

Measuring Extraction from Forced Wage Labour in Portuguese Africa, 1910–1974: Scope, Incidence and Present-Day Valuation

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Abstract

Under the Portuguese colonial system of compulsory recruitment for private wage employment (*contrato*), African men in Angola and Mozambique were conscripted into wage labour for much of the twentieth century. To estimate the income they lost and the respective shares captured by private employers and the colonial state, we propose a new framework that separates the scale of the loss from its opportunity cost valuation and carries these values forward to the present. Drawing on detailed firm wage records, national labour statistics, and fiscal accounts for 1910–1974, we find that, at its peak, the system subjected up to one-fifth of able-bodied men to forced wage labour and extracted approximately 2.2 million years of labour across the two colonies. Applying our framework, wage suppression accounts for roughly three-quarters of the loss due to this coercion, becoming relatively more important toward the last decades of the colonial period. Valued in 2023 euros, the total loss is approximately €1.2 billion. The framework offers a readily applicable method for quantifying historical losses in settings where coercive exposure can be measured and a non-coercive labour market provides a credible counterfactual.

1 Introduction

The extractive nature of colonial institutions is widely accepted across otherwise divergent scholarly traditions. Coerced labour, monopsonistic trade, land alienation and regressive taxation (among other practices) have been understood as instruments of appropriation backed by force (Hobson, 1902; Lenin, 1917; Fieldhouse, 1961; Rodney, 1972; Acemoglu et al., 2001). Yet, while colonialism is also often believed to have impeded long-run economic development, especially in Africa (Heldring and Robinson, 2018), there remains limited quantitative evidence of the microeconomic costs associated with specific forms of coercion. Among these, forced wage labour was one of the most widespread coercive institutions in twentieth-century colonial Africa, operating on a mass scale and compelling large numbers of African workers into wage employment over successive decades. Nonetheless, no systematic, economy-wide estimates exist of the income extracted from these workers or of how that transfer was divided between private employers and the colonial state.

The present paper addresses this gap, seeking to estimate the income losses borne by workers subject to forced wage labour in Portuguese Africa. To do so, we foreground the need for a clear and transparent measurement framework. One explanation for the lack of rigorous evidence on the microeconomic costs of forced labour is the technical difficulty of measuring such losses. A central challenge is that coercive labour regimes frequently eliminate the competitive wage benchmark needed to identify welfare losses, necessitating carefully justified counterfactuals. Moreover, efforts to express historical damages in comparable present-day terms inevitably rely on specific economic and technical assumptions, the implications of which should be made transparent through robustness and sensitivity analyses

In this vein, we separate the estimation exercise into three distinct measurement steps that previous studies have often bundled together or left implicit. The first defines the scope of loss, which requires fixing the dimensions of harm, who and how many were subjected to it, as well as its temporal persistence. Second, valuation and incidence measures the income those workers forwent against a specified non-coercive counterfactual while also partitioning the resulting transfer between distinct beneficiaries (e.g., firms versus the state). Third, a carry-forward step expresses the historical loss in meaningful current terms, based on an explicit inter-temporal transfer rule. The separation of these steps is not merely didactic. Published estimates of historical extraction, such as those relating to slavery (see below; also Darity Jr et al., 2022), often differ by large orders of magnitude precisely because they make different choices at each stage; but such choices are not always stated or justified explicitly. Keeping them apart thus allows a given estimate to be (re)constructed

one step at a time.

We apply the framework to the case of forced wage labour in the two largest of Portugal's African colonies, Angola and Mozambique, viewed over the period 1910 to 1974. This yields three findings. Forced wage labour was large and durable: over five per cent of able-bodied African men were under coerced wage contracts in both colonies by the 1920s, rising to almost twenty per cent in Mozambique in the 1940s and nearly ten per cent in Angola in the 1960s, with peak annual conscription above 200,000 in Mozambique and above 100,000 in Angola. This is consistent with existing research on the fiscal importance of compulsory labour obligations in colonial Africa, such as *corvée* labour in French Africa ([van Waijenburg, 2018](#)).

The income extracted was correspondingly large relative to the colonial economies from which it was taken. At its peak, wage suppression alone exceeded one-fifth of all colonial tax revenue (excluding capitation) in Angola, approaching a similar share in Mozambique; and capitation tax extracted from coerced workers reached around six per cent of the same revenue aggregate in Mozambique at its wartime peak. At its maximum, the combined loss from both components was equivalent to the value of around 77,000 voluntary worker-years of labour annually. Both employers and the state gained substantial amounts from these transfers, but their weight shifted over time. Measured against a comparator tax burden, employers retained a larger share of the cumulative total, at roughly three-quarters, but the fiscal component carries most weight in the interwar decades. The shift in the system's centre of gravity from revenue towards labour supply shows that colonial extraction was not a static institution: colonial rulers, in tandem with employers, adapted its machinery over time to their changing fiscal and economic needs as well as evolving local conditions.

Cumulated over the full period and expressed in the purchasing power of 2023 euros, the components together amount to approximately €1.2 billion for the two countries combined. That figure is a translation of the historical loss into a modern unit, not a claim about foregone wealth accumulation, counterfactual output, or a legally owed sum. As a broad order of magnitude, this estimate appears robust to a range of reasonable changes to underlying assumptions, including the carry-forward rule. The main exception is when a compounding interest rate is applied. As we demonstrate, even small changes to the selected rate translate into very large differences in the final sum, making this approach less robust than price-based alternatives.

Alongside these headline estimates, the paper makes three further main contributions. The first is to provide a framework for measurement of the aggregated microeconomic costs of historical wrongs. This framework is portable, but in a limited sense. It applies wherever

the scope of exposure can be reasonably quantified and when a plausible non-coercive counterfactual can be specified and reconstructed. The framework can therefore generate transparent estimates of economic loss that can inform, but do not determine, normative or legal judgments about what is owed. One possible contemporary application is prison labour, a practice that persists in many countries and is particularly prominent in the United States, where it raises related questions about counterfactual wages and who benefits from coerced work.¹

The second contribution concerns our specification of the counterfactual wage. Because coerced and non-coerced workers coexisted, even in the same organizations and in comparable tasks, colonial-era coercive labour markets often contain the evidence needed to construct meaningful free wage benchmarks. However, an observed voluntary wage should be interpreted as a type of market-clearing price – it is the reservation wage of the marginal volunteer, not of the inframarginal workers whom coercion had already removed from that market. Workers with weaker outside options plausibly would have accepted lower wages, and the least-endowed may have earned less freely than the coerced wage and lost nothing at all. It follows that the familiar quantity ‘number coerced times wage gap’ is not the workers’ loss but the employers’ gross enrichment; and the two coincide only in the implausible limiting case of perfectly homogeneous workers. In contrast, we derive the loss as the area between the free and coerced labour-supply schedules, and implement it through a bounded correction keyed to the ratio of coerced to voluntary workers. This adjustment is more conservative and, under the model, more appropriate when coercion is extensive, the setting in which the distinction between marginal and inframarginal workers matters most.

The third contribution is empirical. Relative to the mass of macroeconomic and long-run growth research on African history and colonialism, estimates of the microeconomic opportunity costs of colonial extraction remain rare. Exceptions include [van Waijenburg \(2018\)](#), who assesses the implicit fiscal levy of *corvée* labour in French Africa; and [Tadei \(2020\)](#), who quantifies losses to smallholder producers from monopsonistic trade via price repression. We extend this analytical tradition to forced wage labour, doing so in a relatively understudied setting.² The object of estimation is deliberately narrower than colonial labour coercion as a whole: for example, it excludes unpaid *corvée* labour and Mozambican circular migration to South African segregationist and later apartheid labour markets. To bring this

¹ A contemporary example is Louisiana State Penitentiary, known as “Angola,” the largest maximum-security prison in the United States. It occupies a former slave plantation named after the African country, from which many of its enslaved workers were believed to have originated. After Louisiana acquired the property in 1900, it became a prison farm organised around the coerced labour of a predominantly Black incarcerated population, with agricultural workers receiving as little as four cents per hour ([Appleman, 2022](#), pp. 648–49).

² There remains a comparative absence of scholarship on Angola’s and Mozambique’s economic history, which echoes [Duffy \(1960\)](#): “The trouble with Portuguese Africa is that the outside world has never been able to see it very clearly.” (p. 451).

setting into clearer empirical view, we contribute new economy-wide series for Angola and Mozambique, constructed from firm wage records, colonial labour statistics, fiscal accounts, demographic evidence and price data. Furthermore, and unlike most previous studies in this tradition, we carry-forward estimates of losses into present-day values to give an intuitive sense of the cumulative magnitude of the economic losses the institution provoked.

2 Measuring the economic cost of coercive labour

This section sets out our three-step framework for measuring the costs of historical wrongs, which we later apply to the case of forced wage labour. Before doing so, it helps to distinguish between two broad historical loss measurement traditions. The first begins from divergent present-day outcomes — e.g., differences in living standards between the descendants of the wronged and some reference population — and infers the magnitude of the original wrong from the size of the current gap. The wealth divide between Black and White households in the United States is a canonical example ([Mullen et al., 2026](#)), as is work linking divergent contemporary development outcomes to distant historical events (e.g., [Acemoglu et al., 2001](#); [Nunn, 2008](#); [Acemoglu et al., 2012](#)). The second tradition begins from the historical wrong itself, values the contemporaneous loss in the prices and conditions of the time it occurred, and then carries-forward that historical value to the present-day. Much of the reparations literature concerned with Atlantic slavery, including both wage- and price-based estimates, belongs to this second camp ([Neal, 1990](#); [Marketti, 1990](#); [Ransom and Sutch, 1990](#); [Craemer, 2015](#); [Bazelon et al., 2023](#)).

Our analysis takes its point of departure from the second tradition, the primary rationale being that gaps in outcomes today generally cannot be attributed to just one specific institution or wrong. For instance, current differences in living standards are not merely the product of an original wrong, but also everything that has intervened since then. For descendants of American slaves, the latter refers to the terms of emancipation, a century of statutory discrimination, and continuing disadvantages in credit, housing, and employment. The most careful practitioners concede this point. Indeed, [Darity Jr et al. \(2022\)](#) attribute the racial wealth gap not to slavery alone but to a continuous regime of racial economic exclusion, treating the gap as an overall accumulated debt, not the consequence of any single act. The substantial economic harms caused by American slavery and subsequent racial discrimination are well established. A separate question, however, is whether the wealth of White Americans provides the most appropriate counterfactual against which to measure the wealth losses experienced by the descendants of enslaved Americans.

In contrast, our approach adopts a narrower lens, valuing the loss against the worker’s contemporaneous opportunity cost. It considers a specified harm and requires a defined counterfactual loss valuation, with identifiable starting and ending dates, and a delimited wronged population. As discussed by [Posner and Vermeule \(2003\)](#), such an approach aligns with compensatory measures familiar from tort cases. But, to be clear, what we seek to establish is a magnitude, not an entitlement. Whether financial transfers are owed, by whom and to whom, are broader questions we do not address here. What our application provides is a qualified estimate of the size of the transfer, without which no serious discussion of a potential reparations sum can proceed.

2.1 Scope

The first step in our measurement framework is to select which type of loss, borne by whom, is to be valued. Coercive labour institutions had consequences well beyond the earnings of those conscripted – e.g., for their households and the communities from which they were drawn. Its harms also extended beyond lost income to illness, premature death and other losses of well-being. Thus, any measure of total loss in year t sums over the admitted dimensions of harm h aggregated over the affected population $\mathcal{N}_h$:

$$\Delta_t = \sum_h \sum_{i \in \mathcal{N}_h} \Delta_{it}^h \quad (1)$$

Defining the scope of loss explicitly means fixing the index sets in equation (1), namely: the dimensions of harm h ; the affected population $\mathcal{N}_h$; and the period of active exposure $t \in \mathcal{T} = \{t_0, \dots, t_N\}$.

Here, we admit a single dimension, labour income, and a single, albeit large, affected population, Mozambican and Angolan workers under coerced wage contracts, over the period 1910–1974. As such, three groups must be distinguished throughout: the coerced, L^F ; those in wage employment outside the coercive system, L^V ; and the working-age population from which both were drawn, which fixes exposure as a share of those at risk. Both labour groups exclude unpaid corvée labour and Mozambican cross-border migrants employed in South African and Rhodesian labour markets. For a discussion of why these groups are excluded, see Section 4.2. Estimates that broaden the analysis to admit further dimensions of harm are not thereby larger versions of the same object; they answer different questions, and we return to this in Section 2.4.

2.2 Valuation and incidence

Having defined the scope of loss, the next step is to value it. Consistent with the principle of compensation, our object of interest is the individual's income under a relevant free-labour counterfactual minus the income actually received under coercion. To fix ideas as regards the nature and incidence of this loss, consider individuals choosing between wage employment and self-employment.³ Under free labour relations, the net income of individual i is:

$$y_i^V = \begin{cases} w^V - \gamma\tau & \text{under voluntary wage employment,} \\ a_i - \gamma\tau & \text{under self-employment,} \end{cases} \quad (2)$$

where a_i is auto-productivity in self-employment, τ a lump-sum head tax, and $0 < \gamma < 1$ the share of that tax the individual would concede voluntarily toward public provision. Individual i is indifferent between the two forms of work when $w^V = a_i$.

Forced wage labour is then a policy that raises revenue and lowers private labour costs by attaching a penalty to remaining in self-employment:

$$y_i^F = \begin{cases} w^F - \tau & \text{under forced wage employment,} \\ a_i(1 - \delta) - \tau & \text{under self-employment,} \end{cases} \quad (3)$$

where $\delta \in (0, 1)$ is the expected loss to self-employment earnings when coercion is resisted — such as via unpaid penal labour (Allina, 2012) — and the full tax τ is borne regardless of the mode of employment. As δ rises, a lower wage suffices to make the individual indifferent. For instance, suppose a worker can earn $a_i = 100$ in self-employment. In the voluntary regime, an employer must offer at least $w^V = 100$ to induce the worker to enter wage employment. However, if resisting recruitment exposes the worker to an expected loss of 40 per cent of his self-employment earnings, so that $\delta = 0.4$, his effective outside option under coercion falls to $100(1 - 0.4) = 60$ and a wage of $w^F = 60$ is then sufficient to make him indifferent. Coercion therefore does not eliminate the worker's outside option; it reduces its value, allowing the employer to pay 40 less than would have been required under voluntary recruitment.

³ This is stylised but faithful to the essentials of colonial Portuguese Africa, where many African workers combined wage employment with self-employment, particularly in rural areas. The binary choice is a simplifying device; it is also closer to the coerced reality than it might appear, since forced recruitment, taxation, and administrative control narrowed precisely the scope for moving flexibly between the two, pushing workers into a coerced proletarian workforce while restricting supplementary earnings. Also, *contrato* workers remained liable for the head tax even while undertaking forced labour, which is why a tax term appears in the income expressions for both regimes below.

Taking the individual at the margin of wage labour under both regimes, the opportunity cost of forced wage labour is:

$$\Delta_i = y_i^V - y_i^F = \delta a_i + (1 - \gamma)\tau = \underbrace{(w^V - w^F)}_{\text{to firms}} + \underbrace{(1 - \gamma)\tau}_{\text{to the state}} \quad (4)$$

which partitions the per-worker opportunity cost by beneficiary: the wage forgone relative to the voluntary market accrues to private employers, and the involuntary portion $(1 - \gamma)$ of the head tax accrues to the state. The economic object remains the total opportunity cost; (4) says where it went. Note that because gross cash wages w^V and w^F include the worker's head tax liability, and because this is a per-capita levy independent of income or employment status, the entire tax wedge between the free and coerced worlds is carried by $(1 - \gamma)\tau$ and appears only in the fiscal component; there is no double counting between the two components.

The above brings to light two key points. First, it highlights that coercive labour institutions did not merely benefit firms. In the colonial case, a head tax payable in cash created pressure to enter wage employment, labour legislation and penal sanctions reduced the value of outside options, and the same administrative apparatus enumerated taxpayers, collected the tax, and assembled recruits. Taxation and forced recruitment were complementary instruments of one coercive labour system, and the income extracted from workers had two destinations. Separating them is an incidence question, not a second exercise. And, substantively it requires us to identify appropriate counterfactuals not only for the gross wage but also for income taxes. We treat each of these in turn below.

Second, the framework suggests that the pertinent concept of loss is one of compensation, which values the worker's shortfall against his *own* alternative, a_i . This is distinct from two other concepts found in the literature. The first is (gross) restitution, which seeks to place the victim, as far as possible, in the position they would have occupied absent the wrongful act. This position would measure the loss from coercion as the quantum of appropriated labour valued at a competitive counterfactual wage: $L^F \times w^V$. The second is disgorgement, which seeks to measure the wrongdoer's gain from the act, which in this case would be those wages the employer avoided by paying w^F not w^V , measured gross of the costs of the wrong itself, and so equal to the transfer $L^F(w^V - w^F)$.⁴ The three concepts are ordered, and the ordering is informative. Restitution exceeds disgorgement by the wages actually paid, $L^F w^F$ — a distinction that is latent under chattel slavery, where $w^F \approx 0$, but plausibly first-order under forced wage labour, where the received wage was positive

⁴ The law of unjust enrichment ordinarily permits a defendant to deduct the legitimate costs of producing a gain, but not the costs of the wrong. Round-ups, pass controls and penal sanctions are therefore not creditable against the gain, so disgorgement is measured gross of enforcement.

and often non-trivial. Disgorgement, in turn, exceeds compensation to the extent that the competitive wage reflects the outside option of the marginal worker, rather than the average outside option of the coerced workforce.

To see how these three measures differ, consider a simple numerical example. Abstracting from taxation, suppose 100 workers receive a coerced wage of 4, the competitive wage required to recruit the full workforce voluntarily is 10, and their average earnings in alternative activities would be 7. Restitution values the appropriated labour at: $100 \times 10 = 1000$; disgorgement measures the employers' wage saving, $100 \times (10 - 4) = 600$; and compensation measures the workers' income loss against their own best alternative: $100 \times (7 - 4) = 300$. Restitution therefore exceeds disgorgement by the wage bill actually paid, while disgorgement exceeds compensation because the competitive wage reflects the marginal rather than the average worker's outside option.

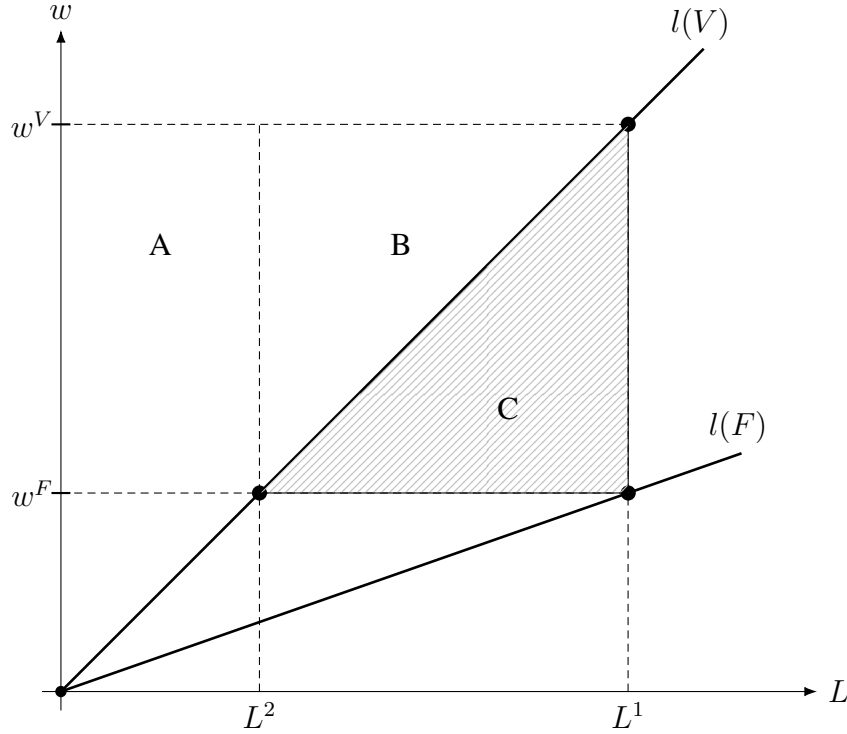
Our preference for compensation is therefore methodological, grounded in the actual operation of a dual labour market in which coerced and non-coerced workers coexisted, rather than an attempt to select the smallest estimate or minimise the potential value of reparations. Compensation corresponds most closely to the object that can be identified from the historical record: the income workers lost relative to their own feasible alternatives. Restitution and disgorgement remain informative, but they answer different questions. Disgorgement, in particular, measures the gains employers derived from wage repression and can therefore help assess how coercion contributed to the profitability of colonial enterprises.

