework to analyse the relation between technical change, distribution, and labour content. They demonstrate that *sectoral* cost-reducing innovations that substitute fixed capital for labour tend to reduce labour content in *all* sectors, and increase the economy's net production possibilities, even if no stringent assumption is made concerning the effect of technical change on the matrix of intermediate inputs A.[6] The proof that profitable fixed-capital-using labour-saving innovations increase consumption and investment opportunities has relevant implications for the LDLC and the understanding of capitalist economies. For it derives a systematic relationship between certain forms of technical change, profit maximising behaviour, and labour values.

Empirically, one may conjecture that distributive conflict and increasing wages have historically introduced a bias in the direction of technical change towards fixed-capital-using labour-saving changes which may partly explain the secular increase in labour productivity observed in capitalist economies. Theoretically, one may construct a plausible scenario in which class conflict leads to wage increases which in turn induce fixed-capital-using labour-saving innovations, and so a decrease in labour content. This argument may provide microfoundations to the LDLC.

As for the second question, the answer is negative because conventional productivity measures (see e.g., OECD 2001; BLS 2008) focus not on labour content but rather on real GDP per unit of labour, or on some notion of 'real value added' per unit of labour, in order to measure the performance of (different sectors of) the economy. In principle, this is not problematic: the LDLC is not self-evidently relevant for understanding trends in labour productivity. If the conventional measures properly captured labour productivity, then one could argue that the notion of labour content, the LDLC, and the evidence in Figures 1 and 2 are either misleading or at best redundant.

The problem is that the conventional measures do *not* properly capture labour productivity. Flaschel et al. (2013) and Cogliano et al. (2018) formalise a reasonable property that all productivity indices should satisfy: namely, labour productivity at t in the production of good i can be said to have increased relative to the base period, if a unit increase of the net product of good i demands less labour than in the base period. This is a weak restriction and it incorporates the key intuitions behind the main productivity measures in the literature. Yet while classical-Marxian indices satisfy it, conventional measures do not. Indeed, Flaschel et al. (2013) and Cogliano et al. (2018) prove that the conventional measures identify an increase in labour productivity even when the production possibility frontier of an economy shifts inwards, leading to an unambiguous reduction of the set of feasible production activities.[7]

The intuition behind these results is that the Marxian indices π_j^m depend only on technological data describing the input-output structure of the economy, whereas conventional

[6]Yet *profitable* fixed-capital-using labour-saving innovations do not fully exploit the potential of technical progress to increase labor productivity. For there exist feasible technologies that are not profitable, and thus will not be adopted by capitalists, which would yield social welfare improvements by increasing net production possibilities.

[7]See, e.g., Propositions 4 and 5 in Flaschel et al. (2013).

productivity measures *definitionally* depend on prices and final demand and bear only an indirect relation with production conditions. This is particularly evident for productivity measures based on value added which is "not an immediately plausible measure of output: contrary to gross output, there is no physical quantity that corresponds to a volume measure of value-added" (Schreyer 2001: 41). Of course, empirically, an inevitable degree of aggregation makes it difficult to collect pure quantity data for *any* productivity measures but the difficulties highlighted by Flaschel et al. (2013) and Cogliano et al. (2018) hold at the theoretical level, and even if all issues related to data collection are abstracted away.

To be sure, one may object that these results, which rely on axiomatic analysis, are largely flukes: they illustrate theoretically conceivable but empirically irrelevant special cases of no practical import. In all empirically plausible scenarios, the objection goes, the conventional measures work just fine and the classical-Marxian indices do not add much. The rest of this section shows that this objection is unwarranted. The two sets of measures are indeed different and therefore focusing on conventional measures may be rather misleading.

Conventional measures of labour productivity π_j^c can be derived from the same IO, GDP by Industry, and employment data we use to estimate labour values. Let Y_j be the total value added by an industry j available in the BEA's IO data deflated by value added price indices from the BEA's GDP by Industry data.[8] Conventional labour productivity at the industry-level is then: $\pi_j^c = Y_j/L_j$. Figures 3 and 4 compare our alternative measure of labour productivity $\pi_j^m = 1/v_j$ to the conventional measure π_j^c from 1997 to 2020.

The overarching trend in Figures 3 and 4 is for π_j^m to increase over time. The figures also show how different the two measures of labour productivity can be from one another. Figure 3, for instance, shows large differences between π_j^c and π_j^m for Mining, Manufacturing, Construction, and both Wholesale and Retail trade, with differences for Agriculture, Utilities, and Transportation and warehousing that are significant in some years. Figure 4 shows similar differences for the FIRE industries, PBS, EHS, AERAF, and Other services, while the difference between productivity measures grows over time for the Information industry.[9]

Perhaps more strikingly, Figures 3 and 4 also show that the two measures of labour productivity can even move in opposite directions over some years, and that they can trend in

[8]Value added price index numbers from the BEA (2017) are constructed using a double deflation method. For more on the use of double deflation in comparing conventional and Marxian productivity measures see Flaschel et al. (2013).

[9]Note that no distinction between productive and unproductive labour is made in our estimation of labour values. This distinction, which is common in classical-Marxian analyses, means that the activities undertaken by industries directly involved in producing goods are viewed as creating value, while others involved in the circulation of goods or provisioning liquidity for the economy, i.e., the FIRE industries, are not viewed as value-creating (see Basu – Foley (2013); Foley (2013); Mohun (2014); Paitaridis – Tsoulfidis (2012) for examples). Viewing some industries as unproductive implies the conventionally-measured value added of unproductive industries is surplus value created by productive industries and realised by unproductive industries (Cogliano 2018). The differences between labour productivity measures for industries shown in Figures 3 and 4 can be seen as capturing some of these differences in value creation and realisation.

The terminology "unproductive" is unfortunate given the connotations associated with the term. The terminology originates in Smith (2000) and is carried through the Classicals and Marx, and is not meant to imply judgement about the merits of different types of labour. The Classicals and Marx used this as analytical distinction to try to trace out what they viewed as the sources of value creation. While some types of labour might be unproductive, from their perspective, this labour is still socially necessary for economies to function.

