Offshoring Domestic Jobs*

Hartmut Egger†
University of Bayreuth
CESifo, GEP, and IfW

Udo Kreickemeier‡
University of Tübingen
CESifo and GEP

Jens Wrona§
University of Tübingen

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Abstract

We set up a two-country general equilibrium model, in which heterogeneous firms from one country (the source country) can offshore routine tasks to a low-wage host country. The most productive firms self-select into offshoring, and we show that offshoring reallocates labour towards less productive firms if offshoring costs are high, and towards more productive ones if these costs are low. Each source-country firm is run by an entrepreneur, and inequality between entrepreneurs and workers as well as intra-group inequality among entrepreneurs is higher with offshoring than in autarky, creating a class of entrepreneurial 'superstars'. All results hold in a model extension with firm-level rent sharing, which features aggregate unemployment. In this extended model, offshoring of high-wage manufacturing jobs furthermore has non-monotonic effects on unemployment and intra-group inequality among workers.

JEL-Classification: F12, F16, F23
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†University of Bayreuth, Department of Law and Economics, Universitätsstr. 30, 95447 Bayreuth, Germany; Email: hartmut.egger@uni-bayreuth.de.

‡University of Tübingen, Faculty of Economics and Social Sciences, Mohlstr. 36, 72074 Tübingen, Germany; Email: udo.kreickemeier@uni-tuebingen.de.

§University of Tübingen, Faculty of Economics and Social Sciences, Mohlstr. 36, 72074 Tübingen, Germany; Email: jens.wrona@uni-tuebingen.de.

1 Introduction

Fragmentation of production processes across country borders, leading to the offshoring of tasks that used to be performed domestically, is widely seen as a new paradigm in international trade. Public opinion in high-income countries has been very critical of this phenomenon, and much more so than of traditional forms of international trade, since it seems obvious that offshoring to low-wage countries destroys domestic jobs.[1] Academic research has drawn a picture of the effects of offshoring that invites a more nuanced view of the phenomenon than the one held by the general public. The academic literature points out that the effect of offshoring on workers in the source country is ambiguous ex ante: On the one hand, offshoring has indeed the obvious *international relocation effect* emphasised in the public discussion, as tasks that were previously performed domestically are now performed offshore, thereby harming domestic workers. On the other hand, however, there is a *productivity effect*, as the ability to source tasks from a low-wage location abroad lowers firms' marginal cost, thereby increasing overall domestic income, which benefits domestic workers, ceteris paribus.

We show in this paper that important additional insights into the effects of offshoring can be gained by adding firm differences to the picture, thereby acknowledging the empirical regularity that offshoring is highly concentrated among large firms, with many smaller firms doing no offshoring at all.[2] Both the international relocation effect and the productivity effect turn out to have new implications in the presence of firm heterogeneity, thereby jointly shaping welfare

[1]As pointed out by The Economist (2009), "Americans became almost hysterical" about the job destruction due to offshoring, when Forrester Research predicted a decade ago that 3.3 million American jobs will be offshored until 2015. Using survey data from Germany, Geishecker, Riedl, and Frijters (2012) find that offshoring to low-wage countries explains about 28% of the increase in subjective job loss fears over the period from 1995 to 2007.

[2]Bernard, Jensen, Redding, and Schott (2007, 2012) show for the US that only a relatively small fraction of firms imports and that these firms systematically differ from their non-importing competitors: they are bigger, more productive, and pay higher wages. Similar evidence can be found for other countries (Wagner, 2012). This evidence is well in line with observations from a literature that looks more specifically on offshoring patterns. For instance, based on information of the IAB Establishment Panel from the Institute for Employment Research in Nuremberg, Moser, Urban, and Weder di Mauro (2009) report that only 14.9 percent of the $8,466$ plants in this data-set undertake some offshoring and that, on average, offshoring firms are larger, use better technology, and pay higher wages than their non-offshoring competitors. Monarch, Park, and Sivadasan (2013) as well as Paul and Yasar (2009) report similar results for firms in the US and Turkey, respectively.

and inequality in the source country of offshoring.

To conduct our analysis, we set up a general equilibrium model that features monopolistic competition between heterogeneous firms. In many aspects, the model resembles Lucas (1978): each firm needs to be run by an entrepreneur and agents are identical in their productivity as production workers, but they differ in their entrepreneurial abilities. These abilities are instrumental for firm productivity and thus for the profit income the entrepreneur earns when becoming owner-manager of a firm. Agents are free to choose between occupations, and individual ability determines who becomes entrepreneur or production worker.[3] We extend the Lucas (1978) model to a two-country setting, and in order to introduce a stark asymmetry between the countries we assume that entrepreneurs exist in only one of them. This country ends up as the source country of offshoring, while the other country is the host country of offshoring.[4]

Similar to Grossman and Rossi-Hansberg (2008) and Acemoglu and Autor (2011) we model output of a firm as a composite of different tasks, and furthermore assume that only part of the tasks performed by a firm are offshorable. According to the taxonomy in Becker, Ekholm, and Muendler (2013), these are tasks that are routine (cf. Levy and Murnane, 2004) and do not require face-to-face contact (cf. Blinder, 2006). Offshoring allows to hire foreign workers for performing routine tasks at a lower wage, and this provides an incentive for firms based in the source country to shift production of these tasks abroad. This incentive is not unmitigated, since firms relocating their routine tasks abroad need to buy offshoring services, resulting in a fixed offshoring cost, and in addition shipping back to the source country the intermediate inputs produced in the host country is subject to iceberg trade costs.

As we model the production process in a similar way to Grossman and Rossi-Hansberg (2008),

[3]Support for the occupational choice mechanism between entrepreneurship and employment as formalised in Lucas (1978) comes from matched worker-firm-owner data, which show that individuals who are unemployed (cf. Berglann, Moen, Røed, and Skogstrøm, 2011) or displaced from their job (cf. von Greiff, 2009) are more likely to select into entrepreneurship. More indirect evidence on this mechanism comes from Germany, where active labour market policies (ALMP) subsidising start-ups for unemployed (unlike other ALMP) turned out to be quite successful (cf. Caliendo and Künn, 2011).

[4]The assumption of a complete absence of entrepreneurs in the second country is not crucial for our results. Rather, it is a particularly convenient way of ensuring that the second country in the absence of offshoring would have the lower wage rate for production workers, thereby making it attractive as the destination country of offshoring. This outcome could be achieved by a less extreme assumption (e.g. by assuming that the host country has entrepreneurs, but they are less productive than in the source country), but this would add nothing interesting to our analysis, while making it considerably more complicated.

our model shares important features of their work. In particular, offshoring in our model and in theirs features both the international relocation effect (which Grossman and Rossi-Hansberg call "labour supply effect") and the productivity effect.[5] Since the goods market in the framework of Grossman and Rossi-Hansberg (2008) is perfectly competitive and firms are atomistic, both effects are identified in their model only in terms of their aggregate implications – the first one harming domestic workers by reducing their wage, the second one benefiting them by increasing their wage. In contrast, our framework with monopolistic competition features firms of well-defined size, and we can therefore identify the international relocation effect and the productivity effect at the firm level (with the first one leading to a reduction in domestic employment of an offshoring firm, and the second one leading to an increase), thereby allowing a direct mapping to the empirical literature using firm level data (Hummels, Jørgensen, Munch, and Xiang, 2013).

With firm heterogeneity, the firm-level effects themselves as well as their implication for the economy-wide labour allocation depend on the composition of offshoring and purely domestic firms (which itself is endogenous). If variable offshoring costs are high, only the high-productivity firms benefit from shifting production of their routine tasks abroad. In this case, the firm-level productivity effect is negligible (since marginal cost savings are small due to high obstacles to international production shifting), while the international relocation effect is sizable (since all offshoring firms relocate a positive fraction of their tasks), and therefore the firm-level employment effect in newly offshoring firms is unambiguously negative. As a consequence, offshoring unambiguously reallocates domestic labour into less productive uses. Domestic jobs in highly productive firms disappear, and workers losing their jobs in these firms either choose to start their own firm despite being of comparatively low productivity, they work for a (new or old) purely domestic firm, or they find work in the offshoring service sector. When variable offshoring costs are low, the effects are reversed: the firm-level employment effect in newly offshoring firms turns positive, and offshoring reallocates labour towards more productive firms. The potentially unfavourable effect on the resource allocation in the source country constitutes a fundamental difference between offshoring and international goods trade, where standard models with firm

[5] Grossman and Rossi-Hansberg (2008) identify a third effect of offshoring, which materializes if the relative prices of export and import goods change in the process of offshoring. In our model with a single final good and production of this good in just one country, this terms-of-trade effect is absent.

heterogeneity (cf. Melitz, 2003), feature an unambiguous reallocation of labour towards more productive firms, and the resulting increase in average industry productivity has been one of the important novel insights from this strand of literature (cf. Melitz and Trefler, 2012).

Despite the fact that source-country employment of newly offshoring firms may fall, their overall employment, revenues and profits increase. We show that as a result the effect of decreasing offshoring costs on the inequality of entrepreneurial incomes is non-monotonic. The reasoning is straightforward: Newly offshoring firms are at the top of the productivity distribution when the share of offshoring firms is low, and hence lower offshoring costs in this case lead to more inequality in entrepreneurial incomes. By contrast, newly offshoring firms are at the bottom of the productivity distribution when the share of offshoring firms is high, and hence lower offshoring costs in this case lead to less inequality in entrepreneurial incomes. We also show that the effect of offshoring on inter-group inequality between entrepreneurs and workers is monotonically increasing in the share of offshoring firms. Both types of inequality are higher in any offshoring equilibrium than in autarky, and hence offshoring generates a *superstar* effect favouring the incomes of the best entrepreneurs, similar to Gersbach and Schmutzler (2007). Empirical support for this kind of superstar effect comes from Gabaix and Landier (2008), who show that small differences in managerial skills are sufficient to explain vast differences in the remuneration of US top managers, once the differences in the size of managed firms are taken into account.[6]

In the main part of our paper, we assume that the market for production labour is perfectly competitive. While this version of our model serves the purpose well to isolate the role of firm heterogeneity in the offshoring process, we show that it is straightforward to extend the framework by using a more sophisticated model of the labour market, which allows us to address the widespread concern that offshoring may have a negative effect on aggregate employment in a country that shifts production of routine tasks to a low-wage location (cf. Geishecker, Riedl, and Frijters, 2012). In this extended version of the model, there is rent-sharing at the firm level,

[6] In particular, Gabaix and Landier (2008) show that the sixfold increase in the remuneration of the top 500 CEOs in the US from 1980 to 2003 is well explained by the simultaneous increase in the size of firms managed by these CEOs. Although the ultimate cause for the increase in firm size is not subject of their analysis, the authors point to "greater ease of communication" (cf. Gabaix and Landier, 2008, p. 93), facilitating the global expansion of US top firms, as one possible explanation.

leading to wage differentiation among production workers and to involuntary unemployment. Interestingly, all our results from the full-employment version of the model remain qualitatively unchanged. In addition, the model variant with firm-level rent sharing and therefore firm-specific wage rates gives even more relevance to the domestic reallocation process for workers who lost their job through offshoring. In line with recent empirical evidence for the US (cf. Crinò, 2010; Ebenstein, Harrison, McMillan, and Phillips, 2013), we find that offshoring at early stages shifts employment from *good* manufacturing jobs (characterised by high wage premia, cf. Krueger and Summers, 1988) to *bad* (i.e. low paid) jobs, that for example emerge in the service sector. At the macro-level this reallocation process generates new results regarding the effect of offshoring on aggregate unemployment, and on inequality within the group of production workers. In particular, we show that both the effect of offshoring on unemployment and the effect on intra-group inequality among production workers are non-monotonic in the share of offshoring firms, with unemployment and inequality being lower than in autarky when only few firms offshore, while the reverse is true when a large share of them does so. Since all production workers are identical ex ante, our extended model offers an explanation for the large variation in wage effects that offshoring has on workers within the same skill group (cf. Hummels, Jørgensen, Munch, and Xiang, 2013).

Our paper is related to the large literature that studies offshoring to low-wage countries, including the key contributions by Jones and Kierzkowski (1990), Feenstra and Hanson (1996), Kohler (2004), Rodriguez-Clare (2010), and, as earlier discussed in detail, Grossman and Rossi-Hansberg (2008).[7] Only few papers in the literature on offshoring consider firm heterogeneity. Antràs and Helpman (2004) were the first to analyse a firm's sourcing decision in the presence of firm heterogeneity. In their model, which features incomplete contracts, they explain the coexistence of up to four different sourcing modes (outsourcing vs. in-house production in the domestic or foreign economy, respectively) as well as the prevalence of certain sourcing patterns,

[7]In very recent work, Acemoglu, Gancia, and Zilibotti (2012) consider a Ricardian model in which offshoring induces directed technical change. With technical change favoring high-skilled workers at low levels of offshoring, this model provides a rationale for the empirical observation of rising skill premia in developed as well as developing countries. Costinot, Vogel, and Wang (2013) use a Ricardian framework with many goods and countries to study vertical specialisation of countries along the global supply chain. In Costinot, Vogel, and Wang (2012) this framework is extended to study how a country's position in the global supply chain affects the income distribution within the respective country.

when firms with different productivities self-select into these modes. Importantly, Antràs and Helpman (2004) address neither the welfare nor the distributional effects of offshoring, which are the focus of our analysis. Antràs, Garicano, and Rossi-Hansberg (2006) develop a model with team production, in which offshoring is synonymous to the formation of international teams. Individuals are heterogeneous in their skill level, and the highest-skilled individuals self-select into becoming team managers. Since individuals with higher skills are more productive in the role of a production worker as well as in the role of a manager, offshoring – by providing access to a large, relatively low-skilled foreign labour force – not only increases the incentives of workers to become managers in the source country, but also reduces the average skill level of the domestic workforce. Due to positive assortative matching between managers and workers, the top managers therefore end up being matched with workers of a lower skill level in the open economy, and hence they lose relative to less able managers. This is a key difference to the superstar effect present in our model. Davidson, Matusz, and Shevchenko (2008) consider high-skilled offshoring in a model with search frictions, in which firms can choose whether to produce with an advanced technology or a traditional technology, and workers are either high-skilled or low-skilled. Their framework is very different from ours, in that all firms hire only a single worker, and in an offshoring equilibrium they have to decide whether to do so domestically or abroad, ruling out incremental adjustments in firm level employment.[8]

The remainder of the paper is organised as follows. In Section 2, we set up the model and derive some preliminary results regarding the decision of firms to offshore and its implications for firm-level profits. We also characterise the factor allocation in the open economy equilibrium and show how the share of offshoring firms is linked to the variable cost of offshoring. In Section 3, we analyse how changes in the offshoring costs affect factor allocation, income distribution, and welfare in our model. In Section 4 we present the extended version of our model that features firm-level rent sharing and involuntary unemployment. In Section 5 we analyse the effect of

[8]There is a complementary literature that looks at offshoring between similar countries in the presence of firm heterogeneity. Amiti and Davis (2012) and Kasahara and Lapham (2013) extend Melitz (2003) and develop a model in which firms may import foreign intermediates which are then combined with domestic labour to produce the final output good. Unlike in our model, firms' sourcing decisions are driven by external increasing returns to scale in the assembly of intermediate goods (cf. Ethier, 1982) and do not follow from a cost-savings motive. In fact, the variable unit cost for imported intermediates (including variable trade cost) in these models usually exceeds the variable unit cost of domestically produced intermediates.

offshoring on economy-wide inequality. In Section 6, we use parameter estimates from existing empirical research to quantify the implications of offshoring on welfare, unemployment, and income inequality in a model-consistent way. Section 7 concludes our analysis with a summary of the most important results.

2 A model of offshoring and firm heterogeneity

We consider an economy with two sectors: A final goods industry that uses differentiated intermediates as the only inputs, and an intermediate goods industry that employs labour for performing two tasks, which differ in their offshorability. One task is non-routine and requires face-to-face communication, and it must therefore be produced at the firm's headquarters location. The other task is routine and can be either produced at home or abroad. Each firm in the intermediates goods industry is run by an entrepreneur, who decides on hiring workers for both tasks. We embed the economy just described in a world economy with two countries, where the second country differs from the first in only one respect: The second country does not have any entrepreneurs. Given our production technology, the country without entrepreneurs cannot headquarter any firms, and therefore ends up being the host country of offshoring. The other country is the source country of offshoring. Trade is balanced in equilibrium, with the source country exporting the final good in exchange for the tasks offshored to the host country. In the remainder of this section, we discuss in detail the main building blocks of the model and derive some preliminary results.