2.2.1 Counterfactual wages

Defining compensation as the worker's own loss surfaces a fundamental identification problem, even when comparable wages for non-coerced workers are observed. Voluntary workers are assumed to sort into employment according to a wage schedule, with the observed wage representing a single point on that schedule: the reservation earnings of the marginal volunteer, that is, the last worker willing to enter wage employment at the prevailing wage. Coercion alters both the size and the composition of the voluntary labour force. Consequently, the observed voluntary wage will only coincide with the counterfactual earnings of the marginal coerced worker by chance.

Figure 1 illustrates this point, showing linear labour-supply schedules under voluntary and forced wage regimes (V and F). A coercive regime shifts supply outward, so that at any non-zero wage $L^F(w) > L^V(w)$. The wage w^V is that required to induce voluntarily the

Figure 1: Supply of wage labour under voluntary and forced regimes



Source: authors' construction.

Notes: $l(V)$ and $l(F)$ denote the supply of wage labour under voluntary and forced regimes respectively. L^1 is the quantity of labour mobilised under coercion at the forced wage w^F (denoted L^F in the text); L^2 is the quantity that would have been supplied voluntarily at that same wage, and whose members therefore bear no wage loss. The rectangle $A + B + C$ is the naive estimate $L^1(w^V - w^F)$; the triangle C is the aggregate opportunity cost of equation (5).

quantity that coercion induces at w^F , given by L^1 on the horizontal axis, and $w^V - w^F$ is the opportunity cost of coercion for the marginal worker at L^1 . Workers brought into wage work below L^1 face a lower opportunity cost, reflecting lower productivity in their outside activity, typically self-employment. The aggregate calculated as $L^1 \times (w^V - w^F)$ — areas A , B and C together — therefore overstates the loss. Area C is the opportunity cost proper, equal to $(L^1 - L^2) \times (w^V - w^F)/2$, where L^2 denotes workers who would have volunteered even at the coerced wage w^F and who bear no wage loss.⁵

Formally, order workers by reservation wage and let $b(\ell)$ be the reservation earnings of the ℓ -th worker, increasing in ℓ . The voluntary wage required to draw L^F workers is

⁵ For intuition, suppose five coerced workers receive a wage of 10, while the voluntary wage required to recruit all five is 20. If their reservation earnings are 20, 17, 14, 11 and 9, their individual wage losses are respectively 10, 7, 4, 1 and zero. The familiar wage-gap calculation gives $5(20 - 10) = 50$, whereas their adjusted compensation is $10 + 7 + 4 + 1 + 0 = 22$. The difference arises because 20 is the reservation wage of the marginal (last) volunteer, not the opportunity cost of every worker; the worker with reservation earnings of 9 would have volunteered even at the coerced wage and loses nothing.

$w^V = b(L^F)$: the voluntary wage is estimated *at the coerced quantity*, which is distinct from the wage observed at the observed voluntary quantity L^V . Aggregate compensation is the area between the free and coerced supply schedules,

$$\Delta^{\text{wage}} = \int_0^{L^F} [b(\ell) - w^F]^+ d\ell, \quad (5)$$

with $[\cdot]^+ = \max(\cdot, 0)$. Workers for whom $b(\ell) < w^F$ incur no wage-income loss under the model, while every other worker contributes the difference between the wage required for voluntary participation and the forced wage. Writing $\tilde{w}^V = b(L^F)$ for the unobserved wage at the apex of the relevant voluntary supply schedule, the three measures of Section 2.2 can be ordered under linear supply as:

$$\underbrace{L^F \tilde{w}^V}_{\text{restitution}} \geq \underbrace{L^F (\tilde{w}^V - w^F)}_{\text{disgorgement}} > \underbrace{\frac{1}{2} (L^F - L^2) (\tilde{w}^V - w^F)}_{\text{compensation}}.$$

The inframarginal correction thus drives a wedge between the beneficiaries' gross enrichment and the workers' compensation. While both objects are informative, we take compensation as our headline measure and report the unadjusted observed wage-gap rectangle as an upper sensitivity specification in Section 6.

Practical implementation requires relating the observed voluntary wage $w^V = b(L^V)$ to the unobserved apex $b(L^F)$. Because b is increasing, the employment ratio locates the observed wage relative to that apex, but does not by itself establish whether the observed wage-gap rectangle overstates or understates the integral in (5). In the absence of evidence on labour-supply elasticities or the full distribution of reservation wages, we therefore use the employment ratio to define a simple bounded correction:

$$\Delta^{\text{wage}} = \theta L^F (w^V - w^F), \quad \theta = \frac{1}{2} \min\left(2, \max\left(\frac{1}{2}, L^F/L^V\right)\right), \quad (6)$$

with $0.25 \leq \theta \leq 1$. This is a transparent, bounded approximation rather than an unrestricted exact recovery of (5). When $L^F = L^V$, $\theta = \frac{1}{2}$, corresponding to the triangular case under the linear-supply and intercept assumptions stated in Appendix C. As coercion becomes more extensive relative to voluntary employment, θ rises towards one; when coercion is comparatively light, it falls towards one-quarter. The bounds prevent the adjusted estimate from exceeding the observed wage-gap rectangle while allowing greater attenuation in periods of lighter coercion. Appendix C derives the exact linear-supply counterpart under its stated assumptions, and Panel C of Table 4 reports sensitivity to alternative values of θ .

2.2.2 Fiscal counterfactual

As noted, measuring the fiscal loss component requires its own counterfactual. Ideally, this would reflect the part of the head tax returned to African taxpayers as genuine benefits, such as through public goods provision. However, this is not answerable from the available record. Colonial accounts report what revenue was spent on, not whose welfare it raised. So, partitioning the share of presumed benefits would be highly subjective. Instead, we apply the same logic as for wages and ask how heavily the head tax burdened African incomes relative to the income taxes faced by a comparable but non-coerced taxpayer, treating the gap as the loss. These estimates also must be constructed at a level supported by the data. We do not observe individual tax payments or incomes, but we do observe aggregate indigenous capitation revenue R and reconstruct taxpayer counts N^g . Since R was paid by several distinct groups — forced wage workers, voluntary wage workers, and some men outside wage employment — it must first be apportioned. In the absence of group-specific income or payment data, we allocate revenue in proportion to each group's share of the taxpayer population:

$$R_g = \frac{N^g}{N} R, \quad \bar{\tau}^g = R_g/N^g = R/N, \quad (7)$$

where $\bar{\tau}^g$ is the effective average nominal tax borne per taxpayer in group g . This revenue-per-head object nets out the exemptions, evasion and rate variation we cannot observe and is cleaner than imposing a statutory schedule. An income-proportional allocation would require group-specific income data that are unavailable, so we use the flat per-capita allocation throughout. Section 6 instead examines sensitivity to the size of the taxpayer base over which that flat levy is spread.

The fiscal loss for the forced-wage group is then the per-capita excess of its apportioned tax over the benchmark, scaled by group size:

$$\Delta_F^{\text{fiscal}} = N^F [\bar{\tau}^F - r^* w^*]^+ = R_F \left(1 - \frac{r^* w^*}{\bar{\tau}^F}\right) = R_F (1 - \gamma) \quad (8)$$

where $w^* \equiv w^F + \theta (w^V - w^F)$ is the counterfactual free wage, estimated in keeping with the wage-loss estimates. Note that this is a pre-tax quantity, consistent with r^* , reflecting what the *average* coerced worker would receive absent coercion rather than the observed raw voluntary wage w^V ; and $R_F = \bar{\tau}^F N^F$ is the group's apportioned revenue.⁶ The second

⁶ The fiscal loss is worked throughout in *gross* (pre-tax) wages, so the coerced base is simply w^F ; these are distinct from the *net* incomes y_i^V, y_i^F of (2)–(3), which subtract the tax (net = gross – tax), and we take the relevant income to be just the wage. When $L^2 > 0$ the untruncated mean free wage lies slightly below w^* , so using w^* mildly overstates the fair tax and hence understates the fiscal loss — a further source of

equality holds whenever $\bar{\tau}^F \geq r^*w^*$, so the floor does not bind for a low-income group. Writing $\tau^* \equiv r^*w^*$ for the counterfactual fair tax, the third equality recovers the involuntary-transfer form $R(1 - \gamma)$ of (4), with $\gamma = \tau^*/\bar{\tau}^F$: the fraction of the actual head tax that a comparably poor but non-coerced taxpayer would also have owed. Note that w^* uses the same θ as the wage loss component, so the two components share one counterfactual wage rather than resting on separate benchmarks.

2.3 Carry-forward

Annual losses $\Delta_t = \Delta_t^{\text{wage}} + \Delta_t^{\text{fiscal}}$ are reconstructed year by year, allowing each underlying component to vary over time. However, since they are calculated as nominal quantities, they cannot be sensibly averaged or aggregated over the full period. Thus, to normalise and carry-forward the series of losses into present-day values (denoted $T > t_N$), we apply a scaling factor κ_t^T to each period- t loss:

$$V_T = \sum_{t \in \mathcal{T}} \Delta_t \kappa_t^T, \quad (9)$$

Various scaling rules are found in the literature, which naturally differ in the price concept used to define κ_t^T . Dropping the terminal superscript, these include: a consumer price index (CPI) chain, $\kappa_t^{\text{CPI}} = p_T/p_t$; a nominal earnings chain, $\kappa_t^{\text{wage}} = w_T/w_t$; a nominal per capita output chain, $\kappa_t^{\text{GDP}} = y_T/y_t$; and a compounding (nominal) return, $\kappa_t^r = \prod_{s=t}^T (1 + r_s)$. Reflecting divergent tendencies in how these prices tend to evolve over time, these factors are typically ordered in expectation: $\kappa_t^{\text{CPI}} \leq \kappa_t^{\text{wage}} \leq \kappa_t^{\text{GDP}} \leq \kappa_t^r$, so a compounded figure will generally dwarf the consumer purchasing-power measure when the interest rate exceeds the GDP growth rate.⁷

An advantage of the long-run price chain scaling rules, such as κ^{CPI} , is that they involve two transparent steps. First is application of historical prices to convert the nominal loss series into real values or quantities, which are often informative in themselves. Second is the scaling of the latter series by a corresponding single fixed present-day price. For present purposes we report the economic magnitudes of losses from extraction in various complementary registers. In addition to using a conventional CPI chain, which is our benchmark choice, we also divide the loss estimates by the counterfactual voluntary wage

conservatism.

⁷ The ordering reflects the point that wages tend to grow faster than consumer prices, and nominal GDP tends to grow faster than wages etc.. The final ordering can compress or reverse in nominal terms where cumulative inflation over the horizon is large relative to the nominal return — as in the high-inflation Portuguese case, where the mean CPI factor in fact exceeds a nominal safe-asset compounding; see Section 6.

(w_t^*) , yielding the number of full years of free-labour income the system appropriated. We also divide by the prevailing (national average) price of a kilo of maize flour, yielding a physical consumption-equivalent of the loss. And, finally, primarily to permit comparison with estimates for other colonial regimes, we express the loss as a share of total colonial revenue other than capitation, placing the loss within the fiscal structure of the state.

It merits emphasis that the choice of scaling rule is not innocuous. Each κ_t answers a different economic question, and none can be considered uniquely appropriate. For instance, the CPI chain tells us what monetary sum today would command equivalent consumption over a broad range of goods that the lost income commanded at the time. The wage-based chain tells us what monetary sum today would be needed to employ a similar quantity of labour power that was extracted during the colonial period. In this sense, compounding rules quietly import their own counterfactual — that lost income would have been saved and reinvested at a given rate of return — which is perhaps least tenable precisely where it is most often invoked. In very low-income settings any additional income is largely consumed not saved, and coercive institutions typically foreclosed access to the secure title, credit and capital markets on which appropriate investment returns rely.

In short, because the choice of carry-forward rule — especially a compounding rule — can generate pronounced shifts in the final valuation, the rule must be named, the economic question it answers made explicit, and alternatives reported rather than buried. We do so in [Section 6](#).

2.4 Relation to existing estimates

Before proceeding, the separation of scope, valuation and carry-forward in our measurement framework helps render previous estimates of losses from coerced labour commensurable. [Appendix Table B1](#) locates some of the principal existing contributions (mainly from the slavery literature), as well as our own, along these three dimensions. Read across, it reveals why the figures differ; read down the final column, it confirms they answer quite different substantive questions. The table suggests that many early slavery estimates and their widely-cited present-value calculations share two common features: loss is measured in terms of labour-income restitution, and compounding rules are used to carry-forward to the present day. These choices largely explain why their totals are large and sensitive. Indeed, the choice of rate is a principal difficulty with the compounding convention that dominates the slavery-reparations literature: Craemer’s wage-based estimate rises from some \$18.6 trillion at three per cent to several thousand trillion at six ([Craemer et al., 2020](#)), and the Brattle group report that twenty basis points move their total by roughly \$30.8 trillion, or about a

quarter of total world output ([Bazon et al., 2023](#)).

Viewed against previous studies, our contribution is not to devise counterfactual wage valuation, which earlier literature also employs. Rather, we apply the general conceptual approach to forced wage labour, placing it within a transparent framework that maintains distinctions between defining the scope of loss, valuing it at the time it occurred, and converting it to the present. A further distinctive feature is not only that forced labour was a common colonial institution, but also that it involved some positive transfers to exposed workers, which often varied with demand pressures. This allows us to net the coerced wage from historically proximate free wages. Furthermore, and unlike previous studies, we take seriously the inframarginal structure of that netting, made explicit in equation (5), which recognises that any observed ‘free’ wage is a marginal quantity.

3 Institutional setting

This section sets out the institutional facts on which our empirical strategy depends. Rather than attempting a comprehensive history of Portuguese colonial labour policy, it focuses on the institutional features directly relevant to measuring extraction through forced wage labour: how coercion was organised and enforced, how taxation and labour mobilisation were combined, why a body of voluntary wage labour existed alongside the coerced workforce, and what the two colonies contribute as cases. In this light, it bears note that Portuguese Africa is an unusually informative setting. As we elaborate, compulsory recruitment for wage employment was institutionally central and persisted in both Angola and Mozambique into at least the mid-1960s, long after comparable systems elsewhere in Africa had been narrowed or dismantled. Also, because colonial administrators regarded labour mobilisation as legitimate, rather than as something to conceal, it was extensively recorded through colonial administrative procedures. Firm archives distinguish contracted from voluntary workers and report the wage paid to each; colonial labour statistics permit economy-wide scaling; and fiscal accounts record the capitation revenue raised from the same population.

3.1 How coercion operated

Coercive labour systems were present across colonial Africa, particularly in concessionary economies and labour-scarce regions. Portuguese Africa stands out for the scale, durability and state-led administrative organization of compulsory recruitment for wage employment.

Indeed, in both Angola and Mozambique, labour coercion remained embedded in the ordinary functioning of colonial rule long after comparable systems elsewhere in Africa had been narrowed, redefined, or formally dismantled (Cooper, 2005; Fall, 2002; Gardner, 2023).

The legal basis for labour coercion was established in the 1890s, as the metropolitan government sought to reconcile the perceived need for cheap ‘native labour’ with international commitments to abolish slavery (Jerónimo and Monteiro, 2018). Its main plank was a moral and legal duty to work for indigenous peoples (*os indígenas*), presented not merely as economic necessity but as part of a civilising mission in which regular labour would discipline, educate and morally uplift African populations (Jerónimo, 2015; Maul et al., 2019; Van Onselen, 2021). From 1892 concessionaires could levy half of the *mussoco*—a direct tax imposed on African inhabitants of the *prazos*, or Crown land concessions in the Zambezi valley, and payable in produce, cash or labour—in direct labour; in 1899 African males aged 14 and over were placed under a legal obligation to work for private employers (Vail and White, 1980, pp. 131–137), against payment at a nominal rate and subject to time limits and exclusions covering perhaps 5 per cent of the population.

Objectives and instruments then remained broadly constant from the 1890s all the way until the early 1960s: through taxation, labour legislation and administrative coercion, the colonial state assumed responsibility for procuring cheap African labour for private enterprise and public works in the name of colonial development (Keese, 2012). How this was organised changed considerably over time and space. For Angola and central Mozambique, early operation was described in detail by Ross (1925, pp. 50–57) in his investigation of labour conditions: regular censuses of households; annual *mussoco* obligations; round-ups for *contrato* and *chibalo*⁸ by police and chiefs; assembly of labourers into *ensaca*, or consignments, at administrative posts; contracts between conscripts and employers or recruitment agents witnessed by administrators; deferred wage payments; and state punishment of evasion. Ross’s account was immediately contested by the Portuguese delegation to the League of Nations, which criticised his reliance on anonymous informants and argued that he had generalised from isolated irregularities rather than described the normal operation of the system (Portuguese Delegation to the League of Nations, 1925).

The ILO Forced Labour Convention of 1930, which called for the suppression of compulsory labour and specifically prohibited its use for the benefit of private individuals or

⁸ The term *chibalo* did not denote a single institution. Its meaning and spelling varied across regional contexts: Ross (1925) used it for *corvée* labour in Angola; in Southern Rhodesia, van Onselen (1976) used it to refer to all minework in interwar Southern Rhodesia, emphasising its commonly constrained character rather than a formal legal status; and elsewhere it could denote penal labour imposed for failure to satisfy labour obligations.

companies, did not dismantle these practices ([International Labour Organization, 1930](#)). On the contrary, the consolidation of the Estado Novo coincided with their more systematic administrative organisation. In Zambézia, abolition of the *prazo* system was followed by the extension of uniform state administration: the territory was divided into *circunscrições*, rural administrative units governed by colonial administrators and subdivided into administrative posts. Their officials were responsible for census-taking, tax collection, enforcement of labour legislation, and the supervision and punishment of African workers, assisted by appointed African chiefs and headmen who received tax and labour exemptions as well as payments for their part in census-taking, tax collection and labour mobilisation ([Head, 1980](#), pp. 52–55).

The 1930 *Regulamento do Trabalho dos Indígenas* integrated these structures into a more closely regulated system of procurement. All but a small minority of African men were formally required to undertake wage employment for six months of the year and to carry passes recording their most recent tax payment and labour contract — documents that restricted mobility while making tax and employment status visible to the authorities. Private recruiters were licensed and assigned territorial labour reserves; contracts were generally concluded under administrative supervision; recruitment increasingly proceeded through organised “concentrations” in which chiefs assembled men liable for contract labour at administrative posts; and regular reports on labour availability enabled officials to allocate workers among employers more systematically. Administrators also possessed broad powers to impose correctional labour on workers accused of desertion, insufficient effort, disobedience, or discouraging others from accepting contracts. Writing some three decades after Ross, Davidson on Angola in the mid-1950s and Anderson at the turn of the 1960s documented much the same coercive apparatus: compulsory labour obligations, coercive tax obligations, administrative round-ups, pass and documentation controls, punishment of evasion, and routine involvement of chiefs, police and district officials in recruitment ([Davidson, 1955](#); [Anderson, 1962](#)).