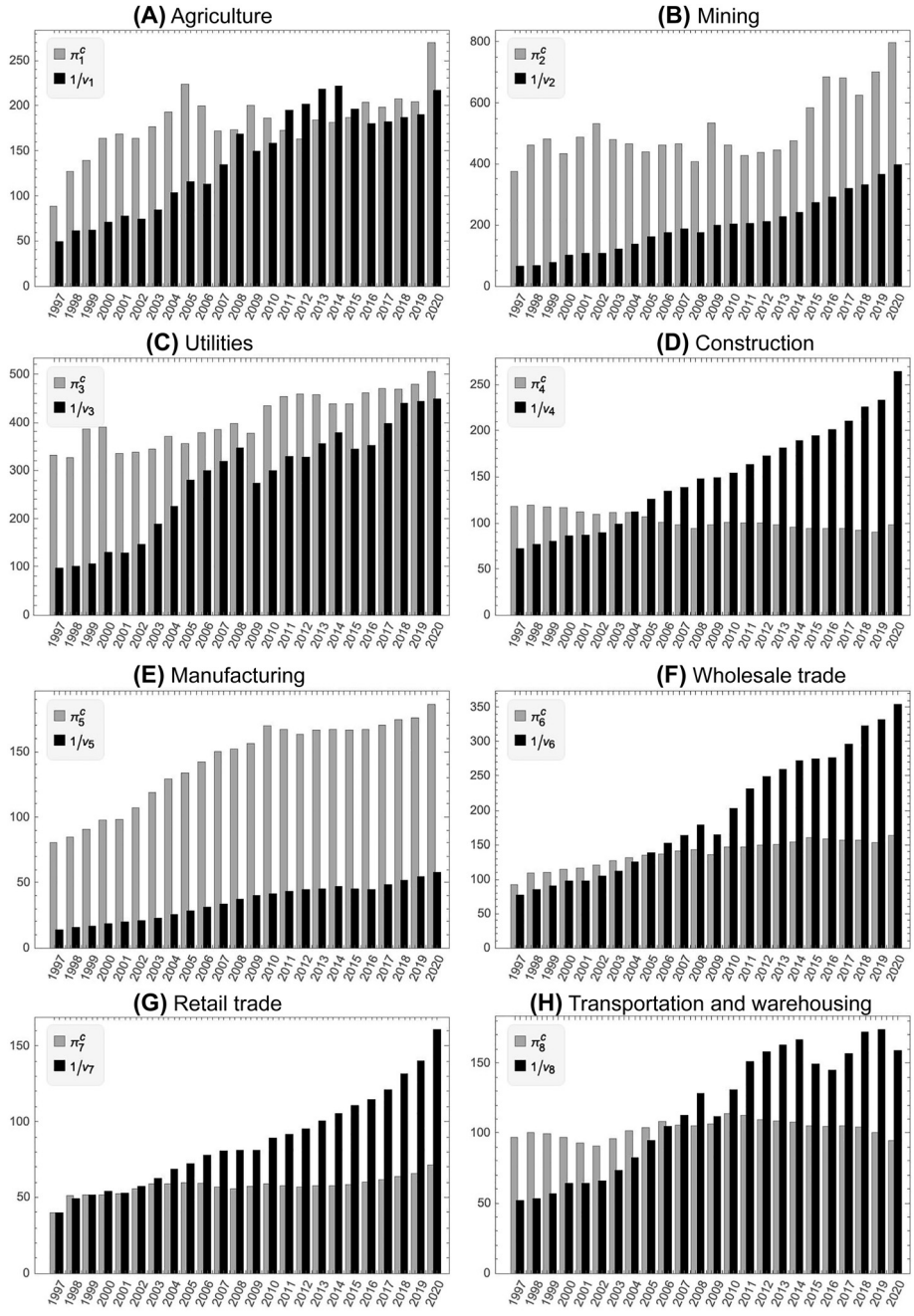

Fig. 3. Labour values and standard labour productivity

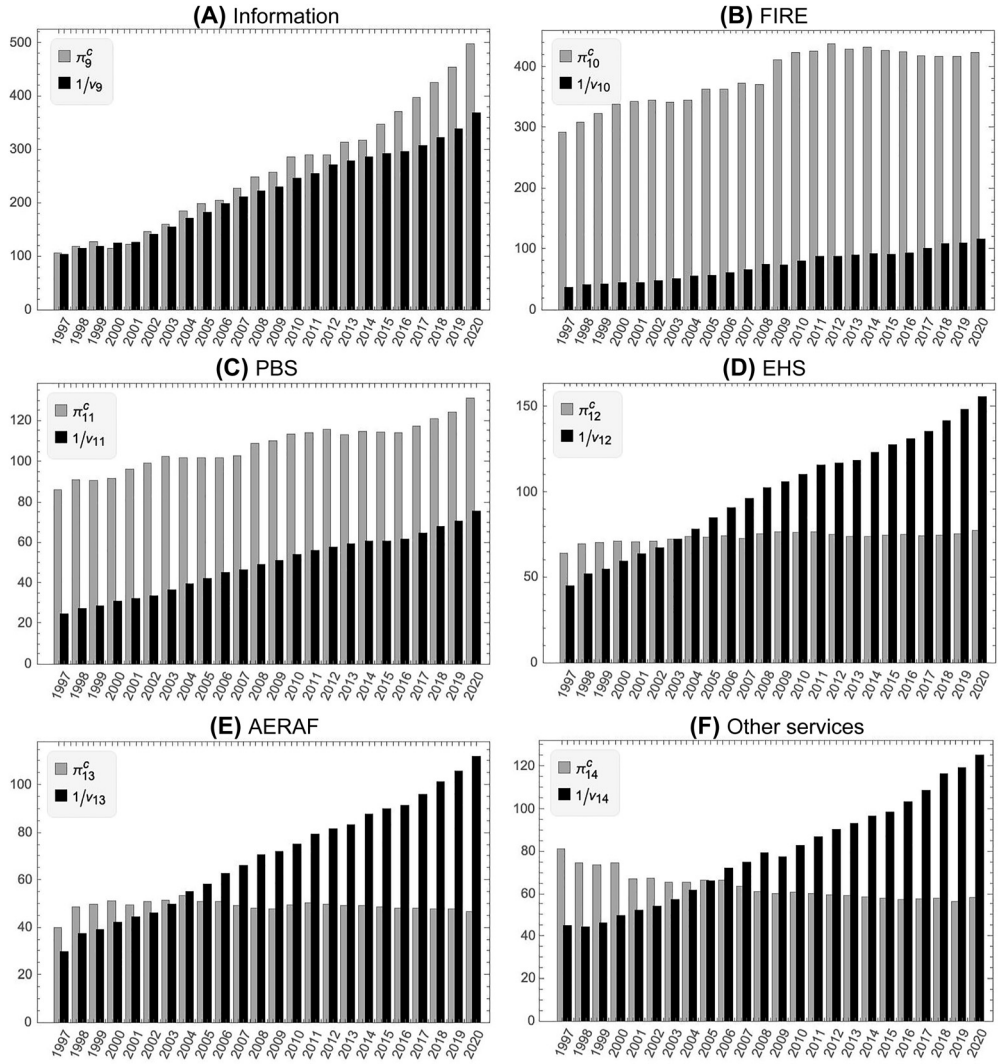

Fig. 4. Labour values and standard labour productivity, contd.

opposite directions over the available time series. The Agriculture, Utilities, and Transportation and warehousing industries, for instance, have notable examples where π_j^m and π_j^c move in opposite directions in some years. For Agriculture the two measures move in opposite directions in multiple years from 2008 to 2014, similar opposite movements take place from 2011 to 2012 and from 2013 to 2014 for Utilities, and opposite movements occur in several years for Transportation and warehousing. In the case of the Construction, AERAF, and Other services industries, π_j^m and π_j^c have different trends over the available time series, and while π_j^c is relatively flat for the EHS industry over time, π_j^m has a strong upward trend.

In summary, we can conclude that the theoretical differences between the two measures do give rise to significant empirical discrepancies. The standard SNA indices of labour productivity lack theoretical foundations, as shown by Flaschel et al. (2013) and Cogliano et al. (2018), and they can also be very misleading in empirical analysis, as the evidence in Figures 3 and 4 forcefully shows. In contrast, labour values provide the foundations for a theoretically robust and empirically relevant approach to the measurement of labour productivity, and to explore its relation with distribution and innovations.