2.1 The final goods industry

Final output is assumed to be a CES-aggregate of differentiated intermediate goods $q(v)$:

$$Y = \left[M^{(1-\varepsilon)(\rho-1)} \int_{v\in V} q(v)^{\rho} dv\right]^{1/\rho}, \tag{1}$$

where V is the set of available intermediate goods with Lebesgue measure M, and $\rho \in (0,1)$ is a preference parameter that is directly linked to the elasticity of substitution between the different varieties in the production of Y: $\sigma \equiv (1-\rho)^{-1} > 1$. Parameter $\varepsilon \in [0,1]$ determines the extent to which the production process is subject to external increasing returns to scale, analogous to Ethier (1982). As limiting cases we obtain for $\varepsilon = 0$ the production technology without external increasing economies of scale, as in Egger and Kreickemeier (2012), and for $\varepsilon = 1$ the textbook CES production function with external increasing returns to scale, as in Matusz (1996). We choose Y as the *numéraire* and set its price equal to one. Profit maximisation in the final goods industry determines demand for each variety v of the intermediate good:

$$q(v) = \frac{Y}{M^{1-\varepsilon}} p(v)^{-\sigma}. \tag{2}$$

As will become clear in the following, the size of ε, and hence the extent of external increasing returns to scale, does not affect our results apart from those on welfare.

2.2 The intermediate goods industry

In the intermediate goods sector, there is a mass M of firms that sell differentiated products $q(v)$ under monopolistic competition. Each firm is run by a single entrepreneur who acts as owner-manager and combines a non-routine task, which must be performed at the firm's headquarters location in the source country, and a routine task, which can either be produced at home or abroad. We denote the non-routine task by superscript n and the routine task by superscript r. In analogy to Antràs and Helpman (2004) and Acemoglu and Autor (2011), we assume that the two tasks are inputs in a Cobb-Douglas production function for intermediate goods. Assuming that one unit of labour is needed for one unit of each task, the production function for intermediates can be written as

$$q(v) = \varphi(v) \left[\frac{l^n(v)}{\eta}\right]^{\eta} \left[\frac{l^r(v)}{1-\eta}\right]^{1-\eta}, \tag{3}$$

where $\varphi(v)$ denotes firm-specific productivity, $l^n(v)$ and $l^r(v)$ are the labour inputs in firm v for the production of the respective tasks, and $\eta \in (0, 1)$ measures the relative weight (cost share) of the non-routine task in the production of the intermediate good.[9] Firms select into one of two

[9]Our production function can easily be extended to account for a continuum of tasks that differ in their offshorability as in Grossman and Rossi-Hansberg (2008). Firms would then not only choose their offshoring status, but also decide on the range of tasks they relocate abroad. In a supplement, available from the authors

categories: either they become a purely domestic firm, denoted by superscript d, or they become an offshoring firm, denoted by superscript o. The two types of firms differ with respect to the unit production cost for the routine task: For a purely domestic firm, performing the routine task onshore, this cost is simply equal to the domestic wage rate w. For an offshoring firm, hiring labour for this task in the host country, the cost is equal to the effective host country wage rate τw^*, where $\tau > 1$ represents the iceberg transport costs an offshoring firm has to incur when importing the output of the routine task from the offshore location.[10] The constant marginal costs of producing output $q(v)$ for the two types of firms are therefore given by

$$c^d(v) = \frac{w}{\varphi(v)}, \qquad c^o(v) = \frac{w}{\varphi(v)\kappa}, \qquad \text{where} \qquad \kappa \equiv \left(\frac{w}{\tau w^*}\right)^{1-\eta} \tag{4}$$

measures the relative change in its marginal cost that a firm achieves by moving the routine task abroad. Assuming that offshoring also entails a fixed cost resulting from the purchase of offshoring services, it is only attractive for source country producers to move routine tasks abroad if $\kappa > 1$, making κ the *marginal cost savings factor* that a firm can achieve by offshoring. While κ is endogenous and yet to be determined, it is immediate that the equilibrium will feature offshoring, provided that variable offshoring costs τ are finite: If no firm were to offshore, w^* would fall to zero since the host country has no local entrepreneurs. Eq. (4) shows that in this case $c^o(v)$ would fall to zero, which implies that at least some firms would self-select into offshoring.

Firms set prices as a constant markup $1/\rho$ over marginal cost, giving

$$p^i(v) = \frac{c^i(v)}{\rho} \qquad i \in \{d, o\}. \tag{5}$$

upon request, we show that all offshoring firms would choose to offshore the same range of tasks, irrespective of their own productivity $\varphi(v)$. As the only additional effect in this more sophisticated model variant, a change in the cost of offshoring would not only be associated with a change in the share of firms entering offshoring, but also with a change in the range of tasks offshored by infra-marginal firms. Since the general equilibrium implications of the latter effect are well understood from Grossman and Rossi-Hansberg (2008), we focus here on the extensive margin of offshoring between rather than on the intensive margin within firms. For an extension of the Grossman and Rossi-Hansberg (2008) framework to a production technology that allows for arbitrary degrees of substitution in the assembly of tasks, see Groizard, Ranjan, and Rodriguez-Lopez (2013).

[10] We use an asterisk to denote variables pertaining to the host country of offshoring.

Using Eqs. (2), (4) and (5), we can compute relative operating profits of two firms with the same productivity, but differing offshoring status. We get:[11]

$$\frac{\pi^o(\varphi)}{\pi^d(\varphi)} = \kappa^{\sigma-1}. \tag{6}$$

With $\kappa > 1$, an offshoring firm makes higher operating profits than a purely domestic firm with identical productivity. Analogously, the relative operating profits by two firms with the same offshoring status but differing productivities φ_1 and φ_2 are given by

$$\frac{\pi^i(\varphi_1)}{\pi^i(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\xi}, \qquad i \in \{d, o\}, \tag{7}$$

where $\xi \equiv \sigma - 1$. Therefore, given their offshoring status, more productive firms make higher operating profits.

2.3 Equilibrium factor allocation

We assume that the source and the host country of offshoring are populated by N and N^* agents, respectively. While the population in the host country has only access to a single activity, namely the performance of routine tasks in the foreign affiliates of offshoring firms, agents in the source country can choose from a set of three possible occupations: entrepreneurship, employment as a production worker, and employment in the offshoring-service sector.[12] An entrepreneur is owner-manager of the firm, and her ability determines firm productivity. To keep things simple, we assume that entrepreneurial ability maps one-to-one into firm productivity, and we can therefore use a single variable, φ, to refer to ability as well as productivity. Being the residual claimant, the entrepreneur receives firm profits as individual income. Agents differ in their entrepreneurial abilities, and hence in the profits they can achieve when running a firm. Following standard practice, we assume that abilities (and thus productivities) follow a Pareto

[11] We suppress firm index v from now on, because a firm's performance is fully characterised by its position in the productivity distribution and its offshoring status.

[12] It is not essential for our analysis that source country labour is used for providing offshoring services. This assumption mediates factor reallocations between entrepreneurship and employment as production workers – which are essential for the main results in this paper – and hence it helps us to secure against overemphasizing the role of occupational changes in the source country of offshoring.

distribution, for which the lower bound is normalised to one: $G(\varphi) = 1 - \varphi^{-k}$, where both $k > 1$ and $k > \xi$ are assumed in order to guarantee that the mean of firm-level productivities and the mean of firm-level revenues, respectively, are positive and finite.

Entrepreneurial ability is irrelevant for the two alternative activities that can be performed in the source country of offshoring, so that agents are symmetric in this respect. If an individual works in the offshoring service sector, she receives a fee s, which is determined in a perfectly competitive market in general equilibrium. Finally, agents in the source country can also apply for a job as production worker and perform the routine or non-routine task, receiving the endogenous wage rate w. As shown below, our equilibrium features self-selection of the most productive firms into offshoring if the variable cost of offshoring is sufficiently high. In this case, the lowest-productivity firm is purely domestic. Denoting this firm's productivity by φ^d, we can characterize the marginal entrepreneur by indifference condition

$$\pi^d(\varphi^d) = w = s. \tag{8}$$

We assume that offshoring requires the purchase of one unit of offshoring services and that the labour input coefficient in the service sector is equal to one.[13] The indifference condition for the entrepreneur running the marginal offshoring firm with productivity φ^o is given by

$$\pi^o(\varphi^o) - \pi^d(\varphi^o) = s, \tag{9}$$

i.e. for the indifferent entrepreneur the gain in operating profits achieved by offshoring equals the fixed offshoring cost. All variables in Eqs. (8) and (9) are endogenous, and both indifference conditions are linked via their dependence on s. To illustrate the nature of this link, consider some change in the value of model parameters that leads to, say, an increase in w. As a consequence, the fee s paid to individuals in the offshoring service sector has to increase by the same amount in order to keep individuals indifferent between both occupations. A higher offshoring service fee s drives up the fixed cost of offshoring, thereby in turn requiring a larger offshoring-induced

[13] Our analysis extends in a straightforward way to the more general case where firms require $f^o > 0$ units of offshoring services.

gain in operating profits in order to keep the marginal offshoring firm indifferent between both modes of operation. We now proceed in two steps: in the remainder of this section we solve for the domestic factor allocation as a function of model parameters and the fraction of offshoring firms $\chi \equiv [1-G(\varphi^o)]/[1-G(\varphi^d)]$, while in Section 2.4 below we link χ to the underlying model parameters, including the costs of offshoring τ.

The indifference condition in Eq. (8) postulates the equality between profits of the marginal firm $\pi^d(\varphi^d)$ and the wage rate of production workers w. We now link these two variables to economy-wide aggregates. For this purpose, it is useful to introduce three new operating profit averages, namely average operating profits $\bar{\pi}$, average operating profits for the counterfactual situation in which all firms would choose domestic production $\bar{\pi}^{\text{dom}}$ and the average operating profit surplus due to the most productive firms actually choosing offshoring instead of domestic production $\bar{\pi}^{\text{off}}$. There is a direct relation between the three averages which is given by $\bar{\pi} = \bar{\pi}^{\text{dom}} + \chi\bar{\pi}^{\text{off}}$. Due to Pareto distributed productivities, the two averages $\bar{\pi}^{\text{dom}}$ and $\bar{\pi}^{\text{off}}$ are linked to operating profits of the marginal domestic firm $\pi^d(\varphi^d)$ and the gain in operating profits of the marginal offshoring firm $\pi^{\text{off}}(\varphi^o) \equiv \pi^o(\varphi^o) - \pi^d(\varphi^o)$, respectively, by the factor of proportionality $\zeta \equiv k/(k-\xi)$. This allows us to write

$$\bar{\pi} = \zeta\left[\pi^d(\varphi^d) + \chi\pi^{\text{off}}(\varphi^o)\right] = \zeta(1+\chi)\pi^d(\varphi^d),$$

where the second equality follows from the fact that due to indifference conditions (8) and (9) both $\pi^d(\varphi^d)$ and $\pi^{\text{off}}(\varphi^o)$ are equal to s. Using the relation $\sigma\bar{\pi} = Y/M$, we can express profits of the marginal firm as a function of economy-wide variables:

$$\pi^d(\varphi^d) = \frac{1}{\zeta}\frac{Y}{\sigma M(1+\chi)}. \tag{10}$$

Turning to the determination of w, we make use of the fact that due to constant markup pricing the wage bill of each source country firm is a constant fraction ρ of the firm's revenues. Taking into account the fact that for offshoring firms only a fraction η of the wage bill is paid to production workers in the source country, and denoting by $\bar{\pi}^d$ and $\bar{\pi}^o$ the average operating profits of purely domestic and offshoring firms, respectively, we get

$$w = \gamma\rho\frac{Y}{L}, \tag{11}$$

where

$$\gamma \equiv \frac{(1-\chi)\bar{\pi}^d + \chi\eta\bar{\pi}^o}{\bar{\pi}}$$

is the share of the overall wage bill paid in the source county, and L is the endogenous supply of source country production workers. We show in the Appendix that γ can be written as

$$\gamma(\chi;\eta) = \frac{1+\eta\chi-(1-\eta)\chi^{\frac{k-\xi}{k}}}{1+\chi}.$$

It is easily confirmed that $\gamma(\chi;\eta)$ decreases monotonically in χ, falling from the maximum value of 1 at $\chi = 0$ to the minimum value of η at $\chi = 1$.

Having derived, in Eqs. (10) and (11), expressions for the wage rate of production workers and the profit income of the marginal entrepreneur, respectively, we can rewrite indifference condition (8) as:[14]

$$L = \gamma\zeta\,(1+\chi)\,(\sigma-1)M. \tag{12}$$

A second condition linking L and M is established by the resource constraint

$$L = N - (1+\chi)\,M, \tag{13}$$

which illustrates that individuals can work as either entrepreneurs (M), workers in the service sector (χM), or production workers (L). Together, Eqs. (12) and (13) pin down the equilibrium mass of intermediate goods producers M and the equilibrium mass of production workers L as functions of model parameters and a single endogenous variable, the share of exporting firms χ:

$$M = \left\{\frac{1}{(1+\chi)\,[1+\gamma\zeta(\sigma-1)]}\right\}N, \tag{14}$$

$$L = \left[\frac{\gamma\zeta(\sigma-1)}{1+\gamma\zeta(\sigma-1)}\right]N. \tag{15}$$

[14]To simplify notation, we suppress the arguments of functions when the dependence is clear from the context.

The mass of firms is linked to the ability of the marginal entrepreneur by the condition $M = [1 - G(\varphi^d)]N$, and solving for φ^d gives

$$\varphi^d = \{(1+\chi)\,[1+\gamma\zeta(\sigma-1)]\}^{\frac{1}{k}}\,. \tag{16}$$

In the next subsection we show how χ is determined as a function of the cost of offshoring τ.

2.4 Determining the share of offshoring firms

In this subsection, we derive the formal condition in terms of model parameters for an interior offshoring equilibrium, i.e. a situation in which some but not all firms offshore, and we also show how the share of offshoring firms χ varies with the cost of offshoring τ in an interior equilibrium.

Given our assumption of Pareto distributed productivities, the indifference condition of the marginal offshoring firm (9) allows us to derive a link between χ and the marginal cost savings factor κ. Substituting from eqs. (6) to (8), we get the *offshoring indifference condition* (OC)

$$\chi = \frac{1-G\left(\varphi^o\right)}{1-G(\varphi^d)} = \left(\kappa^{\sigma-1}-1\right)^{\frac{k}{\xi}}\,. \tag{17}$$

Intuitively, a larger marginal cost savings factor κ makes offshoring more attractive, and therefore a larger share of firms chooses to move production of their routine tasks abroad. It is easily checked in Eq. (17) that an interior equilibrium with $\chi \in (0,1)$ requires $\kappa \in (1, 2^{1/(\sigma-1)})$.

A second link between χ and κ can be derived from the condition for labour market equilibrium in both countries. Labour market equilibrium in the source country follows from Eqs. (11) and (15) as

$$w = \rho\left[\frac{1+\gamma\zeta(\sigma-1)}{\zeta(\sigma-1)}\right]\left(\frac{Y}{N}\right), \tag{18}$$

while labour market equilibrium in the host country is analogously given by

$$w^* = (1-\gamma)\,\rho\left(\frac{Y}{N^*}\right). \tag{19}$$

Using Eq. (4), we arrive at the *labour market constraint* (LC), which links labour market equilibrium in both countries to the marginal cost savings factor κ:

$$\kappa = \left[\frac{1+\gamma\zeta(\sigma-1)}{\tau\,(1-\gamma)\,\zeta(\sigma-1)}\left(\frac{N^*}{N}\right)\right]^{1-\eta}. \tag{20}$$

Since γ decreases monotonically from 1 to η as χ increases from 0 to 1, we know that the labour market constraint is monotonically decreasing in χ, starting from infinity. This is intuitively plausible: At $\chi = 0$, there is no production in the host country, and wage rates there fall to zero, making the marginal cost savings factor κ infinitely large. Holding τ constant, as more firms start to offshore production, effective wages in the host country are bid up, thereby reducing κ.