3.2 Taxation and labour mobilisation

Two features of this system matter for the incidence decomposition of Section 2.2. First, the head tax was payable in cash by a population that was overwhelmingly not in cash employment, making it simultaneously both an instrument of revenue collection and labour mobilisation. Meeting the liability required wage work, and from 1892 the liability could in part be discharged in labour directly. Second, the machinery of taxation and the machinery of recruitment were the same. The censuses that enumerated taxpayers identified the

men liable for contract labour; the pass, to be carried at all times by working age men, recorded both the most recent tax payment and the current contract; the *chefe de posto* who collected the tax also assembled the consignment. Rather than disappearing over time, the components identified by Ross were absorbed into a broader late-colonial regime in which the mobilisation of workers and the extraction of revenue operated through a single administrative apparatus. The state and employers were, in consequence, making simultaneous claims on the incomes of the same coerced workers, by complementary means.

3.3 Voluntary labour and the counterfactual

Alongside the coerced workforce there existed throughout the period a body of wage workers outside the *contrato* system, referred to as *voluntários* (volunteer workers), and it is their wages that provide the basis for the counterfactual of Section 2.2. In Mozambique they made up a minimum of 5 per cent of Zambézia plantation labour between 1890 and 1910, rising to perhaps a third by the 1950s (Vail and White, 1980, p. 357). These workers entered contracts, presented themselves for employment, and received pay outside the *contrato* system, usually while working far from home. Their employment was often associated with higher wages, some degree of occupational specialisation, repeat contracts and, in the later period, gradual labour stabilisation. The category also had a distinct geography: in Angola, districts with more monetised urban and coastal labour markets — e.g., Luanda, Benguela, Moçâmedes — recorded substantially larger numbers of workers outside the contract system, reflecting the greater availability and attractions of wage employment in ports, railways, fisheries, public services and commercial agriculture.

Two implications follow. On the one hand, coerced and voluntary workers were frequently employed by the same firms, in the same years, in comparable tasks, so that a within-firm wage comparison holds constant the sector, the technology, the employer's product market and the local price level. On the other hand, 'voluntary' should not be confused with fully free. As Anderson (1962), among others, argued, much so-called voluntary work was undertaken under the pressure to meet tax obligations, avoid *contrato* (where workers had less choice), or secure somewhat better conditions within a coercive regime. So, *voluntário* labour marked not the absence of coercion but one of its more market-mediated forms. The observed voluntary wage is therefore likely to lie below a genuine no-coercion free wage, which makes the estimated gap, and hence the estimated loss, conservative. We return to this in Section 6.

3.4 Angolan and Mozambican cases

The two colonies were governed under a common legal regime but differed noticeably in the timing, intensity and sectoral composition of coercion, which is what makes the pair informative. In Mozambique, the incidence of *contrato* changed substantially over the period of study. In Zambézia before 1928, the number of *contratados* never approached a majority of those legally liable for compulsory wage labour (Cahen, 2012; Zamparoni, 2007, p. 126). It rose steeply in 1928–31 before falling back until about 1939, after which it rose steadily until 1957, when over 93 per cent of Zambézia's obligated workers were recruited by private employers (Head, 1980, p. 138). The second rise reflected sustained labour demand from plantation agriculture, settler maize farms, tea estates, cotton concessions, mines, railways, construction and sawmills. To meet it, district administrations took over coordination of forced labour supply from private recruiters, introducing more systematic record-keeping and permanent employment of chiefs to tighten enforcement. The elimination of recruitment as a mainly private function was accompanied in 1942 by a law allowing *contratados* assembled at administrative posts to choose between potential employers; implemented unevenly, it nevertheless transmitted rising labour demand to wage levels and led to minimum wages being set at levels calculated to dampen wage competition (Head, 1980, p. 138).

Angola provides a better documented cross-sectional view of coercive allocation. The 1959 district table records 123,685 *contratados*, of whom 102,033, or roughly 82.5 per cent, were assigned to private employers: this was not primarily a system of public-works mobilisation but a mechanism for supplying private colonial production with administratively recruited labour. Its geography is equally revealing. Over the first half of the twentieth century Angola's central highlands became the colony's principal labour reservoir; in 1959 the plateau regions of Huambo, Bié-Cuando-Cubango and Benguela together supplied 50,300 *contratados*, or 40.7 per cent of the recorded colony-wide total. Heywood's work on the Ovimbundu documents the mechanism: from the early 1930s, the Estado Novo's taxation and labour reforms dramatically expanded the number of highland men listed for taxation and recruitment, with Huambo alone recording roughly 345,000 Africans eligible to pay taxes by 1948 (Heywood, 2000, p. 74), and by the late 1950s nearly four out of every five Ovimbundu males performed migrant labour (Heywood, 2000, p. 75). These workers did not remain in the highlands: they dominated Portuguese-run fisheries from Moçâmedes to the Baía dos Tigres, and worked in coastal and São Tomé plantations, public and port services in Luanda, the Benguela Railway, and the sisal, sugar and coffee plantations of the north (Heywood, 2000, pp. 75–76). *Contrato* thereby transferred workers from highland reservoirs to distant zones of colonial demand without the wage increases that would

otherwise have been needed to attract labour across such distances — which is precisely the wage suppression that Section 2.2.1 measures.

The costs borne by sending households extended well beyond the wage gaps we estimate. Rising male and female recruitment contributed to the rapid collapse of the Ovimbundu peasant and subsistence economy, while the absence of men increased further the representation of women and children in unpaid road work for the state (Heywood, 2000; Pössinger, 1973). The system was riddled with corruption and violence: recruiters, chiefs and poorly paid officials converted tax arrears, bribes and quotas into labour consignments, and migrants could be marched “neck to neck with rope” to collection points before transport to worksites (Heywood, 2000, p. 76). One older white settler’s comparison is especially revealing: under slavery, he claimed, he had an incentive to keep enslaved workers alive and healthy because they were his capital; under *contrato*, employers could simply pay the local administrator or *chefe de posto* and “get my needs supplied” (Heywood, 2000, p. 77). None of this enters our estimate, which is confined to foregone labour income.

4 Data and implementation

The framework of Section 2 requires five primary empirical objects: a wage pair (w^V, w^F) observed within the same work and/or employer; economy-wide counts of coerced and voluntary workers, L^F and L^V ; a population denominator against which exposure is expressed; capitation revenue R together with the taxpayer base N ; and a price series to implement κ_t . Table 1 pairs each with its empirical counterpart, its principal source, and the limitation that matters for the estimate. The record is unusually complete for a coercive institution, and for an institutional reason: because colonial administrators regarded labour mobilisation and fiscal extraction as legitimate instruments of governance rather than as practices to be concealed, recruitment, taxation and labour allocation were documented through routine bureaucratic procedure (Jerónimo, 2015). Appendix A documents the sources, harmonisation and gap-filling in full; this section states only what the estimates rest on and how they are constructed.

4.1 Firm-level wage evidence

The wage pair is the one object that cannot be assembled from aggregate statistics: it requires firms that hired coerced and voluntary workers simultaneously and recorded the wages they paid each group. Two firms meet this condition over a long horizon — the diamond

Table 1: Framework objects, empirical counterparts and sources

Object	Empirical counterpart	Principal sources	Limitations
Workforce denominator (§2.1)	Able-bodied males (<i>válidos</i>)	Colonial censuses; UN WPP; Frankema and Jerven (2014)	Sparse for Mozambique (c. 1935–44); age structure imposed pre-1950
Exposure L_t^F (§2.1)	<i>Recrutados</i> as a share of the <i>válido</i> population	<i>Anuário Estatístico</i> (Angola); yearbooks, censuses and <i>Boletim Oficial</i> (Mozambique)	Intermittent; anchored at the endpoints
Voluntary labour L_t^V (§2.2.1)	Firm volunteer/forced ratio scaled to the colony	As above, with benchmark-year labour surveys	Scaling multiplier is a judgement (1.5 Angola, 2.0 Mozambique)
Wage pair w_j^V, w_j^F (§2.2.1)	Within-firm average annual wages by contract status	Diamang labour reports (Angola); Sena Sugar Estates accounts (Mozambique)	Two large firms in two sectors; possible level premia
Capitation R_t , base N_t (§2.2.2)	Indigenous tax revenue; estimated taxpayer population	<i>Conta Geral do Estado</i> ; colonial budgets and yearbooks	Individual payments and incomes unobserved; 1962 Angolan reclassification
Benchmark rate r^* (§2.2.2)	Comparator effective direct tax rate	Settler, neighbouring-colony and metropolitan fiscal records	Not directly observed; range imposed and varied in §6
Carry-forward κ_t (§2.3)	Colonial and metropolitan CPI; staple retail prices	Jordà et al. (2019) ; Valério and Tjipilica (2008) ; Jones and Gibbon (2025) ; yearbook price tables	No colonial CPI of full length; backcasting required

Notes: the table summarises the primary objects of our measurement framework, their historical sources and limitations; for additional details see Appendix A.

Source: own elaboration.

mining company Diamang in Angola, and the plantation company Sena Sugar Estates (SSE) in Mozambique. Both operated continuously within the institutional framework created by Portuguese labour legislation, both survived to the end of the colonial period in 1974, and both left detailed labour-cost records (see [Dolan, 2024](#); [Jones and Gibbon, 2025](#), also Appendix A). Relying on them yields the longest and most internally consistent wage series distinguishing contracted from voluntary workers, in preference to colony-wide gaps averaged from sparse and intermittent observations across many employers.

Two features of that choice bear directly on the estimates. First, the comparison used to identify the counterfactual is within-firm and within-year, so it holds constant the sector, the technology, the employer’s product market and the local price level; what it does not hold constant is worker composition, which is precisely what the correction θ in (6) addresses. Second, both firms were unusually large and may have paid premia to coerced and voluntary workers alike. If those premia were proportionate, the within-firm ratio still travels; if coerced workers were treated relatively better than at smaller employers

(e.g., to enhance retention), the estimated gap is conservative. The Angolan evidence allows this to be checked: the Cassaquel sugar estate records a wider volunteer-to-forced wage ratio than Diamang, consistent with the mining company’s monopsonistic position and more hazardous work compressing the spread, and we scale the Diamang voluntary wage accordingly (Appendix A.2).⁹ As yet, no comparable multi-estate source exists for Mozambique, so SSE wages are used directly — which, since Mozambican wage extraction is the larger of the two colony series, is where the estimate is somewhat exposed (§6).

4.2 From firm evidence to economy-wide estimates

In principle, aggregation is just a sum over all firms engaging coerced labour. In practice, the wage gap is identified only for the benchmark firms, so the procedure factors into three steps, each resting on different evidence: identification of the relative wage gap at the benchmark firms; measurement of exposure, that is economy-wide counts of coerced and voluntary workers; and scaling of the first by the second. Exposure is reconstructed by expressing observed *recrutados* as a share of the *válido* population, the colonial administrative category for able-bodied African men, interpolating between observations, and applying the resulting share back to that population. Voluntary employment is obtained from the firm-level volunteer-to-forced ratio scaled to match aggregate benchmarks.¹⁰ The two components of the loss are then:

$$\Delta_t^{\text{wage}} = \theta_t L_t^F m_t [w_t^V - w_t^F]^+, \quad (10)$$

$$\Delta_t^{\text{fiscal}} = L_t^F [\bar{\tau}_t - r^* m_t w_t^*]^+, \quad \bar{\tau}_t = \max\left(\min(R_t/N_t, \frac{m_t}{3} w_t^F), \frac{m_t}{12} w_t^F\right) \quad (11)$$

⁹ Cassaquel provides a shorter and less complete comparison than the primary company records available for Diamang and Sena Sugar Estates. Portugal’s 1963 return to the ILO reported that Cassaquel employed 4,651 workers on 30 June 1962, of whom 2,585 were “recruited” workers (here treated as *contrato* workers). The ILO’s subsequent 1966 report also reproduces information on recruited-worker cash wages and remuneration in kind. These sources support the Cassaquel comparison, but do not offer payroll material comparable in depth to the Diamang and SSE series.

¹⁰ The substantial flow of cross-border Mozambican migrants requires a separate scope decision. Workers recruited under Witwatersrand Native Labour Association (WNLA) contracts for the South African mining sector, and through related arrangements for employment in Southern Rhodesia, were not subject to the same formal system of direct forced-labour recruitment as the Portuguese *chibalo* or *contrato* regime. Nevertheless, their classification as voluntary is contestable: colonial taxation and livelihood constraints within Mozambique, intercolonial recruitment arrangements, and restrictive conditions (principally, their provision for penal sanctions) in the destination labour markets all narrowed the choices available to prospective migrants. Because assigning these workers to either L^F or L^V could materially alter the reconstructed forced-to-voluntary ratio, and because their employment occurred outside Portuguese Mozambique, we exclude them from both labour totals. They remain relevant to the wider historical context of workers’ outside options (First, 1983; Van Onselen, 2021).

where m_t is the average contract length as a fraction of the year; and $w_t^* = w_t^F + \theta_t(w_t^V - w_t^F)$ is the counterfactual free annual wage. The correction θ_t is computed from the reconstructed counts as in (6) and then smoothed, in common with the other constructed series (Appendix A).

The above expressions are the applied counterparts to equations (6) and (8), with four implementation choices made explicit. First, both the loss dimensions are adjusted to capture temporal variation in contract lengths, which we observe at the firm level. Indeed, coerced workers were generally conscripted for a defined period of less than a full year. Based on the 1930 *Reglamento*, the default nominal term was six months, reflecting the minimum period for which men were required to demonstrate employment in a given year to avoid punishment through *chibalo*. In practice, however, these formal limits afforded workers little protection: contract durations were often disregarded or extended beyond the stipulated term by employers and colonial officials (Duffy, 1963; van Waijenburg, 2018). In our case, we draw on evidence of increasing contract lengths in Angola (from Diamang records), bounding them from $0.5 \leq m_t \leq 0.75$; in Mozambique, we fix $m_t = 0.5$ throughout. The wage loss thus only accrues over the contracted period, and the income against which a comparable non-coerced taxpayer's liability is assessed is the counterfactual wage earned over that same period.¹¹

Second, the taxpayer base N_t is estimated rather than observed. It is taken as the larger of the total *válido* population or 1.5 times the wage-labour force, then smoothed.¹² For illustration, if the *válido* male population was 400k and the combined forced and voluntary wage-labour force was 200k, the two candidate taxpayer bases would be 400k and 300k (respectively). In turn, the unsmoothed estimate of N_t would be 400k, since we take the larger of the two estimates. This again is a conservative choice: a larger taxpayer base spreads observed capitation revenue across more individuals, lowering the estimated per-capita burden and hence the resulting fiscal-loss estimate. In turn, under the flat per-capita allocation of equation (7), the effective tax per head is simply R_t/N_t for every group, which is used in equation (11). Third, the assessed per-head tax is bounded from above by a third of the annual forced wage and from below by one twelfth of the same, which limits the influence of years in which reported revenue per head is implausibly large or small relative to observed wages.

Fourth, for our benchmark results we fix the fair income-tax rate, r^* , at 5 per cent. This represents a defensible calibration of the effective tax burden borne by a relatively low-paid worker in non-coerced wage employment, rather than a direct estimate of the services

¹¹ We also assume that the wage is the only relevant base for assessing income tax.

¹² Concretely, we define: $N_t = \text{LOWESS}[\max((1 + \phi) \text{pop}_t^{\text{válido}}, 1.5(L_t^F + L_t^V))]$.

received in return for taxation. The chosen rate approximately matches the structure and incidence of income taxation observed in British East Africa during the 1950s. In Kenya, for example, the 1952 income-tax schedule provided a £200 minimum allowance and charged the first £400 of chargeable income at 1s. 6d. in the pound (7.5 percent), implying an effective burden of roughly 4–5 percent of gross earnings for workers at the lowest end of the taxable income distribution (UK Parliament, 1952b). The same Hansard return also reports minimum allowances of £200 in Tanganyika and Uganda, although their initial rates differed. More specific tax-liability calculations corroborate this approximation. In 1957, for instance, the reported East African income-tax liability for a single person was £18 15s. on an income of £400 and £28 2s. on £500, corresponding to effective rates of 4.7 and 5.6 percent, respectively (UK Parliament, 1957a).¹³ Evidence on the entire fiscal burden — also including indirect taxes — in French West Africa and Togo provides a complementary check. For poor non-European households, [Cogneau \(2023, Table 7.2, p. 408\)](#) estimates burdens of between 5.8 and 8.1 per cent of income in 1925, rising to between 8.1 and 14.7 per cent in 1955, depending on assumptions about tax incidence and progressivity. The point is that taxes on incomes applied to non-coerced workers were generally set at low to moderate rates in many 20th century colonial contexts.

Setting $r^* = 5\%$ implies average unweighted values of γ in equation (8) of approximately 0.42 (0.46 for Angola and 0.38 for Mozambique). Under this benchmark, therefore, approximately four tenths of the per-capita indigenous taxation levied from forced wage workers is treated as a liability that a comparably poor but non-coerced taxpayer would have owed, while the remaining share is treated as extractive. Without claiming direct commensurability, these values of γ are somewhat higher than the shares of aggregate colonial expenditure allocated to development activities (*fomento*), which formally encompassed expenditure directed toward both European and indigenous populations and whose period averages lie between 20 and 30 per cent across the two colonies. This does not imply that expenditure was distributed equally between the two populations or that its budgetary classification identifies whose welfare it increased.¹⁴ The more general point is that the choice of $r^* = 5\%$ represents a conservative counterfactual rate.

¹³ Appendix D documents these underlying schedules and liabilities.

¹⁴ Appendix A.6 documents the calculation.