3. LABOUR VALUES AND EXPLOITATION

In the previous section, we have defended a *descriptive* interpretation of the LTV arguing that labour values are relevant to measure and understand some important characteristics of capitalist economies – such as the dynamics of productivity and profitability, or the implications of technical progress – that are not immediately visible by focusing on monetary magnitudes, and market variables. Labour values are uniquely suited to capture the amount of labour socially necessary to produce commodities.

In this section, we build on this conclusion, in order to defend a *normative* interpretation of the LTV, which revolves around the idea that human labour is central in our normative intuitions concerning fair distribution. To be precise, labour values play a key role in Marxian exploitation theory, interpreted as a normative theory providing the conceptual tools for the indictment of capitalist relations of production.

At the most general level, *A* exploits *B* if and only if *A* takes unfair advantage of *B*. In other words, exploitative relations entail both a form of maldistribution and a structural, or procedural, unfairness in the relationship between *A* and *B* that allows *A* to take advantage of *B*. In Marxian exploitation theory, the structural element of exploitative relations is related to the unequal bargaining power afforded to some agents (capitalists) by their monopoly in the ownership of productive assets. Human labour is instead the exploitation numéraire, the unit of account of exploitative relations, and labour values play a key role precisely in deriving labour accounts and detecting the origin and direction of maldistribution. To be specific, exploitative relations are characterised by systematic differences between the amount of labour that individuals 'give' to the economy, in some relevant sense, and the amount of labour that they 'receive', in some relevant sense.

Both building blocks of Marxian exploitation theory set it apart from alternative theories of exploitation, not to mention liberal theories of distributive justice more generally.[10] On the one hand, Marxian exploitation theory goes beyond the mere distributive focus of standard theories of justice in the Rawlsian vein. Procedural fairness plays a key role, and unlike in theories of equality of opportunity, for example, asymmetries in bargaining power are objectionable even if the underlying differential ownership of productive assets is not tainted by past injustices. A capitalist economy characterised by massive wealth inequalities remains morally suspect even if wealth is not accumulated by means of robbery, looting, and plunder, such that "capital comes dripping…from every pore, with blood and dirt" (Marx 1976: 926).

[10]Examples of recent contributions in Marxian exploitation theory can be found in Skillman (1995, 2014, 2017, 2019); Veneziani (2007, 2013); Veneziani – Yoshihara (2010, 2013, 2015a, 2015b, 2017); Yoshihara (2010, 2017).

On the other hand, exploitation theory places a special emphasis on human labour, rather than income, wealth, or utility, as the unit of normative concern. The emphasis on human labour can be justified in two different ways.

First, as a prominent *critic* of Marxist economics put it, "Although I am no admirer of Karl Marx, it has to be admitted that he put his finger on all the characteristics of a person that seem to be of interest in studying how a society identifies the worthy" (Binmore 1998: 364). More precisely, Ken Binmore goes on to say: "The Marxist labour theory of value is certainly no jewel in the crown of economic thought, but it is nevertheless true that the relative levels of effort required from [agents] in creating a source of surplus must be one of the major parameters requiring attention in determining their worthiness when it comes to splitting the surplus they have jointly created" (Binmore 1998: 364).

In other words, labour and effort expended in production can be taken as measures of 'worthiness' within an approach that requires benefits to be allocated depending on contribution. This is what Veneziani – Yoshihara (2018) have called the *contribution view* of exploitation as the unequal exchange of labour. The contribution view incorporates an important normative intuition: an efficient and exploitation-free allocation coincides with the *proportional solution*, a well-known fair allocation rule whereby every agent's income is proportional to her contribution to the economy (Roemer – Silvestre 1993). Proportionality is a widely held normative principle, whose foundations can be traced back to Aristotle, and it can be justified in terms of the Kantian categorical imperative (Roemer 2019). The contribution principle ('To each according to his contribution') is also one of the principles of justice famously analysed by Marx (1970) in the *Critique of the Gotha Programme*.

Alternatively, one may argue that Marxian exploitation theory captures some inequalities in the distribution of material well-being and free hours that are – at least *prima facie* – of normative relevance (Roemer 1982; Cohen 1995; Fleurbaey 1996). For example, they may be deemed relevant because material well-being and free hours are key determinants of *individual well-being freedom* (Rawls 1971; Sen 1985). But they are also relevant in approaches that link exploitation and the Marxian notion of alienation in production (Buchanan 1982). This is what Veneziani – Yoshihara (2018) have called the *well-being view* of exploitation as the unequal exchange of labour.

Although these normative intuitions seem *prima facie* plausible, the received wisdom is that Marxian exploitation theory does not stand up to rigorous scrutiny, and does not articulate such intuitions in a logically consistent, theoretically sound, and empirically relevant analytical framework. Two major sets of criticisms have been levied against it. First, it is logically flawed and metaphysical: Marx understood exploitation theory as inextricably linked to the LTV as a theory of equilibrium price formation, and to such notions as surplus value, and therefore it stands, or falls, with the latter. Second, and perhaps even more damning, even if it can be formulated in a rigorous, logically consistent way, the concept of exploitation is ultimately unconvincing from a normative perspective, and it does not properly capture socialist and egalitarian commitments. (More on this below.)

These objections have not gone unchallenged, and a comprehensive discussion of the debate around exploitation theory goes well beyond the boundaries of this paper. In the rest of this section, we discuss recent research in exploitation theory that casts significant doubts on both sets of critiques, and that clarifies the role that labour values may have in a normative approach to understand the inequalities that characterise modern economies.

In a series of contributions, Cogliano et al. (2016, 2019, 2021) have adopted computational methods to explore the positive and normative import of the concept of exploitation, and its potential to inform empirical analyses of advanced capitalist economies. The basic model considered in these contributions is a dynamic extension of Roemer's (1982) accumulating economy with one good produced and consumed, and a capital market.[11] Technology is common knowledge and the production set consists of a set of linear Leontief production techniques, as in Section 2.

Agents have identical preferences, they aim to maximise their wealth subject to consuming a certain amount per unit of labour performed, but possess potentially different endowments of labour (including skills or human capital) and physical capital. As production takes time, every agent must be able to lay out in advance the operating costs for the activities it operates. Each agent ν can either use her own capital, or borrow capital on the credit market in order to produce. Alternatively, ν can lend her capital on the market. Agents can borrow or lend at a competitive market rate.

Following Roemer (1982, 1983), Cogliano et al. (2021) analyse the international economy at a *reproducible solution*, namely, at an equilibrium in which every agent optimises, the demands for physical inputs and commodities does not exceed the supply, and the credit market clears.[12] In this context, they argue that focusing on *actual* consumption would be misleading as both poor and rich agents consume the same amount per unit of labour expended but have very different consumption *opportunities*. Thus, the exploitation status of every agent should be defined focusing on an agent's maximum potential consumption given the agent's initial wealth, market prices, and interest rate.

