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Working the Waste Commodity Frontier: Metabolic Value and Informal Waste Work

Benjamin Irvine

Department of Geography, Universitat Autònoma de Barcelona, Barcelona, Spain; benjamin.irvine@uab.cat

Abstract: Ambitions for a European "circular economy" imply waste is becoming an important "commodity frontier". Increased recycling in Europe has been accompanied by a proliferation of informal waste work. "Southern" geographies of informal recyclers provide resources for interpreting this phenomenon but studies of a commodity frontier in urban waste have tended to focus on moments when informal waste workers are displaced by capital intensive waste management systems. I draw on concepts in world-ecology and materialist ecofeminism to explore the proliferation of informal waste workers in Barcelona and the way their (re)production produces "Metabolic Value". Informal waste work is shown to emerge and persist as part of a commodity frontier process—where the appropriation of unpaid work from non-commodified spaces is the hallmark of how capitalism secures "Cheap Nature". The study suggests that, rather than internalising ecological costs, recycling often rests on the appropriation of value from uncommodified spaces.

Resumen: Las ambiciones de una "economía circular" europea implica que los residuos son una importante "frontera mercantil". Una proliferación del trabajo informal con residuos ha acompañado el aumento del reciclaje en Europa. Las geografías del "sur" sobre los recicladores informales aportan recursos para interpretar este fenómeno, pero suelen enfocarse en cuándo sistemas de gestión intensivos en capital reemplazan la gestión informal. Me baso en conceptos de la ecología-mundo y el ecofeminismo materialista para explorar la proliferación de trabajadores informales de residuos en Barcelona y cómo su (re)producción produce "valor metabólico". Se muestra que el trabajo informal con residuos emerge y persiste como parte de una frontera mercantil, cuya apropiación del trabajo no remunerado de espacios no mercantilizados es el sello distintivo de cómo el capitalismo asegura la "naturaleza barata". En lugar de internalizar los costos ecológicos, el reciclaje se basa frecuentemente en la apropiación de valor de espacios no mercantilizados.

Keywords: waste, informal work, recycling, metabolic value, commodity frontier
Palabras clave: residuos, trabajo informal, reciclaje, valor metabólico, frontera mercantil

Introduction

The "circular economy" is central to European capitalism's attempts to decouple economic growth from mounting ecological damages. Since 2015, the European Commission has been pursuing a circular economy strategy, "where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised" (EC 2015:2). This strategy is

motivated as much by worries about resource scarcity and price volatility as it is about reducing the harms of waste. Recycling, however, costs energy and time—otherwise known as *work* (Georgescu-Roegen 1971). Growth, accumulation and socio-environmental change have been studied as a dynamic, co-constitutive "metabolism" within urban political ecology (Heynen et al. 2006), ecological Marxism (Foster 1999; Moore 2017) and ecological economics (Fischer-Kowalski and Hüttler 1998), where conflicts often unfold at the outer frontiers of extraction and disposal (Martinez-Alier 2009; Temper et al. 2015). The tentative project of a circular economy implies a partial inward "shift" in this metabolism; an extraction frontier increasingly *internal* to world consumption centres, where obtaining nature's "free gifts" becomes mediated through the work of recycling.

Contrary to the EU's circular economy strategy which promises "local jobs at all skills levels and opportunities for social integration and cohesion" (EC 2015:2) are thousands of informal workers—mainly migrants excluded from the formal labour market—collecting recyclable materials for reuse or recycling in the streets of many cities in Europe. The European Public Service Union estimates there are one million "informal recyclers" in Europe, twice as many as the 500,000 formally employed in waste collection (Weghmann 2017). This is an extension of the informal nature of recycling labour globally, as documented by development scholarship (Gutberlet 2008; Medina 2007) and geographies of waste from the global South (Millington and Lawhon 2019). This research has emphasised the contribution of informal waste workers in recycling materials in the relative absence of waste recovery systems and explored their struggles to maintain and improve their livelihoods as capital-intensive waste management systems have been introduced (Rosaldo 2016). Indeed, the rising value of urban waste and increasing exhaustion and resistance at sites of raw materials extraction suggest waste is becoming a "commodity frontier" (Knapp 2016; Labban 2014; Schindler and Demaria 2020). This process is often discussed as evidenced by the dispossession of informal waste workers and enclosure of the "waste commons" they have built (Corwin 2020; Demaria and Schindler 2016; Fahmi 2005; Gidwani 2012; Millington and Lawhon 2019; Samson 2020).

This article follows recent interventions which suggest spaces of informal recycling are a potent entry point into the "wasting processes" (Fredericks 2021) and "constitutive injustices" (Corwin and Gidwani 2021) of the Capitalocene. Gidwani and Maringati's (2016) concept of a "waste-value dialectic" captures the relentless and shifting ways that people, places and things designated as "waste" form the constitutive outsides of capitalist accumulation, renewing its conditions of possibility. Spaces of informal recycling can be seen to be first "effaced", then "enrolled" before being "expunged" again depending on their contingent potential to furnish or obstruct accumulation (Gidwani and Maringanti 2016:125). Whilst Corwin and Gidwani are careful to clarify such "churning" bouts of primitive accumulation are not necessarily a "unidirectional process" (Corwin and Gidwani 2021:4, 16, citing Corwin 2018; Cowan 2021), recent literature seems to presume a certain direction of movement, where a commodity frontier in waste implies the increasing enclosure of spaces of informal recycling. The proliferation of informal waste work in European cities—amidst established integrated waste management

systems and a legislative framework geared towards ambitious recycling targets—complicates this picture. In fact, I suggest it is the persistent informality and devaluation of waste work itself which should be considered the principal expression of a commodity frontier in waste, which—following Jason W. Moore (2015)—depends decisively on bringing larger volumes of the unpaid work of human and extra-human natures into the orbit of capital accumulation without being fully capitalised/commodified.

I illustrate this argument with reference to a case study on informal scrap metal collectors—or *chatarreros*—in Barcelona, Spain. Firstly, I review scholarship on informal waste work and its relation to capital accumulation and a commodity frontier in waste. Secondly, I summarise Moore's theorisation of frontiers and capitalism's logic of "Cheap Nature" and propose to combine it with Ariel Salleh's (2010) characterisation of the way particular spaces of uncommodified labour produce "Metabolic Value". Thirdly, I present the findings of a case study of informal waste workers in Barcelona, who are shown to play a substantial role in cheaply and comprehensively recovering metals through a highly manual and adaptive processes of re/production, supported in turn by global transfers of unpaid reproductive work. The study suggests that the capitalist circular economy which purports to internalise ecological costs remains stubbornly reliant on devalued and unpaid labours.

Informal Waste Work: From Surplus to Indispensable Labour

Waste has proved a rich material for geography in exploring the ecological contradictions of production and the possibilities and limits it presents to the production of space (Gregson and Crang 2015; Millington and Lawhon 2019; Moore 2012). Research on informal waste work, reveals it as an apparent collateral effect of capitalist development, with which it retains close interlinkages, and a fraught locus of struggle within the shifting geography of extraction.

An estimated 15 million people, or one percent of the urban population, earn their living from informal waste work and they are often women, children, elderly, unemployed, and/or migrants (Kaza et al. 2018). Development literature draws attention to the environmental and economic contributions of informal waste workers to urban sanitation—filling a gap in inconsistent or non-existent municipal waste collection systems—and recycling raw materials back into national and international industries (Dias 2016; Medina 2007). Such policy-oriented literature often leaves the historical processes that gave rise to the phenomena underexamined. Medina (2007:48, 254) describes informal waste work as a somewhat mechanistic feedback: an "adaptive response to scarcity" which "conserves natural resources, and supplies low-cost raw materials to industry (improving competitiveness)". Such analyses indicate how such labour may aid or stabilise capital accumulation but remain uncritical of the process.