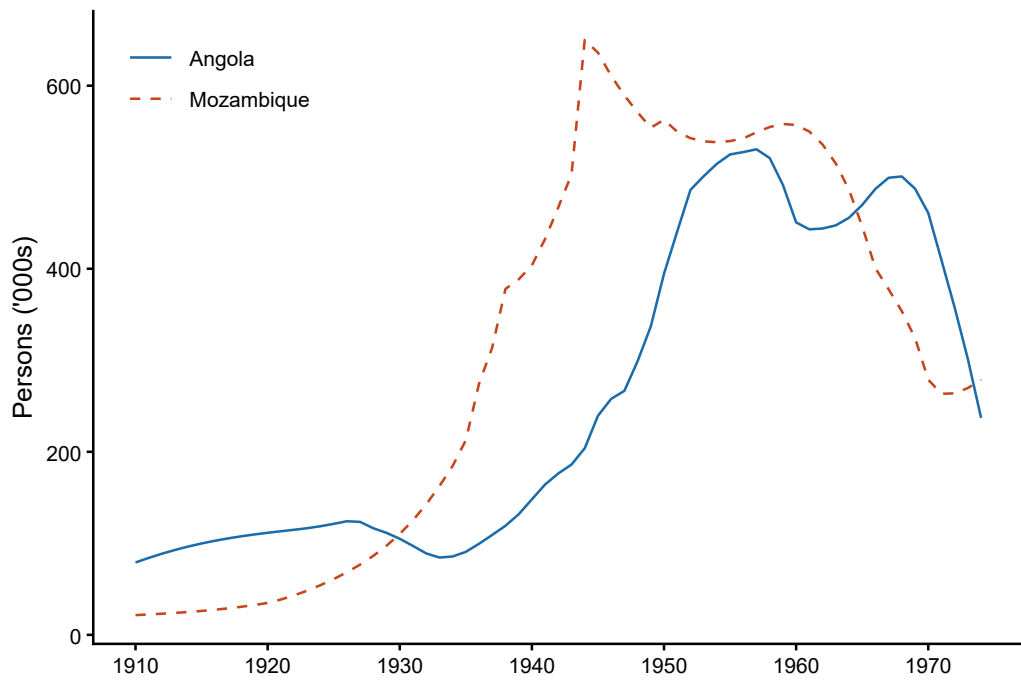
5 Results

5.1 How large was forced labour?

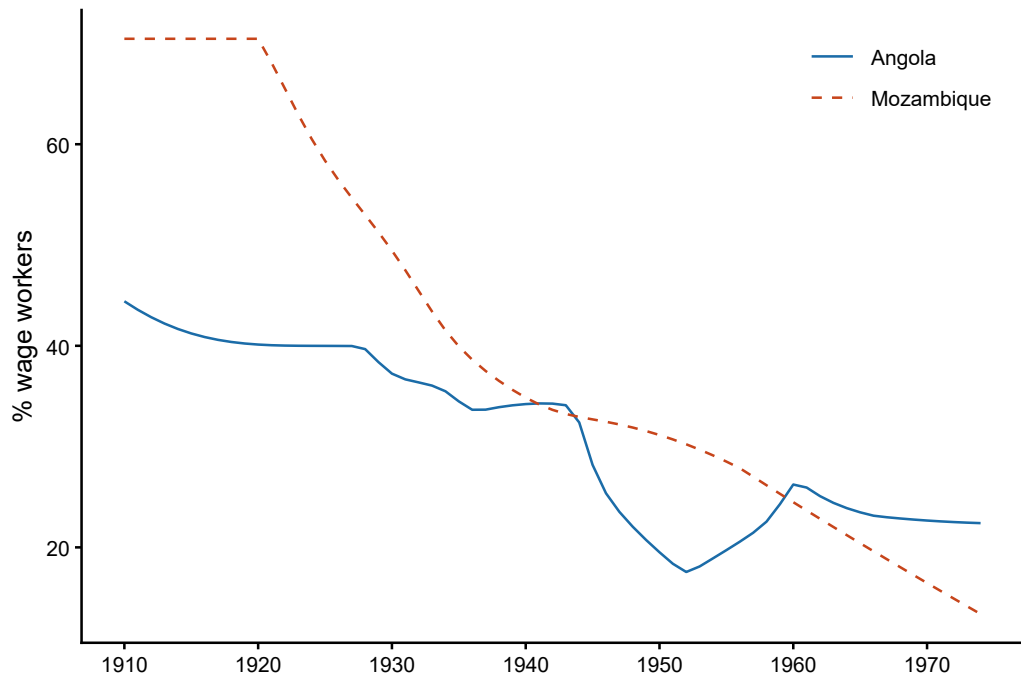
The first-order component of our estimates is the number of individuals exposed to forced wage labour. Table 2 reports decadal averages of the number of individuals under *contrato*, the able-bodied male (*válido*) population from which forced labourers were drawn, and the former as a percentage of the latter. Figure 2 complements these decadal summaries with annual estimates of the total wage-labour force in each colony over 1910–1974, combining the total number of forced and voluntary workers (panel a), and the proportion of wage workers subject to coercion (panel b). Taken together, the table and figure trace the trajectories of coercion across the two colonies, showing how its scale and incidence evolved—and periodically diverged—over time.

In keeping with the historical overview, the results confirm that forced wage labour was not only substantial but durable. Over 5 per cent of the able-bodied male workforce was under coercive wage contracts in both Angola and Mozambique as early as the 1920s, rising to almost 20 per cent in Mozambique in the 1940s and nearly 10 per cent in Angola in the 1960s. At peak, over 200,000 persons per year were contracted in this way in Mozambique and over 100,000 in Angola. Coercion also accounted for a large share of all wage employment: around 70 per cent of Mozambican wage workers and over 40 per cent of Angolan wage workers at the start of the period, declining steadily thereafter as the wage labour force expanded faster than conscription. The comparison reveals two distinct temporal paths. Mozambique undergoes the earlier and more rapid expansion: its decadal mean rises from about 35,000 coerced workers in the 1920s to 178,000 in the 1940s. Angola’s expansion is delayed, rising from around 36,000 in the 1930s to 99,000 in the 1950s and 113,000 in the 1960s. The ordering therefore reverses by the 1960s, when Angola overtakes Mozambique in the annual number under contract.

Figure 2: Scope of (forced) wage labour in Angola and Mozambique



(a) Total number of wage labourers (forced and voluntary)



(b) Share of wage labourers under coercion

Source: authors' own estimates.

Notes: panel (a) reports the reconstructed annual wage-labour force, $L_t^F + L_t^V$, in thousands of workers; panel (b) reports coerced workers as a percentage of that total, $100L_t^F / (L_t^F + L_t^V)$; coverage is 1910–1974. Sources and details of the construction of the forced and voluntary labour series are provided in Appendix A.2.

Table 2: Male workforce structure (annual means, by decade)

	Angola				Mozambique			
	<i>Válidos</i>	<i>Volunt.</i>	<i>Contrato</i>	%	<i>Válidos</i>	<i>Volunt.</i>	<i>Contrato</i>	%
1910	701	56	40	5.7	456	8	18	4.0
1920	722	70	47	6.5	470	25	35	7.5
1930	813	66	35	4.4	570	138	91	16.0
1940	936	165	63	6.7	972	364	178	18.3
1950	1,132	394	99	8.8	1,304	391	156	12.0
1960	1,248	356	113	9.0	1,536	358	97	6.3
1970	1,358	274	80	5.9	1,773	230	40	2.3

Source: authors' own estimates.

Notes: the table summarises estimates of the available male labour force and employment structure; *Válidos* are the total number of able-bodied men; *Volunt.* is the number of voluntary wage labourers; *Contrato* is the number of forced wage labourers; '%' is the share of *válidos* under *contrato*; decades refer to the first year of the decade (e.g. 1910 = 1910–1919); the final decade covers 1970–1974 only; all cells report annual means; absolute values are in thousands.

5.2 How much income did workers lose?

For each decade, Table 3 reports annual average estimates of both the wage and fiscal components of foregone income in each colony. These are expressed in three meaningful units (see §2.3): thousands of worker-year equivalents, obtained by dividing each loss by the prevailing annualised voluntary wage; millions of kilograms of maize flour, obtained by dividing the same loss by the prevailing average maize price; and shares of total colonial tax revenue other than capitation taxes. The three registers answer related but distinct comparative questions: the absolute quantity of labour income taken, the staple consumption it represented, and its importance relative to the contemporary colonial fiscal economy. Their cross-colony rankings need not coincide because wages, prices and the revenue denominator evolved differently. Figures 3 and 4 illustrate the wage and fiscal components respectively, expressed in worker-year equivalents and as shares of non-capitation tax revenue.

A number of insights emerge. At the broadest level, the series divide into three phases: a Mozambique-led acceleration through the interwar and wartime decades; a post-war divergence as Mozambican extraction contracts while Angolan extraction remains high or expands; and a final decline associated with the ending of *contrato*. Within that sequence, wage extraction exceeds fiscal extraction in every decade in Mozambique and, in Angola, in every decade except the 1920s and 1930s. That is, the two are of comparable size only in interwar Angola, where the hut/head tax was the state's principal operative tax handle. Elsewhere, however, the predominance of wage losses should not be taken to

imply that the wage gap itself was especially wide. Observed forced and voluntary wages, while unequal, were not as far apart as a purely coercive setting with no market discipline would imply. What makes the wage component large is instead the number of men to whom the gap applied and the duration over which it applied. This is consistent with the qualitative literature, which documents minimum wages being periodically raised in response to competitive pressure from South African recruiters and outside options in neighbouring territories, as well as *voluntário* status exerting some upward pull on the wage structure. The economic interpretation is that the coerced wage was suppressed but not arbitrary: employers operated against an outside option that coercion narrowed rather than eliminated.

Table 3: Summary of extraction by decade (annual means) and cumulative totals

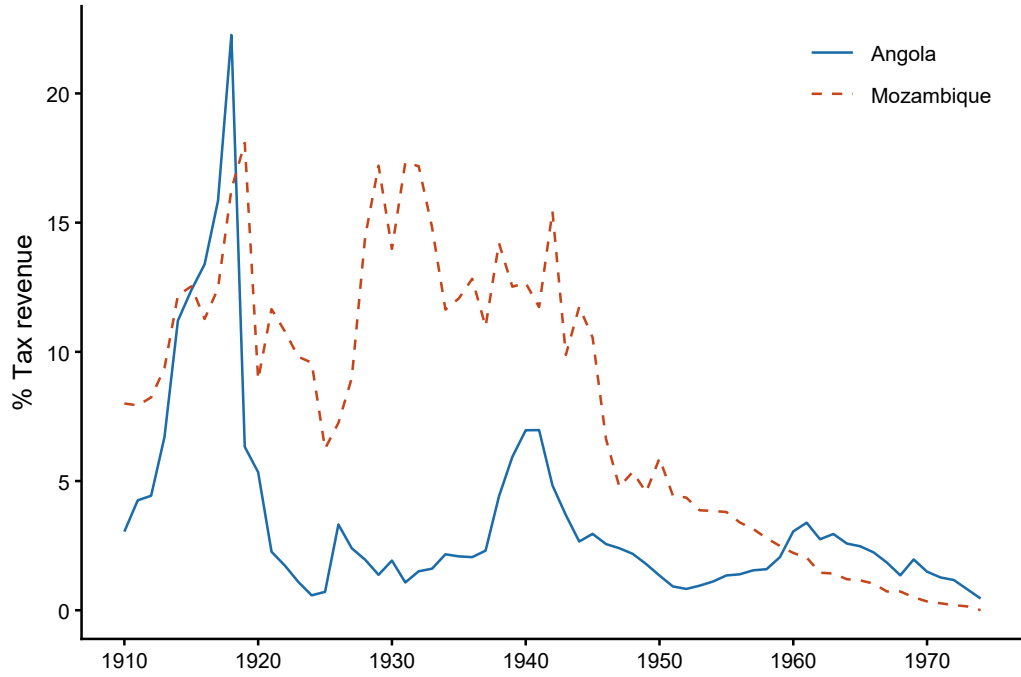
	Worker years (10^3)		Maize kg (10^6)		% Tax rev.	
	Wage	Fiscal	Wage	Fiscal	Wage	Fiscal
<i>Angola:</i>						
1910	4.57	0.31	0.86	0.06	9.98	0.71
1920	4.19	4.25	0.55	0.70	2.08	1.92
1930	3.73	3.84	1.29	1.45	2.51	2.69
1940	9.48	5.12	3.24	1.71	3.70	1.93
1950	8.97	4.34	3.54	1.63	1.31	0.62
1960	10.76	1.92	10.49	1.91	2.46	0.43
1970	5.21	1.56	10.13	3.01	1.04	0.31
Total	442.90	205.61	250.31	89.58	225.54	84.55
<i>Mozambique:</i>						
1910	7.07	0.26	1.99	0.07	11.64	0.42
1920	11.64	1.14	4.77	0.46	10.49	1.02
1930	21.11	5.87	8.19	2.09	13.76	3.56
1940	34.76	13.63	9.52	3.72	9.33	3.63
1950	25.88	11.53	10.10	4.49	3.80	1.69
1960	10.14	5.61	6.60	3.64	1.25	0.68
1970	2.51	1.42	1.89	1.04	0.19	0.10
Total	1,118.60	387.42	421.19	149.92	503.60	110.55

Source: authors' own estimates.

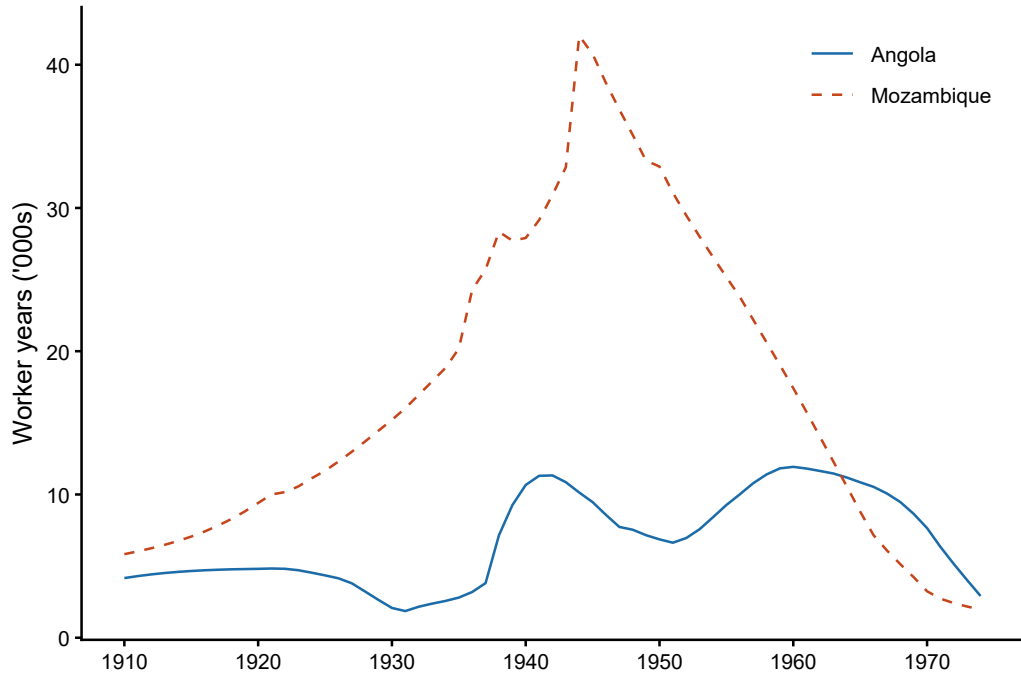
Notes: 'Worker years' are thousands of annual counterfactual free-wage equivalents (w_t^*); 'Maize kg' are millions of kilograms of maize flour; '% Tax rev.' is extraction as a share of non-capitation tax revenue. Entries are decadal annual means, except 'Total', which is the cumulative total over the full period 1910–1974; the 1970 row covers 1970–1974 only.

In worker-year equivalents, wage extraction peaks in the mid-1940s in Mozambique and around 1960 in Angola — the latter after an earlier local peak in the early 1940s — tracking the expansion of the plantation and mining sectors that sustained demand for contracted

Figure 3: Estimates of extraction via wage repression



(a) As % non-capitation tax revenue

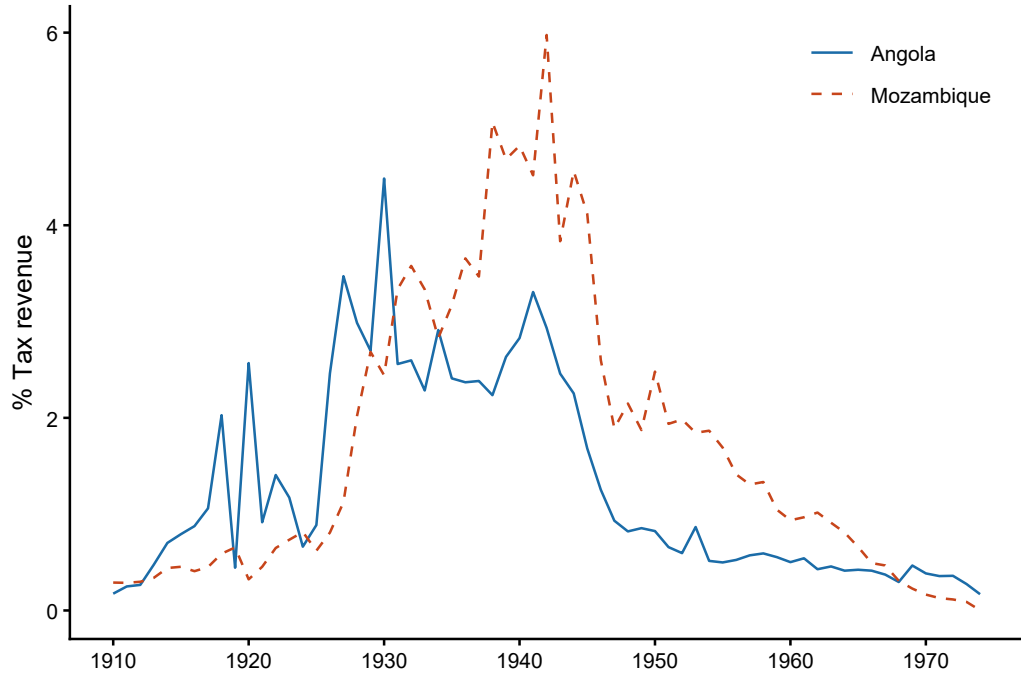


(b) In thousands of voluntary worker years

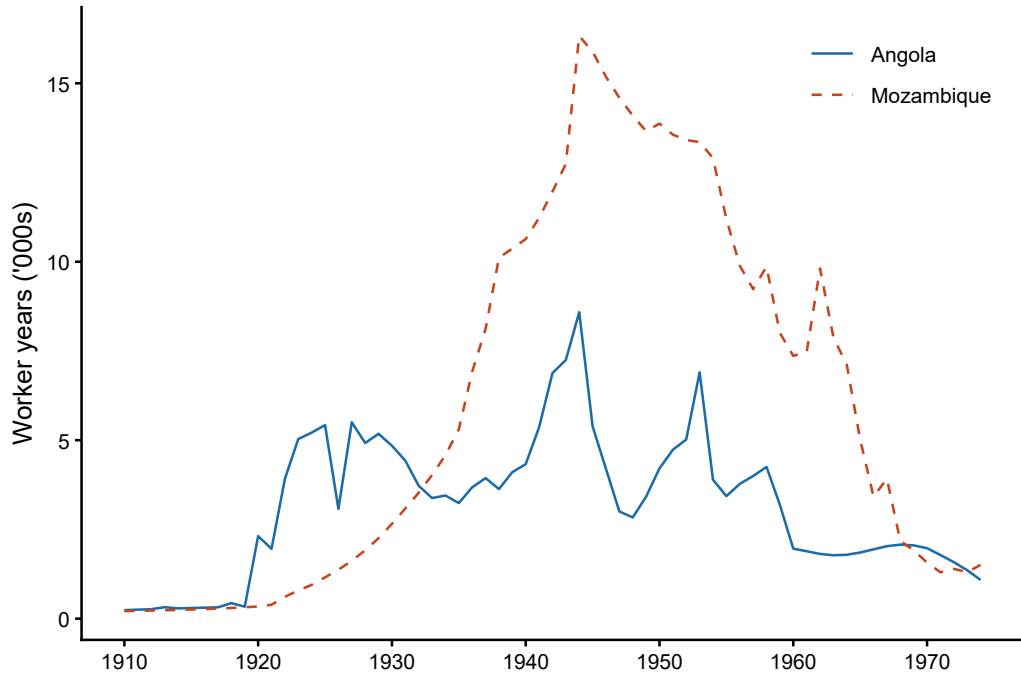
Source: authors' own estimates.

Notes: the figure reports annual estimates of extraction through wage suppression. Panel (a) expresses the estimated wage loss as a percentage of total colonial tax revenue excluding capitation taxes; panel (b) expresses the same loss in thousands of voluntary worker-year equivalents, calculated by dividing it by the contemporaneous counterfactual annual free wage, w_t^* ; coverage is 1910–1974. Sources and details of the construction of the wage-loss series are provided in Section 4.2 and Appendix A.

Figure 4: Estimates of fiscal extraction via capitation taxes



(a) As % non-capitation tax revenue



(b) In thousands of voluntary worker years

Source: authors' own estimates.