Combining Eqs. (17) and (20), we can conclude that an interior equilibrium with $\chi < 1$ is reached if the right-hand side of Eq. (20), evaluated at $\gamma(1,\eta) = \eta$, is smaller than $2^{1/(\sigma-1)}$. This can obviously be achieved for sufficiently high values of τ, because a higher τ lowers for any given χ the marginal cost-saving factor of offshoring determined by the right-hand side of Eq. (20), while leaving the link between χ and κ established by the offshoring indifference condition in Eq. (17) unaffected. A decline in the relative population size N^*/N has a similar effect. The smaller the relative size of the host country population, the larger is, all other things equal, the endogenous relative wage $\tau w^*/w$, and hence the smaller are the potential cost savings from offshoring, according to Eq. (20). Therefore, focusing on an interior equilibrium with $\chi \in (0,1)$ is equivalent to focusing on sufficiently high levels of τ and/or sufficiently low levels of N^*/N, and this is what we do in the subsequent analysis. Such an interior equilibrium is illustrated in Figure 1.

To get insights on the link between offshoring cost τ and the share of offshoring firms χ, we can combine Eqs. (17) and (20) to the implicit function

$$F(\chi,\tau) \equiv \left[\frac{1+\gamma\zeta(\sigma-1)}{\tau\,(1-\gamma)\,\zeta(\sigma-1)}\left(\frac{N^*}{N}\right)\right]^{1-\eta} - \left(1+\chi^{\frac{\xi}{k}}\right)^{\frac{1}{\sigma-1}} = 0.$$

Implicit differentiation yields $d\chi/d\tau < 0$ for any interior equilibrium with $0 < \chi < 1$. As noted above, higher direct costs of shipping intermediate goods, i.e. a higher parameter τ, shifts the LC locus downwards, but does not affect the OC locus in Figure 1. We therefore have the intuitive result that a higher τ reduces the marginal cost savings factor κ, and thus reduces χ,

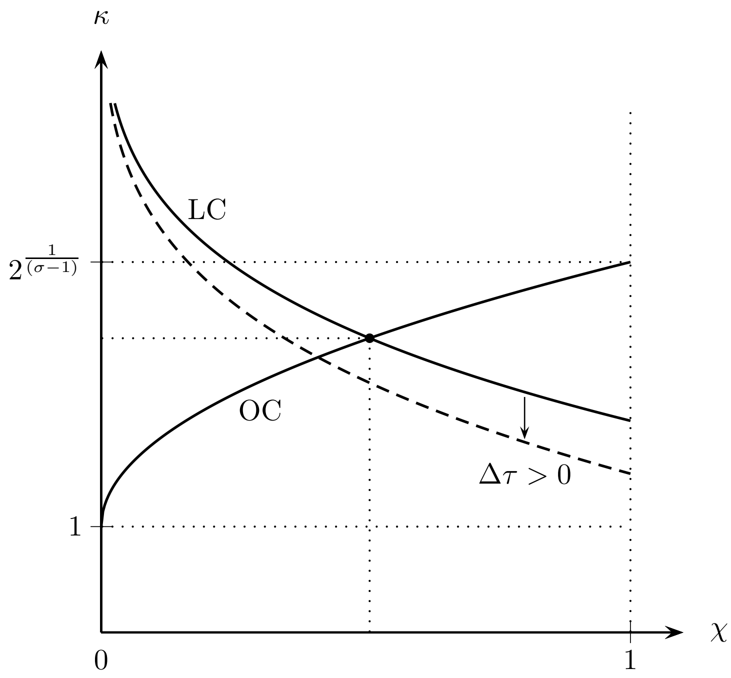


Figure 1: *Partitioning of firms by their offshoring status*

the equilibrium share of firms that shift production of their routine task abroad. Due to the monotonic relationship between (endogenous) χ and (exogenous) τ we can equivalently derive comparative static results below in terms of either variable.[15]

3 The effects of offshoring

The purpose of this section is to look at the effects of offshoring on key economic variables, namely on the factor allocation between occupations and between firms, on income inequality within the group of entrepreneurs as well as between entrepreneurs and production workers, and on aggregate welfare. Throughout this section, we derive comparative static results in terms of changes in χ. As shown above, this is equivalent to considering exogenous changes in offshoring cost τ, noting that $d\chi/d\tau < 0$, and hence in the discussion of results we will sometimes refer to changes in τ as well. Also, we focus our discussion on the source country, since the effects for

[15] One can see in Eq. (20) that the limiting case $\chi \to 0$ is induced by $\tau \to \infty$.

the host country are trivial due to our simplifying assumption that no firms are headquartered there.

3.1 Factor allocation

Since our economy is populated by firms of well-defined size, we can distinguish between allocation effects at the firm level and economy-wide allocation effects. Looking first at the firm level, we ask the question what the offshoring decision does to employment of a firm in the source country. Firm-level employment in the source country for an offshoring firm and for a purely domestic firm, respectively, follow from applying Shephard's Lemma to the firm-specific variable unit cost functions, and multiplying the resulting labour input coefficients by firm-level output. This gives:

$$l^o(\varphi) = \frac{\eta q^o(\varphi)}{\varphi\kappa} \qquad \text{and} \qquad l^d(\varphi) = \frac{q^d(\varphi)}{\varphi},$$

respectively. The source-country employment effect of offshoring at the firm level can now be computed as the log difference $\ln l^o(\varphi) - \ln l^d(\varphi)$, which is the difference in percent between domestic employment of an offshoring firm and employment of a purely domestic firm with the same productivity. The firm-level employment effect thus measured compares for each firm the actual employment level with the employment in a counterfactual situation in which the respective firm would be in the other category.

To get a better intuition, it is helpful to write the firm-level effect as the sum of two partial effects, the effect of offshoring on employment per unit of output, and the effect of offshoring on firm-level output. We call the first effect the *international relocation effect* (IR), since it measures the direct effect of relocating tasks abroad on firm-level employment in the source country, without taking into account the induced reduction in marginal cost. The second effect we call the *firm-level productivity effect* (FP), since it is a measure of the change in output – and, hence, the change in employment – induced by the reduction in marginal cost.[16] Using the

[16] The effects are directly analogous to the labour supply effect and the productivity effect, respectively, derived by Grossman and Rossi-Hansberg (2008), but in contrast to the latter they are identified at the firm level rather than just at the aggregate level.

link between κ and χ given in offshoring indifference condition Eq. (17), we obtain

$$\ln l^o(\varphi) - \ln l^d(\varphi) = \underbrace{\ln\left[\eta\left(1+\chi^{\frac{\xi}{k}}\right)^{\frac{1}{1-\sigma}}\right]}_{\text{IR}} + \underbrace{\ln\left[\left(1+\chi^{\frac{\xi}{k}}\right)^{\frac{\sigma}{\sigma-1}}\right]}_{\text{FP}}. \tag{21}$$

The international relocation effect is negative for any $\chi \geq 0$, since on the one hand the routine task is now produced by foreign labour and on the other hand the input ratio changes in favour of the – now relatively cheaper – routine task. The latter effect is stronger if the marginal cost savings factor κ is higher, i.e. if χ is higher. In contrast to the international relocation effect, the firm-level productivity effect is zero if evaluated at $\chi = 0$ (since the marginal cost savings factor κ is zero), and it increases monotonically with increasing κ, i.e. with increasing χ.

Two aspects of the partial firm-level employment effects identified above are noteworthy. First, Eq. (21) shows that neither effect depends on firm productivity. Hence, for a given level of offshoring costs, implying some value of χ, the percentage difference in firm-level domestic employment relative to the respective counterfactual (offshoring for the purely domestic firms, purely domestic production for the offshoring firms) is the same for all firms. Second, the fact that only the international relocation effect is of first order at $\chi = 0$, while both effects are continuous in χ, means that the international relocation effect determines the overall effect at low levels of offshoring. Inspection of Eq. (21) furthermore shows that the firm-level productivity effect dominates at high levels of offshoring if and only if the cost share of non-routine tasks η is greater than 0.5. This is the case we focus on in the following, which is in line with the findings of Blinder (2009) and Blinder and Krueger (2013), who report for the US that 25 percent of tasks can be classified as offshorable and thus could be moved abroad in principle. While this number is not a perfect match for our cost-share parameter η, the fact that the Blinder-Krueger measure considers potential offshorability rather than actual offshoring renders our parameter constraint of $\eta > 0.5$ a rather conservative assumption.[17]

[17] Empirical evidence for the effect of offshoring on firm-level employment comes from Moser, Urban, and Weder di Mauro (2009), Hummels, Jørgensen, Munch, and Xiang (2013) and Monarch, Park, and Sivadasan (2013), who sort out the firm-level productivity effect and the international relocation effect using matched employer-employee-data. While the former study finds that the firm-level productivity effect dominates for the case of Germany, the opposite seems to occur in Denmark and the US as noted by Hummels, Jørgensen, Munch, and Xiang (2013) and Monarch, Park, and Sivadasan (2013), respectively.

The firm-level employment effects of the decentralised offshoring decisions have consequences for the allocation of domestic workers across firms. Considering a decrease in marginal costs of offshoring τ, Eq. (21) describes the effect on the employment in marginal (newly) offshoring firms, which is negative at high levels of τ and positive if τ is low. To derive the effect on the employment in infra-marginal firms (purely domestic firms and incumbent offshoring firms) we use the result that due to constant-markup pricing relative employment across firms in the same category is identical to relative operating profits, and therefore in analogy to Eq. (7) given by $l^i(\varphi_1)/l^i(\varphi_2) = (\varphi_1/\varphi_2)^\xi$. In addition, also as a consequence of constant-markup pricing, the wage bill of the marginal firm is a multiple $\sigma - 1$ of its operating profits, and with $w = \pi^d(\varphi^d)$ we find that employment of the marginal firm is given by $l^d(\varphi^d) = \sigma - 1$.

Using these results, Figure 2 illustrates the effects of a decrease in τ on the allocation of production labour, where the top panel shows the case of low χ (high τ), while the bottom panel shows the case of high χ (low τ). If χ is low, a marginal reduction in τ increases employment in all purely domestic firms (of which there are relatively many), including – as shown formally below – some new entrants. It also increases employment in the incumbent offshoring firms (of which there are relatively few). The newly offshoring firms – which are high productivity firms in this case – are therefore the only ones to shed production workers in the source country if τ is reduced and the share of offshoring firms is low. If χ is high the picture is different: following a decrease in τ employment in all offshoring firms, marginal and infra-marginal, increases, while employment in purely domestic firms falls, and the least productive firms stop production and exit. Hence, offshoring exerts a non-monotonic effect on the allocation of production workers across firms, reallocating them towards less productive firms if offshoring costs are high, and towards more productive ones if offshoring costs are low.

The effect of offshoring on aggregate factor allocation in our model works via its effect on occupational choice, considering that the labour indifference condition has to hold throughout. Formally, the effects of offshoring on the mass of production workers and the mass of firms follow directly from Eqs. (14) and (15):

$$\frac{dL}{d\chi} = \frac{\zeta(\sigma-1)\partial\gamma/\partial\chi}{[1+\gamma\zeta(\sigma-1)]^2}N, \quad \frac{dM}{d\chi} = -\frac{1+\zeta(\sigma-1)\left[\gamma+(1+\chi)\partial\gamma/\partial\chi\right]}{(1+\chi)^2[1+\gamma\zeta(\sigma-1)]^2}N.$$

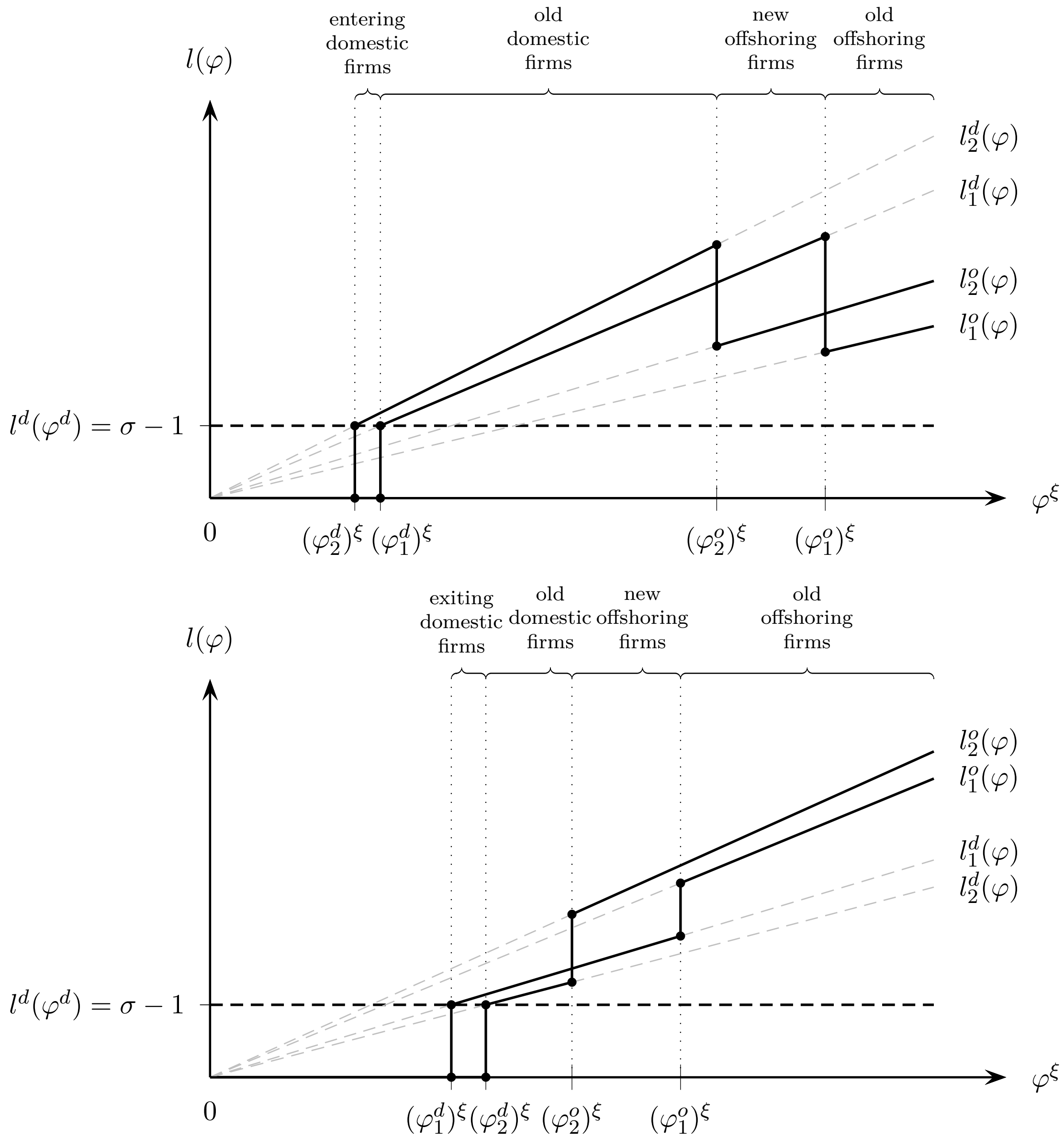


Figure 2: *Offshoring and the allocation of production workers*

Since $\partial\gamma/\partial\chi$ is negative, it is immediate that $dL/d\chi < 0$ holds for arbitrary levels of χ, and hence in line with the empirical findings of Ebenstein, Harrison, McMillan, and Phillips (2013) offshoring unambiguously reduces the mass of production workers in our model, with the affected individuals either moving to the offshoring service sector, or becoming managers of newly-opened low-productivity firms.

The effect of offshoring on the mass of firms (or, equivalently, on the cutoff productivity of the marginal firm) is non-monotonic, with $dM/d\chi > 0$ for low levels of χ and $dM/d\chi < 0$ when χ is high. If χ is close to zero and τ is reduced, the newly offshoring firms are the most productive ones and these are the firms with the largest workforce in both tasks. Not all workers losing their jobs in these firms can be absorbed by expansion of other already existing firms or by expansion of the offshoring service sector, and hence new firms have to enter in order to restore the labor market equilibrium. For low levels of χ, M therefore increases as τ decreases. The effects are different for high levels of χ, because labour demand from offshoring firms (new and old) increases as τ decreases, and the mass of firms has to fall in order to restore the labour market equilibrium.[18] The effects are summarized in the following proposition:

Proposition 1 *When χ is low, a reduction in marginal offshoring costs τ reallocates production workers towards less productive firms, and new firms enter the market in the lower tail of the productivity distribution. When χ is high, a reduction in τ reallocates production workers towards more productive firms, and firms at the lower tail of the productivity distribution leave the market. The mass of production workers decreases monotonically with a decrease in τ.*

Proof Analysis in the text.