A specific postcolonial context has produced Southern geographies of informal waste work which can be fruitfully extended, namely the experience of "sizeable populations deemed superfluous to processes of capitalist production and wage

labor" (Millington and Lawhon 2019:1048). Informal waste work in Nigeria, Ghana (Grant and Oteng-Ababio 2012; Nwosu et al. 2016), Senegal (Fredericks 2018), and Argentina (Whitson 2011) can be linked to recession and structural adjustment induced unemployment. Informal waste work must, then, be contextualised within the longstanding situation of global un-and-under-employment resulting from processes of de-peasantisation and the neoliberal structural adjustment programmes implemented between 1978 and 2003 which produced an informal working class concentrated in cities of the global South—amounting to "two-fifths of the economically active population of the developing world" (Davis 2007:176).

Informal waste work is, as Chris Birkbeck (1978:1178) described, "a refuge occupation, which can support people when they have no other opportunities for earning". However, its import surely exceeds its role in sustaining an "industrial reserve army" which produces wage discipline (Marx 1887:444). Birkbeck also called informal recyclers "self-employed proletarians" in an "informal factory" tightly linked to providing valuable inputs to the industrial sector. Marx's (1887:449–450) "stagnant" but—nevertheless— "self-reproducing" part of the relative surplus population is, in fact, a source of vital energy, reproducing life and materials for production.

Research on "global recycling networks" (Gregson and Crang 2015) or "global destruction networks" (McGrath-Champ et al. 2015) has drawn attention to the unique role of highly manual informal labour in turning waste into a valuable commodity again. Value is added in recycling by a fine degree "separation, segregation, and sorting" and capital intensive resource recovery systems in the "global North"—needing to process large volumes rapidly—often produce materials of a low grade which are "exported to other parts of the world for further segregation" in "more labour-intensive operations" (Gregson and Crang 2015:167). This research signals the way capital-intensive processes and high labour costs may fetter recycling, the persistent need for highly manual labour to revalorise materials and the tendency for it to be sourced on the cheap.

The increasing costliness of virgin materials and the rising value of urban waste streams suggest waste is becoming a "commodity frontier" (Schindler and Demaria 2020), within new geographies of extraction in the "flexible" (Knapp 2016) or "planetary" (Labban 2014) mine. Informal waste work might then be seen as a salvaged "commons" vulnerable to enclosure by increasingly capitalised and privatised waste management systems (Fahmi 2005; Gidwani and Chaturvedi 2011; Reddy 2015; Samson 2015). As Vinay Gidwani (2012:283) writes, such processes have disrupted the livelihoods of groups including "the zabbaleen of Cairo, the 'reclaimers' of Johannesburg, and the kabaris of Delhi: urban commoners who have fabricated intricate and ingenious circuits of waste". It is often suggested that "pressures towards capital intensivity" in waste management will continue to displace informal recyclers (Millington and Lawhon 2019:1056). Julia Corwin describes how corporate interests in the "urban mine" of e-waste in India attempt to discursively devalue informal waste work as dangerous and polluting in order to gain access to this resource. They do so, she suggests, because they struggle to compete with informal recycling networks

which are "uniquely efficient at scrap collection" and "able to offer better prices for e-waste" (Corwin 2020:117). Whilst mining and waste management capitals increasingly eye the waste stream the idea that informal recycling systems may be more efficient and environmentally preferable is a common refrain (Demaria and Schindler 2016).

The services rendered by informal waste workers—to cities and in global recycling networks—suggests it is not only when waste streams are enclosed that value is extracted from them. As Gidwani (2013:776) suggests, "We must acknowledge frequent scenarios where commons and the communities that sustain them are relay points in the social life of commodities and, as such, may subsidize and supplement capital accumulation". He has thus called waste work "a permanent border area of primitive accumulation" and a type of "*infra*structural labour", simultaneously invisible and essential, which reproduces what Marx called capital's "general" and "external" conditions of production (Gidwani 2015:577). Rosalind Fredericks (2018, 2021) also refers to informal waste work in Dakar, Senegal as a type of "embodied infrastructure". Her account of how disinvestment in waste management infrastructure "devolved" its functions onto workers' bodies (Fredericks 2018) highlights the way waste work carries a burden that the state and capital, at times, might prefer to liberate themselves from. Documenting a World Bank funded project to "modernise" and "formalise" recycling at the Mbeubeuss landfill in Dakar, she again draws attention to the value "forged" by the toil, expertise and toxic burdens assumed in informal waste work which "return[s] the city's detritus to circuits of value", the disruption of which by modernisation plans represents "a double assault" (Fredericks 2021:2–4, 18). Fredericks illuminates the curious cannibalistic character of the Capitalocene as it "depends on", "contaminates" and further "preys" on the value produced in spaces of informal recycling, but I do not believe we can be so certain that as waste becomes a commodity "frontier"—its recirculation a more pressing condition for accumulation—the overall direction of movement within the "waste-value dialectic" (Gidwani and Maringanti 2016) will necessarily be towards "commodifying the waste commons" (Fredericks 2021:2).

In a series of instructive studies, Samson (2015) describes plans to expel the informal "reclaimers" from a landfill in Johannesburg as a form of "accumulation by dispossession", centred not only on enclosing the *de facto* common resource but an "epistemic dispossession" of the workers' intellectual labour in pioneering a system of materials recovery. Importantly, the city sought to sell rights to extract recyclables to another company for which the reclaimers would then become piece workers, continuing to be paid per weight for recyclables but at a lower rate (Samson 2015:822). Documenting subsequent attempts to "integrate" the reclaimers, Samson (2020) suggests it was the reclaimers who first established the "commodity frontier" which the city then attempted to "seize". She describes the city's bungled attempts at integration, which—steeped in colonial attitudes—disregarded reclaimers' knowledge and applied experimental pilot initiatives, which led to deteriorations in their incomes. The waste commodity frontier cannot, it appears, seem to wean itself from informal work.

Amidst struggles over waste, capitalised systems struggle to compete with informal recycling on cost and efficiency and there is a stubborn reliance on extracting value from informal waste work—even when waste streams are enclosed or informal recyclers are "integrated". What I wish to emphasise is that it is precisely the uncommodified, ecologically benign and efficient character of informal waste work—as well as the web of social reproduction that sustains it—which energises the commodity frontier in waste.

Unpaid Work, Metabolic Value, and Ecological Surplus at the Frontier

> The accumulation of capital is a kind of metabolism between capitalist economy and those pre-capitalist methods of production without which it cannot go on and which, in this light, it corrodes and assimilates. (Luxemburg 2003:397)

The environmental historian Jason W. Moore's study of colonial "frontiers" has led him to a theory of capitalism as not merely a narrow set of economic relations but "*a way of organizing nature*", whose history of expansion, contradictions, struggle, crises and resolutions is "co-produced by human and extra-human natures in the web of life; and cohered by a 'law of value' that is a 'law' of Cheap Nature (Moore 2015:14). For Moore, accumulation is always a frontier process which depends not only on the *exploitation* of wage labour in the production of commodities but to a greater extent on the *appropriation* of the "unpaid work/energy" of both humans and nature outside of—but in service to—commodity production. These appropriations are defined as "those extra-economic processes that identify, secure, and channel unpaid work outside the commodity system into the circuit of capital" (Moore 2015:17).