Formally, let c_t^ν and Λ_t^ν denote, respectively, agent ν's potential consumption and the amount of (effective) labour expended in production at t. Let $(p_t,\ r_t)$ be the price vector at a reproducible solution in period t, where p_t is the price of output and r_t is the competitive interest rate. For all agents ν, Cogliano et al. (2016, 2019, 2021) prove that in equilibrium, $c_t^\nu = r_t\omega_{t-1}^\nu + \widehat{w}_t\Lambda_t^\nu$ where ω_{t-1}^ν is the agent's capital endowment at the beginning of period t and $\widehat{w}_t$ is the equilibrium real wage.[13]

Then the following definition generalises Roemer (1982) and identifies exploitation status in terms of an agent's potential consumption.[14]

Definition 1. *Agent ν is exploited at t if and only if $\Lambda_t^\nu > v_t c_t^\nu$; whereas agent ν is an exploiter if and only if $\Lambda_t^\nu < v_t c_t^\nu$.*

Based on this definition, Cogliano et al. (2016, 2019, 2021) generalise the results obtained by Roemer (1982) in his pioneering work and prove that the exploitation status of each agent is determined by her wealth per unit of labour performed: richer agents tend to be exploiters, whereas poorer agents are exploited. Perhaps more importantly for our purposes here, they also derive a measure of exploitation intensity.

[11]Actually, Cogliano et al. (2016, 2019) consider an accumulating economy with a labour market. Because none of our key conclusions depend on which factor market operates, here we shall focus on the model in Cogliano et al. (2021).

[12]In Cogliano et al. (2016, 2019) it is the labour market that clears.

[13]Even though only one factor market operates in the economies considered, the price of the other factor is also determined in equilibrium. In the international context considered below, this is just a version of the factor price equalisation theorem. Formally, at all t, the nominal wage in equilibrium is given by $w_t = \frac{p_t - (1+r_t)p_{t-1}A}{l}$.

[14]Observe that exploitation status is defined in every period t: this reflects a focus on *within period* exploitation. For a discussion of *within period* and *whole life* exploitation, see Veneziani (2007, 2013).

Definition 1 states that exploitation status is determined according to whether $\Lambda_t^\nu \gtrless \nu c_t^\nu$. Therefore, a natural index of the intensity of exploitation of each agent ν in period t is:

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

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

The exploitation index 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 agents need to work more than exploiters in order to secure an analogous standard of living, and the additional labour they contribute to the economy is transferred to the latter.

If agents have identical skills, or human capital, Definition 1 and the index e_t^ν nicely incorporate the key aspects of both the contribution view and the well-being view outlined above. If, instead, agents have heterogeneous skills, then one may argue that a focus on effective labour more appropriately reflects the contribution view, while labour time would be a more appropriate indicator of well-being, and thus represents the amount an agent 'gives' in Definition 1, and at the denominator of e_t^ν. Either way, the theoretical framework developed by Cogliano et al. (2016, 2019, 2021) allows them to rebut the two sets of objections to Marxian exploitation theory.

The first criticism, related to the transformation problem, is immaterial. The validity, and relevance, of the Marxian theory of exploitation does not rest on the assumption that (market or equilibrium) prices are determined by labour values – a point already made by Morishima (1974) and Roemer (1982). Whether one adopts the 'contribution view', or the 'well-being view', human labour is the focus of normative analysis and labour values play a key role in constructing labour accounts and thus detecting exploitative relations, not in determining prices. To be precise, whereas the amount 'given' by agents coincides with the (possibly, effective or skill-adjusted) labour they expended in productive activities, labour values can be used to measure the amount of labour 'received' by agents via the goods they purchase, or via the income that accrues to them. This allows one to construct a logically rigorous approach that can identify the exploitation status of any agents based on empirically observable magnitudes and without assuming any precise relations between (market or equilibrium) prices and labour values.

Contrary to a widespread view, the exploitation index is all but metaphysical: it is entirely based on empirically measurable magnitudes and it can be used to analyse exploitative relations in a number of different contexts. For example, Cogliano et al. (2021) interpret countries as 'agents' in the model, and estimate the distribution of the exploitation intensity index in the international context in 2017, identifying a number of thought-provoking stylised facts. To illustrate the empirical reach, and potential, of exploitation theory, here we replicate their methodology and consider a longer time span.

We use data from the Penn World Table (PWT) (Feenstra et al. 2015) to estimate the distribution of the exploitation index at reproducible solutions in which the world economy is not labour constrained – that is, there is no excess demand for labour – a plausible assumption.[15]

[15]For a thorough description of the estimation procedure, see Cogliano et al. (2021).

We focus on six sample years (1970, 1980, 1990, 2000, 2010, 2019) to get a picture of changes in the structure of international exploitation over time. The Penn estimates of nations' capital stock at current PPPs (millions of 2017 U.S. dollars) are taken as ω_{t-1}^{ν} for each country ν and data on population and average human capital attainment are used to determine effective labour capacities (or endowments of human capital).[16] Countries for which there are no estimates of the capital stock or average human capital attainment are removed from the analysis, leaving $N = 128$ for 1970 and 1980 and $N = 144$ for each of the remaining years.[17] As for technology, we fix the technology and set: $A = 0.75$, and $L = 0.5$, thus $\nu = 2$. These values are chosen so the economy is not labour constrained and ensure a reasonable value of the equilibrium interest rate r_t, but our key insights are robust to different choices of parameters. Based on the actual distribution of endowments, we compute the general equilibrium of the economy in the six different years.

Figure 5 shows the exploitation intensity index e_t^{ν} and per capita wealth across countries in 1970, 1980, 1990, 2000, 2010, and 2019. The horizontal dashed line in each panel shows the threshold where a country would be neither an exploiter nor exploited. Countries above this line are exploited and those below are exploiters. Figures 6 and 7 provide a closer look at the exploited and exploiter groups of countries in each year.

Some general features should be noted. First, in each year, there is a very strong negative relation between capital endowments and exploitation. To be precise, there is a strong relation between wealth and exploitation *status*: countries with high (resp. low) levels of wealth per capita tend to be exploiters (exploited). Assuming wealth per capita to be a proxy of a country's level of development, this seems to confirm the Marxian theory of international relations whereby advanced countries in the core exploit poorer countries in the periphery.

But the data suggest that there is also a strong, negative relation between wealth per capita and exploitation *intensity*: the lower the wealth per capita of a nation the more exploited it is, and vice versa countries with higher wealth per capita tend to be on the high end of the exploitation spectrum.

Second, setting clear outliers aside, there seems to be a surprising level of stability in the dispersion of the exploitation intensity index. The exploitation status of certain countries may change over time but the structure of international relations as a whole does not appear to become more just over time. Contrary to the standard neoclassical growth model, there appears to be no tendency towards convergence over the past half century, and a clear division between exploiters and exploited countries seems to persist.

Third, looking at individual countries, with few exceptions the overall picture seems consistent with intuition. Countries placed at the core of the global economy are consistently among the main exploiters, with countries playing a central role in the financial system gaining prominence especially in the last three decades. Countries relegated to the periphery of the

[16] In the PWT, 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 is based on average years of schooling, provided by Barro – Lee (2013), and assumptions about the rate of return to education from Psacharopoulos (1994). The values of the countries' endowments of human capital 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 in order to rule out excess labour demand. This is somewhat arbitrary but it does not affect the position of any country relative to the others in terms of effective labour capacity.