The potentially unfavourable effect of offshoring on the resource allocation in the source country constitutes a key difference to international trade in goods, which in a comparable setting always reallocates labour from low to high productivity firms (cf. Egger and Kreickemeier, 2012), with the latter effect of course well known from the canonical model by Melitz (2003). The finding that offshoring in our setting has a non-monotonic effect on labour allocation is furthermore a direct

[18] To see these effects formally, consider $\eta > 0.5$ and note that $\partial\gamma/\partial\chi$ is equal to $-\infty$ if evaluated at $\chi = 0$ and equal to $(\eta - 1)/(2\zeta)$ if evaluated at $\chi = 1$.

consequence of firm heterogeneity. To see this, consider the limiting case of $k \to \infty$, in which all firms have the same productivity (equal to 1, the lower bound of the Pareto distribution). In this model variant, both the international relocation effect and the firm-level productivity effect are independent of the level of χ and, according to Eq. (21), they are given by $\ln[\eta 2^{1/(1-\sigma)}]$ and $\ln[2^{\sigma/(\sigma-1)}]$, respectively. Consequently, the firm-level productivity effect of offshoring is of first order already at $\chi = 0$, whereas the adverse international relocation effect is mitigated, because the newly offshoring firms have lower employment than in the model variant with heterogeneous producers. A reduction in τ therefore reallocates production workers towards offshoring firms, and some firms leave the market for any $\chi \in (0, 1)$.

3.2 Inequality among entrepreneurs and between groups

Intra-group inequality of entrepreneurial income is measured by the Gini coefficient for profit income, which, as formally shown in the Appendix, is given by

$$A_M(\chi) = \frac{\zeta - 1}{\zeta + 1}\left[1 + \frac{\chi(2-\chi)}{\zeta + (\zeta - 1)\chi}\right]. \tag{22}$$

The relationship between Gini coefficient $A_M(\chi)$ and the share of offshoring firms χ is non-monotonic: Offshoring always increases profits of newly offshoring firms. If the share of offshoring firms is small, an increase in χ implies that newly offshoring firms are run by entrepreneurs with high ability, and these are firms that already ranked high in the profit distribution prior to offshoring. Hence, an increase in χ raises the dispersion of profit income in this case. Things are different at high levels of χ, because newly offshoring firms are now firms with a low rank in the distribution of profit income and an increase in χ therefore lowers the dispersion of profit income. Furthermore, comparing $A_M(\chi)$ for $\chi > 0$ with $A_M(0)$, we find that offshoring increases the dispersion of profit income relative to the benchmark without offshoring, irrespective of the prevailing level of χ. This result is due to the fact that the common fixed cost of offshoring disproportionately affects the profits of less productive firms, thereby contributing to an increase in the dispersion of profit incomes.[19]

[19] Since the offshoring service sector is perfectly competitive, one can think of individuals working there as one-person firms, and hence we can define the group of self-employed agents, which covers both entrepreneurs

Inter-group inequality is measured by the ratio of average entrepreneurial income and average labour income, where the latter is simply given by wage rate w. According to Eq. (10), average entrepreneurial income, $\bar{\psi}$, is equal to $\pi^d(\varphi^d)(1+\chi)\zeta - \chi s$. Applying indifference condition (8), the ratio of average entrepreneurial income and average income of production workers, $\bar{\omega} \equiv \bar{\psi}/w$, is therefore given by

$$\bar{\omega} = \zeta + (\zeta - 1)\chi. \tag{23}$$

It follows immediately that inter-group inequality rises monotonically in the share of offshoring firms χ. The intuition is as follows. A higher value of χ indicates that the marginal cost saving factor κ must be higher, which in turn implies that profits of all offshoring firms increase, both in absolute terms and relative to the profits of the marginal firm in the market. Since the marginal firm's profits are equal to w, it is clear that inter-group inequality has to go up in response to an increase in χ.

The following proposition summarises the results.

Proposition 2 *The inequality of entrepreneurial income, measured by the Gini coefficient, rises with the share of offshoring firms at low levels of χ, and decreases at high levels of χ, while always staying higher than in the benchmark situation without offshoring. Increasing the share of offshoring firms χ leads to a monotonic increase in inter-group inequality between entrepreneurs and workers.*

Proof Analysis in the text and formal discussion in the Appendix.

Together the two effects in Proposition 2 give birth to a class of entrepreneurial superstars (cf. Gabaix and Landier, 2008), who benefit from the global expansion of their respective firms by sourcing part of their production from low-cost locations abroad.

and offshoring service providers. The Gini coefficient for this broadly defined income group can be expressed as

$$A_S(\chi) = \frac{\zeta - 1}{\zeta + 1}\left[1 + \frac{2}{\zeta}\frac{\chi}{(1+\chi)^2}\right],$$

with $A_S'(\chi) > 0$. Therefore, inequality in the group of all self-employed agents increases monotonically with χ. The comparison of $A_M(\chi)$ and $A_S(\chi)$ furthermore shows that inequality within the group of all self-employed agents is less pronounced than inequality within the subgroup of entrepreneurs.

3.3 Welfare

With just a single global consumption good, welfare for the source country is simply given by source country income per capita. Aggregate income in the source country is given by $I = (1-\rho+\gamma\rho)Y$, where $(1-\rho)Y$ is the sum of profit income and offshoring service income, and $\gamma\rho Y$ is domestic labour income. The determination of the welfare effects of offshoring is the only place in our analysis where the extent of external increasing returns to scale, introduced earlier in Eq. (1) via parameter $\varepsilon \in [0,1]$, matters for the results. Using Eq. (2) for the marginal firm with productivity φ^d, as well as Eqs. (8) and (10), we get

$$I(\chi) = (1-\rho+\gamma\rho)\,\mathcal{A}\,(1+\chi)^{\frac{\sigma}{\sigma-1}}\left(M\varphi^d\right)M^{\frac{\varepsilon}{\sigma-1}}, \tag{24}$$

with $\mathcal{A} \equiv (\sigma-1)\zeta^{\sigma/(\sigma-1)}$ collecting parameters, and a solution for I in terms of model parameters and χ follows by substituting for M and φ^d from Eqs. (14) and (16), respectively. Income in the source country is higher in an offshoring equilibrium than in autarky if for the specific share χ of offshoring firms in this equilibrium we have $\Phi(\chi) \equiv I(\chi)/I(0) > 1$, and lower than in autarky if $\Phi(\chi) < 1$. It is easy to see that ε plays a crucial role for the welfare effect of offshoring: the greater the external increasing returns to scale, the more beneficial is an increase in the mass of produced varieties M for aggregate output, ceteris paribus, and therefore the less harmful will be the resource allocation towards less productive firms that, as shown above, is characteristic for offshoring at low levels of χ.

For the sake of transparency, we start with the discussion of the two borderline cases $\varepsilon = 0$ and $\varepsilon = 1$. If $\varepsilon = 0$, there are no external increasing returns to scale, and the mass of firms has no independent effect on aggregate output. As we show formally in the Appendix, source country welfare in this case is lower than in autarky if the level of offshoring is low, and it is higher than in autarky if the level of offshoring is high. The sign of the welfare effect is determined by two partial effects: an expansion of economy-wide output that can be achieved by using foreign labour to perform routine tasks at lower cost; and an outflow of labour income because foreign workers must be paid by offshoring firms. The relative strength of these two counteracting effects depends on the relative strength of international relocation and firm-level productivity effect.

Therefore, the main forces determining the welfare implications of offshoring are the same as the forces determining its implications for labour allocation. Offshoring reallocates labour towards less productive uses if χ is low, and in this case source country welfare falls. By contrast, offshoring reallocates labour towards more productive uses if χ is high, and in this case source country welfare increases.

The reallocation effect is of course also welfare relevant if $\varepsilon = 1$, and viewed on its own it leads to a welfare decrease at low levels of χ. But the increase in the mass of varieties now affects welfare positively, and hence overall offshoring has an unambiguously positive effect on welfare. Intuitively, this is so since with $\varepsilon = 1$ decentralized entry decisions establish allocational efficiency, and hence the market outcome replicates the solution to the social planner's problem in the source country under autarky (see the Appendix). Offshoring provides access to (cheap) foreign labour. This expands domestic production possibilities with positive welfare implications for the source country, as in Grossman and Rossi-Hansberg (2008). We show in the Appendix that the welfare results for the two borderline cases carry over to intermediate cases of ε. In particular, we derive a critical value $\bar{\varepsilon} \equiv (\sigma - \xi)(\sigma - 1)/(\sigma k)$ and show that offshoring is detrimental for source-country welfare at low levels of χ if the external increasing returns to scale are sufficiently weak ($\varepsilon < \bar{\varepsilon}$), while offshoring is always beneficial for the source country if the external increasing returns to scale are sufficiently large ($\varepsilon > \bar{\varepsilon}$).[20]

Taking stock, source country welfare in our model can only fall as a consequence of offshoring if the factor allocation is not efficient under autarky, and hence $\varepsilon < 1$ is a necessary condition for welfare losses. In this case, offshoring can lower source country welfare by reallocating workers towards less productive uses. Domestic misallocation of resources as a potential source of losses from offshoring in the case $\varepsilon < 1$ distinguishes our model from similar results in Grossman and Rossi-Hansberg (2008) and Rodriguez-Clare (2010), where source country welfare can fall due to an offshoring-induced negative terms-of-trade effect. As outlined above, offshoring cannot have such unfavourable allocation effects in our model if firms are identical, and hence welfare losses from offshoring in our model are the result of a misallocation of resources in the presence of heterogeneous firms. This relates our analysis to Dhingra and Morrow (2013) who construct a

[20] In the Appendix, we also show that the external increasing returns to scale reported by Ardelean (2011) for the US are sufficiently small to render the welfare losses of offshoring at low levels of χ empirically relevant.

model with monopolistic competition among heterogeneous firms in which endogenous markups lead to a misallocation of resources that can be amplified by trade.

We summarise our insights regarding the welfare implications of offshoring in the following proposition.

Proposition 3 *For strong external increasing returns to scale welfare in the source country increases monotonically in the share of offshoring firms. For weak external increasing returns to scale welfare in the source country decreases with the share of offshoring firms at low levels of χ. The effect is reversed as more firms offshore, and welfare surpasses its autarky level if χ is sufficiently large.*

Proof Analysis in the text and formal discussion in the Appendix.

4 Offshoring in the presence of firm-level rent-sharing

In this section, we extend our framework by a more sophisticated labour market model, which allows us to address the widespread concern that offshoring may have a negative effect on aggregate employment in a country that shifts production of routine tasks to a low-wage location (cf. Geishecker, Riedl, and Frijters, 2012). More specifically, we develop a model of firm-level rent sharing that features involuntary unemployment of production workers, and at the same time captures the stylised fact that more profitable firms pay higher wages (cf. Blanchflower, Oswald, and Sanfey, 1996).[21]

The labour market model proposed in this section is a fair-wage effort model which builds upon the idea of gift exchange, and whose main assumptions are rooted in insights from psychological research (see Akerlof, 1982; Akerlof and Yellen, 1990). The model postulates a positive link between a firm's wage payment and a worker's effort provision, and workers exert full effort, normalised to equal one, if and only if they are paid at least the wage they consider fair.[22] As

[21]Offshoring in the presence of labour market imperfections is also discussed in other papers, including Egger and Kreickemeier (2008), Keuschnigg and Ribi (2009) and Mitra and Ranjan (2010). While all of these studies highlight important channels through which offshoring can affect domestic employment, neither study sheds light on the specific role of firm heterogeneity or the consequences of occupational choice.

[22]Fehr, Goette, and Zehnder (2009) survey the extensive experimental evidence for the fair-wage effort hypothesis. Cohn, Fehr, and Goette (2013) provide evidence supportive of the fair-wage effort hypothesis in a field study.

in Egger and Kreickemeier (2012) and Egger, Egger, and Kreickemeier (2013) we assume that the fair wage $\hat{w}$ is a weighted average of firm-level operating profits $\pi(\varphi)$ and the average wage of production workers $(1-U)\bar{w}$, where U is the unemployment rate of production workers and $\bar{w}$ is the average wage of those production workers who are employed:

$$\hat{w}(\varphi) = [\pi(\varphi)]^{\theta}[(1-U)\bar{w}]^{1-\theta}, \qquad \theta \in (0,1). \tag{25}$$

An analogous condition, with $(1-U^*)\bar{w}^*$ substituted for $(1-U)\bar{w}$, holds in the host country of offshoring, which implies that multinationals share their rents with workers in the source *and* host country of offshoring.[23] Following Akerlof and Yellen (1990), we assume that effort decreases proportionally with the wage if workers are paid less than $\hat{w}$, and hence firms have no incentive to do so. At the same time, as we discuss below, our model features involuntary unemployment in equilibrium, and therefore even low-productivity firms do not need to pay more than $\hat{w}$ to attract workers. Firms therefore set $w(\varphi) = \hat{w}(\varphi)$, and Eq. (25) describes the distribution of wages across firms as a function of firm-level operating profits.[24]

In contrast to the full employment version of our model the decision to become a production worker in a labour market with firm-specific wages now carries an income risk.[25] We make the standard assumption that workers have to make their career choice before they know the outcome of the job allocation process among applicants (cf. Helpman and Itskhoki, 2010).[26] With risk

[23] Evidence supportive of international rent sharing within firms is provided by Budd, Konings, and Slaughter (2005) and Martins and Yang (2013).

[24] Even though firms set wages unilaterally, their profit maximisation problem does not differ from the one in Section 2.2. As pointed out by Amiti and Davis (2012), wages depend positively on profits due to fair wage constraint (25), and hence the firm has no incentive to manipulate the wage, but instead treats it parametrically at the equilibrium level $w(\varphi) = \hat{w}(\varphi)$.

[25] Guided by the findings of Katz and Summers (1989), we maintain the assumption that the wage in the perfectly competitive service sector is fully flexible, and hence it is only the occupation as production worker which carries an income risk in our model.

[26] Production workers would of course prefer to work for a firm that offers higher wages and, in the absence of unemployment compensation, those who do not have a job would clearly benefit from working for any positive wage rate. However, since due to contractual imperfections it is impossible to fix effort of workers ex ante, firms are not willing to accept underbidding by outsiders: once employed, the new workers would adopt the reference wage of insiders and thus reduce their effort when the wage paid by the firm falls short of the wage considered to be fair (see Fehr and Falk, 1999).

neutral individuals, the indifference condition for the marginal entrepreneur then becomes

$$\pi^d(\varphi^d) = (1 - U)\bar{w} = s. \tag{8'}$$

Together, Eqs. (25) and (8′) imply that (only) the lowest-paid manufacturing workers, employed by the marginal firm with productivity φ^d, are paid the same wage as workers in the service sector. Hence, all production workers employed by infra-marginal firms hold "good" jobs in the sense that they get wages in excess of the wage rate in the service sector.

In comparison to the full employment version of our model, the relative operating profits of more productive firms are lower with rent-sharing, since part of the advantage stemming from higher productivity is compensated by having to pay a higher wage rate. Formally, the elasticity of firm-level relative operating profits with respect to relative firm productivity (cf. Eq. (7)) is no longer given by $\xi \equiv \sigma - 1$, but by $\bar{\xi} \equiv (\sigma - 1)/[1 + \theta(\sigma - 1)]$, which is smaller than ξ if θ is strictly positive.[27] It then follows from Eq. (25) that the elasticity of the firm-level wage with respect to firm-level productivity is given by $\theta\bar{\xi}$, while the elasticity of firm-level employment with respect to firm-level productivity is given by $(1 - \theta)\bar{\xi}$.

All results derived in earlier parts of this paper are robust with respect to our extension featuring an imperfectly competitive labour market for production workers. In particular, the two counteracting effects of offshoring on firm-level employment do not change qualitatively. Of course, there are quantitative effects, which can be best understood by considering the following mechanism that additionally arises due to firm-level rent sharing: For an offshoring firm, there is a feedback effect on firm-level marginal costs in the source country, since higher operating profits lead to higher firm-level wage rates via fair wage constraint (25). This implies that the input ratio changes more strongly in favour of the imported routine task. As a consequence, the international relocation effect identified in Eq. (21) is now multiplied by the factor $\xi/\bar{\xi} > 1$, and hence more strongly negative than in the full employment model. In addition, the functional relationships between χ and the the two inequality measures in Section 3 on the one hand and between χ and welfare on the other hand are still given by Eqs. (22) to (24), with the mere

[27] In the limiting case $\theta = 0$, firm-level operating profits have zero weight in the determination of the fair wage, Eq. (25) simplifies to $\hat{w} = w$, and the model collapses to the full employment version.

difference that $\bar{\xi}$ replaces ξ and $\bar{\zeta} \equiv k/(k-\bar{\xi})$ replaces ζ.[28] Hence, the comparative static effects of offshoring on aggregate welfare and on income inequality among entrepreneurs as well as between entrepreneurs and workers change only quantitatively, but remain qualitatively the same in the model extension considered here.