Particularly influential on Moore is Maria Mies' (1998:77) tracing of the inner connections and "colonizing divisions" which made possible the subordination, devaluation and appropriation of value from "women, nature and colonies", and the way unpaid reproductive work enables minimally commodified Cheap Labour in "socio-ecological relations whose reproduction is relatively autonomous to the circuit of capital" (Moore 2015:147). Moore's focus on the shifting configurations of paid and unpaid work concurs with recent work in geography on the way accumulation unfolds through the "interpenetration of production and social reproduction" (Mezzadri 2021:1200) in gendered, racialised and classed dynamics of migration (Bhattacharyya 2018), where labour costs are checked by externalising social reproduction onto rural and informal spaces or invisibilised "infra-economies" (Gidwani and Maringanti 2016; Mezzadri 2021; Shah and Lerche 2020). Such configurations contribute to what Moore calls the "ecological surplus"—the volume of unpaid or minimally commodified work/energy that is brought into the orbit of capital accumulation without capital having to pay for the costs of their reproduction—and have ongoing implications for accumulation as a whole (Moore 2015:91–110).

The progress of the commodity frontier is a contradictory one as commodity relations "tend to exhaust the life-making capacities that enter into the immediate

production of value" (Moore 2015:68). Whilst the frontier extends commodity relations into previously uncommodified spaces—if accumulation is to proceed vigorously—the frontier must involve the *faster* extension of the "zone of appropriation": the mobilisation of unpaid work/energy in service to commodity production. This is a "decisive requirement", in Moore's analysis, to keep the cost of inputs in check and underproduction tendencies at bay (Moore 2015:66, 240).

It is tempting to see the enclosure of informal waste work as the principal expression of a commodity frontier in waste. Moore's analysis suggests that if urban metabolism is the contested process through which nature is constantly being made and remade (Gandy 2004; Swyngedouw 2006), capitalism's logic is not always about "commodifying nature" but plays out through a dialectic between uncommodified nature and the commodity system (Moore 2015:66). From this perspective, the persistence of informal waste work and enclosures of "waste commons" are distinct moments in the contradictory progress of a commodity frontier in waste. The latter opens new grounds for profits for individual recycling companies but often requires cross-subsidy via public funding, extended producer responsibility schemes and gate fees. Informal waste work on the other hand collects and separates waste for free, receiving only the (discounted) price of its product as a raw material. It increases the ecological surplus brought into capital's gravitational field. Whilst the enclosure of "waste commons" represents gains for a particular capital it may undermine the conditions for accumulation for capital in general. Such a view helps to explain why formal/capitalised systems struggle to compete on cost or efficiency and resort to shipping waste to be separated by hand in global recycling networks and tend to shift costs onto workers via work intensification (Gregson et al. 2016) or the atmosphere (waste-to-energy).

The way value is appropriated from informal waste work can thus be established in the abstract but supporting it empirically presents methodological challenges. I suggest Moore's view can be usefully combined with materialist ecofeminist insights about relatively uncommodified human-environment relations. In particular, Ariel Salleh's (Salleh 2009, 2010) characterisation of the "Metabolic Value" produced by the "meta-industrial working class", those workers nominally outside of capitalism, including "peasants, mothers, fishers and gatherers". We can see the metabolic value produced by these workers as analogous to the "life making capacities" which enter into Moore's ecological surplus when Salleh (2009:300) writes: "what is missing from the value equation is the role of reproductive or meta-industrial labour in mediating matter/energy transformations and minimising metabolic depletion".

Salleh describes the metabolic value produced by such labour in some detail. In contrast to productivity increases achieved in industry by mobilising more energy and materials per hour, meta-industrial labour possesses characteristics which make it ecologically regenerative: the consumption footprint is small because local resources are used, an intimate hands-on scale "maximizes responsiveness to matter/energy transformations so minimizing entropy" and provides "opportunity for synergistic problem solving" (Salleh 2009:302). The labour is "relational, flow oriented, and regenerative of biotic chains" (Salleh 2010:212). Salleh's main

examples are reproductive work in the household and the agro-ecology of subsistence production. She cites Vandana Shiva's example of Indian forest dwellers in stewarding the circulation of organic waste between crops and animals and the way such production distributes extractive activity across a wide range of resources (Salleh 2009:31, 293).

Informal waste work shares many of these characteristics: both low-external-input/uncapitalised subsistence agriculture and low-external-energy/uncapitalised waste work circulate "minerals" using minimal energy and materials. Waste work does not necessarily regenerate "biotic chains" but often recirculates inorganic materials and products. It would be Physiocratic, however, to limit the concept of metabolic value to agronomic spheres. Meta-industrial labours, or "forces of reproduction" (Barca 2020), have a double character: both modelling eco-sufficiency whilst subsidising capitalist production—becoming subject to exhaustion as they are drawn into its sphere of influence. Metabolic value thus offers a fruitful diagnostic tool to trace how informal waste work provides "unpaid work/energy" within the commodity frontier.

Methodology

What follows is a case study based on fieldwork conducted in Barcelona between April and July 2019 including interviews with workers, middlemen, the head of waste programmes and studies at the metropolitan authority, analysis of grey literature and descriptive statistics on waste and scrap metal wholesalers in Catalonia, Spain.

In interviewing informal waste workers, I was influenced by the basic motivation of a "workers' enquiry" (Marx 1938); to explore the labour process from the point of view of the worker. Adopting an expanded conception of where value is produced within this approach suggests a need to consider production and social relations as an "overall process" (Pitts 2014:354). As such, interviews enquired about the work process but also living conditions, family ties, migratory and labour histories. Reluctant to ask collectors to take lengthy periods away from meeting their needs, interviews were based predominantly on simple questions about the work and living conditions. More searching questions enquired about the respondents' experience and perceptions of their work, their political priorities and hopes for the future. Many of the interviews were carried out on the spot, lasting as long as respondents were willing to take a break from collecting and, as such, were partial. A total of 11 interviews were conducted as a result of requesting interviews from 21 people encountered collecting recyclables whilst walking in the city and on purposive visits to an encampment of scrap collectors and scrapyards (see Table 1).

The role of Roma people in informal recycling and Roma women in particular may be underrepresented here. Whilst informal recycling is performed predominantly by men in Catalonia (Datambient 2013:31; Rendon et al. 2021:485), the low number of women respondents was also impacted by my reluctance, as a man, to approach women in the street if the spatial context was not conducive.[1] Despite these caveats, the case provides insights into the substantial role of

Table 1: Profile of informal waste workers

No of interviews	Gender	Material collected	Average daily earnings	Average daily work hours	Country of birth	Residency documents	Years in activity
Complete: 4 Partial: 7 Total: 11 Response rate: 52%	M: 10 W: 1	Metals: 100% Useable products for resale: 55%	€25	8.9	Romania: 5 Senegal: 2 Burkina Faso: 1 Tanzania: 1 Mali: 1 No data: 1	Yes: 1 No: 5 No data: 5	<6m: 2 1yr: 1 2yrs: 3 4yrs: 1 9yrs: 1 10yrs: 1 No data: 2

Source: Interviews conducted by the author in Barcelona between April and July 2019.

informal waste workers in collecting and sorting materials in Barcelona and how value is recuperated by and appropriated from this arrangement.

Informal Waste Work in Barcelona

Within Europe, Spain was second only to Greece in the severity of impact of the global financial crisis of 2008 and ensuing austerity on unemployment. The unemployment rate peaked in July 2013 at 26.3%; it wasn't until 2017 that real GDP per capita recovered to the level of a decade earlier (Eurostat 2019a), albeit with a casualised and precarious employment landscape, a persistent underground economy and undocumented labour force. Approximately 25–30% of the Spanish labour force are thought to be in informal employment (Packard et al. 2012). It is within this period that Barcelona saw a proliferation in the number of *chatarreros* (the colloquial name for informal waste workers, from the Spanish for scrap: *chatarra*). The decade prior to the crash had seen a significant wave of immigration to the country, which fed demands for cheap labour in construction and agriculture as the labour market tightened in the boom. In more recent years, Spain has also been a country of first landing for migrants and refugees making the Mediterranean crossing and the Barcelona city government has made efforts to be a "Refuge City". There were an estimated 10,000–15,000 undocumented migrants Barcelona in 2017, often grafting a living from informal services surrounding the city's tourism-driven economy and informal recycling—mainly scrap metal collection. The first *chatarrero* I spoke to, Moussa, 37, came to Spain in the late 1990s from Mali and worked on a pork farm outside Madrid for a number of years. He was laid off in the crisis: "The boss said, 'I've run out of cash, everyone needs to go', and I couldn't find work. But I've got papers, residence and everything in Spain". He worked on another farm in the Burgos region but was given few hours, after which he came to Barcelona. He had been collecting scrap metal as his main income for two years at the time I spoke to him.