Notes: the figure reports annual estimates of fiscal extraction from coerced workers through capitation taxation. Panel (a) expresses the estimated fiscal loss as a percentage of total colonial tax revenue excluding capitation taxes; panel (b) expresses the same loss in thousands of voluntary worker-year equivalents, calculated by dividing it by the contemporaneous counterfactual annual free wage, w_t^* ; coverage is 1910–1974. Sources and details of the construction of the fiscal-loss series are provided in Section 4.2 and Appendix A.5.

labour into the final decades of colonial rule. The comparative ordering consequently changes over time. In the 1940s, Mozambique's mean annual wage loss, at about 35,000 worker-years, was nearly four times Angola's; by the 1960s the two were approximately equal, and in the early 1970s Angola's was more than twice Mozambique's. The same reversal appears in the loss relative to non-capitation revenue: Mozambique's wage-extraction rate was more than twice Angola's in the 1940s, whereas Angola's was about twice Mozambique's in the 1960s. At their annual peaks, wage suppression alone was equivalent to roughly 42,000 voluntary worker-years in Mozambique and 11,900 in Angola: that is, the income taken through the wage gap alone could have paid a further forty-two and nearly 12 thousand free workers a full year's free wage, respectively. The contrast between the two colonies is particularly striking in the postwar period: coercive extraction contracted rapidly in Mozambique while expanding anew in Angola, rather than declining uniformly across Portuguese Africa.

The fiscal series, in Figure 4, reveals a broadly shared but differently timed pattern: a burden that builds through the 1920s, concentrates in the interwar and wartime decades, and is followed by pronounced secular decline. Mozambique again displays the stronger wartime acceleration. Its mean fiscal loss rises from about 1,000 worker-years in the 1920s to almost 14,000 in the 1940s, compared with an increase from roughly 4,000 to 5,000 in Angola. The net capitation burden attributable to forced wage workers peaks at around 4.5 per cent of total non-capitation revenue in Angola, in 1930, and at close to 6 per cent in Mozambique in 1942, falling to around one per cent or less by the 1960s (Table 3, Figure 4). Unlike wage extraction, however, fiscal extraction remains larger in Mozambique than in Angola through the 1960s and reverses only in the final years of Portuguese colonial rule. This lag is consistent with the fiscal component reflecting both labour exposure and the changing productivity of alternative colonial tax handles.

Consistent with the broader fiscal importance of labour coercion documented by [van Waijenburg \(2018\)](#), the relative weight of capitation in the present case during the interwar decades reflects the limited development of other tax handles: trade taxes, excises and corporate levies were less productive in smaller, less commercialised economies, making the capitation and labour system not merely extractive but structurally central to colonial fiscal viability. The decline from the mid-1940s reflects both the broadening of the revenue base as the settler economy expanded and, after 1961, the formal abolition of *contrato*, which removed the administrative mechanism linking capitation payment to forced labour recruitment.

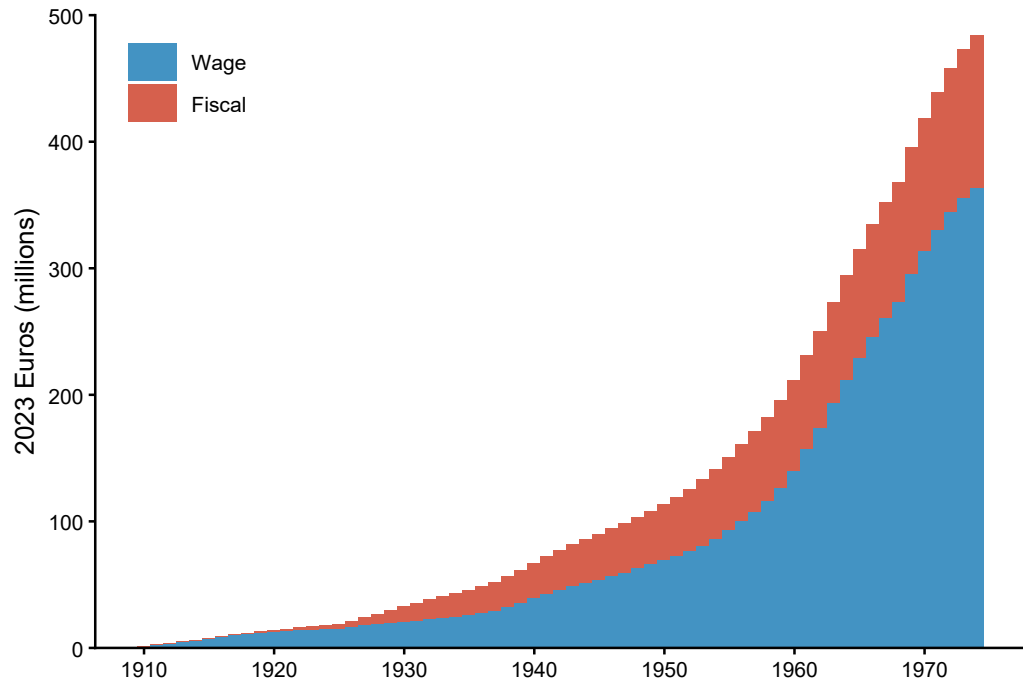
5.3 Total extraction and its present-day equivalent

Summing the two components gives the total opportunity cost borne by coerced workers, with the split between them denoting its destination. In the deflator-free register, the cumulative loss over 1910–1974 amounts to some 0.65 million worker-years in Angola and 1.51 million in Mozambique, about 2.15 million between the two territories (Table 3). Mozambique therefore accounts for more than twice Angola’s cumulative worker-year loss, largely because its extraction was both earlier and more intense at its peak. This is the estimate on which nothing but the reconstruction itself depends; everything else is a repricing of this loss. Expressed in the purchasing power of 2023 euros via the CPI chain of Section 2.3, total losses amount to around €484 million in Angola and €682 million in Mozambique (also see Figure 5), or approximately €1.17 billion across the two territories. Mozambique’s cumulative loss is approximately 2.3 times Angola’s in worker-year equivalents, but only around 1.4 times as large when expressed in 2023 euros, because the carry-forward also reflects when the losses occurred and the evolution of prices in each colony. In both territories the wage component is the larger of the two, at around 75 per cent of the colony total in each case, with capitation taxation accounting for the remainder. The accumulation profiles also differ. Mozambique’s burden accrues earlier and more steeply, consistent with the higher and earlier incidence of forced wage labour, while Angola’s accelerates through the 1950s and 1960s, as increased Portuguese migration contributed to the expansion of settler agriculture and existing plantations alongside continued growth in mining.

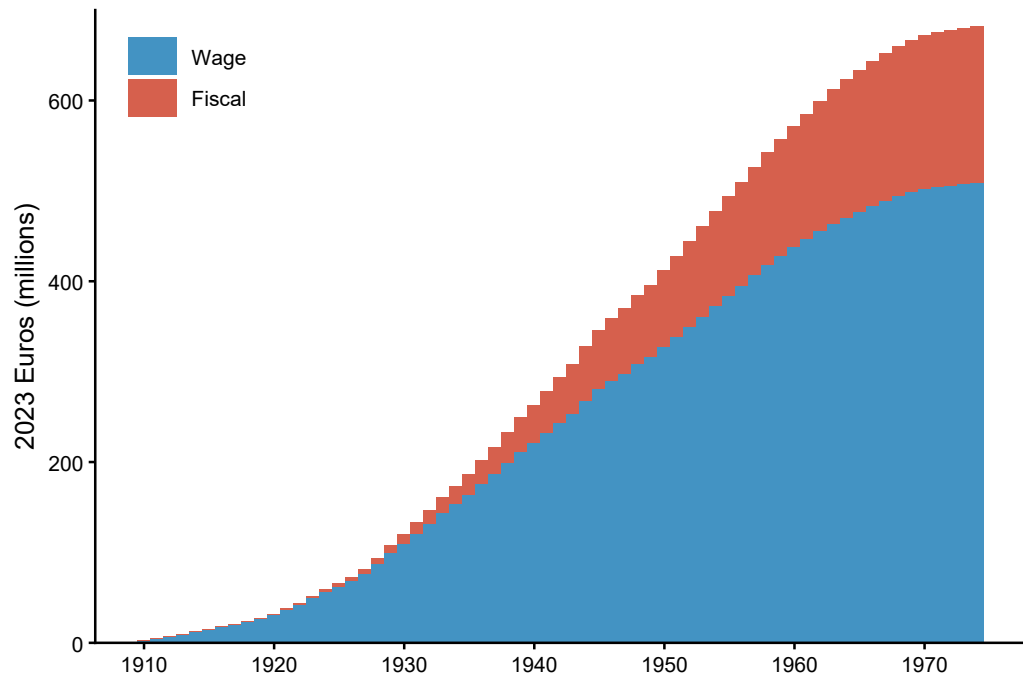
The ordering of the two dimensions suggests employers, rather than the state, are the larger beneficiaries of the measured transfer, and the margin narrows appreciably only in Angola and only under the most extreme fiscal assumption. At $r^* = 0$, treating the head tax as pure extraction, the Angolan fiscal head rises to €268 million, still clearly below the Angolan wage head of €364 million. In Mozambique, by contrast, the wage loss remains considerably larger under every scenario reported in Table 4. The more robust conclusion concerns the relative magnitude and timing of the two components rather than a strict ranking between them: both employers and the colonial state extracted substantial amounts, with employers capturing about three-quarters of the cumulative measured loss and fiscal extraction playing a relatively larger role during the interwar decades.

That both loss dimensions are large is itself an economic finding. It supports the notion that the mechanism of extraction was joint: a pecuniary tax liability imposed on a population with little cash income made labour available at a suppressed wage; and the wage was suppressed at the point where that liability was discharged. The two components should

Figure 5: Cumulative cost of extraction, millions of 2023 Euros (deflation method)



(a) Angola



(b) Mozambique

Source: authors' own estimates.

Notes: the figure reports the cumulative estimated cost of extraction in millions of 2023 euros under the benchmark CPI carry-forward rule. Panel (a) reports Angola and panel (b) Mozambique; within each bar, the wage and fiscal components are stacked, so the total height represents their sum. Each bar gives the cumulative value of losses from 1910 through the year shown; coverage is 1910–1974. Details of the carry-forward rule and underlying price series are provided in Section 2.3 and Appendix A.7.

therefore be understood as interdependent and mutually reinforcing: neither constituted an entirely separate injury, and neither would have been as extractive without the other. Supporting this view, both loss components fall to negligible levels within roughly a decade of the abolition of *contrato* in 1961, and they do so together, which is what one would expect if the two instruments were joined administratively rather than merely coincident. In Angola the turning point is sharp and dated: both series are still substantial at the end of the 1950s and fall away from the early 1960s. In Mozambique the decline begins earlier — both loss components were already contracting from the late 1940s as the coerced share of the wage-labour force falls — so abolition completed a decline rather than initiating one. This is consistent with [Dolan \(2025\)](#)’s finding that welfare ratios in Portuguese Africa improved rapidly and discontinuously following abolition, converging toward levels observed elsewhere in colonial Africa within a few years of the institutional change.

It further merits emphasis that the Euro figure is simply a cumulative translation of the same underlying losses into a modern unit, not an additional finding. And it also is conservative in scope. Our scope is confined to workers under forced wage contracts; we exclude non-wage coercion such as *chibalo*; and we apply the inframarginal correction that attenuates the raw rectangular estimate. The magnitudes are large relative to the colonial economies, but modest relative to modern metropolitan aggregates, and both readings are informative. On the one hand, a transfer that at its peak was worth a fifth or more of non-capitation revenue, and tens of thousands of free worker-years annually, can be considered a structurally central feature of colonial public finance and of the labour market it governed. On the other hand, that the same quantity converts to well below one per cent of Portugal’s present GDP is more a statement about the growth of the metropolitan economy to the present date and about the choice of transfer rule, not about the historical weight of the institution itself ([Portuguese Ministry of Finance, 2024](#)).

6 Robustness

As with any model-based historical reconstruction involving counterfactuals, our headline estimates rest on various classes of assumptions. These include: the size of the labour force and its composition; the extent to which coercion may have depressed voluntary wages; the inframarginal correction applied to the wage gap; the estimates of the size of the capitation tax base; the proposed fiscal counterfactual (fair tax rate); and the rule used to carry historical losses forward. To evaluate the sensitivity of our headline results to these underlying assumptions, Table 4 reports cumulative total losses in 2023 euros under alternative specifications. The first row reproduces the headline benchmark estimates reported in

§5.3. Panels A–F assess their sensitivity by varying a different class of assumptions while holding all others at their benchmark values.

Two features of the table are worth highlighting. First, holding the carry-forward rule fixed at the CPI chain, the range spanned by Panels A–E places the two-colony aggregate loss between roughly €0.82 and €3.23 billion, versus the benchmark estimate of €1.17 billion — that is, between 0.7 and just under three times the benchmark. However, much of that range comes from a single choice, namely ignoring the inframarginal correction in Panel C ($\theta = 1$), which reflects the difference between measuring the workers’ loss and the employers’ enrichment (disgorgement). Excluding it, the maximum of the remaining rows equals €1.79 billion, about one-and-a-half times the benchmark. This suggests that, although the precise aggregate loss varies across specifications, it remains within a reasonably bounded range and its broad order of magnitude is stable. No single variation among the reasonably defensible assumptions in Panels A–E moves the two-colony total outside a range of approximately 0.8 to 3.2 billion euros.

Second, Panel F alone spans €0.75 to €7.62 billion, a far wider range than Panels A–E together, which is precisely the argument of §2.3. It indicates *how* a historical loss is carried forward to the present typically contributes more to variation in the resulting estimates than how the loss is valued contemporaneously. Specifically, where a compounding rule is used, even small differences in the choice of interest rate can alter final valuations by an extremely large magnitude. For instance, increasing the interest rate from 7% to 9% increases aggregate losses by a factor of about 4.6.

Scope of extraction (Panel A). The absolute number of persons coerced into wage labour is not only a variable of first order importance (see equations 10 and 11), but is also subject to uncertainty. For instance, the economy-wide forced-labour share is anchored at 2 per cent of the *válido* population at both ends of the period, while the *válido* series itself is interpolated from irregular administrative observations. The size of the voluntary wage labour force suffers from similar challenges, as discussed in Appendix A. Consequently, we introduce two proportional adjustment factors. The first simply rescales the total size of the wage labour force in each period: $\tilde{L}_t^W = (1 + \alpha)(L_t^F + L_t^V)$; the second keeps the total fixed and varies only the forced labour component: $\tilde{L}_t^F = (1 + \alpha)(1 + \beta)L_t^F$, with $\tilde{L}_t^V = \tilde{L}_t^W - \tilde{L}_t^F$. We independently vary both of these adjustment parameters over $\{-0.25, 0, 0.25\}$, where zero corresponds to the benchmark assumption. This means that the resulting sensitivity analysis evaluates underlying labour-force components over a range extending from 75 to 125 percent of the benchmark values. This range is chosen as a conservative sensitivity interval, intended to assess robustness to deviations from the benchmark, but not to represent

Table 4: Summary of different scenarios (robustness analysis)

	Angola			Mozambique			Both
	Wages	Fiscal	Total	Wages	Fiscal	Total	Total
<i>Benchmark</i>	364	120	484	509	173	682	1,166
A. Demographics							
$\alpha = -0.25$	273	90	363	381	130	511	874
$\alpha = 0.25$	455	150	605	636	216	852	1,457
$\beta = -0.25$	267	90	358	325	133	457	815
$\beta = 0.25$	483	149	632	828	207	1,035	1,667
B. Wage to coercion slope							
$\epsilon = 0.2$	414	118	532	564	170	734	1,266
$\epsilon = 0.4$	464	115	579	620	168	787	1,366
C. Inframarginal adj.							
$\theta = 1$	1,426	67	1,493	1,624	117	1,741	3,234
$\theta = 0.5$	713	103	816	812	158	970	1,785
$\theta = 0.25$	356	121	477	406	178	584	1,061
D. Tax base							
$\phi = -0.25$	364	149	513	509	203	712	1,224
$\phi = 0.25$	364	101	464	509	150	659	1,123
E. Uncoerced tax rate							
$r^* = 0\%$	364	268	632	509	244	753	1,385
$r^* = 2.5\%$	364	194	558	509	209	717	1,275
$r^* = 10\%$	364	31	395	509	103	612	1,007
F. Alt. carry forward rules							
Maize price	213	76	289	337	120	457	746
Poverty-line anchor	347	161	508	940	326	1,265	1,773
Compounding (7%)	296	139	435	949	261	1,209	1,644
Compounding (8%)	571	291	862	2,114	546	2,659	3,522
Compounding (9%)	1,118	615	1,734	4,734	1,149	5,882	7,616

Source: authors' elaboration.

Notes: entries are estimated cumulative losses over 1910–1974, in millions of 2023 euros. ‘Wages’ and ‘Fiscal’ report the two components of estimated losses; ‘Total’ combines them within each colony, while ‘Both’ reports the global total (Angola and Mozambique). The first row (benchmark) reproduces the headline estimates. Panels A–E vary one class of measurement assumption at a time using the benchmark CPI carry-forward rule; Panel F varies the carry-forward rule only. Parameter definitions and interpretations of the panels are provided in Section 6.

a formal statistical confidence interval.

The response to α is close to proportional, as it must be when both heads scale with the number of coerced workers: a quarter reduction in the wage-labour force lowers the Angolan total from €484 to €363 million and the Mozambican from €682 to €511 million, and a quarter increase raises them to €605 and €852 million. The fiscal head tracks α almost exactly one-for-one because the taxpayer base is anchored on the *válido* population rather than on the wage-labour force, so the assessed per-head tax $\bar{\tau}_t$ is unchanged and only L_t^F moves.

Composition matters more than scale, and asymmetrically across the two colonies. In Mozambique a 25 per cent increase in the coerced share raises the wage head by 63 per cent, from €509 to €828 million, because β moves L^F and the coercion ratio L^F/L^V — and hence θ — in the same direction; the same variation in Angola raises the wage head by 33 per cent, since Angolan coercion is light enough for θ to sit at its lower clamp in most years (Panel C below). Taken together, the labour-force assumptions place the two-colony total between roughly €0.82 and €1.67 billion, against a benchmark of €1.17 billion.

Depression of volunteer wages (Panel B). Section 3.3 argued that the observed *voluntário* wage was itself set within the coercive system and therefore may well lie below a genuine no-coercion free wage. Panel B reviews what that would imply by replacing the estimated voluntary wage with $\tilde{w}_t^V = (1 + \epsilon L_t^F/L_t^W) w_t^V$, so the counterfactual free wage scales up with the intensity of coercion in the wage-labour market: ϵ is the proportional uplift that would apply if the entire wage-labour force were conscripted, with $\epsilon = 0$ as the benchmark. This device is deliberately crude and reduced-form in the sense that it simply imposes a slope and assumes labour magnitudes are unchanged, implying no attempt to capture general-equilibrium effects.

As expected, the wage loss rises with ϵ . At $\epsilon = 0.2$ and 0.4 it rises by 14 and 27 per cent in Angola and by 11 and 22 per cent in Mozambique. Angola is the more sensitive of the two because the observed wage gap is narrower, so a given proportional uplift to w^V raises the difference $w^V - w^F$ more than proportionally. The fiscal loss moves slightly the other way: at $\epsilon = 0.2$ and 0.4 , it falls from the benchmark of €120 million to €118 million and €115 million in Angola, and from €173 million to €170 million and €168 million in Mozambique. This is because the comparator's liability is assessed on the counterfactual free wage w^* , which rises with ϵ , so a larger part of the observed head tax is counted as fair. However, these movements are modest: at $\epsilon = 0.4$ the two-colony total rises to €1.37 billion, about 17 per cent above the benchmark. This is worth stating plainly, since

the validity of the observed voluntary wage may be a fundamental objection to its use as a counterfactual. The adjustments considered here increase estimated losses but do not alter the order of magnitude of the benchmark.