In the model variant with an imperfectly competitive labour market there are two further aggregate variables that are worthwhile to look at: involuntary unemployment and wage inequality among employed production workers. In the presence of firm-level rent sharing, L is the mass of individuals looking for employment as production workers in the source country, while the mass of employed production workers is now given by $(1-U)L$. Neither entrepreneurs nor workers in the offshoring-service sector can be unemployed, and therefore the economy-wide unemployment rate in the source country is given by $u \equiv UL/N$. When looking at u/u^a, it is helpful to consider separately the effect of offshoring on the unemployment rate of production workers, measured by U/U^a, and the effect on the supply of production labour due to adjustments in the occupational choice, measured by L/L^a.[29] As shown in the Appendix, the unemployment rate of production workers is given by

$$U = \frac{\theta(\bar{\zeta}-1)+1-\Delta(\chi;\eta)}{\theta(\bar{\zeta}-1)+1}, \tag{26}$$

where $\Delta(\chi;\eta) \equiv \beta(\chi;\eta)/\alpha(\chi;\eta)$ and

$$\beta(\chi;\eta) \equiv 1+\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\left[\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{(1-\theta)}-1\right], \quad \alpha(\chi;\eta) \equiv 1+\chi^{\frac{k-\bar{\xi}}{k}}\left[\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)-1\right]. \tag{27}$$

It is easily checked that $\Delta(0,\eta)=1$, and therefore U is lower in an equilibrium with offshoring than in autarky if $\Delta(\chi;\eta)>1$ and higher than in autarky if $\Delta(\chi;\eta)<1$. The effect of offshoring on L follows directly from Eq. (15), and as discussed in Subsection 3.1, the supply of production labour is smaller in an offshoring equilibrium than in autarky. By reducing L, this effect reduces

[28] A detailed discussion on how firm-level rent-sharing alters the equations in Section 2 is deferred to a supplement, which is available upon request.

[29] The importance of occupational choice for understanding how a country's labour market absorbs the consequences of trade and offshoring has recently been pointed out by Liu and Trefler (2011) and Artuç and McLaren (2012).

aggregate unemployment u, ceteris paribus. Putting together these partial effects leads to

$$\frac{u}{u^a} = \Lambda(\chi;\eta), \quad \text{with} \quad \Lambda(\chi;\eta) \equiv \frac{\theta(\bar{\zeta}-1)+1-\Delta(\chi;\eta)}{\theta(\bar{\zeta}-1)} \frac{[1+\bar{\zeta}(\sigma-1)]\gamma}{1+\bar{\zeta}(\sigma-1)\gamma}, \tag{28}$$

where u^a can be computed from Eqs. (15) and (26). The first fraction of $\Lambda(\chi;\eta)$ is equal to U/U^a and the second fraction is equal to L/L^a. Unemployment rate u is lower with $\chi > 0$ than with $\chi = 0$ if $\Lambda(\chi;\eta) < 1$, while the opposite is true if $\Lambda(\chi;\eta) > 1$. We show the following result.

Proposition 4 *Unemployment in the source country decreases with the share of offshoring firms at low levels of χ. Under the sufficient condition*

$$\eta > \hat{\eta} \equiv \frac{2^\theta \theta \bar{\xi}}{2^\theta \theta \bar{\xi} + (2^\theta - 1)(k\sigma - \bar{\xi})}$$

the effect is reversed as more firms offshore, and unemployment surpasses its autarky level if χ is sufficiently large.

Proof See the Appendix, where it is also shown that $\hat{\eta} < 0.5$ if $k \geq 2$.[30]

The intuition for this result is straightforward. Since the labour supply effect works unambiguously in favour of a reduction in overall unemployment, cf. Eq. (15), all potentially harmful employment effects must work via an increase in the unemployment rate of production workers U. This effect is understood most easily by noting that the fair wage constraint implies $w^d(\varphi^d) = \pi^d(\varphi^d)$, which together with the indifference condition for the marginal entrepreneur leads to

$$U = 1 - \frac{w^d(\varphi^d)}{\bar{w}}$$

in any equilibrium with $\chi < 1$. Whenever the average wage of employed production workers is higher than the wage paid by the marginal firm (which is the case whenever there is firm-level rent sharing) this is accompanied in equilibrium by a strictly positive level of unemployment.

Moreover we see that if $\bar{w}/w^d(\varphi^d)$ changes U has to change in the same direction, which has the following implication: For an increase in χ, starting from zero the international relocation

[30] Since empirical estimates for k are higher than two, it follows that, when focusing on the empirically relevant parameter domain, $\eta > 0.5$ is sufficient for unemployment in the neighbourhood of $\chi = 1$ being higher than under autarky.

effect in Eq. (21) dominates and offshoring displaces workers in high-productivity firms, which – due to the rent-sharing mechanism – earn high wages, thereby reducing the average wage relative to the wage paid by the marginal firm. This is only compatible with indifference between occupations if unemployment of production workers decreases as well. The effect of a marginal increase in offshoring on U is reversed at high levels of χ, since now the productivity effect in Eq. (21) is dominant, such that both newly offshoring *and* infra-marginal offshoring firms create additional high-wage jobs, pushing up the average wage relative to the wage paid by the marginal firm, which is only compatible with indifference between occupations if unemployment of production workers increases as well. Overall unemployment is then driven by two opposing effects: the supply of production workers decreases, but a larger share of them is without a job. If η is large, and hence the international relocation effect is small, the negative impact of offshoring on U dominates the decline in L at high levels of χ.

The ratio $\bar{w}/w^d(\varphi^d)$ provides one measure of income inequality among production workers, but not a very informative one, since it ignores information on individual wage rates by everybody but the workers in the marginal firm. Hence, in analogy to the measurement of entrepreneurial income inequality we now look at the Gini coefficient as a more sophisticated measure of wage dispersion. As formally shown in the Appendix, this Gini coefficient is given by

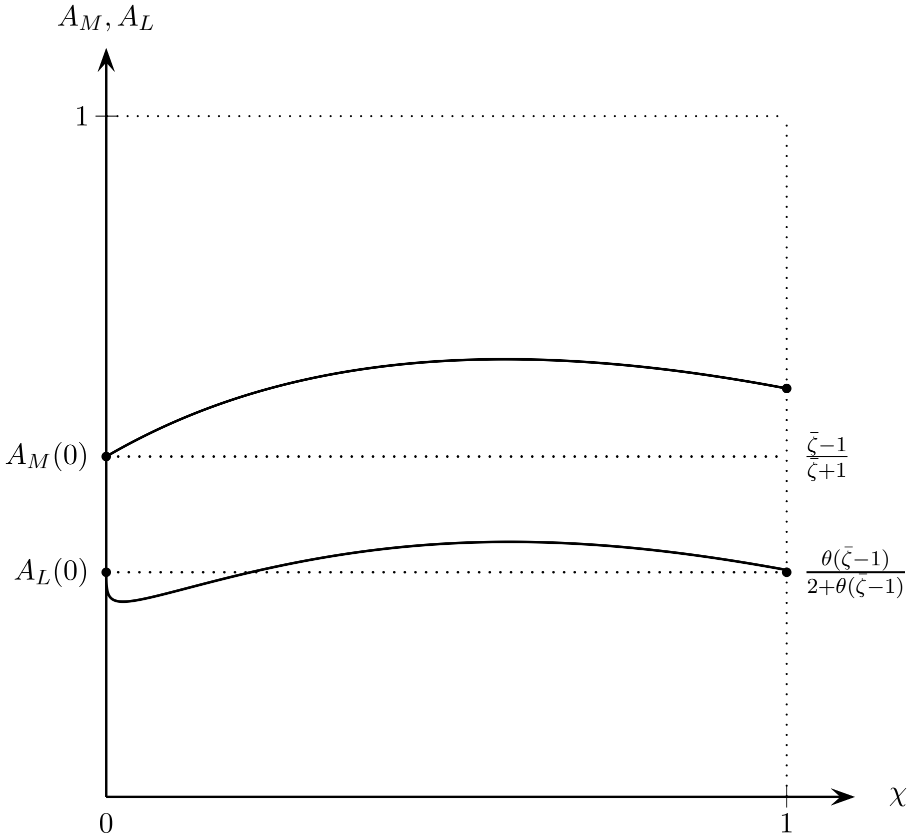
$$A_L(\chi) = \frac{\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)} \left\{ 1 + \frac{2\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right)[\alpha(\chi;\eta)-1]}{\alpha(\chi;\eta)\beta(\chi;\eta)\theta(\bar{\zeta}-1)} \right. \\ \left. - \frac{2\left[1+\theta(\bar{\zeta}-1)\right]\left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)[\beta(\chi;\eta)-1]}{\alpha(\chi;\eta)\beta(\chi;\eta)\theta(\bar{\zeta}-1)} \right\}. \tag{29}$$

Inequality of wage income is the same in the polar cases where either no firms or all firms offshore: $A_L(0) = A_L(1) = \theta(\bar{\zeta}-1)/[2+\theta(\bar{\zeta}-1)]$.[31] We can furthermore show that A_L is lower than the autarky level at low levels of offshoring, and higher than the autarky level at

[31] An analogous result holds for the trade models of Egger and Kreickemeier (2009, 2012) and Helpman, Itskhoki, and Redding (2010), where wage inequality is the same in the cases of autarky and exporting by all firms.

high levels of offshoring. Figure 3 illustrates the resulting S-shape of the A_L locus, alongside the Gini-coefficient for entrepreneurial income A_M that we computed in Section 3.2, with the only modification that now $\bar{\zeta}$ replaces ζ.

Figure 3: *Gini coefficients for entrepreneurial income and wage income*



The intuition is analogous to the one for the effect of offshoring on $\bar{w}/w^d(\varphi^d)$. In a situation where the offshoring strategy is only chosen by the most productive firms, the international relocation effect shifts good high-wage jobs abroad, and displaced workers have to accept less well paid jobs in- *and* outside the manufacturing sector. This effect is in accordance with results from Ebenstein, Harrison, McMillan, and Phillips (2013), who find for the US that workers who have to switch occupations as they are displaced from the manufacturing sector suffer discrete income losses of about 12 to 17 percent, and in our model it is responsible for the reduction of wage inequality at low levels of χ. The influence of the relocation effect is reversed at high levels of χ, since now the low-productivity firms shift low-wage jobs abroad, thereby contributing to an increase in wage inequality in the source country. There is also a firm-level wage effect due to the rent-sharing mechanism in our model: It increases wage dispersion at low levels of χ (wage-boosting increase in profits by high-wage firms) and reduces wage dispersion at high levels of χ (wage-boosting increase in profits by low-wage firms). The firm-level wage effect thereby influences wage inequality in the opposite direction to the international relocation effect, and it dominates the overall effect when many firms offshore.[32]

The following proposition summarises the main insights regarding the distributional effects of offshoring within the group of (employed) production workers.

Proposition 5 *The impact of offshoring on the dispersion of wage income, measured by the Gini coefficient, is non-monotonic. Wage income inequality falls relative to the benchmark without offshoring if χ is small, while it rises relative to this benchmark if χ is sufficiently large.*

Proof Analysis in the text and formal discussion in the Appendix.

5 Economy-wide inequality

So far, our focus was on inequality within and between various subgroups of the population. We now analyse the impact of offshoring on economy-wide inequality. For computing a comprehensive measure of economy-wide income inequality, we have to solve the problem that distributions of profit and labour income overlap if $\theta > 0$. Due to this overlap, we cannot simply calculate Gini coefficients for ranking the economy-wide income distributions with and without offshoring, but instead look at the Theil index as an alternative measure of income inequality. In discrete notation, the Theil index for the income distribution in a group of agents with population size

[32]The Gini coefficient for the income distribution within the broadly defined group of *all* production workers, including those who are unemployed, is given by $A_U(\chi) = [1 - U(\chi)] A_L(\chi) + U(\chi) \geq A_L(\chi)$. Since $U(\chi)$ is smaller than $U(0)$ at low levels of χ, while the reverse is true at high levels of χ, the non-monotonic effect of χ on $A_L(\chi)$ is reinforced. The only difference in the behaviour of both indices is that $A_U(1) > A_U(0)$ while $A_L(1) = A_L(0)$, which results from the fact that $U(1) > U(0)$.

n can be computed according to

$$T = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{\bar{y}} \ln \left(\frac{y_i}{\bar{y}} \right), \tag{30}$$

where y_i is income of agent i, while $\bar{y}$ is the average income. If income is equally distributed, the Theil index has a value of zero. The index increases with inequality and reaches a maximum value of $\ln n$ if all the income is fully concentrated on one person. This implies that the range of the Theil index depends on population size. One of the main advantages of the Theil index as compared to other measures of inequality is its decomposability. For instance, if there are m subgroups of population, Theil index T can be decomposed according to

$$T = \sum_{j=1}^{m} \frac{n_j \bar{y}_j}{n \bar{y}} T_j + \sum_{j=1}^{m} \frac{n_j \bar{y}_j}{n \bar{y}} \ln \left(\frac{\bar{y}_j}{\bar{y}} \right), \tag{31}$$

where $\sum_{j=1}^{m} n_j = n$ and T_j refers to the Theil index of income group j, which can be computed in analogy to Eq. (30). The Theil index can thus be written as a weighted average of inequality within subgroups, plus inequality between these subgroups (cf. Shorrocks, 1980). This makes it particularly useful for our purpose.

In our model, we can distinguish between self-employed agents (entrepreneurs plus offshoring-service agents) and all production workers (employed and unemployed) as the two main income groups. Denoting the Theil indices for these specific subgroups by T_S and T_U, respectively, the Theil index for the economy-wide income distribution can be written as[33]

$$T = a_S \left(T_S + \ln \bar{\zeta} \right) + a_U T_U + \ln \left(\frac{a_S}{\bar{\zeta}} + a_U \right), \tag{32}$$

with

$$a_S \equiv \frac{1-\rho}{\rho\gamma + 1 - \rho} \qquad \text{and} \qquad a_U \equiv \frac{\rho\gamma}{\rho\gamma + 1 - \rho} \tag{33}$$

being the income shares of the two population subgroups. To understand how offshoring influences Theil index T, we first look at the benchmark scenario without firm-level rent-sharing, i.e.

[33] See the Appendix for derivation details.

$\theta = 0$. In this case, all firms pay the same wage and all production workers find a job, implying that Theil index T_U falls to zero. Eq. (32) therefore simplifies to

$$T = \frac{1-\rho}{\rho\gamma + 1 - \rho}\left(T_S + \ln\zeta\right) + \ln\left[\frac{\zeta\rho\gamma + 1 - \rho}{\zeta(\rho\gamma + 1 - \rho)}\right], \tag{34}$$

where $\bar{\zeta}$ has been replaced by ζ due to $\theta = 0$. To see how offshoring affects economy-wide inequality, it is crucial to understand how it influences the distribution of income within the subgroup of self-employed agents. From the analysis in Section 3.2 we already know that offshoring raises inequality within the group of self-employed agents according to the Gini criterion. However, this is not sufficient for an increase in Theil index T_S. Unlike the Gini coefficient, the Theil index does not rely on the Lorenz curve. But the two indices share one important property: both of them respect mean-preserving second-order stochastic dominance, which is equivalent to Lorenz dominance. We can therefore conclude that the Gini coefficient and the Theil index rank two distributions equivalently, if one of them Lorenz dominates the other one. One can show that the distribution of income among self-employed agents under autarky Lorenz dominates the respective distribution in an offshoring equilibrium for arbitrary values of $\chi \in (0,1)$.[34] This implies $T_S > T_S^a$ (where superscript a refers to autarky).

Accounting for $T_S > T_S^a$, it follows from Eq. (34) that $T - T^a > \Delta_T(\chi)$, with[35]

$$\Delta_T(\chi) \equiv \frac{\rho(1-\rho)(1-\gamma)(\zeta-1)}{\rho\gamma + 1 - \rho} + \ln\left[\frac{\zeta\rho\gamma + 1 - \rho}{\zeta(\rho\gamma + 1 - \rho)}\right] - \ln\left[\frac{1 + \rho(\zeta - 1)}{\zeta}\right]. \tag{35}$$

Economy-wide inequality is higher with offshoring than under autarky if $\Delta_T(\chi) > 0$ holds for $\chi > 0$. This is the case, because

$$\frac{d\Delta_T(\chi)}{d\chi} = -\frac{\rho^2(1-\rho)\gamma(\zeta-1)^2}{\left[\rho\gamma + (1-\rho)\right]^2(\zeta\rho\gamma + 1 - \rho)}\frac{d\gamma(\chi;\eta)}{d\chi} > 0 \tag{36}$$

and $\Delta_T(0) = 0$. We can therefore conclude that an increase of χ from zero to any positive level increases Theil index T, and hence renders the economy-wide distribution of income less equal.