A survey of informal waste workers in Catalonia—commissioned by a scrap metal industry association in 2011—found 70% had started the activity from

2009 onwards (Datambient 2013:36). It estimated that around 53,500 people engaged in the recovery of metals in 2011, a figure that exceeds the 47,387 employed in construction in the same year (Statistical Institute of Catalonia 2013). Of those for which it was their main or sole income (an estimated 33,000 people), over two-thirds had migrated to Spain, mainly from Morocco, Senegal, Gambia, Latin America, and Eastern Europe (Datambient 2013:34). Driven by unemployment from their countries of origin, these excess labourers found a salvaged livelihood in the material excess of the dense urban waste stream which contained a growing value.

The head of programmes and studies in the waste management department at the Metropolitan Area of Barcelona (AMB), speaks nostalgically about the city's old neighbourhood scrap shops to which he sold his family's newspapers as a child. He attributes their disappearance to the cheapening of materials in the 1980s and 1990s which made waste materials of little value; a cost to be managed by the municipal authorities (AMB interview). The commodity boom, which began in the early 2000s, laid the grounds for the urban waste stream to be seen as valuable once again—and for a new type of parallel extra-municipal collection system. From a period of low and stable prices between 1995 and 2003, prices of metals began to rise and became increasingly volatile. In 2017 the index of metal prices was 75% higher than in 1995 (Álvarez and Skudelny 2017). Moore calls this durable commodity price boom the "signal crisis" of neoliberalism as an accumulation regime, revealing that its current strategies of securing Cheap Nature are faltering (Moore 2015:264). European Central Bank economists identify a number of "commodity specific supply factors": strikes in copper mines in Peru, supply shortfalls of iron ore in Australia and Brazil, the shutdown of Chinese aluminium factories due to air pollution (Álvarez and Skudelny 2017). These are the sources of socio-ecological inertia and exhaustion in the current Cheap Nature strategy in metals, part of the context for the circular economy as a solution to resource worries and volatile prices. There is no doubt more capital being invested and labour recruited for the revalorisation of waste. Employment in waste and recycling industries in the EU grew by 32% between 2008 and 2016 and an eyebrow-raising 265% in Catalonia (Eurostat 2019b). However, "invisible green jobs" in informal recycling likely exceed the formal labour force (Weghmann 2017). Within Catalonia's wholesale of scrap metal industry, the number of formal workers has remained flat at around 4,000 (Statistical Institute of Catalonia 2016) whilst its informal labour force of suppliers has almost certainly expanded.

This expansion in the number of *chatarreros* from 2008 onwards may well have increased the *rate* of collection and separation of scrap metal from the urban waste stream. The volume of discarded durable goods rises and falls with economic output and the quantity of non-packaging metals collected by municipal systems in the Metropolitan Area of Barcelona fell as expected by 49% between 2010 and 2015 (AMB 2019). In contrast, the turnover in cash terms of the scrap waste and wholesale industry in Catalonia was relatively stable and even increased in the years 2012 and 2014 (Figure 1a).

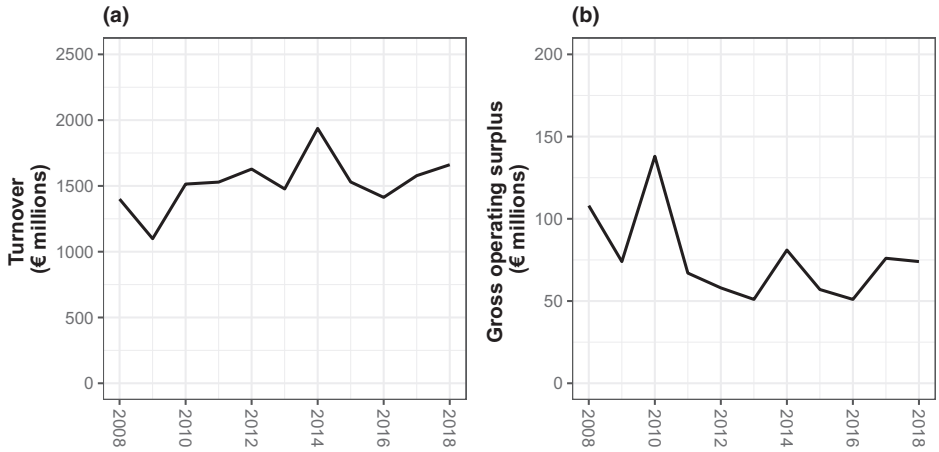

Figure 1: Turnover (a) and Gross operating surplus (b) of wholesale of waste scrap businesses, Catalonia 2008–2018. (Source: own elaboration based on Statistical Institute of Catalonia, structural statistics of companies in the service sector, wholesale trade of scrap metal and waste products, 2008–2018)

It is estimated that "individual salvagers" collected, sorted and sold 125,492 tonnes of metals to wholesalers in Catalonia in 2011 (Datambient 2013).[2] This is equal to 26% of the annual industrial metal waste reported in the same year and eclipses the 6,256 tonnes of non-packaging metals recovered by the municipal waste system in Catalonia (Waste Agency of Catalonia 2019).[3] Informal waste workers appear to play a substantial if not dominant role in the recovery of metals from *durable end-of-life products*. This is significant considering that the municipal system is intended to cover the collection of voluminous waste, appliances and waste electrical and electronic equipment (WEEE) from households but also—often reluctantly—from small and medium commercial activities like shops and home renovations (AMB interview). These are the same waste sources pored over by *chatarreros* and these figures suggest they collected 20 times more non-packaging metal than municipal systems. They are able to do this because the municipal "collection" of bulky and miscellaneous metal-containing wastes in Barcelona requires households and small businesses to transport them to one of the 21 recycling centres or put them out during a two-hour collection window once a week. Many households instead make use of the *de facto* free daily kerbside collection service offered by *chatarreros*. Informal waste work is tolerated because the targets and incentives of the municipal collection and treatment system are oriented towards increasing separation at source and focused on packaging waste and the organic fraction. Collecting unseparated bulky wastes is seen largely as a cost to be reduced (AMB interview). As such, municipal authorities have not contested *chatarreros'* role in collecting scrap metal—beyond a well-intentioned project, Alencop 2015–2020, which supported a number of *chatarreros* to form a bulky waste collection cooperative but was unable to become financially self-sustaining. Neither have recycling companies challenged *chatarreros'* collection of scrap metal. On the contrary, as discussed below, they have lobbied against

regulatory changes that would have imperilled it. This labour plays a substantial role in recovering metals and has coexisted with the formal waste management system in a relatively stable fashion for the last decade. To better understand why this occurs we must consider the work and these workers in more detail.

The scrap that enters the metal recycling chain each year is referred to as "arisings" in the industry. A fitting term for the seemingly weightless ascent of "free gifts" propelled by hidden labours. The accounts of informal waste workers help describe the inner workings of this "submerged part of the iceberg" (Gibson-Graham 2006; Mies 1998), its relations via materials and the workers to other spaces of production and reproduction.