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

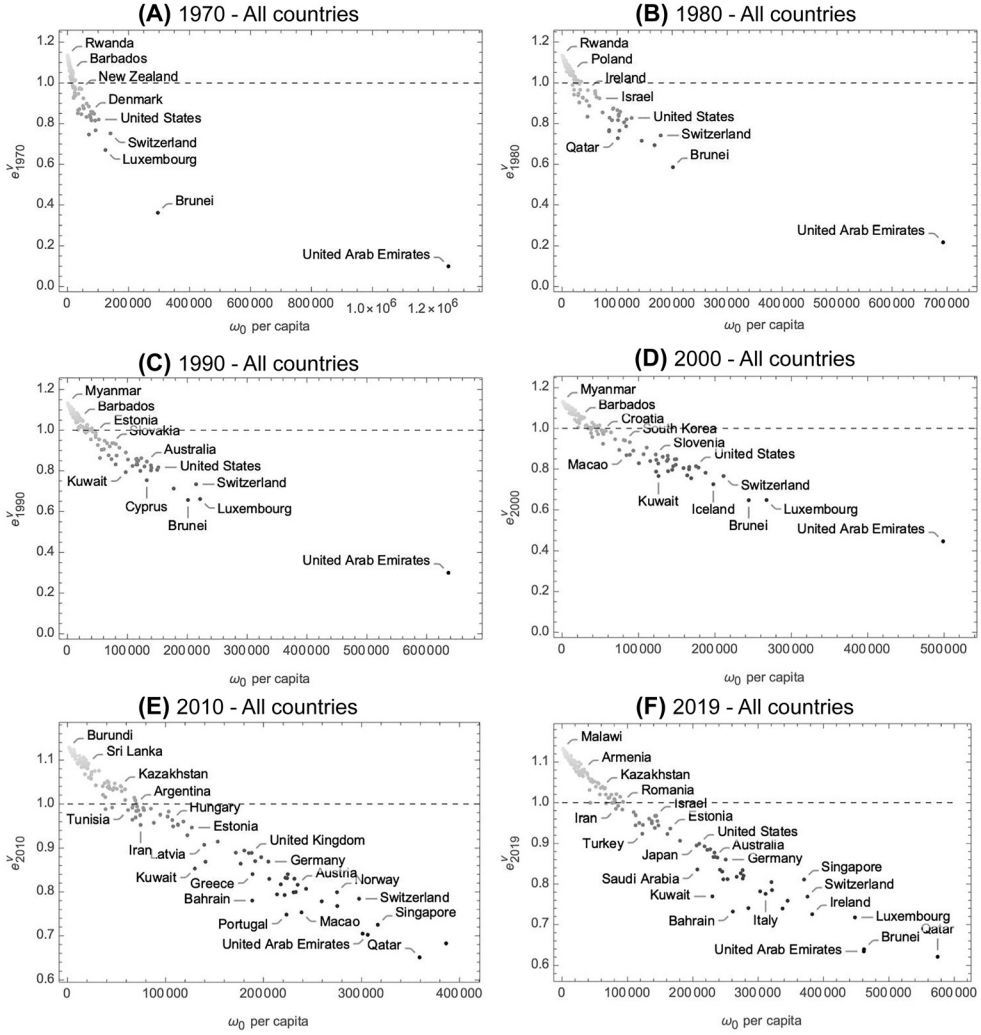

Fig. 5. Exploitation intensity e^{ν}_{t} by country

global economy, especially in Africa, Central and Latin America, and South Asia, populate the group of exploited nations throughout the period.

An interesting case is that of the countries of the former socialist bloc. The difference in the number of available countries from 1970 and 1980 to 1990 onward is mostly due to the inclusion of formerly socialist countries in the PWT data. In the subset of the PWT data we use, which includes estimates of average human capital attainment, all of the new countries appearing as we shift from 1980 to 1990 are former socialist countries. The former socialist countries are: Armenia, Croatia, Czech Republic, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Ukraine, and Yemen. Croatia, the Czech Republic, Latvia, Russia, Slovakia, and Slovenia maintain consistent exploiter status with $e^{\nu}_{t} < 1$ for 1990, 2000, 2010, and

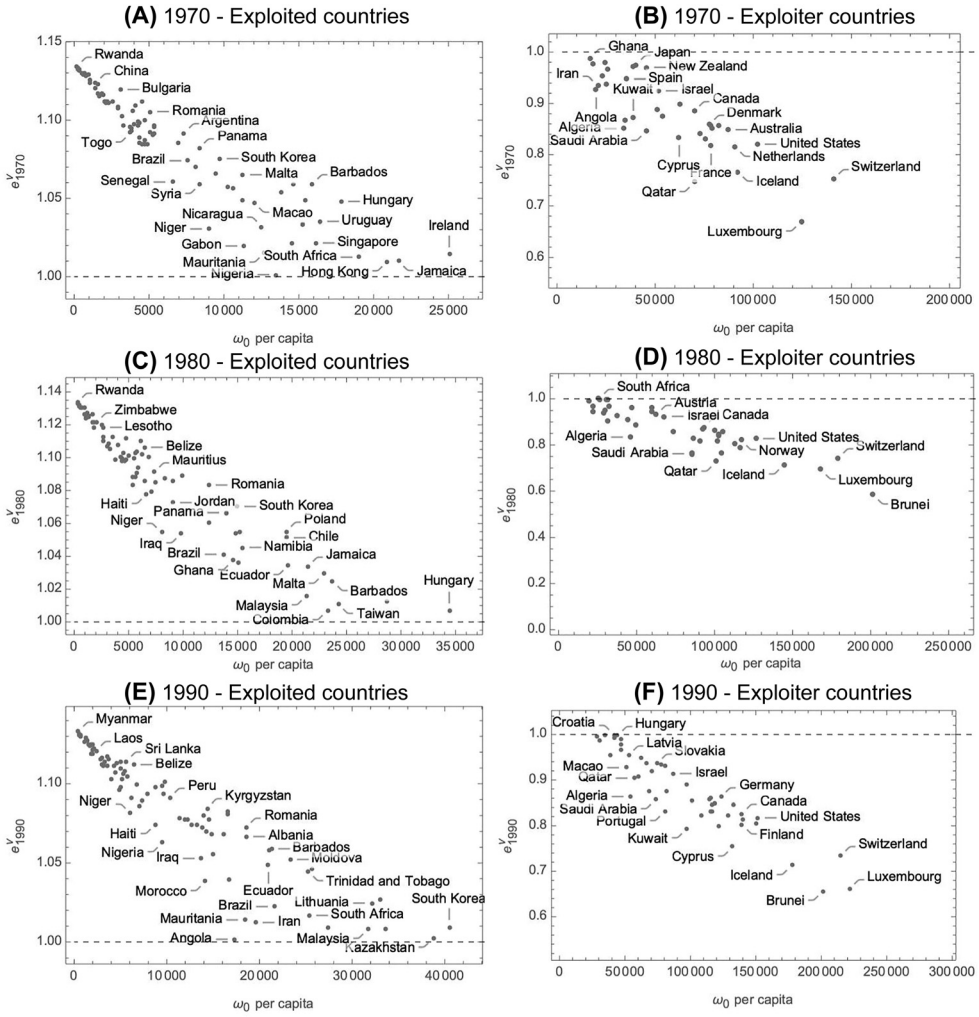

Fig. 6. Exploited and exploiter countries

***Note*: Panels showing exploiter countries exclude the United Arab Emirates (UAE) as an outlier for 1970, 1980, and 1990. This is purely for expositional purposes to show a wider range of exploiter countries. The exploitation intensity of the UAE in relation to other countries can be seen in Fig. 5.**

2019. Armenia, Kazakhstan, Kyrgyzstan, Moldova, and Tajikistan are exploited in all of 1990, 2000, 2010, and 2019. Estonia, Lithuania, Serbia, and Ukraine shift between being exploiters and being exploited: Estonia is exploited only in 2000; Lithuania is an exploiter only in 2010 and 2019; Serbia is only exploited in 2019; and Ukraine is exploited only in 2010.