[34] Showing Lorenz dominance in this case is tedious, and therefore we have delegated formal details of this analysis to a supplement which is available upon request.

[35] Thereby, $T_S^a = (\zeta-1)^{-1}\int_1^\infty x^{-k/\xi}\left[\ln x - \ln\zeta\right]dx = \zeta - 1 - \ln\zeta$ has been considered.

Things are more complicated if rent sharing gives rise to firm-specific wages and involuntary unemployment, because in this case changes in Theil index T additionally account for adjustments in the distribution of income within the group of production workers, as captured by T_U. Since we know from the analysis in the previous section that offshoring may increase or decrease income inequality among production workers, it is *a priori* not clear, whether offshoring in our model renders the economy-wide distribution of income more or less even than under autarky.[36] We address this question as part of the numerical exercise conducted in the next section.

6 A quantitative exercise

In this section, we conduct a numerical exercise using the model variant from Section 4 and parameter estimates from the empirical trade literature. The purpose of this exercise is twofold. On the one hand, our aim is to illustrate the non-monotonic effect of offshoring on inequality, welfare, and unemployment. On the other hand, we want to shed additional light on the consequences of offshoring for the economy-wide distribution of income under firm-level rent-sharing, for which the analytical results are not clear. Since our model – even with its extension including firm-level rent sharing – is highly stylized, the quantitative effects should be viewed as illustrative.

A first set of parameters is taken from Egger, Egger, and Kreickemeier (2013), who structurally estimate key parameters of a trade model along the lines of Egger and Kreickemeier (2012), which is in may respects similar to the theoretical framework underlying our analysis, but does not account for offshoring. Employing information from the Amadeus data-set, Egger, Egger, and Kreickemeier (2013) report the following parameter estimates for the average country in their data-set, which covers five European economies: $\theta = 0.102$, $\sigma = 6.698$, $k = 4.306$. While, to the best of our knowledge, there are no other directly comparable estimates for the rent-sharing parameter available, the estimate of σ lies in the range of parameter estimates reported by Broda and Weinstein (2006) and is well in line with the parameter value considered by Arkolakis (2010) in his calibration exercise. The parameter estimate of k is higher than the

[36] In a supplement, we show that a movement from autarky to high levels of offshoring increases economy-wide inequality if θ is sufficiently small.

estimate of about 2 reported by Corcos, Gatto, Mion, and Ottaviano (2012). However, it is consistent with findings by Arkolakis and Muendler (2010) and – together with the estimates for θ and σ – guarantees that the parameter constraint $k > \bar{\xi}$ is fulfilled.

It is challenging to come up with a theory-consistent measure of η. We take guidance from the findings by Blinder (2009) and Blinder and Krueger (2013) that about a quarter of jobs in US manufacturing can be classified as offshorable.[37] In our model, all jobs done by individuals employed in routine tasks can in principle be offshored, and the economy-wide cost share of these jobs is $1 - \eta$. Under autarky, all workers within each firm are paid the same wage, and therefore in this situation $1 - \eta$ is also the fraction of jobs that can be offshored. We therefore set $\eta = 0.75$. Of course, estimates on the actual extent of offshoring are much smaller than the numbers reported by Blinder (2009) and Blinder and Krueger (2013). For the US economy, Forrester Research predicted in 2002 a loss of 3.3 million jobs due to offshoring by 2015, which is less than 2.5 percent of the workforce. Bringing the quantitative results from our numerical exercise in accordance with such estimates therefore requires that the fraction of offshoring firms is sufficiently small.

Based on these parameter estimates, we can quantify the effects of offshoring. For this purpose, we compute how a given exposure to offshoring alters our variables of interest relative to a benchmark without offshoring. Thereby, we first look on changes of intra- and inter-group inequality and determine the relative importance of these changes for the adjustments in economy-wide inequality. The results from this exercise are summarised in Table 1.

Columns 2-4 quantify the impact of offshoring on the inequality measures discussed in Sections 3 and 4. Evaluated at our parameter estimates, offshoring has only a moderate effect on intra-group inequality among (employed) production workers and among entrepreneurs, whereas its impact on inter-group inequality between entrepreneurs and production workers can be sizable. Columns 5-7 summarise the quantitative effects of offshoring on the distribution of income within the two main income groups – self-employed agents (entrepreneurs plus offshoring service agents) and all production workers (employed and unemployed) – as well as for the whole econ-

[37] Based on the taxonomy of Blinder (2009) and Blinder and Krueger (2013) researchers have provided estimates on the share of offshorable tasks also for other industrialised countries. For Germany, the share of jobs that can be classified offshorable amounts to 42 percent and is thus significantly higher than for the US (see Laaser and Schrader, 2009).

Table 1: *Impact of offshoring on different measures of inequality*

χ	Change of					
	A_M in pct.	A_L in pct.	$\bar{\omega}$ in pct.	T_S in pct.	T_U in pct.	T in pct.
0.001	0.033	−8.685	0.084	0.167	−9.818	−0.174
0.01	0.322	−6.910	0.837	1.174	−9.161	2.589
0.10	2.860	−0.488	8.369	6.485	−1.291	11.642
0.25	5.902	2.270	20.922	10.735	3.953	18.499
0.50	8.626	2.362	41.844	13.762	9.351	23.967
0.75	9.395	1.224	62.766	14.820	12.062	26.488
0.90	9.211	0.477	75.319	15.025	13.035	27.319

Notes: All reported figures refer to percentage changes relative to autarky.

omy, relying on Theil indices. The qualitative effects of offshoring on income inequality within the now more broadly defined income groups are the same as those reported in Columns 2 and 3, but the quantitative effects seem to be more pronounced. The quantitative differences regarding the effects of offshoring on intra-group inequality can be explained by different definitions of income groups and by the fact that the Gini coefficient is confined to the unit interval, while this is not the case for the Theil index. Our numerical results point to a considerable increase in economy-wide income inequality at higher levels of χ. We can also see that, evaluated at our parameter estimates, offshoring lowers economy-wide income inequality if χ is sufficiently close to zero.

We now turn to the impact of offshoring on welfare and unemployment, which we summarise in Table 2. As outlined in Section 3.3, the impact of offshoring on source-country welfare crucially depends on the value of ε. To illustrate this, we run separate numerical experiments for the two polar cases highlighted in Section 3.3: a production technology without external increasing returns to scale ($\varepsilon = 0$) and a textbook CES production technology ($\varepsilon = 1$). The results for these two exercises are reported in Columns 2 and 3. Thereby, Column 2 confirms our analytical finding that in the absence of external increasing returns to scale source country income I declines relative to autarky at low levels of χ. However, the welfare loss is small compared to the potential welfare gains at high levels of χ. With a textbook CES production technology, external increasing returns to scale generate additional welfare gains from firm entry, and these gains are sufficiently strong to dominate welfare losses from unfavourable labour reallocations at low levels of χ. At higher levels of χ offshoring leads to firm exit and in this case the external increasing returns to scale viewed on their own lead to a welfare loss. However, this loss is not strong enough to dominate the positive welfare implications of the now more favourable resource allocation and relying on the textbook production technology offshoring is therefore a success story for the source country, irrespective of the level of χ.

Table 2: *Impact of offshoring on welfare and unemployment*

	Change of			
	I in pct.			u in ppt.
χ	$\varepsilon = 0$	$\varepsilon = 1$	$\varepsilon = 0.56$	
0.001	−0.800	0.624	−0.005	−2.554
0.01	−0.827	1.164	0.283	−2.654
0.10	2.067	3.796	3.032	−0.944
0.25	7.202	7.289	7.251	0.898
0.50	15.222	12.235	13.540	2.560
0.75	22.564	16.492	19.125	3.502
0.90	26.692	18.804	22.212	3.839

Notes: Welfare effects refer to percentage changes relative to autarky, whereas unemployment effects refer to changes in percentage points.

The results for the two cases $\varepsilon = 0$ and $\varepsilon = 1$ define a corridor in which the welfare effects of offshoring can lie in our model. We also provide results using $\varepsilon = 0.56$, which is the empirical estimate of Ardelean (2011). The insights from this exercise are summarized in Column 4, and we see that in this case there are small welfare losses from offshoring for the source country if $\chi = 0.001$. The last column of Table 2 confirms our analytical finding from Section 4 that offshoring lowers aggregate unemployment at low levels of χ, whereas it exacerbates the unemployment problem in the source country at high levels of χ. In general, the quantitative effect of offshoring on economy-wide unemployment is fairly small, when evaluating the model at our parameter estimates.

To complete our discussion on the quantitative effects of offshoring, we finally look more specifically on the consequences of the observed exposure to offshoring. This requires empirical information upon the share of firms that engage in offshoring, which is reported for Germany by Moser, Urban, and Weder di Mauro (2009). Using a large sample of 8,466 German plants from the IAB Establishment Panel, they find that the share of offshoring firms is 14.9 percent.

This share is somewhat lower than the share of offshoring firms reported by The Economist (2004) from a small survey of 150 British firms, while it is significantly higher than the share of firms conducting international outsourcing and/or FDI in Japan as reported by Tomiura (2007). Evaluated at $\chi = 0.149$, our model predicts that offshoring has increased inequality within the group of entrepreneurs by 4.0 percent and inequality within the group of production workers by 0.9 percent, when relying on the metric of Gini coefficients. Looking at the relative income of entrepreneurs and workers, offshoring has augmented the preexisting gap in Germany by 12.5 percent. Also economy-wide income inequality has widened considerably due to offshoring, with the respective Theil index being 14.4 percent higher under the observed exposure to offshoring than under autarky. With respect to its welfare consequences, our model predicts a moderate increase for Germany, ranging between 3.1 (for $\varepsilon = 0$) and 5.0 (for $\varepsilon = 1$) percent. Using Ardelean's estimate of $\varepsilon = 0.56$, the welfare increase amounts to 4.5 percent. In contrast to the widespread perception of large negative employment effects, our model predicts that offshoring has lowered unemployment in Germany by 0.2 percentage points.[38]

7 Concluding remarks

In this paper, we have developed an analytically tractable general equilibrium framework for analysing offshoring to low-wage countries. It is a key feature of our framework that firms differ from each other in terms of their productivity. As a consequence, the costly option to offshore routine tasks to the low-wage country, while available to all firms, is chosen only by a subset of them in equilibrium. The effects that offshoring has on welfare and the income distribution depends on the share of firms that offshore tasks in equilibrium, and we are therefore able to show that considering firm heterogeneity adds a relevant dimension to the established offshoring

[38]Since empirical evidence for Germany suggests setting $\eta = 0.58$ instead of $\eta = 0.75$, we have repeated our numerical exercise from this paragraph for $\eta = 0.58$. This change in the value of η does not affect the predicted consequences of observed offshoring for A_M and $\bar{\omega}$, and it has only a small quantitative effect on the predicted consequences for I. At the same time, using the lower value for η leads to larger quantitative effects of observed offshoring on economy-wide inequality and aggregate unemployment in Germany. With $\eta = 0.58$ our model predicts that offshoring has increased economy-wide inequality by 21.73 percent and has lowered aggregate unemployment by 2.46 percentage points. Finally, the reduction of η changes the predicted consequences of offshoring for A_L in a qualitative way. According to our model the observed exposure to offshoring has lowered intra-group inequality among production workers in Germany by 2.19 percent, when considering $\eta = 0.58$ instead of $\eta = 0.75$.

literature that has mainly focussed on the heterogeneity of tasks.

Offshoring is attractive for firms because it leads to lower marginal production costs, and this implies an expansion of employment in non-routine tasks at home. However, offshoring also destroys domestic jobs for performing routine tasks. The relative strength of these two opposing effects on firm-level employment depends on the costs of offshoring. If these costs are high, offshoring is only attractive for a relatively small fraction of high-productivity firms, because its potential for lowering marginal production costs is small. As a consequence, the destruction of domestic jobs for performing routine tasks dominates the establishment of new jobs for performing non-routine tasks, and offshoring lowers firm-level employment. Workers losing their jobs in offshoring firms find employment in less productive activities, including jobs in low-productivity firms newly entering the domestic market. Unlike trade in final goods, which in canonical models with heterogeneous producers triggers a reallocation of domestic workers from low- to high-productivity firms, offshoring therefore causes a shift of domestic employment from high- to low-productivity firms.

The reallocation of workers from low- to high-productivity firms constitutes a detrimental welfare effect, which can dominate traditional sources of welfare gain, and therefore render the source country worse off with offshoring than in autarky. The situation is more favourable at lower costs of offshoring, because in this case offshoring becomes attractive for a broad range of producers and leads to a reallocation of workers towards high-productivity firms. As a consequence, source country welfare unambiguously increases relative to autarky if the costs of offshoring are sufficiently small.

Income inequality between entrepreneurs and workers increases unambiguously with the share of offshoring firms. However, the effect on income inequality among entrepreneurs is non-monotonic: income inequality within this group increases if only a few firms shift the production of routine tasks abroad, and it decreases (while always staying above the autarky level) if offshoring becomes common practice among high- and low-productivity firms. Both of these effects contribute to the emergence of a new class of entrepreneurial superstars, who gain disproportionately from the global expansion of their firms under offshoring.

An extended version of our model with firm-level rent sharing, which preserves all results derived in the benchmark model with perfectly competitive labour markets, allows us to address the public concern that offshoring destroys domestic jobs and exacerbates the problem of unemployment. Our analysis shows that it is important to distinguish between what happens at the level of offshoring firms (firm-level effect) and what happens in the aggregate, after taking into account general equilibrium effects. We find that firm-level employment of production workers and aggregate employment tend do move in opposite directions: aggregate employment increases unambiguously at low levels of offshoring, where the negative firm-level effects on source country employment are largest. The reverse is true at high levels of offshoring: firm-level employment of production workers goes up, while aggregate employment falls.

The model extension with rent sharing also provides a richer picture of the distributional effects of offshoring, by additionally allowing for wage inequality of ex ante identical production workers. To understand its distributional consequences for production workers, it is noteworthy that offshoring constitutes a threat to the incomes of workers employed in both *good* (high-wage) and *bad* (low-wage) jobs. The former fear the relocation of their jobs abroad at early stages of offshoring, leaving them with alternatives that invariably yield lower incomes. The latter face a potential shut-down of their firms when production shifting becomes common practice among high- and low-productivity employers at later stages of offshoring, and some of those losing their job join the ranks of the unemployed. An immediate consequence of these firm-level employment effects is that offshoring reduces wage inequality initially, but widens it if a sufficiently large share of firms shifts the production of routine tasks abroad. A non-monotonicity also materializes with respect to the effect of offshoring on economy-wide inequality. Relying on the Theil index, we show that economy-wide inequality decreases if only a few high-productivity firms make use of offshoring, whereas it increases if offshoring also becomes common practice among firms with lower productivity levels.

Our analysis highlights the relevance of the extensive margin of offshoring for understanding how relocating routine tasks to low-wage countries affects economy-wide variables, such as income inequality, welfare, and unemployment. Firms in our model react differently to the offshoring opportunity, and we show that their asymmetric response has important general equilibrium effects. We hope that these insights together with the tractability of our framework can provide guidance to the rapidly growing empirical literature on offshoring using firm-level data, and that it will also be a useful point of departure for further theoretical work.