All the informal waste workers interviewed had migrated to Spain and collected scrap as their main source of income. The majority were men and had been collecting scrap metal for between three months and two years. Bogdan, 64, from Romania, however, had been collecting scrap for ten years. Unemployment combined with barriers to formal employment are the basic drivers that compel workers into the activity. They described the occupation as a self-evident survival strategy in the absence of work opportunities. Andrei, who described travelling back and forth from Romania to Barcelona by bus every three months, told me that "there is no work in Romania". Dennis, 45 from Tanzania, arrived in Spain in 2005 and was previously employed as a gardener, but when his residency document expired he didn't have an employer to renew it: "that's why I took the decision to do scrap". He described how many people took up the activity after 2008:

> After the crisis … —the crisis of Spain, the global crisis, that has happened all over the world— … people didn't have work and entered into this, recycling, now there are a lot of people. Before people wouldn't think of working in this. After they started, they realised they could live with the money that they earned. (Dennis)

Workers complained about competition for scrap and spoke about their earnings as low and unpredictable. Sebastian, 19 from Romania, says he often earns very little: "it's like a lottery, it depends". Dennis contrasted the work to waged employment: "in scrap you don't have an agreement. Today you're going to get this, tomorrow? You don't know what's going to happen". Moussa told me there is no minimum: "one day you can earn a decent amount, one day nothing". The workers interviewed reported average earnings of around half the minimum wage. This is in line with the earnings calculated in 2011, which suggested 66% of informal waste workers had a monthly income below €600 and that practically all were below the Eurostat poverty line (Datambient 2013). Low earnings meant many were unable to access housing and described sleeping on the street (two interviewees) or in a makeshift encampment with other scrap collectors (Dennis), although others were renting (Moussa). Sub-minimum-wage earnings are the most basic sense in which unpaid work is appropriated from informal waste workers, enabling plentiful and cheap "arisings" of scrap metal.

The value of informal waste work to the commodity frontier, however, is not simply measured in more and cheaper metals delivered by sub-minimum-wage work but in production and reproduction performed in a particular type of way.

The work of *chatarreros* is, in the first instance, a process of collection of metal-containing waste on foot using simple technologies; a repurposed supermarket trolley sometimes augmented with an additional storage space and a pole for probing inside containers. A mobile phone is, however, often an important part of the work equipment. All the interviewees described the work of pushing a trolley across distances of 5–13 kilometres a day as physically taxing. Vicente, who'd been doing it for some years, told me that "some people can only work four hours [a day]". For Moussa, his understanding of work as a whole was shaped by an acute awareness of the need to apply physical effort:

> If you don't do [the work] with effort it will never end … like any job … if I'm sat here with you talking all day, we won't get done … yes it's very hard work. When you do a lot of hours you get tired. You have to force it. (Moussa)

With minimal external inputs of energy or fixed capital, the process of collecting, sorting and transporting metals is powered by the workers' own endosomatic energy; the work recovers materials effectively precisely because its own material and energy intensity is minimal.

There is also a more relational, qualitative character to this reproductive labour. *Chatarreros* built relationships with construction workers or people who did house clearances or renovations who would call them when they had things to dispose of (Moussa, Dennis). Just over half of the *chatarreros* I spoke to also collected re-useable goods like clothes, shoes and appliances or tools and sold them to second-hand shops (Moussa), between each other (Dennis), to people on the street (Bogdan), or to informal buyers for export (Sebastian):

> [I collect] clothes and shoes too … I sell them to the Moroccans … they buy up lots of stuff: shoes, clothes, televisions, boilers, washing machines, cookers, microwaves as well. All types of electronics. They buy them up and store them and then they drive them to Morocco. (Sebastian)

In this, the work is based on an open, adaptive and diversified approach to the materials collected, their sources and buyers. We can recall here Salleh's emphasis on the hands-on scale of meta-industrial labours, their adaptive, synergistic problem-solving character and the meeting of needs by drawing on multiple resource bases. Reusable goods for resale are a secondary income and rather than feeding a materials commodity frontier instead enter domestic and international thrift markets that both sap consumer demand and help reproduce the global poor.

Indeed, metabolic value can also be traced in the way informal waste workers reproduce themselves in the city. I met Dennis at an encampment of scrap collectors in a park near the historic centre of Barcelona and glimpsed a busy web of relationships during their Sunday off work as he lent a couple of euros to a friend and fielded phone calls during our interview. Dennis described how they had arranged with buyers who would come in vans daily to buy scrap from this central point and take it to a scrapyard to be sold. This allowed the workers to bypass the requirement of the larger yards to show a residency and identification document. Rather than seeing the buyers as gatekeepers, they represented a transport

"facility": "we depend on the people who come with the van … he's also like the second level of recycling" (Dennis). The living communities, relationships and exchanges these workers assemble form an infrastructure, a "platform providing for and reproducing life in the city" (Simone 2004:408). Perhaps the largest example was a recuperated factory, evicted in 2013, where 300 people lived and 700 worked in warehouses dedicated to the separation of metals and repair of reusable goods, and included a bar, hairdresser's and café—as documented by Climent and Bulla (2018). The metabolic value produced by reproduction in urban informal settlements has been gestured at in quantitative social metabolism research. They are characterised by a low energy throughput, often develop complex self-reproducing structures and function as "net providers of labour" to the city (Smit et al. 2019:5). Evictions periodically disturb these infrastructures in Barcelona, where they obstruct capitals' plans to valorise pieces of urban space. Nevertheless, they continue to spring up again in spaces left fallow, particularly in industrial districts where scrap metal wholesalers are based.

Whilst workers' relationships and makeshift settlements help to reproduce them in the city, a further crucial possibility condition for this labour are flows of unpaid reproductive work from "peripheries". Romanian workers reported circular migratory routes, spending a few months in Barcelona and a few months in Romania before returning again. Many of the workers had parents, partners and children living in their countries of origin. Whilst they sent remittances when they could, their partners carried large burdens of reproductive work, which often included working the land (Bogdan, Andrei). Moussa's wife, for instance, cares for his children and for his elderly mother in Mali and he sends remittances when he can:

> When I have €100, €150 I'll send it to her … I have three kids and the school needs to be paid for, every month I have to pay for school and give money to my wife for caring for my children and my mother. (Moussa)

The externalisation of social reproductive costs observed here is a central feature of how informalised work and reproduction of workers is organised around the world. Migrant workers are often paid less than the going rate for the full maintenance of workers and their families in the place of work because they are looked after—periodically and intergenerationally—by the unpaid work of family members and kinship networks in cheaper, more rural places (Mezzadri 2021; Shah and Lerche 2020). The metabolic value produced by informal waste work is undergirded here by another layer of reproductive work. As Salleh (2010:212) suggests, households and hinterlands are subject to the same logic, often articulated together: "North and South, the *domestic periphery* supplies metabolic value to capital through intergenerational nurture of the bodies of wage workers".