More complete results on countries' exploitation intensity are shown in Tables A1 and A2 in the Appendix, which list countries alphabetically. They show, respectively, countries that are exploited and those that are exploiters in 2019.

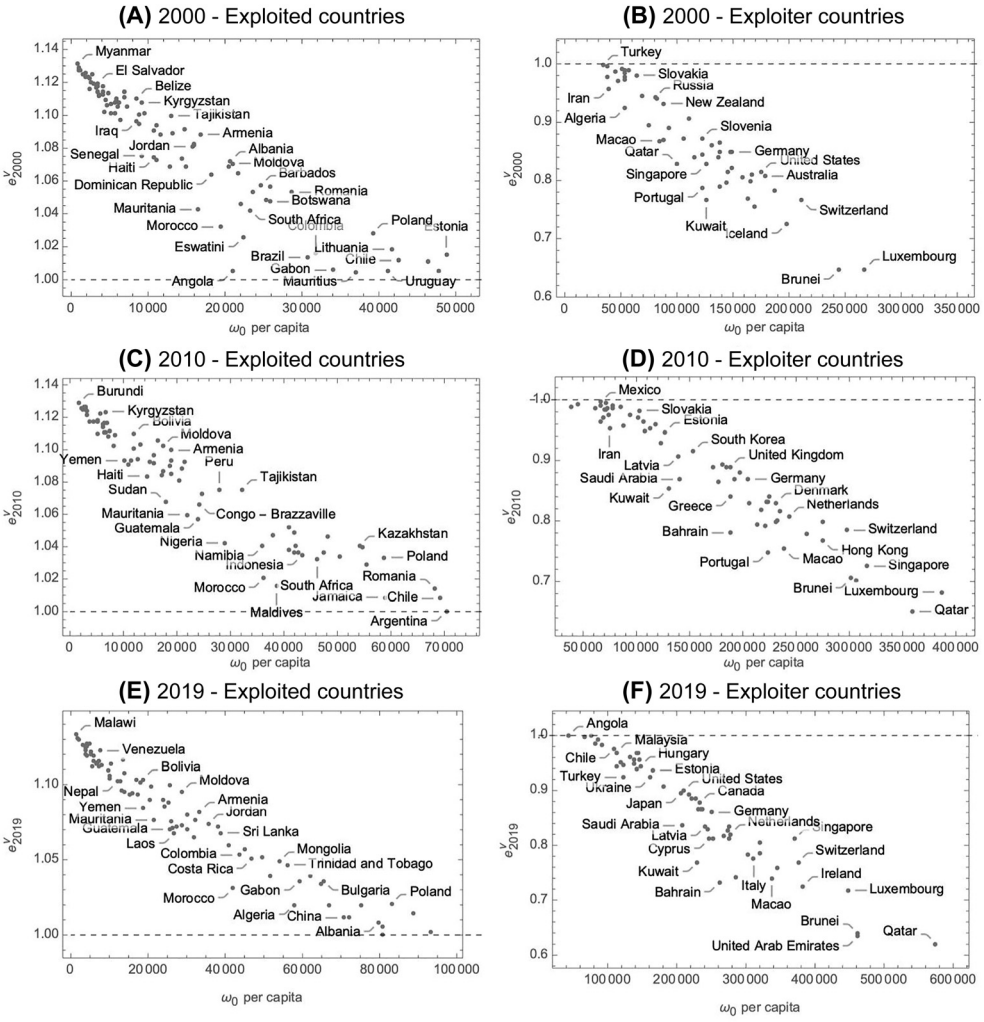

Fig. 7. Exploited and exploiter countries, contd.
Note: Panels showing exploiter countries exclude the United Arab Emirates (UAE) as an outlier for 2000. This is purely for expositional purposes to show a wider range of exploiter countries. The exploitation intensity of the UAE in relation to other countries can be seen in Fig. 5.

To be sure, this brief discussion does not provide a comprehensive empirical description of the global economy, and eyeballing the data does not substitute for proper econometric analysis. Hopefully, however, it should convincingly show that a rigorous definition of labour values can be used to develop a distinctive Marxist normative approach to examine various injustices that characterise modern economies in a way that is empirically meaningful and consistent with widespread normative intuitions.

Providing a convincing rebuttal of the first criticism, and showing that the notion of exploitation is neither logically inconsistent nor metaphysical, does not mean that Marxian exploitation theory offers a satisfactory normative approach. Some critics have argued that the focus on labour is rather partial and does not capture many other aspects of social and economic reality that are important for individuals. While this criticism is not groundless, it is also true that all other measures of well-being commonly used in the literature suffer from similar shortcomings, and the debate on the appropriate distribuendum is far from settled.

More importantly, other authors have argued that the very normative foundations of exploitation theory are shaky, the concept of exploitation is not normatively meaningful, and the elimination of capitalist exploitation does not necessarily lead to a just society. According to Roemer (1982, 2008), an exploitation-free allocation requires income to be allocated in proportion to labour contributed and, in the presence of heterogeneous skills, this implies an unequal income distribution – a phenomenon that Roemer has dubbed 'socialist' exploitation. Actually, using a simple model of the U.S. economy, Roemer (2008) has shown that, rather surprisingly, the elimination of exploitation would lead to *higher* income inequality than was actually experienced in the United States. This is an unpalatable conclusion for socialists and egalitarians, especially if skills are inherited and not acquired.

Cogliano et al. (2019) develop a computational analysis of their model in order to assess this conclusion and evaluate the normative implications of exploitation theory.[18] They assume that initial aggregate capital mimics the empirical wealth distribution for the U.S. and calibrate the distribution of skills in relation to wealth, such that the initial income distribution is close to the empirical one in the U.S. Then, they analyse the dynamics of the economy computationally, and trace the behaviour of the distributive variables over time.

They derive two main sets of results. First, the analysis of the distribution of the exploitation index yields distinctive insights on the injustices that characterise advanced economies and on the effects of redistributive policies. The simulations confirm that exploitation, income inequality, and wealth inequality provide rather different normative insights, and socialists and egalitarians may face trade-offs when implementing alternative policies. Second, Roemer's (2008) negative conclusions are significantly qualified. Roemer's (2008) result showing income inequalities persisting in the socialist allocation critically depends on his specific modelling framework, including his assumptions on preferences, technology and – crucially – the distribution of skills. Under a range of more realistic assumptions on the skill distribution, income and wealth inequalities in the socialist allocation are nowhere close to the values in Roemer (2008). The *static* trade-offs are much less severe than he suggested.

Further, as Roemer (2008: 24) himself notes, even granting that "the socialist allocation, given the distribution of skills in the United States today, would bring with it a relatively high degree of income inequality,…[one may object that] under socialism, that distribution of skills would change". Indeed, if a very limited form of wealth taxation à la Piketty is introduced, and a fraction of the revenues from wealth taxation are devoted to education and the growth of skills, Cogliano et al. (2019) show that, *dynamically*, the trade-off becomes less severe over time and can be led to vanish in the long run. Socialists and egalitarians may not face a major conundrum after all.

[18]Computational methods have a wide range of applications in classical-Marxian economics. The use of these methods in classical-Marxian economics is a growing, and potentially quite fruitful, practice. Recent contributions in this area are surveyed by Cogliano et al. (2022).