A Appendix

A.1 Derivation of $\gamma(\chi,\eta)$

We first show that the two averages $\bar{\pi}^o$ and $\bar{\pi}^d$ are proportional to $\pi^d(\varphi^d)$. An analogous result has already been shown in the main text for $\bar{\pi}$. It is an immediate implication of the Pareto distribution of productivities that the average operating profits of offshoring firms $\bar{\pi}^o$ are a multiple ζ of the marginal offshoring firm's operating profits $\pi^o(\varphi^o)$. Hence, we can write:

$$\bar{\pi}^o = \zeta\pi^o\left(\varphi^o\right) = \zeta\left[\frac{\pi^o\left(\varphi^o\right)}{\pi^d\left(\varphi^o\right)}\right]\left[\frac{\pi^d\left(\varphi^o\right)}{\pi^d\left(\varphi^d\right)}\right]\pi^d(\varphi^d) = \zeta\left(1+\chi^{-\frac{\xi}{k}}\right)\pi^d(\varphi^d), \tag{A.1}$$

where $\pi^o\left(\varphi^o\right)/\pi^d\left(\varphi^o\right) = 1+\chi^{\xi/k}$ from Eq. (6) and the definition of χ reflects the firm-level productivity effect, while $\pi^d\left(\varphi^o\right)/\pi^d(\varphi^d) = (\varphi^d/\varphi^o)^{-\xi} = \chi^{-\xi/k}$ from Eq. (7) and the definition of χ captures the positive selection of offshoring firms. Using $\bar{\pi} = (1-\chi)\bar{\pi}^d + \chi\bar{\pi}^o$ as well as the solutions we have derived for $\bar{\pi}$ and $\bar{\pi}^o$ in terms of $\pi^d(\varphi^d)$, we get:

$$\bar{\pi}^d = \frac{\bar{\pi}-\chi\bar{\pi}^o}{1-\chi} = \zeta\frac{1-\chi^{\frac{k-\xi}{k}}}{1-\chi}\pi^d(\varphi^d). \tag{A.2}$$

Substituting for $\bar{\pi}$, $\bar{\pi}^o$, and $\bar{\pi}^d$ in the definition of γ, we then obtain $\gamma(\chi;\eta)$ as given in the main text.

A.2 Derivation of the Gini coefficient in Eq. (22)

For characterising the Gini coefficient in Eq. (22), we must distinguish between firms which offshore and those that produce only domestically. Cumulative profits of purely domestic firms with productivity $\bar{\varphi} \in [\varphi^d, \varphi^o)$ are given by $\Psi(\bar{\varphi}) \equiv N\int_{\varphi^d}^{\bar{\varphi}}\pi^d(\varphi)dG\left(\varphi\right)$. Considering

$\pi^d(\varphi)/\pi^d(\varphi^d) = (\varphi/\varphi^d)^\xi$ from Eq. (7), we can solve for

$$\Psi(\bar{\varphi}) = M\pi^d(\varphi^d)\zeta\left[1-\left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\xi-k}\right]. \tag{A.3}$$

Economy-wide profit income is given by $\Psi = M(1+\chi)\zeta\pi^d(\varphi^d) - M\chi s$. Accounting for $s = \pi^d(\varphi^d)$ from Eq. (8), gives $\Psi = M\pi^d(\varphi^d)[\zeta + (\zeta-1)\chi]$. The share of cumulative profits realised by firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$ is therefore given by

$$\frac{\Psi(\bar{\varphi})}{\Psi} = \frac{\zeta}{\zeta + (\zeta-1)\chi}\left[1-\left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\xi-k}\right]. \tag{A.4}$$

Denoting the fraction of firms with a productivity level $\varphi \leq \bar{\varphi}$ by $\mu \equiv 1(\bar{\varphi}/\varphi^d)^{-k}$, Eq. (A.4) can be rewritten as the first segment of the Lorenz curve for the distribution of profit income:

$$Q_M^1(\mu) = \frac{\zeta}{\zeta + (\zeta-1)\chi}\left[1-(1-\mu)^{\frac{k-\xi}{k}}\right], \tag{A.5}$$

which is relevant for parameter domain $\mu \in [0, 1-\chi)$.

We now follow the same steps as above to calculate the second segment of the Lorenz curve for the distribution of profit income. We can first note that cumulative profits of all firms with productivities up to $\bar{\varphi} \in [\varphi^o, \infty)$ are given by $\Psi(\bar{\varphi}) = \Psi(\varphi^o) + N\int_{\varphi^o}^{\bar{\varphi}} \pi^o(\varphi)dG(\varphi) - N\int_{\varphi^o}^{\bar{\varphi}} s dG(\varphi)$. Accounting for $\pi^d(\varphi)/\pi^d(\varphi^d) = (\varphi/\varphi^d)^\xi$ from Eq. (7) and $\pi^o(\varphi)/\pi^d(\varphi) = 1 + \chi^{\xi/k}$, according to Eqs. (6) and (17), we can calculate

$$\Psi(\bar{\varphi}) = \Psi(\varphi^o) + M\pi^d(\varphi^d)\left\{\zeta\left(1+\chi^{\frac{\xi}{k}}\right)\left[\chi^{\frac{k-\xi}{k}} - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\xi-k}\right] - \left[\chi - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{-k}\right]\right\}. \tag{A.6}$$

Dividing the latter by economy-wide profit income Ψ gives the share of profit income accruing to entrepreneurs with an ability up to $\bar{\varphi} \in [\varphi^o, \infty)$:

$$\frac{\Psi(\bar{\varphi})}{\Psi} = Q_M^1(1-\chi) + \frac{\zeta\left(1+\chi^{\frac{\xi}{k}}\right)\left[\chi^{\frac{k-\xi}{k}} - \left(\bar{\varphi}/\varphi^d\right)^{\xi-k}\right]}{\zeta + (\zeta-1)\chi} - \frac{\chi - \left(\bar{\varphi}/\varphi^d\right)^{-k}}{\zeta + (\zeta-1)\chi}. \tag{A.7}$$

Substituting μ from above, Eq. (A.7) can be reformulated to the second segment of the Lorenz curve, which is relevant for $\mu \in (1-\chi, 1]$

$$Q_M^2(\mu) = Q_M^1(1-\chi) + \frac{\zeta\left(1+\chi^{\frac{\xi}{k}}\right)\left[\chi^{\frac{k-\xi}{k}} - (1-\mu)^{\frac{k-\xi}{k}}\right]}{\zeta + (\zeta-1)\,\chi} - \frac{\mu - 1 + \chi}{\zeta + (\zeta - 1)\,\chi}, \tag{A.8}$$

with $Q_M^2(1-\chi) = Q_M^1(1-\chi)$. Together Eqs. (A.5) and (A.8) form the Lorenz curve[39]

$$Q_M(\mu) \equiv \begin{cases} Q_M^1(\mu) & \text{if} \quad \mu \in [0, 1-\chi) \\ Q_M^2(\mu) & \text{if} \quad \mu \in [1-\chi, 1] \end{cases}. \tag{A.9}$$

The Gini coefficient for the distribution of profit income in Eq. (22) can then be computed according to $A_M(\chi) \equiv 1 - 2\int_0^1 Q_M(\mu) d\mu$.

A.3 Proof of Proposition 3

Substitution of Eqs. (14) and (16) for M and φ^d, respectively, in Eq. (24) and using the resulting expression in $\Phi(\chi) = I(\chi)/I(0)$, we obtain after tedious but straightforward computations: $\Phi(\chi) = T_1(\chi) \times T_2(\chi) \times T_3(\chi)$, with

$$T_1(\chi) \equiv \frac{[1+\gamma(\sigma-1)]\,[1+\zeta(\sigma-1)]}{\sigma\,[1+\gamma\zeta(\sigma-1)]}, \qquad T_2(\chi) \equiv \left\{\frac{(1+\chi)\,[1+\gamma\zeta(\sigma-1)]}{1+\zeta(\sigma-1)}\right\}^{\frac{\sigma-1-\varepsilon k}{k(\sigma-1)}}, \tag{A.10}$$

and $T_3(\chi) \equiv (1+\chi)^{1/(\sigma-1)}$. Differentiation of $\Phi(\chi)$ establishes

$$\Phi'(\chi) = \frac{\Phi(\chi)}{1+\gamma(\sigma-1)}\left\{-\left[\frac{\hat{\kappa}(\chi;\varepsilon)+\xi(\sigma-1)}{\gamma k(\sigma-1)+k-\xi}\right]\frac{\partial\gamma}{\partial\chi} + \left[\frac{(1-\varepsilon)\,k+\sigma-1}{k(\sigma-1)}\right]\frac{1+\gamma(\sigma-1)}{1+\chi}\right\}, \tag{A.11}$$

with $\hat{\kappa}(\chi;\varepsilon) \equiv [k\varepsilon - \sigma + 1]\,[1+\gamma(\chi;\eta)\,(\sigma-1)]$. In view of $\partial\gamma/\partial\chi < 0$, it is immediate that $\hat{\kappa}(\chi;\varepsilon)+\xi(\sigma-1) \geq 0$ is sufficient for $\Phi'(\chi) > 0$. $\Phi'(\chi) > 0$ is therefore guaranteed if $\varepsilon \geq (\sigma-1)/k$, because in this case we have $\hat{\kappa}(\chi;\varepsilon) \geq 0$. Things are less obvious for parameter domain $\varepsilon < (\sigma-1)/k$, because in this case we have $\hat{\kappa}(\chi;\varepsilon) < 0$. However, noting that for parameter domain $\varepsilon < (\sigma-1)/k$ we have $\partial\hat{\kappa}(\chi;\varepsilon)/\partial\chi > 0$, it follows that in this case $\hat{\kappa}(\chi;\varepsilon) + \xi(\sigma-1) > 0$ must

[39]The Lorenz curve in Eq. (A.9) has the usual properties: $Q_M(0) = 0$, $Q_M(1) = 1$ and $Q'_M(\mu) > 0 \;\forall\; \mu \in (0,1)$.

hold for all possible χ if $\hat{\kappa}(0;\varepsilon)+\xi(\sigma-1)\geq 0$ or, equivalently, if $\varepsilon\geq(\sigma-\xi)(\sigma-1)/(\sigma k)\equiv\bar{\varepsilon}$. We can thus safely conclude that $\Phi'(\chi)>0$ is guaranteed if $\varepsilon\geq\bar{\varepsilon}$. Put differently, if $\varepsilon\geq\bar{\varepsilon}$ source country welfare is monotonically increasing in the share of offshoring firms, and hence welfare in the source country is unambiguously higher with offshoring than in autarky.

We now consider the parameter domain $\varepsilon<\bar{\varepsilon}$. In this case, $\Phi'(0)<0$ follows from $\hat{\kappa}(0;\varepsilon)+\xi(\sigma-1)<0$ and the fact that $\lim_{\chi\to 0}\partial\gamma/\partial\chi=-\infty$, and hence offshoring lowers source country welfare relative to autarky if χ is small. Furthermore, evaluating the derivative in Eq. (A.11) at $\chi=1$, we obtain

$$\Phi'(1)=\frac{\Phi(1)}{2k}\,\frac{[b(\eta)+k(k-\xi)(1-\eta)]\,[1+\eta(\sigma-1)]+\xi(\sigma-1)(k-\xi)(1-\eta)}{[1+\eta(\sigma-1)]\,[\eta k(\sigma-1)+k-\xi]},\tag{A.12}$$

with $b(\eta)\equiv[(1-\varepsilon)k+\sigma-1]\,[(2\eta-1)k+\xi(1-\eta)+(k-\xi)/(\sigma-1)]$. It is immediate that $\eta>0.5$ is sufficient for $b(\eta)>0$ and in this case we have $\Phi'(1)>0$. Hence, if $\eta>0.5$, offshoring exerts a non-monotonic effect on source country welfare. Noting that $T_1(\chi)>1$ and $T_3(\chi)>1$ hold for any $\chi>0$, whereas $\eta>0.5$ is sufficient for $T_2(1)>1$ if $\varepsilon<(\sigma-1)/k$, we can safely conclude that $\Phi(1)>1$, and hence the source country benefits from offshoring if χ is large.

Taking stock, our previous analysis has identified a critical level of external increasing returns to scale in the production of Y: $\bar{\varepsilon}$. If external increasing returns to scale are larger than the critical level, offshoring exerts a positive monotonic effect on source country welfare. In contrast, if the external increasing returns to scale are smaller than the critical level, offshoring exerts a non-monotonic effect on source country welfare. In this case, the source country is worse off with offshoring than under autarky if χ is small, while it benefits from offshoring if χ is large. Using the parameter estimates from Section 6, we can determine 0.61 as an empirically plausible value for $\bar{\varepsilon}$. Empirical estimates for parameter ε are reported by Ardelean (2011). Relying on UN COMTRADE data, Ardelean identifies an average value of $\varepsilon=0.56$ across all industries in her data-set. This lends support to the non-monotonic welfare effect of offshoring in Proposition 3.[40] This completes the proof.

[40] Ardelean (2011) does not distinguish between final and intermediate goods, and hence her ε estimates capture external increasing returns to scale due to a love of variety of consumers in a Krugman-type model as well as external increasing returns to scale in final goods production due to labor division in an Ethier framework. Furthermore, it is notable that variation in the ε estimates is large, ranging from a low level of 0.19 in the

A.4 The social planner problem for $\varepsilon = 1$ under autarky

In autarky, the social planner sets φ^d and the quantity $q(v) > 0$ of all varieties v to maximize output Y, subject to the binding resource constraint. We first consider the problem of setting optimal quantities $q(v)$ for a given φ^d. Holding φ^d constant under autarky is tantamount to fixing the amount of resources used as variable production input: $L = NG(\varphi^d)$. The social planner's problem in this case is therefore to maximize $Y = \left[\int_{v \in V} q(v)^\rho dv\right]^{1/\rho}$, subject to $\int_{v \in V} [q(v)/\varphi(v)]\, dv = NG(\varphi^d)$. The first-order conditions for this maximization problem establish for any two varieties v_1, v_2 the following output ratio: $q(v_1)/q(v_2) = [\varphi(v_1)/\varphi(v_2)]^\sigma$. This implies that output increases with productivity and hence, we can refer to varieties by means of the underlying productivity parameter. The marginal variety is the one with the lowest output and produced with productivity φ^d. We can define $a \equiv q(\varphi^d)/(\varphi^d)^\sigma$. An optimal allocation of resources then requires that the output level of any firm with productivity $\varphi \geq \varphi^d$ is set to $q(\varphi) = a\varphi^\sigma$, with $a > 0$.

With these insights at hand, we can reformulate the social planner's problem as

$$\max_{\varphi^d, a} \; Y = \left[N \int_{\varphi^d}^{\infty} q\left(\varphi\right)^\rho dG(\varphi)\right]^{\frac{1}{\rho}} \quad \text{s.t.} \quad \int_{\varphi^d}^{\infty} \left[\frac{q\left(\varphi\right)}{\varphi}\right] dG(\varphi) = G(\varphi^d), \quad q(\varphi) = a\varphi^\sigma. \quad \text{(A.13)}$$

Applying $q(\varphi) = a\varphi^\sigma$, we can rewrite the resource constraint as follows: $\zeta a (\varphi^d)^{\sigma-1-k} = 1 - (\varphi^d)^{-k}$. Furthermore, economy-wide output can be written as $Y = \left[N\zeta a^\rho (\varphi^d)^{\sigma-1-k}\right]^{1/\rho}$. Solving the resource constraint for a and substituting the resulting expression into Y, we can simplify the social planner's problem to

$$\max_{\varphi^d} \; N^{\frac{\sigma}{\sigma-1}} \zeta^{\frac{1}{\sigma-1}} \left[1 - \left(\varphi^d\right)^{-k}\right] \left(\varphi^d\right)^{\frac{\sigma-1-k}{\sigma-1}}. \quad \text{(A.14)}$$

The first-order condition to this maximization problem establishes $\varphi^d = \left[1 + \zeta(\sigma - 1)\right]^{1/k}$ and this coincides with the outcome of decentralized firm entry in Eq. (16), when considering $\chi = 0$. Hence, for $\varepsilon = 1$ the market equilibrium under autarky is allocationally efficient.

'Headgear and Parts Thereof' industry to a relatively high level of 0.88 in the 'Soap etc.; Waxes, Polish, etc; Candles; Dental Preps' industry.

A.5 Derivation of Eq. (26)

Adding up domestic employment over all purely domestic and offshoring firms in the source country gives $(1-U)L = N\left[\int_{\varphi^d}^{\varphi^o} l^d(\varphi)\,dG(\varphi) + \int_{\varphi^o}^{\infty} l^o(\varphi)\,dG(\varphi)\right]$. Using $l^d(\varphi)/l^d(\varphi^d) = (\varphi/\varphi^d)^{(1-\theta)\bar{\xi}}$ and $l^o(\varphi)/l^d(\varphi^d) = \eta\kappa^{(\sigma-1)(1-\theta)}(\varphi/\varphi^d)^{(1-\theta)\bar{\xi}}$, according to Eqs. (2), (7), the equivalent of Eq. (21) for the scenario with $\theta > 0$, and Eq. (25), and accounting for the definition of $\beta(\chi;\eta)$ in Eq. (27), we can calculate

$$(1-U)L = Ml^d(\varphi^d)\beta(\chi;\eta)\frac{\bar{\zeta}}{1+\theta(\bar{\zeta}-1)}. \tag{A.15}$$

Furthermore, combining Eqs. (8′), (10), (11) and noting that constant markup pricing implies $(\sigma-1)\pi(\varphi^d) = l^d(\varphi^d)w(\varphi^d)$, we can express the total wage bill in the source country as follows:

$$(1-U)L\bar{w} = Ml^d(\varphi^d)w(\varphi^d)\alpha(\chi;\eta)\bar{\zeta}. \tag{A.16}$$

Together Eq. (A.15) and Eq. (A.16) determine the wage ratio $w(\varphi^d)/\bar{w} = \Delta(\chi;\eta)/[1+\theta(\bar{\zeta}-1)]$, where $\Delta(\chi;\eta) = \beta(\chi;\eta)/\alpha(\chi;\eta)$ has been considered. Applying the fair-wage constraint (25) for the marginal firm and considering indifference condition (8), we can compute $U = 1 - w(\varphi^d)/\bar{w}$. Substituting for $w(\varphi^d)/\bar{w}$, then gives Eq. (26).