Supported by uncommodified reproduction, informal waste workers not only perform *collection* but rigorous *separation* of materials, the benefit of which is recognised by actors further down the value chain. Workers reported dismantling products to separate different materials or "cleaning" the metals. Carlos, 28 from Ecuador, buys up scrap metal from *chatarreros* on the street—including at the encampment discussed above—and transports it to a scrapyard by the van-load. He described the importance of this "cleaning" work:

> You see that all this is disassembled … they dismantle the [tables] to sell it as steel. They earn more than if they sell the piece whole with the wood and things. All the metal has to go clean. [The people I buy from] some maybe earn €10 … others get €80 because what they sell is clean. (Carlos)

Carlos buys iron from *chatarreros* for €0.09 per kilo and sells it for €0.13. On the day I spoke to him he had transported two tonnes of iron in two trips and at least 100 kilograms of other more valuable metals. The benefits of this labour in achieving a fine-grained separation of materials were also clearly spelled out by the industry commissioned study:

> separation by individuals at the beginning of the metal recovery chain achieves a level of purity of the material that enables increased levels of recycling further down the line. It is therefore a specialised and manual work, difficult to achieve through machined industrial processes. (Datambient 2013:62)

This study was motivated by the industry's concern over the implementation of a new national waste law (Law 22/2011) which may have obliged scrap metal wholesalers to require an invoice for all purchases of scrap from "individual salvagers". This would in turn require informal waste workers to register as self-employed workers, making their activity untenable when subject to flat-rate monthly social security contributions, which would push the monthly earnings of most salvagers below €200, likely causing them to cease the activity (Datambient 2013:54). The industry managed to see off this requirement and another for payments to be made electronically—for the time being (AMB interview)—a testament to the importance of informal recyclers to the sector. That the work would be unviable if subject to social security contributions illustrates deftly how uncommodified reproduction enables forms of cheap, minimally commodified work. As the activity stands, earnings cannot cover the going rate of reproduction of workers in Spain—as partially reflected in the cost of social security contributions.

The work of *chatarreros* in collecting and separating metal containing wastes has likely recovered more metals more cheaply than would be possible were arisings to travel by other routes. The minimally commodified character of production and reproduction in informal waste work produces metabolic value, increasing the share of unpaid work/energy that enters into the accumulation of capital—increasing the ecological surplus. Where, one may ask, can these profits be seen? The workers did not see either the scrapyards (Bogdan) or the informal buyers they sold to as profiting improperly from their work: "they have a facility, they have transport … the person that comes to collect the scrap, you must value him, if he doesn't come I don't have the possibility to get anything" (Dennis). Nor, it should be mentioned, have the profits of the wholesale of scrap metal sector in Catalonia increased over the period; if anything they have been squeezed (Figure 1a,b). But if the commodity frontier is to deliver cheap raw materials, the margins of such firms might be expected to be low.

The value of informal waste work for capitalism's Cheap Nature strategy can start to be seen further up the value chain in Spain's metal industry. The production of base metals and metal products is the third largest manufacturing division

in Spain after food products and vehicles (National Statistics Institute 2017). Spain is the fourth largest steel producer in the EU, producing 14 million tonnes in 2017, and using a higher proportion of scrap in steel production (77%) than the EU average (55%) (BIR 2018). The quantity of metallic waste recycled in Spain doubled from five million tonnes in 2006 to ten million tonnes in 2016 (Eurostat 2019c). Exports of Spanish steel products weathered the recession robustly, maintaining their 2008 levels of around nine million tonnes per year through to 2019 (Worldsteel 2019). With imports reduced and domestic consumption contracted, what had been a physical trade deficit in steel products between 2000 and 2008 became a modest trade surplus in the period 2009–2015 (Figure 2). Accompanied by the proliferation of informal waste work in Barcelona, Spain became a thrifty metals recycler and—for six years—a net exporter of steel products.

The scrap collected by *chatarreros* in Barcelona need not travel far to support Spain's circular steel industry. Via small scrapyards it finds its way to larger wholesalers with greater separation, compaction and transport facilities like FERIMET SL, a wholly owned subsidiary of CELSA Group, a multinational vertically integrated steelmaking company and the largest ferrous scrap recycler in Europe (CELSA Group 2020). CELSA's Castellbisbal steelworks on the outskirts of the metropolitan area of Barcelona is one of Spain's largest plants, comprising two electric arc furnaces with an annual manufacturing capacity of 2.5 million tonnes. This steel manufacturing route is fed exclusively by ferrous scrap, often referred to as "circular steel" or "green steel" due to the technology's role in efforts to decarbonise steelmaking.

Whilst informal waste workers around the world have often organised into associations to protect their livelihoods and struggle for a greater share of the value they create, the workers I spoke to didn't offer opinions about changes to the organisation of the waste collection system. Many told me they were looking for other work and would pick up other cash-in-hand jobs where possible. They saw improvements in their lives through finding work outside of recycling materials:

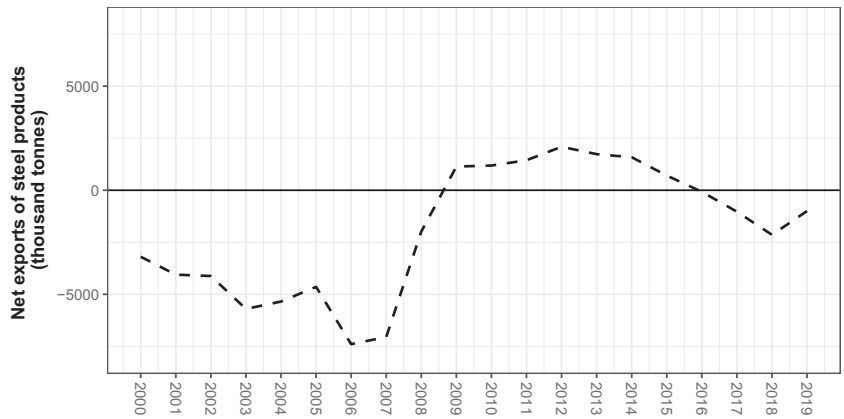

Figure 2: Net exports of semi-finished and finished steel products, Spain, 2000–2019. (Source: own elaboration based on Worldsteel 2019)

"If I find something better than this scrap, I'm going to do that, my life isn't doing this … I want to find a job and they pay me every month and nothing more" (Moussa). Dennis described it as a temporary situation whilst he's unable to access employment: "this job is just a matter of time, now I'm organising to fix my documents" (Dennis). For Amadou, 25, who had arrived from Senegal four months prior, he hopes it's a stepping-stone towards other work. Workers did not identify with the work and have manifold skills and capacities, including and exceeding their experience driving taxis, in agriculture, as factory operatives, landscapers and construction workers. Border policies function as the "colonizing divisions" (Mies 1998:210) which contribute to the de-valuation of these workers' labours, excluding them from economic citizenship and the collectivised institutions of reproduction. Defined outside the economy they are defined into Nature. Their work becomes "free gifts". As such, the most pressing front of struggle for these workers is perhaps the "boundary struggle" (Fraser 2014) articulated by the state-wide migrant-led movement for a mass regularisation (#RegularizacionYa 2022). A demand couched in calls for reparations for colonialism and recognition for the essential work they carry out.

Conclusion

The nascent circular economy in the EU has been accompanied by a proliferation of minimally commodified informal waste work in Barcelona, which can be understood as a combined process resulting from crisis and reorganisation in the capitalist logic of "Cheap Nature" (Moore 2015). The study suggests *chatarreros* in Barcelona have likely recovered more metals, more cheaply than would otherwise be possible. This meta-industrial labour produces "Metabolic Value" (Salleh 2009) by recirculating a maximum of metals using minimal energy via a highly manual process of collection and separation and workers' adaptive and synergistic approach to their livelihoods. The possibility conditions for this cheap labour are the threadbare uncommodified infrastructures of reproduction produced by the workers themselves and flows of unpaid reproductive work from peripheries. By tracing the metabolic value produced by informal waste work we observe its regenerative, eco-sufficient character but are also confronted with its precariousness as a form of sub-minimum-wage piece-work based on squeezing the costs of reproduction. The study affirms both the "creative" potential of labour as nature-making activity (Ekers and Loftus 2013) whilst highlighting the corrosive relationship between the commodity system and the uncommodified spaces it depends upon.