The inframarginal correction (Panel C). The wage component is proportional to θ , so its bounds are transparent: $\theta \equiv 1$ recovers the gross transfer $L^F(w^V - w^F)$, which is the employers' enrichment and an upper bound on the workers' loss, while $\theta \equiv \frac{1}{4}$ is the most attenuated triangle the correction admits. Read against the benchmark, the panel also recovers the effective, loss-weighted θ implied by the reconstructed series: the benchmark wage head is 25 per cent of the $\theta \equiv 1$ row in Angola and 31 per cent in Mozambique. The Angolan benchmark total (€484 million) is almost identical to its $\theta \equiv \frac{1}{4}$ row (€477 million), confirming that Angolan coercion is light enough ($L^F < \frac{1}{2}L^V$) for the lower clamp to bind in nearly every year; the Mozambican benchmark (€682 million) sits between the $\theta \equiv \frac{1}{4}$ and $\theta \equiv \frac{1}{2}$ rows (€584 and €970 million), reflecting a coercion ratio that falls from above one early in the period to well below it after 1950.

Valuing the loss at the gross transfer instead — that is, measuring what employers gained rather than what workers lost — multiplies the wage head by four in Angola and by a little over three in Mozambique, raising the two-colony total from €1.17 to €3.23 billion. This range of estimates is the widest among the measurement assumptions in Panels A–E (not F) and underscores a central contribution of our framework: distinguishing the observed voluntary wage, a marginal market outcome, from the average counterfactual wage of the coerced workforce. Failing to make this distinction materially overstates the estimated loss. Note also the partial offset in the fiscal column: raising θ raises the counterfactual free wage w^* , hence the comparator's fair liability, so the fiscal head falls from €120 to €67 million in Angola and from €173 to €117 million in Mozambique as θ goes to one. The two components share a single counterfactual wage: increasing the inframarginal correction raises the wage component while reducing the fiscal component.

The capitation tax base (Panel D). The fiscal head is assessed on revenue per head, so it depends on how widely the observed capitation revenue is spread. Panel D scales the demographic term in the taxpayer base, N_t , by ± 25 per cent. A wider taxpayer base spreads capitation revenue across more people, lowering $\bar{\tau}_t$ and therefore reducing the estimated fiscal loss. As such, the fiscal component falls to €101 million for Angola and €150 million for Mozambique at $\phi = 0.25$, and rises to €149 million and €203 million at $\phi = -0.25$. The response is muted rather than proportional for two main reasons: the wage-labour floor $1.5 L_t^W$ binds in some years, and the cap and floor on $\bar{\tau}_t$ — a third and one twelfth of the

annual forced wage — bind in others. The wage head is untouched by construction, so the colony totals move by at most about 6 per cent in either direction. Of the assumptions specific to the fiscal head, this is the least consequential.

The fiscal counterfactual (Panel E). The fiscal component is bounded above by treating the head tax as pure extraction, $r^* = 0$, and vanishes at $r^* = r_A \equiv \bar{\tau}/(mw^*)$, the rate at which coerced workers were taxed no more heavily relative to income than the comparator. At $r^* = 0$ the fiscal loss is €268 million in Angola and €244 million in Mozambique; halving the benchmark to $r^* = 2.5$ per cent gives €194 million and €209 million; a generous $r^* = 10$ per cent gives €31 million and €103 million. As noted, the benchmark $r^* = 5$ per cent is anchored to reported effective income-tax liabilities for relatively low-income taxpayers in British East Africa. Since settlers were exempt from the *imposto indígena* altogether and only became liable to a general tax on wage income tax from the 1960s, the value $r^* = 10$ per cent should be read as a generous comparator, yielding a conservative lower fiscal loss estimate.

However, there is some asymmetry between the colonies in their response to r^* . The Angolan fiscal component drops significantly at $r^* = 10$ per cent, or by almost three-quarters relative to the benchmark, which suggests that the implied effective rate on counterfactual earnings, r_A , was of about that order in various years. In contrast, the Mozambican fiscal component falls by closer to forty percent over the same range. Indeed, we estimate the mean effective tax rate on income was around 14.4% in Angola and 15.1% in Mozambique over the period (see Figure B3). The Angolan fiscal loss thus appears somewhat more sensitive to the choice of rate. Even so, the ordering of the two loss components in the two countries remains stable to the choice of r^* .

Carry-forward rule (Panel F). Holding scope and valuation fixed at the benchmark assumptions, the carry-forward rules of Panel F span a wide range. Three alternatives to the CPI chain are reported: a staple-price rule, a subsistence-anchored labour-time (low-wage) rule, and nominal compounding at several rates. The first focuses on forgone consumption, using maize prices rather than a general price index to convert losses into real terms. We use maize flour because staple-grain prices, and maize in particular, are well-established components of historical reconstructions of African real wages and living standards, notably in the influential subsistence-basket approach of Frankema and van Waijenburg (2012). For workers living close to subsistence, marginal income is likely to have been especially valuable in terms of additional food consumption. The rule therefore converts each year's monetary loss into kilograms of maize flour at the prevailing local price and then values

that same quantity at the present-day maize-flour price in each country. For illustration, if a loss of 100 escudos occurred when maize flour cost 2 escudos per kilogram, it represented 50 kilograms of forgone staple consumption. If that quantity costs €50 today, this is taken as the present-day equivalent value of the historical loss. Applied throughout, the rule gives €289 million for Angola and €457 million for Mozambique, approximately 60 and 67 per cent of their respective benchmarks. This lower valuation reflects the relative-price movement embedded in our Angolan and Mozambican series. Comparative evidence from East Africa likewise indicates that maize prices have fallen relative to the general consumption basket over the long run

citep[Figures 4a–4b]frankemaEtAl2025maize. Consequently, replacing the historical quantity of forgone maize requires a smaller present-day sum than that required to preserve the loss’s general purchasing power.

The second alternative holds the loss fixed in units of labour time rather than units of staple goods consumption. Each annual loss is expressed in worker-year equivalents, as in the second register of §2.3, and each worker-year is then priced at what it would cost today to sustain the household that a worker-year sustained. The rule is:

$$\kappa_t^{\text{pov}} = \frac{(1+n) w_T}{w_t^*}, \quad w_T = \frac{3 \times 365 \times \Pi^{2021} \times (\text{CPI}_{2023}/\text{CPI}_{2021})}{e_{2023}}, \quad (12)$$

where 3 denotes the daily international extreme-poverty threshold in 2021 international dollars; Π^{2021} is the country’s 2021 PPP conversion factor in local currency units per international dollar; CPI is the domestic consumer price index; e_{2023} is the average 2023 market exchange rate in local currency per euro; and n is the age-dependency ratio (dependants per working-age person).

Three features of equation (12) deserve comment. First, the anchor is built in each country’s own currency and price level rather than imposed as a common euro figure. Because the PPP-denominated poverty line is first converted into local currency and only then converted into euros at the contemporaneous market rate, the resulting euro anchor incorporates the prevailing real exchange rate. A major nominal devaluation that is not fully offset by domestic inflation raises the number of local-currency units per euro and therefore mechanically lowers the euro value of the anchor. Second, it is a reference subsistence anchor rather than a specific labour price: it says what a worker-year should deliver at the extreme poverty line, not what the labour would fetch. This is deliberate. In 2023, the statutory agricultural minimum wage was Kz32,181 per month in Angola and MT5,800 in Mozambique ([Ministério da Administração Pública, Trabalho e Segurança Social, 2023](#); [Instituto Nacional de Segurança Social, 2023](#)). At the annual-average exchange rates used

here, these correspond to approximately €43 and €84 per month, respectively. While seemingly low by international standards, these statutory minima nevertheless exceeded the actual earnings of many workers: survey evidence indicates that at least half of Angolan agricultural workers and approximately 53 per cent of Mozambican agricultural wage workers earned below the applicable minimum ([World Bank, 2023](#); [International Labour Organization, 2025](#)). The statutory floors also reflect different institutional arrangements. Mozambique’s agricultural minimum is renegotiated annually and represents a relatively large share of average income, whereas Angola’s was fixed in nominal terms in early 2022 and substantially eroded by the high inflation of 2023; Angolan legislation also permits authorised agricultural employers to pay below the statutory rate. A minimum-wage anchor would therefore import country-specific differences in formal wage setting, enforcement and inflation into the carry-forward calculation rather than provide a commensurable measure of low-income earnings.

Third, n is the age-dependency ratio, calculated by dividing the number of children and older people by the working-age population. For both Angola and Mozambique, its average is approximately 0.9, corresponding to around 90 dependants for every 100 working-age people. We do not use the larger ratio of household members to wage earners, estimated at roughly four to five, because applying it as a support multiplier would effectively treat everyone outside wage employment as economically dependent on the wage earner. Many working-age household members, particularly women, instead contributed to household production through agriculture and other forms of self-employment.¹⁵

Table B2 assembles the required components of equation (12). Applied to the cumulative sums of extracted worker-years (Table 3), this rule gives an estimate of €508 million for Angola and €1,265 million for Mozambique, also plotted in Figure B1. The two anchors differ by under ten per cent, so the divergence from the benchmark is substantive rather than merely a product of using two different scalars. Specifically, relative to the CPI chain, the Angolan total is little changed, at some five per cent higher, while the Mozambican total rises by around 85 per cent. This occurs because a given monetary loss represents a larger number of worker-years when the real free wage w_t^* is low, and Mozambican losses are concentrated in precisely such years. Read the other way, the row restates the deflator-free finding of §5.3, which indicates that some 2.15 million worker-years were appropriated across the two colonies, and what a worker-year is worth today is the whole of the remaining judgement. Taken together, the table and figure trace the trajectories

¹⁵ This interpretation is consistent with contemporary ILO-modelled estimates reported by the World Bank, which indicate female labour-force participation of approximately 72 per cent in Angola and 77 per cent in Mozambique, alongside very high female self-employment in both countries. Although contemporary rather than historical, these indicators demonstrate why absence from formal wage employment should not be equated mechanically with economic dependency; see [World Bank \(2026a\)](#) and [World Bank \(2026b\)](#).

of coercion across the two colonies, showing how its scale and incidence evolved—and periodically diverged—over time.

The remaining rows apply the compounding convention that dominates the reparations literature, using nominal rates of 7, 8 and 9 per cent. The 7 per cent rate is anchored to the rounded average nominal return on Portuguese safe assets over the period 1910–2017 estimated by [Jordà et al. \(2019\)](#). At this rate, the estimates are €435 million for Angola and €1.209 billion for Mozambique. The discrepancy relative to the benchmark reflects two features of the data. First, CPI inflation during the colonial period was moderately higher in Angola than in Mozambique (8.4% compared with 8.0%). Second, a much larger share of Mozambique’s losses occurred in earlier years. Increasing the compounding rate by just one percentage point, from 7 to 8 per cent, raises the estimates to €862 million for Angola and to €2.659 billion for Mozambique. A further one-percentage-point increase, from 8 to 9 per cent, raises them again to €1.734 billion and €5.882 billion, respectively. Thus, each one-percentage-point change approximately doubles the estimated loss, with the increase slightly greater in Mozambique. Put differently, with the exception of the gross-transfer upper bound, our headline estimate and the bulk of the robustness estimates in Panels A–E cluster around the range implied by nominal compounding at rates of 6 to 7 per cent.¹⁶ This extreme sensitivity to consecutive one-percentage-point changes underscores why we avoid the compounding convention: its output is dominated by a parameter that is inherently difficult to justify.

Before concluding, two main limitations should be flagged. The first concerns firm representativeness. The voluntary-forced wage gap is identified at Diamang and Sena Sugar Estates and assumed to apply economy-wide. Diamang’s monopsonistic position and more hazardous work appear to have compressed the free–forced spread relative to the wider economy, which the Cassaquel adjustment seeks to correct. No comparable multi-estate wage series is available for Mozambique, so SSE’s wages are used directly; and since Mozambican wage extraction is the larger of the two colony series, this is where our estimate is most exposed. The second is the general-equilibrium status of the voluntary wage. Panel B tabulates one half of the problem — that the observed voluntary wage was set inside the coercive system, and so lies below a genuine no-coercion free wage — but not the other: absorbing the coerced workforce into voluntary employment would itself have shifted the effective labour-supply curve outward, lowering the market-clearing wage. The two effects work in opposite directions. Panel B reports the direction and approximate magnitude of the first, while we make no adjustment for the second; the available records cannot identify the net effect. The first nevertheless plausibly dominated for much of the period because

¹⁶ As noted in §2.3, the usual ordering of carry-forward rules compresses and reverses in high-inflation cases when conservative rates are adopted.

wage formation in Portuguese Africa was embedded in an extensive coercive institutional architecture that likely constrained local labour market adjustment.

7 Conclusion

This paper developed and applied a framework for estimating the opportunity cost of forced wage labour in Portuguese Africa between 1910 and 1974. The analysis was organised around a transparent three-step measurement framework, which involved: fixing the scope of loss; valuing it against a contemporaneous non-coercive counterfactual and partitioning it between beneficiaries; and carrying it forward under an explicit rule. We implemented this framework drawing on extensive firm wage records, colonial labour statistics and fiscal accounts for both Angola and Mozambique. We found that coercion was extensive and persistent. Over five per cent of able-bodied men were under coerced wage contracts in both colonies by the 1920s, rising to almost twenty per cent in Mozambique in the 1940s and nearly ten per cent in Angola in the 1960s, with peak annual conscription above 200,000 and 100,000 respectively. The income extracted was correspondingly large relative to the colonial economies: at its peak, wage suppression alone exceeded a fifth of all colonial tax revenue other than capitation in Angola and approached that share in Mozambique, while capitation extraction from coerced workers reached around six per cent of the same aggregate in Mozambique in the early 1940s. Cumulated over the period, the system appropriated some 2.15 million years of free labour across the two colonies, equivalent in purchasing power to approximately €1.2 billion in 2023 prices.

Both the framework and results highlight that forced wage labour in Portuguese Africa was not only a mechanism for allocating labour to employers. It also was a mechanism for extracting and transferring income away from the affected workers, through two joined instruments: wage suppression, which delivered income to employers; and capitation taxation, which delivered income to the colonial state. Our benchmark estimates show Mozambique represented a larger share of total losses, reflecting (in part) the larger absolute mass of individuals under forced contracts. Estimated losses from wage suppression exceed those from fiscal extraction, at roughly three-quarters of the cumulative total. The fiscal estimate, however, nets out the tax liability attributed to a comparable non-coerced worker. When that comparator liability is set to zero—so that the entire head tax is treated as extraction—Angola’s fiscal loss rises close to, but remains below, its wage loss. As we have emphasised, the two instruments were therefore not merely complementary but mutually reinforcing components of a single extractive system. The cash liability from capitation taxes created pressure to enter wage employment, penal sanctions reduced the value of

staying out, and a single administrative apparatus enumerated, taxed and conscripted the same men. Their timing reflects that joint construction: fiscal extraction peaks in the interwar and wartime decades, when the head tax was the state's principal working tax handle and African cash incomes were lowest — around 1930 in Angola and in the early 1940s in Mozambique — while wage extraction peaks at the height of plantation and mining demand, in the mid-1940s in Mozambique and around 1960 in Angola; but both fall to negligible levels within about a decade of the abolition of *contrato* in 1961. This reinforces the need to treat colonial labour coercion and colonial fiscal extraction as inherently connected and to analyse them as components of a single extractive system.

Methodologically, the paper makes a more general point. Coercive labour markets often contain the evidence needed to value the opportunity cost of coercion, because coerced and non-coerced workers coexisted, often even under the same employer. But that evidence must be handled with care: an observed voluntary wage is the reservation wage of the marginal volunteer, not of the inframarginal workers whom coercion had removed from the market. Applying the observed gap to every coerced worker measures the employers' enrichment rather than the workers' loss — two defensible objects that the literature has generally not distinguished, and which differ here by a large factor. Recovering the latter requires the area between the free and coerced supply schedules, and hence a correction keyed to how far the observed voluntary quantity sits from the coerced one.

The framework applies wherever three conditions hold: exposure can be counted rather than presumed; a non-coercive labour-market counterfactual can be observed or credibly reconstructed for the same period, sector and population; and, the incidence of the transfer can be traced to its beneficiaries. These conditions held in Portuguese Africa, but were not unique to that context. They also characterise a range of coercive labour institutions across different periods and geographical settings.

What our estimates do not capture should be made equally clear. They measure foregone labour income for workers exposed to coerced wage contracts, and nothing more. They do not measure the full welfare costs of coercion, which included morbidity, mortality, household disruption and deprivation of liberty; nor do they reflect the collapse of sending economies that recruitment produced; nor lost human capital, demographic effects or intergenerational transmission; nor counterfactual output or long-run development paths; and they are not a statement of what is owed. Tracing intergenerational consequences would require an overlapping-generations framework that would need to model the very constraints the *indigenato* imposed (e.g., restricted property rights, credit, mobility, enforceable contracts etc.), rather than presuppose those very market conditions that the apparatus of coercion denied. Direct contemporaneous measurement is not a second-best substitute

for that accounting. Given the institutional environment that prevailed, it is instead the most historically grounded and empirically defensible starting point for quantifying the economic extraction arising from specific episodes of historical injustice.

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A Appendix: Data, sources and variable construction

This appendix documents the construction of the annual panel underlying the estimates: the archival sources for each series, the harmonisation and gap-filling decisions taken, and the parameters entering the estimating equations (10) and (11). It is organised in the order in which the series are built: firm-level wages (§A.1), economy-wide labour flows (§A.2), population denominators (§A.3–A.4), capitation revenue and the fiscal base (§A.5), the *fomento*-based calibration check (§A.6), and prices and currency conversion (§A.7).

Three conventions apply throughout and are not repeated below. Gap-filling within a series uses monotone Hermite spline interpolation, which preserves the sign of observed trends while avoiding the oscillatory artefacts of higher-order polynomial methods. Series that enter the welfare calculation directly are smoothed with a locally weighted scatterplot smoother (LOWESS) before use, to remove year-to-year irregularities attributable to measurement noise in the underlying colonial records; where a raw observation exists it is retained and the smoother is used only to fill non-observed years. Zero-valued observations in the labour and revenue series are recoded as missing, on the judgement that a reported zero reflects administrative non-reporting rather than the genuine absence of recruitment or collection in a year in which the colonial apparatus was operational.

A.1 Firm-level wage series

Angola: Diamang. The principal firm-level source is the Diamang (*Companhia de Diamantes de Angola*) archive, whose records from operations in the north-eastern Lunda region are housed in the Life Sciences Faculty of the University of Coimbra. Over sixty annual reports (*Relatórios e Contas*) and internal board minutes (*Relatórios do Conselho de Administração*) were consulted, together with a series of specialised labour reports issued as *Relatório da Secção de Trabalho Indígena*, compiled by the firm’s Luanda headquarters (*Direcção Geral*). These provide year-by-year information on workforce composition, recruitment practices, provisioning standards, health conditions and wage structures, covering the diamond-mining operations from 1918 to the end of the colonial period. Of particular importance are the detailed labour cost accounts, which record total monthly cost per African worker disaggregated by category: direct wage payments alongside non-wage expenditure on rations, transport to and from the mines, medical treatment and other provisions. For each year the accounts record the number of contracted forced workers (lab_f), the number of voluntary workers (lab_v), and the average annual wage paid to each category. Contract lengths are recorded in months and converted into fractions of a year; any remaining gaps in the series are filled using the nearest available observation.

Angola: the Cassaquel adjustment. The Diamang wage series is cross-validated against records from the Cassaquel sugar estate, a plantation-sector source spanning a different region and occupational mix. The comparison is reconstructed from evidence reported in the 1962 ILO Commission of Inquiry and subsequent ILO supervisory materials. In particular, the Portuguese Government’s report for 1963–64 included a table prepared by Angola’s

labour authorities covering Cassaquel’s recruited workers, cash wages and benefits in kind for 1957–64; this appears to be the original source of the company-specific series. Because its coverage and reporting format are less complete than the underlying Diamang records, Cassaquel is used only to calibrate the robustness adjustment rather than as an independent economy-wide wage series. The Cassaquel data indicate that the ratio of voluntary to forced wages in the plantation sector systematically exceeded the corresponding ratio within Diamang, suggesting that the mining company’s monopsonistic position, isolated location and more hazardous work may have compressed the spread between free and forced wages relative to the wider colonial economy. We correct for this by computing a time-invariant scalar equal to the median ratio of the Cassaquel volunteer/forced wage ratio to the Diamang volunteer/forced wage ratio over all overlapping years, and applying it to the Diamang voluntary wage series throughout. The adjustment scales up the estimated wage gap, yielding a moderately larger measure of the opportunity cost of forced labour.