4. CONCLUSIONS

Labour values do not enjoy a stellar reputation among economists of either the mainstream or the heterodox variety. Conventional wisdom has it that Marxian value theory, and labour values themselves, are logically inconsistent, theoretically shaky, and empirically irrelevant. In this paper, we have discussed recent research showing that this conclusion is not warranted. While past debates have definitively proved that labour values, or employment multipliers, cannot be used to explain equilibrium prices, a sound, empirically oriented Marxian approach can be built which assigns a central role to labour values.

To be specific, we have defended a *descriptive* interpretation of labour values, which can be used to understand certain fundamental laws of capitalist economies. Marxian labour values provide the foundations for a rigorous measurement of labour productivity at both the sectoral and the aggregate level, and they can be used to understand the relation between profitability, technical progress, and accumulation.

We have argued that labour values can also be used to construct *normatively* interesting indices capturing either certain inequalities in well-being freedom, or the amount of labour that individual agents receive from their economic activities, within an approach that emphasises the proportionality between contribution and reward.

To be sure, we have not provided a full-fledged alternative to mainstream microeconomic theory, nor – more modestly – do we presume to have rebutted all possible criticisms against labour values, or exploitation theory. Nonetheless, we think that the news of the death of Marxian economics is greatly exaggerated and, as concerns the specific role that labour values may play in positive or normative economics, the jury is definitely still out.

ACKNOWLEDGEMENT

This paper builds on our long-term collaboration with Peter Flaschel. Shortly after we started working on it, however, Peter passed away. This paper is dedicated to his memory. The usual disclaimer applies.

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APPENDIX

Table A1. Exploitation intensity – Exploited countries, 2019

	1970	1980	1990	2000	2010	2019		1970	1980	1990	2000	2010	2019
Albania	1.0491	1.0540	1.0667	1.0722	1.0289	1.0085	Lesotho	1.1232	1.1184	1.1160	1.1103	1.1005	1.0963
Algeria	0.8515	0.8342	0.8635	0.9245	0.9646	1.0199	Liberia	1.0849	1.0978	1.1114	1.1227	1.1259	1.1218
Argentina	1.0918	1.0888	1.0583	0.9782	1.0001	1.0194	Madagascar	1.1160	1.1214	1.1251	1.1192	1.1172	1.1247
Armenia			1.0828	1.0885	1.0996	1.0820	Malawi	1.1297	1.1253	1.1236	1.1236	1.1262	1.1329
Bangladesh	1.1244	1.1246	1.1220	1.1178	1.1092	1.0936	Mali	1.1328	1.1314	1.1297	1.1247	1.1246	1.1222
Belize	1.1119	1.1063	1.1121	1.1104	1.1061	1.0998	Mauritania	1.0153	0.9901	1.0139	1.0425	1.0599	1.0764
Benin	1.1118	1.1100	1.1115	1.1009	1.1105	1.1159	Moldova			1.0522	1.0708	1.1021	1.0950
Bolivia	1.0955	1.1032	1.1138	1.1113	1.1097	1.1035	Mongolia	1.0983	1.1002	1.0990	1.0823	1.0343	1.0489
Botswana	1.1122	1.0905	1.0779	1.0474	0.9939	1.0059	Morocco	1.1123	1.1057	1.0384	1.0319	1.0206	1.0310
Brazil	1.0741	1.0412	1.0224	1.0134	0.9911	1.0342	Mozambique	1.1289	1.1260	1.1263	1.1277	1.1257	1.1199
Bulgaria	1.1197	1.1103	1.1016	1.0917	1.0466	1.0360	Myanmar	1.1334	1.1332	1.1332	1.1313	1.1178	1.0938
Burkina Faso	1.1289	1.1241	1.1186	1.1163	1.1174	1.1189	Namibia	1.0572	1.0454	1.0740	1.0737	1.0404	1.0650
Burundi	1.1175	1.1187	1.1186	1.1229	1.1286	1.1302	Nepal	1.1300	1.1267	1.1211	1.1061	1.1085	1.1020
Cambodia	1.0850	1.0983	1.1138	1.1171	1.1142	1.1026	Nicaragua	1.0319	1.0363	1.0551	1.0690	1.0870	1.0902
Cameroon	1.1028	1.1007	1.1032	1.1054	1.1087	1.1097	Niger	1.0306	1.0545	1.0814	1.1017	1.1097	1.1125
Central African Republic	1.0857	1.0991	1.1120	1.1199	1.1175	1.1138	Nigeria	1.0012	0.9041	1.0630	1.0970	1.0423	1.0947
China	1.1236	1.1203	1.1133	1.0942	1.0472	1.0113	Pakistan	1.1113	1.1128	1.1153	1.1127	1.1115	1.1129
Colombia	0.9677	1.0071	1.0089	1.0156	1.0366	1.0531	Paraguay	1.1060	1.0872	1.0700	1.0459	1.0383	1.0594
Congo - Brazzaville	1.0959	1.0989	1.0992	1.1094	1.0663	1.0715	Peru	1.0996	1.1039	1.0912	1.0687	1.0750	1.0572

(continued)

Table A1. Continued

	1970	1980	1990	2000	2010	2019		1970	1980	1990	2000	2010	2019
Congo - Kinshasa	1.0931	1.0880	1.0859	1.1067	1.1251	1.1265	Philippines	1.0855	1.1017	1.0977	1.0889	1.0883	1.0883
Costa Rica	1.0566	1.0550	1.0685	1.0533	1.0409	1.0504	Poland	1.0587	1.0552	1.0268	1.0283	1.0333	1.0208
Dominican Republic	1.0700	1.0604	1.0738	1.0638	1.0364	1.0120	Romania	1.1056	1.0833	1.0725	1.0531	1.0140	1.0018
Ecuador	1.0337	1.0346	1.0487	1.0488	1.0366	1.0199	Rwanda	1.1342	1.1336	1.1320	1.1293	1.1262	1.1252
Egypt	1.1324	1.1303	1.1251	1.1080	1.0964	1.1012	Senegal	1.0604	1.0833	1.0964	1.0754	1.0912	1.1044
El Salvador	1.1285	1.1269	1.1275	1.1196	1.0922	1.0701	Serbia			0.9771	0.9851	0.9891	1.0142
Eswatini	1.1259	1.1124	1.0935	1.0257	0.9917	1.0718	Sierra Leone	1.1319	1.1323	1.1310	1.1122	1.1240	1.1293
Ethiopia	1.1299	1.1305	1.1304	1.1271	1.1215	1.1155	South Africa	1.0125	0.9998	1.0168	1.0422	1.0319	1.0520
Fiji	1.0967	1.0860	1.0940	1.1015	1.0932	1.0761	Sri Lanka	1.1098	1.1120	1.1142	1.1145	1.0922	1.0680
Gabon	1.0197	0.9396	0.9949	1.0058	0.9747	1.0360	Sudan	1.1108	1.1071	1.1126	1.1129	1.0676	1.1122
Gambia	1.0967	1.0986	1.1032	1.1010	1.1022	1.1203	Syria	1.0591	1.0943	1.1251	1.1252	1.0898	1.0895
Ghana	0.9875	1.0375	1.0783	1.0884	1.0724	1.1078	Tajikistan			1.0807	1.0998	1.0756	1.0725
Guatemala	1.0868	1.0855	1.0898	1.0689	1.0574	1.0702	Tanzania	1.1073	1.0999	1.0910	1.1093	1.0935	1.1148
Haiti	1.0891	1.0777	1.0745	1.0742	1.0838	1.0950	Thailand	1.0907	1.0851	1.0680	0.9718	0.9845	1.0004
Honduras	1.0994	1.0994	1.1047	1.0949	1.0914	1.0856	Togo	1.0920	1.0883	1.1074	1.1187	1.1153	1.1191
India	1.0951	1.1089	1.1161	1.1074	1.0842	1.0760	Trinidad and Tobago	1.0537	1.0123	1.0447	1.0567	0.9292	1.0467
Iraq	1.0846	1.0539	1.0529	1.0965	1.0807	1.0728	Tunisia	1.0886	1.0792	1.0396	0.9769	0.9858	1.0797
Ivory Coast	1.1156	1.1067	1.0977	1.1143	1.1108	1.1059	Uganda	1.1208	1.1245	1.1271	1.1259	1.1164	1.1274
Jamaica	1.0099	1.0338	1.0779	1.0819	1.0087	1.0391	Venezuela	0.9377	0.9123	0.9548	0.9955	0.9576	1.1224
Jordan	1.0969	1.0725	1.0777	1.0810	1.0517	1.0741	Vietnam	1.1294	1.1303	1.1292	1.1178	1.1034	1.0988