Studies of how waste enters into the production of socio-spatial relations often emphasise waste as an object "through which state power operates" (Moore 2012:791), where the moral signification of waste as "disorder" or "out of place" frequently wins out in the final instance, displacing informal waste workers (Whitson 2011). Through a focus on the antientropic work required to turn waste into raw material for commodity production again, the emergence and perennialism of informal waste work can be viewed as induced by and imbricated with capitalism "as a way of organizing nature" (Moore 2015:173). Contrary to

studies which have focused on the enclosure of spaces informal waste work as the primary expression of the commodity frontier in waste, the present study suggests that if waste is a commodity frontier for materials, it is the work of informal recyclers that supplies the "free gifts of nature". This signals the potential limits of capitalist ambitions for a circular economy or the prospect that it will be accompanied by increasing volumes of poorly remunerated recycling work. Challenging border policies which produce hierarchical divisions of economic citizenship and devalued classes of workers emerges as central to countering the "unjust transition" this would represent. Indeed, immigration policies are also the mechanisms which beget cheap labour to produce cheap food in the greenhouses of Southern Spain (Gerbeau and Avallone 2016) and an important component of the logic of Cheap Nature in Europe.

The paper contributes to overturning an imbalance in research on waste in geography which produces an image of recycling in the North as "formal" and "sustainable" and where informality is a phenomenon unique to the South (Millington and Lawhon 2019). Gregson and Crang (2015) argue a narrative of "toxic dumping" oversimplifies contemporary flows of global waste. They suggest that a shift from viewing waste as an "externalised cost" towards a valuable secondary raw material reveals that "familiar economic geographies … are upturned as the developed North becomes a source for scrap/raw materials" (Alexander and Reno 2012:4, cited in Gregson and Crang 2015:153). The waste streams of the North as a source of raw materials, as examined here, do not so much invert the core/periphery relations of "ecologically unequal exchange" (Hornborg 1998) but reorder them onto flows of migrant workers supported by distanced reproductive labour. As recent work on the labour geographies of extraction has indicated, the logic of the periphery is increasingly "ubiquitous" and perhaps better considered "immanent to the capitalist production space" (Arboleda 2020:60). Attention to the shifting spatial configurations of minimally commodified natures accompanying capitalism's "green" mutations would therefore appear central to assessing its injustices, limits and how a less malignant metabolism might come to the fore.

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Data Availability Statement

Data available on request from the authors

Endnotes

[1] For an intricate study of how informal waste work is but one of many economic "niches" (with a gendered division of tasks) through which Roma communities "assemble access to the city" in Europe, see Rosa and Cirelli (2018).

[2] The study surveyed 184 informal waste workers and gathered transactions data from 84 scrap wholesalers.
[3] The volume of non-packaging metal collected by municipal systems is for 2012, the earliest year for which data is available. Definitive statistics on the total metal waste produced and recycled in Catalonia is lacking (AMB interview). These figures demonstrate the significance of metals recovered relative to the largest stream of metal waste reported (industrial metal wastes declared).

References

Alexander C and Reno J (2012) Introduction. In C Alexander and J Reno (eds) *Economies of Recycling: The Global Transformation of Materials, Values, and Social Relations* (pp. 1–34). London: Zed Books
Álvarez I A and Skudelny F (2017) What is driving metal prices? *ECB Economic Bulletin* 8: 36–40
AMB (2019) "PREMET25: Gestió per fraccions." Àrea Metropolitana de Barcelona
Arboleda M (2020) *Planetary Mine: Territories of Extraction under Late Capitalism*. London: Verso
Barca S (2020) *Forces of Reproduction: Notes for a Counter-Hegemonic Anthropocene*. Cambridge: Cambridge University Press
Bhattacharyya G (2018) *Rethinking Racial Capitalism: Questions of Reproduction and Survival*. London: Rowman & Littlefield
BIR (2018) "World Steel Recycling in Figures 2013–2017." Bureau of International Recycling
Birkbeck C (1978) Self-employed proletarians in an informal factory: The case of Cali's garbage dump. *World Development* 6(9/10):1173–1185
CELSA Group (2020) "Recycling." https://www.celsagroup.com/en/recycling/ (last accessed 7 October 2022)
Climent V and Bulla J P (2018) An analysis of informal work: The case of SubSaharan scrap metal waste pickers in the city of Barcelona. *Intangible Capital* 14(4):536–568
Corwin J E (2018) "Nothing is useless in nature": Delhi's repair economies and value creation in an electronics "waste" sector. *Environment and Planning A* 50(1):14–30
Corwin J E (2020) Between toxics and gold: Devaluing informal labor in the global urban mine. *Capitalism Nature Socialism* 31(4):106–123
Corwin J E and Gidwani V (2021) Repair work as care: On maintaining the planet in the Capitalocene. *Antipode* https://doi.org/10.1111/anti.12791
Cowan T (2021) The village as urban infrastructure: Social reproduction, agrarian repair, and uneven urbanisation. *Environment and Planning E: Nature and Space* 4(3):736–755
Datambient (2013) "Diagnosi ambiental, social i econòmica de la compra de residus metàl·lics a particulars a Catalunya." Gremi de Recuperació de Catalunya
Davis M (2007) *Planet of Slums*. New York: Verso
Demaria F and Schindler S (2016) Contesting urban metabolism: Struggles over waste-to-energy in Delhi, India. *Antipode* 48(2):293–313
Dias S M (2016) Waste pickers and cities. *Environment and Urbanization* 28(2):375–390
EC (2015) "Closing the Loop: An EU Action Plan for the Circular Economy." European Commission
Ekers M and Loftus A (2013) Revitalizing the production of nature thesis: A Gramscian turn? *Progress in Human Geography* 37(2):234–252
Eurostat (2019a) "Unemployment rate (tps00203), Spain."
Eurostat (2019b) "Annual Detailed Enterprise Statistics for Industry (NACE Rev. 2, B-E) (E38 Waste collection, treatment and disposal activities; materials recovery [sbs_na_ind_r2] / SBS data by NUTS 2 regions [sbs_r_nuts06_r2])."
Eurostat (2019c) "Treatment of Waste by Waste Category, Hazardousness and Waste Management Operations (env_wastrt)."
Fahmi W S (2005) The impact of privatization of solid waste management on the Zabaleen garbage collectors of Cairo. *Environment and Urbanization* 17(2):155–170