Mozambique: Sena Sugar Estates. The equivalent source is Sena Sugar Estates (SSE), a large plantation complex in the lower Zambezi valley for which annual labour and wage data survive from the early 1920s, reconstructed by [Jones and Gibbon \(2025\)](#). The underlying materials are the Hornung and Oury papers together with SSE’s own occasional publications, and a detailed production ledger compiled by H. Bakker (1967), *Cane Supplies and Field Costs: Provisional Estimates 1967–71*. The Hornung papers, an uncatalogued private collection held at the West Sussex County Record Office, contain ledgers with detailed sales, production, employment and cost data covering roughly 1930–1961, alongside less systematic records from the 1920s and 1970s, and correspondence and diaries of SSE directors from the company’s London office. The Oury papers, at the Borthwick Institute in York, include a full run of published SSE annual reports and accounts as well as additional financial documentation circulated among directors.

Much of the SSE company archive did not survive Mozambique’s transition from colonial rule. In 1974, shortly before independence, Leroy Vail and Landeg White, together with J.F. Head, were granted direct access to SSE’s central archives at Luabo; part of that archive was subsequently transported to Maputo for deposit in the national archives but was reportedly lost, and the documentation remaining at Luabo was destroyed when Renamo forces sacked the town in 1985. We therefore draw heavily on the work of Head ([Head, 1980](#)), Vail and White ([Vail and White, 1980](#)), and Lapperre ([Lapperre, 2020](#)), whose studies incorporate company documents, internal reports and inspection records; Lapperre himself worked for SSE between 1965 and 1974, providing an insider perspective on the firm’s organisation and labour practices. Additional contextual information comes from SSE’s own publications (reports issued in 1932, 1945, 1955 and 1956) and from inspection reports and administrative correspondence preserved at the Mozambique National Archives at Eduardo Mondlane University.

The SSE records report the total workforce (lab_{tot}), an average wage across all workers ($wage_{av}$), and the share of the workforce under coerced contracts. Separate forced and voluntary wage rates are recovered by solving the weighted-average identity, which is identified by the separately observed forced-to-voluntary wage ratio. The voluntary share and wage-ratio series both contain some gaps; we interpolate linearly across missing years,

floor each series at its observed historical minimum to prevent extrapolation below plausible bounds, and apply LOWESS smoothing. No comparable multi-estate Mozambican dataset exists from which to derive an analogous upward wage correction, so SSE wages are used directly as the colony-wide benchmark.

Annualisation, currency and imputation. Mozambican plantation wage data, originally recorded in old pence, are expressed here as decimalised pence sterling per day and are converted to annual escudos by $WD_t \times e_t/100$, where WD_t is the assumed number of working days per year and e_t the escudo-per-pound rate of §A.7. Angolan wages are recorded in escudos and require no conversion. Missing voluntary wages are filled by nearest-neighbour interpolation *in real terms* and re-inflated, so that the imputation carries no implicit assumption about price movements: $w_t^V = CPI_t \times \text{nearest}(w_t^V/CPI_t)$. The relative wage gap $(w_t^V - w_t^F)/w_t^V$ is then nearest-filled and used to complete the forced-wage series, so that imputed forced wages maintain the observed relative position rather than an absolute level. Contract length m_t is nearest-filled and capped at 0.75, i.e. nine months.

A.2 Economy-wide forced and voluntary labour

Sources. For Angola the principal source is the *Anuário Estatístico* published by the *Repartição Central de Estatística Geral* in Luanda, whose dedicated labour section records the number of African workers recruited under different contractual arrangements, in various years explicitly distinguishing those engaged voluntarily from those recruited through state-administered contracting. The statistics are geographically disaggregated across the colony's thirteen districts, though spatial variation is not exploited here. The Mozambican record is more fragmented: while the yearbooks document labour migration to external mining centres in South Africa and Southern Rhodesia in detail, domestic recruitment into private and public-works employment is less consistently recorded. To construct a continuous exposure series we combine colonial statistical yearbooks, census summaries, official bulletins such as the *Boletim Oficial de Moçambique*, census tabulations reproduced in the *Anuário Estatístico do Império Colonial* and later the *Anuário Estatístico do Ultramar*, and secondary historical studies compiling administrative labour statistics from archival sources.

Extrapolation to the colony. Colonial administrative records of workers under registered contracts (*recrutados*) are available at territorial level for a subset of years from district and provincial reports. These observations are expressed as a share of the estimated *válido* male population. The territory-wide forced-labour share is anchored at 2 per cent of this population at both the start (1910) and the end (1974) of the analysis period: the opening anchor reflects the gradual and uneven expansion of the formal contract-labour apparatus in the early colonial decades, when systematic recruitment outside established plantation enclaves was limited; the closing anchor reflects the documented contraction of the system and improvement of worker living standards in the final years before independence, as the

administration faced intensifying local resistance and international scrutiny. Between the anchors the series is interpolated through the observed administrative ratios and LOWESS-smoothed, then applied to the *válido* series to recover annual forced worker counts.

Economy-wide voluntary labour is estimated from the company-level volunteer-to-forced ratio, using a multiplier calibrated against the aggregate ratios of voluntary to forced contract workers directly observed in colonial labour-force surveys across multiple benchmark years. For Angola the multiplier is 1.5; for Mozambique it is 2.0. The higher Mozambican multiplier is intended to correct for SSE’s unusually heavy reliance on forced labour and to approximately match the territory-wide volunteer-to-forced ratios reported in colonial labour-force surveys for benchmark years. Cross-border migrants employed outside Portuguese Mozambique are excluded from both L^F and L^V and therefore do not enter this calibration; their ambiguous classification and our resulting scope decision are discussed in Section 4.2. These multipliers necessarily introduce a degree of judgement because the coverage of territory-wide voluntary-labour statistics is uneven: detailed observations are available for some benchmark years, but the record is less complete or absent for others, and they enter the estimate twice over — through the level of L^V and through the correction θ — which is why they are varied in Panel A of Section 6.

The inframarginal adjustment in the data. The correction θ_t applied in (10) and (11) is computed directly from the reconstructed counts as defined in (6) of the main text, that is $\theta_t = \frac{1}{2} \min\{2, \max(\frac{1}{2}, L_t^F / L_t^V)\}$, bounded in $[0.25, 1]$. The outer factor of one-half reflects the standard result that the aggregate surplus loss from a given wedge equals one-half of the product of the wedge and the quantity distorted under linear supply; the triangular treatment follows Naidu et al. (2016). The same θ_t enters both the wage head and, through w_t^* , the fiscal head, so the two components rest on a single counterfactual wage rather than on separate benchmarks. Its exact counterpart under linear supply is derived in Appendix C.

A.3 Total and working-age population

Post-1950 benchmark. The anchor for both territories is the United Nations World Population Prospects 2024 revision (UN WPP 2024; United Nations, Department of Economic and Social Affairs, Population Division, 2024), from which we extract five-year age-group data for both sexes combined and for males separately, covering 1950 to 1975. From these we construct total population ($total_{mf}$, in millions) and the population of males aged 15–59 ($total_{m,15-59}$), the latter serving as the starting point for labour-force calculations. We also record the ratio of males aged 15–59 to total population at each quinquennial observation, for use in constructing the pre-1950 working-age series.

Backcast to 1900. For the pre-1950 period, total population is backcast using annual growth rates derived from version 3.0 of the Frankema–Jerven African Population Database (Frankema and Jerven, 2014), which provides estimates for both territories from 1850 onwards. These are model-based backward projections anchored to 1950 population benchmarks and informed by colonial censuses, tax registers and contemporary demographic

surveys. Their underlying default growth path also draws on comparative Asian demographic evidence, treating Indian growth rates as a lower bound and those of land-abundant Indonesia and the Philippines as an upper bound, before applying region- and country-specific modifications. Annual growth rates are computed from successive observations and LOWESS-smoothed. In the transition zone 1950–1960, where both series are available, we blend the smoothed Frankema–Jerven growth rates with those implicit in the UN WPP data using a linearly declining weight on the former, so that the series converges fully to the UN benchmark by 1960. Pre-1950 levels are recovered by backward iteration, $total_{mf}(t) = total_{mf}(t+1)/(1 + g_{t+1})$, where g is the blended growth rate. Since the Frankema–Jerven database does not disaggregate by age or sex, the share of males aged 15–59 cannot be observed before 1950; we impute it using the country-specific mean of the ratio observed in the UN WPP data. This imposes constancy on the age structure, but the bias is likely modest over the colonial period, when high fertility and limited life expectancy kept age structures relatively stable compared with the moderate demographic transition observed after independence.

A.4 The able-bodied (*válido*) denominator

The labour-force denominator is not total working-age males but the narrower category of men administratively classified as fit to work (*válidos*) under Portuguese colonial law: adult males deemed able-bodied and therefore liable to meet the labour and tax obligations that the *indigenato* regime imposed. The concept maps broadly onto prime-age adult males net of those exempted through formal assimilated (*assimilado*) status, disability, or approved wage contracts such as military duties, and its administrative tally is the direct denominator used in colonial-era recruitment ratios. Colonial annual reports provide irregular observations of the registered *válido* count for both territories, which we assemble into an original series.

To complete missing observations, the Angolan registered count is expressed as a share of estimated total male working-age population; the ratio is interpolated across gaps, extrapolated to the boundary years using the nearest observed value, and applied back to the working-age series to generate a continuous annual estimate. For Mozambique the available observations are sparser and concentrated in a narrower window (approximately 1935–1944), so we clamp the ratio at its observed minimum before 1935 and at its observed maximum after 1944, reflecting the years for which the administrative series has reliable bookends. This yields a lower bound on the recruitable population in the earlier period, when the system was still expanding, and a plausible ceiling in the final decades before independence.

A.5 Capitation taxes and the fiscal base

Coverage and sources. Portuguese colonial fiscal law imposed a head or hut tax (*imposto indígena*) on the African population which, excluding the very earliest years, was payable only in cash and constituted the principal direct fiscal obligation under the *indigenato* system. We construct an annual series of indigenous capitation revenue for each territory by aggre-

gating across the tax categories recorded in the colonial budgets and administrative accounts. In Angola these are the *imposto de cubata* (hut tax), *mussoco*, *imposto pessoal*, *imposto mínimo*, and an annual general assessment; in Mozambique, the *imposto de palhota* and the *imposto indígena*. Emigration fees (*emigração*) are excluded throughout, representing a separate charge on cross-border labour migration rather than a domestic capitation liability. The primary source is an original series assembled from published colonial budgets, annual reports (*Relatórios*) and, for later years, the colonial statistical yearbooks, supplemented by fiscal reports in *Conta Geral do Estado* (CGE) audit records and the *Anuário Estatístico do Império Colonial* and *do Ultramar*. Legislative documents and circulars governing assessment and collection — including the *Regulamento do recenseamento e cobrança do imposto indígena* approved by Diploma Legislativo no. 237 (1931) — together with parliamentary debates and legislative bulletins, allow official statutory rates to be reconstructed for reference, though they are not used in the estimator.

Harmonisation and imputation. The revenue series is cross-checked against the Frankema–Jerven colonial fiscal panel, which covers total direct and indirect revenue for a wider set of African territories. When both sources are available for the same year and territory we average them; when only one is available it is used directly. Panel figures pre-dating 1960 and denominated in thousands of escudos are divided by 1,000 for consistency with the budgetary series. The indigenous tax series is patchier than the total direct tax series, particularly in the early decades, so rather than imputing levels directly we exploit the greater continuity of total direct revenue: we compute the annual ratio $\rho_t = \text{indigenous Taxes}_t / \text{direct Taxes}_t$, cap it at unity, interpolate across missing observations with extrapolation beyond the observed range where needed, and LOWESS-smooth the result; missing indigenous values are then filled as the product of the smoothed ratio and the interpolated direct tax series. A discontinuity in the Angolan series around 1962 — attributable to a reorganisation of the provincial tax administration and a reclassification of several categories — is handled by splicing on growth rates rather than levels: from the first post-reorganisation year forward, year-on-year growth rates in the new series are applied cumulatively to the last pre-discontinuity level, preserving the long-run dynamics while discarding an apparently spurious step change.

The taxpayer base and the assessed rate. Equation (11) requires the effective tax per head, $\bar{\tau}_t$, which under the flat-levy weights of (7) is simply R_t/N_t . The taxpayer base N_t is not directly observed and is constructed as

$$N_t = \text{LOWESS} \left[\max \left(\text{pop}_t^{m, \text{válido}}, 1.5 (L_t^F + L_t^V) \right) \right], \quad (\text{A1})$$

that is, the larger of the full *válido* male population or one and a half times the wage-labour force, smoothed. The first term reflects that capitation liability extended across the registered able-bodied male population; the second permits the estimated base to exceed that count where the observed wage-labour force implies broader coverage. The assessed per-head tax is then bounded above at one-third of the forced wage and below at one-twelfth of the same wage over the standard contract period (see equation 11). The upper bound limits the influence of years in which reported revenue per head is implausibly large relative

to observed wages. For reference, the implied effective rate on counterfactual earnings is $r_{A,t} = \bar{\tau}_t / (m_t w_t^*)$, and the fiscal loss vanishes where $r^* = r_A$. The construction and historical basis of the comparator rate $r^* = 5$ per cent are documented in Appendix D.

A.6 *Fomento* spending as a calibration check

A share of colonial expenditure was allocated to economic development activities designated *fomento* in the Portuguese colonial budget classification, including public works, transport infrastructure, agricultural development and urban construction. These allocations formally encompassed activities directed toward both European and indigenous populations, although expenditure was often concentrated in settler-serving and export-oriented projects.

We construct the annual expenditure share

$$s_t^f = \frac{\text{Despesa sobre fomento}_t}{\text{Despesa total}_t}. \quad (\text{A2})$$

Annual data on total colonial expenditure (*despesaTotal*) and development spending (*despesaFomento*) are drawn from original series assembled from the colonial budgets for each territory. Figures reported before 1954 in Angola and 1958 in Mozambique are expressed in thousands of escudos and divided by 1,000 for harmonisation. Gaps in the underlying series and resulting expenditure share are filled by linear interpolation, after which the share is LOWESS-smoothed to reduce volatility associated with the budget cycle.

The period-average *fomento* share lies between 20 and 30 per cent across the two colonies. The average values of γ implied by the benchmark $r^* = 5\%$ are higher: 0.46 in Angola and 0.38 in Mozambique, or approximately 0.42 across the two colonies. The comparison is used only as a calibration check. If anything, the benchmark is generous insofar as it treats a larger fraction of indigenous taxation as a comparator liability than the share of expenditure classified as *fomento*, even before recognising that such spending served both European and indigenous populations. Colonial accounts identify the administrative classification under which expenditure was recorded, not whether spending was distributed equally between European and indigenous populations or whose welfare it was intended to raise. *Fomento* spending cannot therefore be interpreted directly as the portion of indigenous taxation returned to African taxpayers. For this reason, it is not treated as a separate fiscal-loss estimator or reported as an additional robustness row in Table 4.

A.7 Prices, deflators and currency conversion

Expressing nominal escudo values in constant prices and converting them to a common modern unit requires three components: a deflator for metropolitan Portugal, colony-specific deflators, and a sterling-to-escudo exchange rate for Mozambique, where certain plantation wages were recorded in pence sterling.

Metropolitan Portugal. The baseline deflator is drawn from the Jordà–Schularick–Taylor (JST) Macrohistory Database (Jordà et al., 2017), which provides an annual consumer price index for Portugal from 1900. For the post-1948 period the JST index is extended and, where necessary, corrected using a supplementary CPI series covering 1948–2023 supplied by the Portuguese statistics institute. The JST database also supplies annual average nominal exchange rates against the US dollar for both Portugal and the United Kingdom, from which we derive the annual escudo-per-pound rate ($xrate_{pt}$) used to convert pence-denominated wage data from Mozambique into escudos.

Colony-specific deflators. For Mozambique we use the consumer price index constructed by Jones and Gibbon (2025), which covers the years for which the SSE administrative sources provide wage and employment records. For Angola no direct colonial CPI of equivalent length exists; Valério and Tjipilica (2008) provides colonial price-level data for both territories, but coverage is incomplete for the early decades. We therefore backcast from the first year of available observations (1914 for Angola; 1920 for Mozambique) using Portuguese CPI inflation as a predictor, estimating for each territory $x \in \{\text{Angola, Mozambique}\}$ a bivariate OLS regression of the annual log-change in the colonial price index on the contemporaneous log-change in the Portuguese CPI:

$$\Delta \ln CPI_{\tau}^x = \alpha + \beta \Delta \ln CPI_{\tau}^{PT} + \varepsilon_{\tau}^x. \quad (\text{A3})$$

For years within the observed colonial series the actual log-change is retained; for missing years the predicted value is substituted. The resulting first-difference series is cumulated and exponentiated to recover a level index, re-normalised to unity at the base year (1970), and LOWESS-smoothed before entering the welfare calculations.

Conversion to 2023 euros. The conversion is effected through a single scalar (*convert*) defined as the ratio of the Portuguese CPI in 2023 to the official irrevocable conversion rate between the escudo and the euro (200.482 escudos per euro). Since all colonial price series are normalised to 1970, a nominal escudo value V_t is expressed in euros of 2023 purchasing power as $V_t \times \text{convert} / CPI_t$. This is the chain underlying the headline register: nominal colonial escudos $\rightarrow$ constant 1970 escudos $\rightarrow$ 2023 euros.

Staple prices. For the complementary deflation exercise in §6 of the main text we use retail prices for basic foodstuffs reported in the colonial statistical yearbooks, which give annual prices for rice, maize flour and wheat flour across multiple district capitals and urban markets: for Angola across the thirteen district capitals from 1940, and for Mozambique from the mid-1920s, initially for Lourenço Marques and from 1929 for a wider set of district capitals and localities. Where regional coverage is available we construct colony-wide average prices; where only a single location is reported, that observation is adjusted using the average relationship between it and the wider colonial price series in overlapping years.