(continued)

Table A1. Continued

	1970	1980	1990	2000	2010	2019		1970	1980	1990	2000	2010	2019
Kazakhstan			1.0026	1.0114	1.0407	1.0389	Yemen			1.1307	1.1279	1.0933	1.0842
Kenya	1.0972	1.1028	1.1114	1.1139	1.1167	1.1134	Zambia	1.0926	1.1014	1.1098	1.0904	1.0854	1.1035
Kyrgyzstan			1.0847	1.1078	1.1235	1.1161	Zimbabwe	1.1119	1.1216	1.1169	1.1050	1.1219	1.1271
Laos	1.1169	1.1213	1.1209	1.1141	1.0941	1.0673							

Table A2. Exploitation intensity – Exploiter countries, 2019

	1970	1980	1990	2000	2010	2019		1970	1980	1990	2000	2010	2019
Angola	0.9265	0.9426	1.0017	1.0051	0.9880	0.9994	Luxembourg	0.6702	0.6937	0.6612	0.6481	0.6826	0.7177
Australia	0.8489	0.8585	0.8459	0.8073	0.8700	0.8670	Macao	1.0470	0.9662	0.9271	0.8684	0.7534	0.7395
Austria	0.9716	0.9305	0.8216	0.8048	0.8163	0.7850	Malaysia	1.0218	1.0161	1.0082	0.9724	0.9907	0.9693
Bahrain	0.8666	0.8875	0.9063	0.8703	0.7803	0.7321	Maldives	1.1291	1.1262	1.1059	1.0725	1.0154	0.9447
Barbados	1.0592	1.0248	1.0590	1.0576	0.9857	0.9505	Malta	1.0651	1.0293	0.9921	0.9466	0.9493	0.9382
Belgium	0.8303	0.8173	0.8304	0.8144	0.7784	0.7818	Mauritius	1.0918	1.0912	1.0722	1.0047	0.9837	0.9992
Brunei	0.3612	0.5854	0.6567	0.6471	0.7049	0.6391	Mexico	0.9787	0.9995	0.9974	0.9875	0.9963	0.9921
Canada	0.8849	0.8756	0.8268	0.8480	0.8943	0.8773	Netherlands	0.8155	0.8381	0.8459	0.8401	0.8071	0.8204
Chile	1.0489	1.0514	1.0464	1.0116	1.0080	0.9762	New Zealand	0.9700	0.9596	0.9319	0.9324	0.9525	0.9550
Croatia			0.9995	0.9892	0.9540	0.9550	Norway	0.8579	0.8210	0.8048	0.8103	0.7993	0.8047
Cyprus	0.8331	0.7655	0.7539	0.7895	0.7944	0.8116	Panama	1.0821	1.0666	1.0802	1.0645	1.0488	0.9457
Czech Republic			0.8575	0.8658	0.8885	0.8843	Portugal	0.9526	0.9269	0.8317	0.7877	0.7483	0.7406
Denmark	0.8584	0.8455	0.8503	0.8486	0.8300	0.8345	Qatar	0.7466	0.7279	0.9039	0.8287	0.6508	0.6207
Estonia			0.9892	1.0152	0.9467	0.9367	Russia			0.8558	0.9426	0.9715	0.9608
Finland	0.8422	0.8061	0.8023	0.8213	0.8322	0.8665	Saudi Arabia	0.8466	0.7621	0.8577	0.8943	0.8687	0.8359
France	0.8166	0.7871	0.8309	0.8453	0.8173	0.8177	Singapore	1.0216	0.9286	0.8765	0.8275	0.7251	0.8111
Germany	0.8575	0.8662	0.8624	0.8490	0.8691	0.8602	Slovakia			0.9364	0.9806	0.9825	0.9676
Greece	0.8873	0.8168	0.8239	0.7966	0.8406	0.8305	Slovenia			0.8905	0.8720	0.8894	0.8653
Hong Kong	1.0097	0.9990	0.9205	0.7550	0.7677	0.7588	South Korea	1.0754	1.0702	1.0095	0.9405	0.9147	0.8928
Hungary	1.0480	1.0071	0.9972	1.0055	0.9638	0.9443	Spain	0.9477	0.8551	0.8754	0.8396	0.7928	0.8120
Iceland	0.7670	0.7154	0.7131	0.7255	0.8297	0.8135	Sweden	0.8514	0.8440	0.8146	0.7992	0.8313	0.8265

(continued)

Table A2. Continued

	1970	1980	1990	2000	2010	2019		1970	1980	1990	2000	2010	2019
Indonesia	1.1085	1.1075	1.1083	1.1005	1.0346	0.9983	Switzerland	0.7521	0.7419	0.7340	0.7658	0.7844	0.7689
Iran	0.9340	0.9662	1.0123	0.9581	0.9528	0.9847	Taiwan	1.0661	1.0109	0.9658	0.8909	0.8644	0.9067
Ireland	1.0143	0.9645	0.9361	0.8732	0.7997	0.7256	Turkey	0.9775	0.9478	0.9882	0.9985	0.9695	0.9239
Israel	0.9248	0.9242	0.9139	0.8603	0.9604	0.9677	Ukraine			0.9483	0.9880	1.0393	0.9233
Italy	0.8749	0.8287	0.7998	0.7691	0.7991	0.7759	United Arab Emirates	0.0992	0.2172	0.2997	0.4466	0.7023	0.6341
Japan	0.9751	0.8720	0.8595	0.7819	0.8403	0.8949	United Kingdom	0.8987	0.9470	0.9353	0.9056	0.8890	0.8857
Kuwait	0.8717	0.7681	0.7937	0.7658	0.8533	0.7695	United States	0.8204	0.8277	0.8175	0.8141	0.8791	0.8992
Latvia			0.9544	0.9913	0.9073	0.8351	Uruguay	1.0352	0.9953	1.0085	1.0050	0.9852	0.9827
Lithuania			1.0246	1.0184	0.9756	0.9498							