Fischer-Kowalski M and Hüttler W (1998) Society's metabolism: The intellectual history of materials flow analysis, part II, 1970-1998. *Journal of Industrial Ecology* 2(4):107–136
Foster J B (1999) Marx's theory of metabolic rift: Classical foundations for environmental sociology. *American Journal of Sociology* 105(2):366–405
Fraser N (2014) Behind Marx's hidden abode. *New Left Review* 86:55–72
Fredericks R (2018) *Garbage Citizenship: Vital Infrastructures of Labor in Dakar, Senegal*. Durham: Duke University Press
Fredericks R (2021) Anthropocenic discards: Embodied infrastructures and uncanny exposures at Dakar's dump. *Antipode* https://doi.org/10.1111/anti.12796
Gandy M (2004) Rethinking urban metabolism: Water, space, and the modern city. *City* 8 (3):363–379
Georgescu-Roegen N (1971) *The Entropy Law and the Economic Process*. Cambridge: Harvard University Press
Gerbeau Y M and Avallone G (2016) Producing cheap food and labour: Migrations and agriculture in the capitalistic world-ecology. *Social Change Review* 14(2):121–148
Gibson-Graham J K (2006) *A Postcapitalist Politics*. Minneapolis: University of Minnesota Press
Gidwani V (2012) Waste/value. In T J Barnes, J Peck and E Sheppard (eds) *The Wiley-Blackwell Companion to Economic Geography* (pp. 275–288). Oxford: Wiley-Blackwell
Gidwani V (2013) Six theses on waste, value, and commons. *Social and Cultural Geography* 14(7):773–783
Gidwani V (2015) The work of waste: Inside India's infra-economy. *Transactions of the Institute of British Geographers* 40(4):575–595
Gidwani V and Chaturvedi B (2011) The right to waste: Informal sector recyclers and struggles for social justice in post-reform India. In W Ahmed, A Kundu and R Peet (eds) *India's New Economic Policy: A Critical Analysis* (pp. 125–153). New York: Routledge
Gidwani V and Maringanti A (2016) The waste-value dialectic: Lumpen urbanization in contemporary India. *Comparative Studies of South Asia, Africa, and the Middle East* 36(1): 112–133
Grant R and Oteng-Ababio M (2012) Mapping the invisible and real "African" economy: Urban e-waste circuitry. *Urban Geography* 33(1):1–21
Gregson N and Crang M (2015) From waste to resource: The trade in wastes and global recycling economies. *Annual Review of Environment and Resources* 40:151–176
Gregson N, Crang M, Botticello J, Calestani M and Krzywoszynska A (2016) Doing the "dirty work" of the green economy: Resource recovery and migrant labour in the EU. *European Urban and Regional Studies* 23(4):541–555
Gutberlet J (2008) *Recovering Resources—Recycling Citizenship: Urban Poverty Reduction in Latin America*. Burlington: Ashgate
Heynen N, Kaika M and Swyngedouw E (eds) (2006) *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*. New York: Routledge
Hornborg A (1998) Towards an ecological theory of unequal exchange: Articulating world system theory and ecological economics. *Ecological Economics* 25(1):127–136
Kaza S, Yao L, Bhada-Tata P and Van Woerden F (2018) "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." International Bank for Reconstruction and Development / The World Bank https://datatopics.worldbank.org/what-a-waste/ (last accessed 14 October 2022)
Knapp F L (2016) The birth of the flexible mine: Changing geographies of mining and the e-waste commodity frontier. *Environment and Planning A* 48(10):1889–1909
Labban M (2014) Deterritorializing extraction: Bioaccumulation and the planetary mine. *Annals of the Association of American Geographers* 104(3):560–576
Luxemburg R (2003 [1951]) *The Accumulation of Capital* (trans A Schwarzschild). New York: Routledge
Martinez-Alier J (2009) Social metabolism, ecological distribution conflicts, and languages of valuation. *Capitalism Nature Socialism* 20(1):58–87
Marx K (1887) *Capital: A Critique of Political Economy*. Moscow: Progress Publishers https://www.marxists.org/archive/marx/works/1867-c1/ (last accessed 14 October 2022)

Marx K (1938 [1880]) A workers' inquiry. *New International* 4(12):379–381
McGrath-Champ S, Rainnie A, Pickren G and Herod A (2015) Global destruction networks, the labour process, and employment relations. *Journal of Industrial Relations* 57(4): 624–640
Medina M (2007) *The World's Scavengers: Salvaging for Sustainable Consumption and Production*. Lanham: AltaMira Press
Mezzadri A (2021) A value theory of inclusion: Informal labour, the homeworker, and the social reproduction of value. *Antipode* 53(4):1186–1205
Mies M (1998) *Patriarchy and Accumulation on a World Scale: Women in the International Division of Labour*. London: Palgrave Macmillan
Millington N and Lawhon M (2019) Geographies of waste: Conceptual vectors from the global South. *Progress in Human Geography* 43(6):1044–1063
Moore J W (2015) *Capitalism in the Web of Life: Ecology and the Accumulation of Capital*. New York: Verso
Moore J W (2017) Metabolic rift or metabolic shift? Dialectics, nature, and the world-historical method. *Theory and Society* 46(4):285–318
Moore S A (2012) Garbage matters: Concepts in new geographies of waste. *Progress in Human Geography* 36(6):780–799
National Statistics Institute (2017) "Structural Business Statistics, Industrial Sector (Production Value)."
Nwosu B U, Nzeadibe T C and Mbah P O (2016) Waste and well-being: A political economy of informal waste management and public policy in urban West Africa. *Review of African Political Economy* 43(149):478–488
Packard T, Koettl J and Montenegro C E (2012) "In From the Shadow: Integrating Europe's Informal Labor." International Bank for Reconstruction and Development / The World Bank https://openknowledge.worldbank.org/handle/10986/9377 (last accessed 14 October 2022)
Pitts F H (2014) Follow the money? Value theory and social inquiry. *Ephemera* 14(3): 335–356
Reddy R N (2015) Producing abjection: E-waste improvement schemes and informal recyclers of Bangalore. *Geoforum* 62:166–174
#RegularizacionYa (2022) "#RegularizacionYa: Movimiento Estatal." https://regularizacionya.com/ (last accessed 17 March 2022)
Rendon M, Espluga-Trenc J and Verd J M (2021) Assessing the functional relationship between the formal and informal waste systems: A case-study in Catalonia (Spain). *Waste Management* 131:483–490
Rosa E and Cirelli C (2018) Scavenging: Between precariousness, marginality, and access to the city—The case of Roma people in Turin and Marseille. *Environment and Planning A* 50(7):1407–1424
Rosaldo M (2016) Revolution in the garbage dump: The political and economic foundations of the Colombian recycler movement, 1986-2011. *Social Problems* 63 (3):351–372
Salleh A (ed) (2009) *Eco-Sufficiency and Global Justice: Women Write Political Ecology*. London: Pluto Press
Salleh A (2010) From metabolic rift to "metabolic value": Reflections on environmental sociology and the alternative globalization movement. *Organization and Environment* 23 (2):205–219
Samson M (2015) Accumulation by dispossession and the informal economy: Struggles over knowledge, being, and waste at a Soweto garbage dump. *Environment and Planning D: Society and Space* 33(5):813–830
Samson M (2020) Whose frontier is it anyway? Reclaimer "integration" and the battle over Johannesburg's waste-based commodity frontier. *Capitalism Nature Socialism* 31(4): 60–75
Schindler S and Demaria F (2020) "Garbage is gold": Waste-based commodity frontiers, modes of valorization, and ecological distribution conflicts. *Capitalism Nature Socialism* 31(4):52–59

Shah A and Lerche J (2020) Migration and the invisible economies of care: Production, social reproduction, and seasonal migrant labour in India. *Transactions of the Institute of British Geographers* 45(4):719–734
Simone A M (2004) People as infrastructure: Intersecting fragments in Johannesburg. *Public Culture* 16(3):407–429
Smit S, Musango J K, Kovacic Z and Brent A C (2019) Towards measuring the informal city: A societal metabolism approach. *Journal of Industrial Ecology* 23(3):674–685
Statistical Institute of Catalonia (2013) "Main Aggregates of the Real Estate Sector: People Employed, 2011."
Statistical Institute of Catalonia (2016) "Structural Statistics of Companies in the Services Sector, Wholesale of Waste and Scrap (Persons Employed)."
Swyngedouw E (2006) Circulations and metabolisms: (Hybrid) natures and (cyborg) cities. *Science as Culture* 15(2):105–121
Temper L, del Bene D and Martinez-Alier J (2015) Mapping the frontiers and front lines of global environmental justice: The EJAtlas. *Journal of Political Ecology* 22(1):255–278
Waste Agency of Catalonia (2019) "Metal Waste (Municipal Waste and Industrial Waste classified by Annex I of European Regulation 2150/2002)."
Weghmann V (2017) "Waste Management in Europe: Good Jobs in the Circular Economy?" Public Services International Research Unit / European Public Service Union https://www.epsu.org/article/will-circular-economy-be-economy-no-workers-new-study-published (last accessed 14 October 2022)
Whitson R (2011) Negotiating place and value: Geographies of waste and scavenging in Buenos Aires. *Antipode* 43(4):1404–1433
Worldsteel (2019) "Total Production of Crude Steel / Exports and Imports of Semi-Finished and Finished Steel Products (Spain 2000-2019)."