B Appendix: Additional tables and figures

Table B 1: Reparations estimates as positions on the scope–valuation–transfer axes

Study	Measure (tradition)	Counterfactual	Transfer	Question
Neal (1990)	Restitution (transported)	Free wage; coerced wage ≈ 0	Compound return	Value of appropriated labour, accumulated
Marketti (1990)	Restitution (transported)	Free wage; income diverted	Compound return	Diverted income, accumulated
Ransom and Sutch (1990)	Compensation (transported)	Free wage net of upkeep	Compound return	Net unpaid earnings, accumulated
Craemer (2015)	Restitution (transported)	Free wage; actual ≈ 0	Compound (rate-driven)	Principal, accumulated at a chosen return
Bazelon et al. (2023)	Multiple dimensions (transported)	Labour, life, liberty, continuing harm	Dual compounding	Itemised damages, accumulated
van Waijenburg (2018)	Compensation	Imputed market wage; corvée wage ≈ 0	None (period values)	Forced labour as fiscal transfer
Tadei (2020)	Compensation	Competitive producer price	None (period values)	Trade extraction vs competitive price
Darity Jr et al. (2022)	Gap closure (outcome-based)	Reference-group wealth	None (endpoint)	Cost of closing the present wealth gap
This paper	Adjusted compensation (transported)	Contemporaneous voluntary wage in same firm/sector	CPI chain	Present purchasing power of within-period income loss

Table B2: Derivation of reference (anchor) values for contemporary low wages

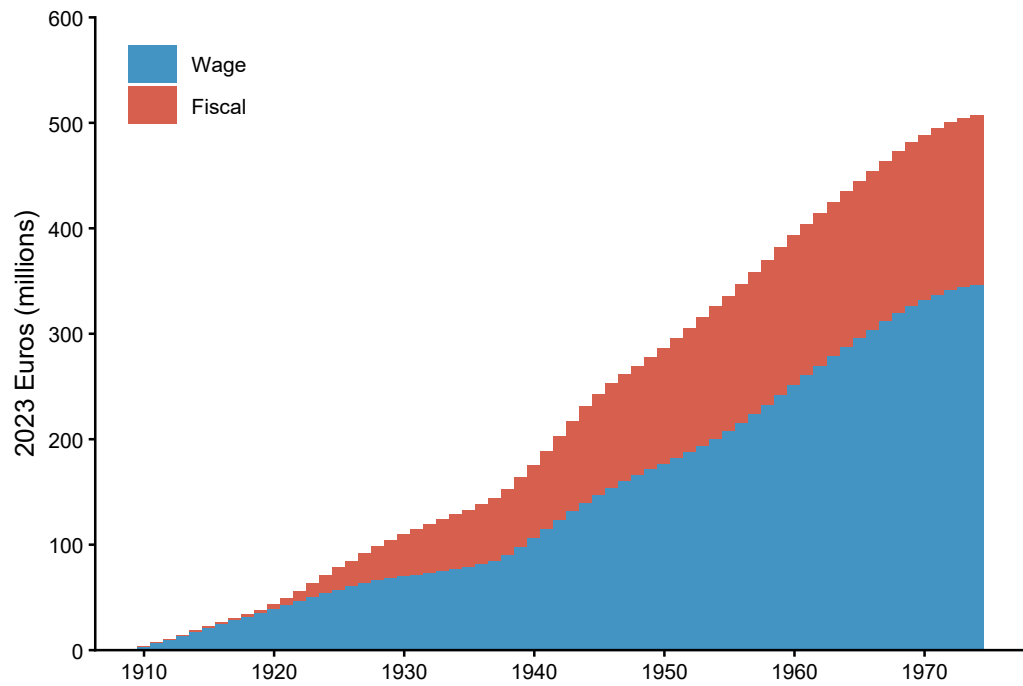
Item	Angola	Mozambique	Unit
Daily international poverty line	3.0	3.0	2021 international \$
Days per year	365	365	days
Annual international poverty line	1095	1095	2021 international \$
PPP conversion factor	203.69	23.62	LCU per international \$
Annual line, 2021 local currency	223,039	25,867	LCU
Consumer price index, 2021	583.7	200.8	-
Consumer price index, 2023	805.0	237.2	-
CPI ratio, 2023/2021	1.38	1.18	-
Annual line, 2023 local currency	307,600	30,560	LCU
Average exchange rate, 2023	746.6	69.1	LCU per euro (annual av.)
Annual individual line, 2023 euros	€412.00	€442.25	Euros
Household multiplier	1.90	1.90	-
Anchor per worker-year	€782.80	€840.28	2023 euros

Notes: the table details the calculation of the anchor used to estimate the current value of earnings among low-wage workers in Angola and Mozambique, taking the \$3 per day extreme-poverty threshold in 2021 international dollars as the earnings benchmark and expressing it in 2023 €. The PPP factors are for private consumption; the CPI observations are annual period averages; and the market exchange rates are 2023 annual averages. The household multiplier is $1 + n = 1.9$, where $n = 0.9$ is the age-dependency ratio; the rationale for preferring this measure to household members per wage earner is discussed in Section 6.

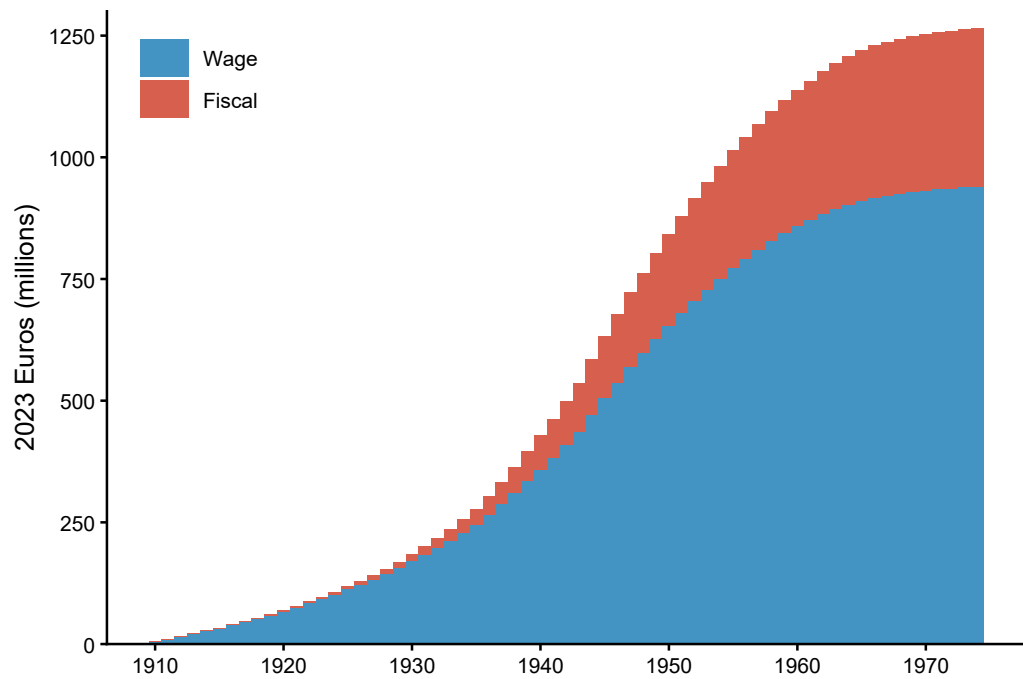
Exchange-rate sensitivity: For Angola, using a pre-devaluation proxy of 537.57 AOA per euro raises the worker-year anchor to €1,087.20 and the implied total to €705 million, whereas an end-2023 proxy of 916.05 lowers them to €638.00 and €414 million; the 2023 annual-average conversion remains the preferred central case ([International Monetary Fund, 2025](#); [European Central Bank, 2022, 2023](#)).

Source: authors' calculations using the World Bank's \$3 poverty line ([World Bank, 2025](#)), World Development Indicators (PA.NUS.PRVT.PP and FP.CPI.TOTL; [World Bank, 2026c](#)), and annual-average exchange rates from [Banco de Portugal \(2024\)](#).

Figure B1: Cumulative cost of extraction, millions of 2023 Euros (worker-year poverty-line valuation)



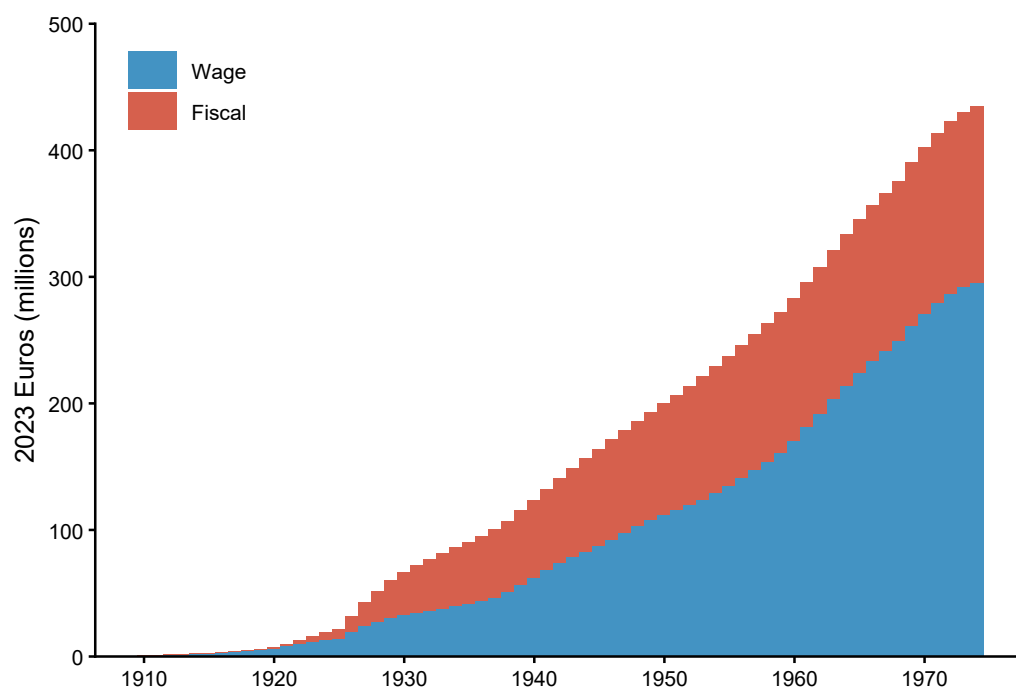
(a) Angola



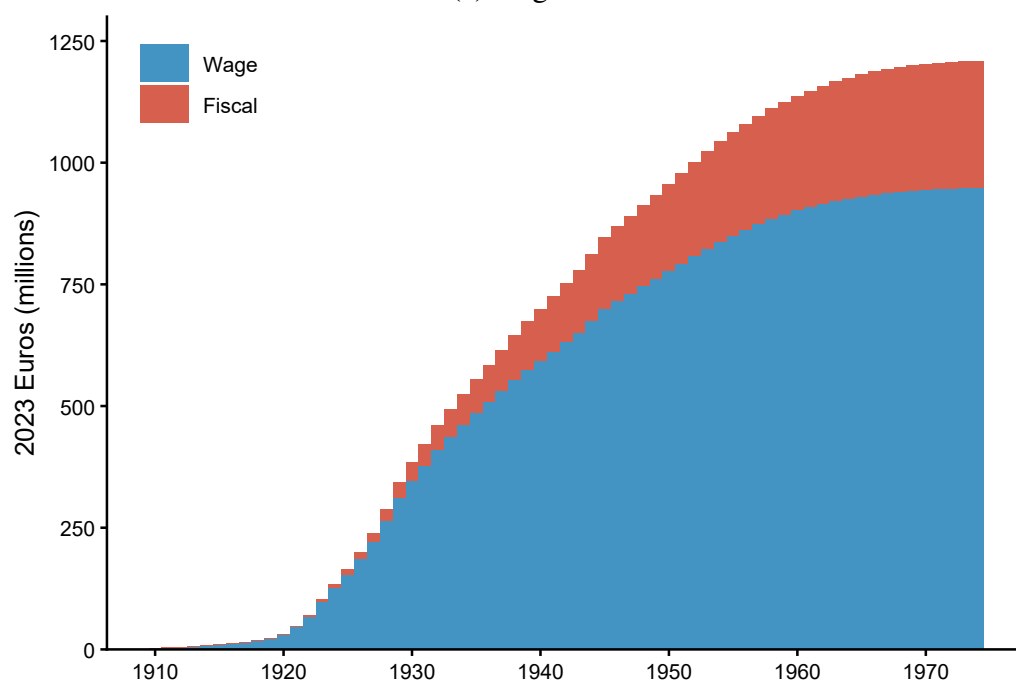
(b) Mozambique

Notes: figure reports the cumulative estimated cost of extraction in millions of 2023 euros under the worker-year poverty-line valuation rule. Panel (a) reports Angola and panel (b) Mozambique; within each bar, the wage and fiscal components are stacked, so the total height represents their sum. Each bar gives the cumulative value of losses from 1910 through the year shown; coverage is 1910–1974. Details of the carry-forward rule and underlying wage series are provided in Section 2.3 and Appendix A.7.

Figure B2: Cumulative cost of extraction, millions of 2023 Euros (compound interest method)



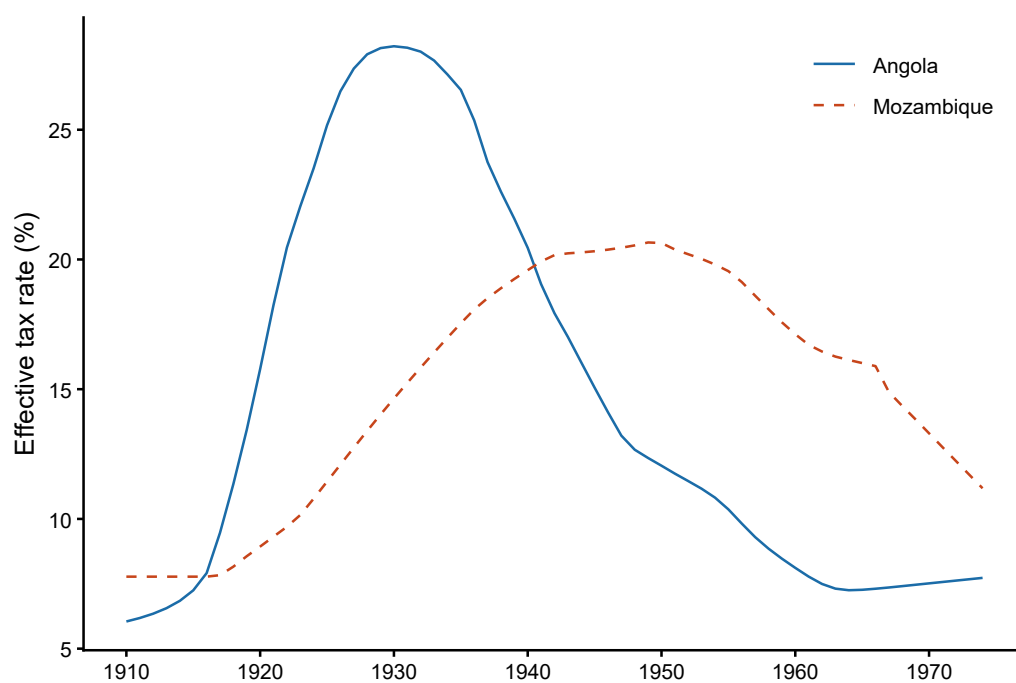
(a) Angola



(b) Mozambique

Notes: figure reports the cumulative estimated cost of extraction in millions of 2023 euros under a nominal compound-interest carry-forward rule of 7 per cent. Panel (a) reports Angola and panel (b) Mozambique; within each bar, the wage and fiscal components are stacked, so the total height represents their sum. Each bar gives the cumulative value of losses from 1910 through the year shown, with each annual loss compounded forward to 2023; coverage is 1910–1974. Details of the compounding rule are provided in Section 2.3, with comparisons to alternative carry-forward methods discussed under Panel F in Section 6.

Figure B3: Effective income tax rates on African wage workers (smoothed)



Notes: the figure reports the smoothed effective average income tax paid by forced wage labourers, calculated as the average per capita tax take divided by the mean forced wage (w^F).

C Appendix: Derivation of the inframarginal correction

This appendix derives the exact counterpart of the bounded correction θ used in equation (6) of the main text, and states the sensitivity exercise built on it.

The correction under linear supply

The adjustment θ_j of (6) has an exact counterpart when the voluntary supply schedule is linear, $b(\ell) = \alpha + \beta\ell$ with $\beta > 0$. Writing $L_j^2 = (w_j^F - \alpha)/\beta$ for the employment level at which the schedule crosses the forced wage, the target of (5) is the triangle $\frac{1}{2}\beta (L_j^F - L_j^2)^2$, while the observed rectangle equals $\beta L_j^F (L_j^V - L_j^2)$, so the exact correction is

$$\theta_j^* = \frac{(L_j^F - L_j^2)^2}{2 L_j^F (L_j^V - L_j^2)}. \quad (\text{C4})$$

When the forced wage sits at the base of the reservation distribution ($L_j^2 = 0$), (C4) reduces to $\theta_j^* = L_j^F / (2L_j^V)$, which is exactly the interior branch of (6). The clamps to $[\frac{1}{4}, 1]$ then bound the correction where $L_j^2 > 0$ or supply departs from linearity, and in particular cap it at the observed rectangle in heavily coerced periods ($L_j^F \geq 2L_j^V$, where $\theta_j^* \geq 1$ and the observed rectangle is itself a lower bound on true compensation) rather than extrapolating to the unobserved apex.

Sensitivity to the supply specification

The exact correction also depends on the position of the forced wage relative to the voluntary supply schedule. The available records do not identify this position sufficiently to estimate it directly. Panel C of Table 4 therefore assesses sensitivity to alternative values of the bounded correction used in the empirical estimates. The case $L_j^2 = 0$ yields the interior branch of (6); other values of L_j^2 , or departures from linear supply, need not do so. The reported correction should therefore be read as a transparent bounded approximation rather than as an unrestricted exact recovery of the compensation integral.

D Appendix: The fiscal benchmark

The fiscal loss (8) depends on the comparator effective direct income tax rate r^* , read ideally off a comparator population's tax-to-income ratio. We set $r^* = 5$ per cent, drawing primarily on the incidence of income taxation in British East Africa during the 1950s. This provides a geographically and temporally proximate comparator and, because the underlying evidence reports income-tax liabilities relative to gross earnings, maps directly onto the object required by the model. We treat this as a comparatively less extractive benchmark because it comes from a regionally and temporally proximate colonial setting in which

taxation was somewhat less directly integrated with compulsory labour mobilisation than under Portuguese *contrato*. The Kenyan income-tax schedule reported in 1952 provided a minimum allowance of £200 and charged the first £400 of chargeable income at 1s. 6d. in the pound, equivalent to a marginal rate of 7.5 per cent. For a single taxpayer with gross earnings of £400, the resulting liability was £15, or 3.75 per cent of gross income; at earnings of £500, it was £22.50, or 4.5 per cent. Tanganyika and Uganda provided the same minimum allowance, although their initial rates differed (UK Parliament, 1952a). Reported liabilities for East Africa in 1957 provide a further check. A single person owed £18 15s. on an income of £400 and £28 2s. on £500, corresponding to effective rates of approximately 4.7 and 5.6 per cent, respectively (UK Parliament, 1957b). The published figures exclude the additional surcharge and personal tax payable in Kenya, but the reported income-tax liabilities nevertheless place 5 per cent close to the centre of the relevant range.

Evidence from the French empire provides a complementary comparison based on the entire fiscal burden, including indirect taxes. For poor non-European households in French West Africa and Togo, Cogneau (2023, Table 7.2, p. 408) reports estimated burdens of between 5.8 and 8.1 per cent of income in 1925 and between 8.1 and 14.7 per cent in 1955. These ranges represent alternative assumptions about the incidence and progressivity of taxation rather than statistical confidence intervals: under the more progressive allocation, less of the burden is assigned to poor households. The midpoints of the two ranges are approximately 7 and 11.4 per cent, respectively. The underlying incidence construction is documented in Cogneau et al. (2021, Appendix 4).

We retain the lower British East African estimate as the benchmark because it measures income taxation on gross earnings directly, whereas the French estimates encompass the entire fiscal system. British East Africa is also the closer regional comparison, particularly because Tanganyika bordered Mozambique. Britain ratified the ILO Forced Labour Convention in 1931 (International Labour Organization, 1931), while statutory abolition across the French overseas territories came only in 1946 (International Labour Organization, 1946). This does not mean that British East African labour markets were wholly free of coercion; rather, the British income-tax evidence provides the most defensible available benchmark for workers in nominally free wage employment. The higher French estimates serve as a check that $r^* = 5$ per cent is not an aggressive assumption.

At $r^* = 0$ the tax is treated as pure extraction and $\Delta_F^{\text{fiscal}} = R_F$, providing an upper bound on the fiscal loss. Panel E of Table 4 varies r^* from 0 to 10 per cent around the 5 per cent benchmark while holding the remaining assumptions fixed. The loss vanishes only at $r^* = r_A$, that is, if the forced-wage group was taxed no more heavily relative to income than a comparable low-paid worker in non-coerced wage employment.