A.6 Proof of Proposition 4

Let us first consider the impact of offshoring on U. From Eq. (27), we can conclude that, for all $\chi \in (0,1]$, $\Delta(\chi;\eta) >,=,< 1$ is equivalent to $\Omega(\vartheta) \equiv (\eta\vartheta^{1-\theta}-1)(\vartheta-1)^{\theta} - (\eta\vartheta-1) >,=,< 0$, with $\vartheta \equiv 1+\chi^{\bar{\xi}/k} \in (1,2]$. Differentiating $\Omega(\vartheta)$ gives $\Omega'(\vartheta) = -\eta[1-(1-\theta)\vartheta^{-\theta}(\vartheta-1)^{\theta}] + \theta(\vartheta-1)^{\theta-1}(\eta\vartheta^{1-\theta}-1)$ and $\Omega''(\vartheta) = \theta(1-\theta)(\vartheta-1)^{\theta-2}[1-\eta/\vartheta^{1+\theta}]$. Accounting for $\Omega''(\vartheta) > 0$ and $\Omega'(2) = -\eta(1-2^{-\theta}) - \theta(1-\eta 2^{-\theta}) < 0$, it follows that $\Omega'(\vartheta) < 0$ must hold for all $\vartheta \in (1,2)$. Noting finally that $\Omega(1) = 1-\eta > 0$ and $\Omega(2) = -2\eta[1-(1/2)^{\theta}] < 0$, we can define a unique $\hat{\chi} \in (0,1)$, such that offshoring lowers U if $\chi < \hat{\chi}$, while it raises U if $\chi > \hat{\chi}$.

From inspection of Eq. (28) we can note that $\Lambda > 1$ requires $\Delta < 1$ and thus a positive effect of offshoring on U. This implies that $\Lambda(\chi;\eta) > 1$ can only materialise if $\chi > \hat{\chi}$. Furthermore, it is worth noting that partially differentiating $\Delta(\chi;\eta)$ with respect to η gives

$$\frac{\partial\Delta\left(\chi;\eta\right)}{\partial\eta}=-\frac{\chi^{\frac{k-\bar{\xi}}{k}}\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)\left[\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right)-\left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)\chi^{\frac{\theta\bar{\xi}}{k}}\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{-\theta}\right]}{\alpha(\chi;\eta)^{2}}<0. \quad \text{(A.17)}$$

Additionally accounting for $\partial\gamma\left(\chi;\eta\right)/\partial\eta>0$, it follows from Eq. (28) that $\partial\Lambda\left(\chi;\eta\right)/\partial\eta>0$. Considering $\Lambda(1;0)=0$ and $\Lambda(1;1)>1$, this implies that $\Lambda(1;\eta)=1$ has a unique solution in $\eta\in(0,1)$, which is given by $\hat{\eta}$ in Proposition 4. We can thus safely conclude that u/u^a is non-monotonic in χ if $\eta>\hat{\eta}$, with $u/u^a<1$ if χ sufficiently small and $u/u^a>1$ if χ close to one.

We finally show that $\hat{\eta}<0.5$ if $k\geq 2$. For this purpose, we can note that $\hat{\eta}>,=,<0.5$ is equivalent to $\Gamma(\theta,k,\bar{\xi})\equiv 2^{\theta}\theta\bar{\xi}-(2^{\theta}-1)(k\sigma-\bar{\xi})>,=,<0$. To determine the sign of $\Gamma(\theta,k,\bar{\xi})$, let us first consider a parameter domain with $k\geq\bar{\xi}\geq 2$. In this case, we have $\Gamma(\theta,k,\bar{\xi})\leq\Gamma(\theta,\bar{\xi},\bar{\xi})=g(\theta)\bar{\xi}$, with $g(\theta)\equiv(\sigma-1)-2^{\theta}(\sigma-1-\theta)$. Since $\bar{\xi}\geq 2$ implies $\sigma-1\geq 2$ and $g(\theta)$ decreases in $\sigma-1$, we can further conclude that $g(\theta)\leq 2-2^{\theta}(2-\theta)\equiv\underline{g}(\theta)$. Differentiation of $\underline{g}(\theta)$ gives $\underline{g}'(\theta)=2^{\theta}\left[1-\ln 2(2-\theta)\right]$ and $\underline{g}''(\theta)=2^{\theta}\ln 2\left[2-\ln 2(2-\theta)\right]>0$. From inspection of these derivatives, it follows that $\underline{g}(\theta)$ has a unique extremum, which is a minimum. Noting further that $\underline{g}(0)=\underline{g}(1)=0$, it is clear that $\underline{g}(\theta)<0$ must hold for all $\theta\in(0,1)$. This proves that $\Gamma(\theta,k,\bar{\xi})<0$ and thus $\hat{\eta}<0.5$ if $k\geq\bar{\xi}\geq 2$. Let us now consider a parameter domain with $k\geq 2>\bar{\xi}$. In this case, we have $\Gamma(\theta,k,\bar{\xi})\leq\Gamma(\theta,2,\bar{\xi})=\hat{g}(\theta)\bar{\xi}$, with $\hat{g}(\theta)\equiv 2^{\theta}\theta-(2^{\theta}-1)[(\sigma+1)/(\sigma-1)+2\sigma\theta]$. Noting that $\sigma+1+2\sigma\theta(\sigma-1)=(\sigma-1)[1+2/\bar{\xi}+2\theta(\sigma-1)]$, it follows from $\bar{\xi}<2$ that $\sigma+1+2\sigma\theta(\sigma-1)>2(\sigma-1)[1+\theta(\sigma-1)]$ and thus $\hat{g}(\theta)<2[1+\theta(\sigma-1)]-2^{\theta}\{2[1+\theta(\sigma-1)]-\theta\}<\underline{g}(\theta)$. From above, we know that $\underline{g}(\theta)<0$ holds for all $\theta\in(0,1)$. This confirms that $\Gamma(\theta,k,\bar{\xi})<0$ and thus $\hat{\eta}<0.5$ if $k\geq 2>\bar{\xi}$, which completes the proof.

A.7 Derivation of the Gini coefficient in Eq. (29)

To characterise the Gini coefficient for the distribution of wage income we must distinguish workers employed in purely domestic firms from those employed in offshoring firms. Cumulative labour income of workers employed in purely domestic firms with a productivity level up to $\bar{\varphi}\in$

$[\varphi^d, \varphi^o)$ is given by $W(\bar{\varphi}) \equiv N \int_{\varphi^d}^{\bar{\varphi}} w^d(\varphi) l^d(\varphi) dG(\varphi)$. Since constant markup pricing implies that a firm's wage bill is proportional to its revenues, we can make use of $w^d(\varphi)l^d(\varphi) = (\sigma - 1)\pi^d(\varphi)$. Considering $\pi^d(\varphi)/\pi^d(\varphi^d) = (\varphi/\varphi^d)^{\bar{\xi}}$ from Eq. (7), then gives

$$W(\bar{\varphi}) = (\sigma - 1)M\pi^d(\varphi^d)\bar{\zeta}\left[1 - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\bar{\xi}-k}\right]. \tag{A.18}$$

Total economy-wide labour income equals $W = \rho\gamma Y$. Using Eq. (10) and the definition of γ, we obtain $W = (\sigma - 1)M\pi^d(\varphi^d)\bar{\zeta}\alpha(\chi; \eta)$. Hence, the share of wage income accruing to workers, who are employed in firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$, can be expressed as

$$\frac{W(\bar{\varphi})}{W} = \frac{1}{\alpha(\chi; \eta)}\left[1 - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\bar{\xi}-k}\right]. \tag{A.19}$$

To calculate the Lorenz curve for the distribution of labour income, we must link the income ratio in Eq. (A.19) to the respective employment ratio. For this purpose, we first note that total employment in all firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$ is given by $L(\bar{\varphi}) \equiv N \int_{\varphi^d}^{\bar{\varphi}} l^d(\varphi) dG(\varphi)$. Substituting $l^d(\varphi)/l^d(\varphi^d) = (\varphi/\varphi^d)^{(1-\theta)\bar{\xi}}$, we can calculate

$$L(\bar{\varphi}) = Ml^d(\varphi^d)\frac{\bar{\zeta}}{1 + \theta(\bar{\zeta} - 1)}\left[1 - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{(1-\theta)\bar{\xi}-k}\right]. \tag{A.20}$$

In a similar vein, we can show that economy-wide employment of production workers in the source country equals $(1-U)L = Ml^d(\varphi^d)\beta(\chi; \eta)\bar{\zeta}/[1+\theta(\bar{\zeta}-1)]$. Hence, the share of production workers that are employed in firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$ is given by $\lambda = \beta(\chi; \eta)^{-1}[1 - (\bar{\varphi}/\varphi^d)^{(1-\theta)\bar{\xi}-k}]$. Combining the latter with Eq. (A.19), we obtain the first segment of the Lorenz curve for the distribution of labour income

$$Q_L^1(\lambda) = \frac{1 - [1 - \beta(\chi; \eta)\lambda]^{\frac{k-\bar{\xi}}{k-(1-\theta)\bar{\xi}}}}{\alpha(\chi; \eta)}, \tag{A.21}$$

which is relevant if $\lambda \in [0, b_L)$, with $b_L \equiv \beta(\chi; \eta)^{-1}(1 - \chi^{1-(1-\theta)\bar{\xi}/k})$.

We now follow the same steps as above to calculate the second segment of the Lorenz curve. We first compute the total domestic wage bill of firms with a productivity level up to $\bar{\varphi} \in [\varphi^o, \infty)$.

This gives $W(\bar{\varphi}) \equiv W(\varphi^o)+N\int_{\varphi^o}^{\bar{\varphi}} w^o(\varphi)l^o(\varphi)dG(\varphi)$. Accounting for $w^o(\varphi)l^o(\varphi) = \eta(\sigma-1)\pi^o(\varphi)$ and considering $\pi^d(\varphi)/\pi^d(\varphi^d) = (\varphi/\varphi^d)^{\bar{\xi}}$ from Eq. (7) as well as $\pi^o(\varphi)/\pi^d(\varphi) = 1+\chi^{\bar{\xi}/k}$, according to Eqs. (6) and (17), we can calculate

$$W(\bar{\varphi}) = W(\varphi^o) + M\pi^d(\varphi^d)\bar{\zeta}(\sigma-1)\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)\left[\chi^{\frac{k-\bar{\xi}}{k}} - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\bar{\xi}-k}\right]. \tag{A.22}$$

Dividing Eq. (A.22) by economy-wide labour income W, yields

$$\frac{W(\bar{\varphi})}{W} = 1 - \frac{\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)}{\alpha(\chi;\eta)}\left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\bar{\xi}-k}. \tag{A.23}$$

The mass of domestic workers employed by firms with a productivity level up to $\bar{\varphi} \in [\varphi^o,\infty)$ is given by $L(\bar{\varphi}) = L(\varphi^o) + N\int_{\varphi^o}^{\bar{\varphi}} l^o(\varphi)dG(\varphi)$. Accounting for $l^o(\varphi)/l^d(\varphi) = \eta\kappa^{(\sigma-1)(1-\theta)} = \eta(1+\chi^{\bar{\xi}/k})^{1-\theta}$ and $l^d(\varphi)/l^d(\varphi^d) = (\varphi/\varphi^d)^{(1-\theta)\bar{\xi}}$, we can further write

$$L(\bar{\varphi}) = L(\varphi^o) + Ml^d(\varphi^d)\frac{\bar{\zeta}\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{1-\theta}}{1+\theta(\bar{\zeta}-1)}\left[\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}} - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{(1-\theta)\bar{\xi}-k}\right]. \tag{A.24}$$

Dividing $L(\bar{\varphi})$ by economy-wide employment $(1-U)L$, then gives $\lambda = 1-\eta\beta(\chi;\eta)^{-1}(1+\chi^{\bar{\xi}/k})^{1-\theta}(\bar{\varphi}/\varphi^d)^{(1-\theta)\bar{\xi}-k}$. Solving the latter for $\bar{\varphi}/\varphi^d$ and substituting the resulting expression into Eq. (A.23), we obtain the second segment of the Lorenz curve

$$Q_L^2(\lambda) = 1 - \frac{\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)}{\alpha(\chi;\eta)}\left[\frac{(1-\lambda)\beta(\chi;\eta)}{\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{1-\theta}}\right]^{\frac{k-\bar{\xi}}{k-(1-\theta)\bar{\xi}}}, \tag{A.25}$$

which is relevant if $\bar{\varphi} \in [\varphi^o,\infty)$. Together Eqs. (A.21) and (A.25) form the Lorenz curve[41]

$$Q_L(\lambda) \equiv \begin{cases} Q_L^1(\lambda) & \text{if} \quad \lambda \in [0, b_L) \\ Q_L^2(\lambda) & \text{if} \quad \lambda \in [b_L, 1] \end{cases}. \tag{A.26}$$

[41] The Lorenz curve in Eq. (A.26) has the usual properties: $Q_L(0) = 0$, $Q_L(1) = 1$ and $Q'_L(\lambda) > 0 \;\forall\; \lambda \in (0,1)$.

The Gini coefficient for the distribution of labour income in Eq. (29) can then be computed according to $A_L(\chi) \equiv 1 - 2\int_0^1 Q_L(\lambda)d\lambda$.

A.8 Proof of Proposition 5

From the definitions of $\alpha(\chi;\eta)$, $\beta(\chi;\eta)$ and inspection of Eq. (29), it follows that $A_L(1) = A_L(0)$. Furthermore, if $\chi \in (0,1)$, the sign of $A_L(\chi) - A_L(0)$ is equivalent to the sign of

$$\delta(\chi;\eta) \equiv \frac{1}{1+\theta(\bar{\zeta}-1)}\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right)\left[\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)-1\right] \\ -\left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)\chi^{\frac{\theta\bar{\xi}}{k}}\left[\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{1-\theta}-1\right]. \tag{A.27}$$

Noting further that

$$\frac{1}{1+\theta(\bar{\zeta}-1)}\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right) > \left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)\chi^{\frac{\theta\bar{\xi}}{k}} \tag{A.28}$$

holds for any possible $\chi \in (0,1)$, it is straightforward to show that $\delta(\chi;\eta) > 0$ must hold if $\eta(1+\chi^{\bar{\xi}/k}) \geq 1$, or, equivalently, if $\chi \geq [(1-\eta)/\eta]^{k/\bar{\xi}}$.

But what is the sign of $\delta(\chi;\eta)$ if $\chi < \bar{\chi} \equiv [(1-\eta)/\eta]^{k/\bar{\xi}}$, where $\bar{\chi} < 1$ follows from $\eta > 0.5$? To answer this question, we can first note that if $\chi < \bar{\chi}$, condition $\delta(\chi;\eta) >,=,< 0$ is equivalent to condition $\delta_0(\chi;\eta) >,=,< \delta_1(\chi)$, with

$$\delta_0(\chi;\eta) \equiv \frac{1-\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)^{1-\theta}}{1-\eta\left(1+\chi^{\frac{\bar{\xi}}{k}}\right)}, \quad \delta_1(\chi) \equiv \frac{1}{1+\theta(\bar{\zeta}-1)}\frac{1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}}{\left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)\chi^{\frac{\theta\bar{\xi}}{k}}}. \tag{A.29}$$

It is easily confirmed that $\delta_0(\chi;\eta)$ increases in χ over the relevant interval, reaching a minimum function value of $\delta_0(0;\eta) = 1$ at $\chi = 0$. Accordingly, $\delta_0(\chi;\eta)$ reaches a maximum function value of ∞ at $\bar{\chi}$. In a similar way, we can show that $\delta_1(\chi)$ is decreasing in χ, reaching a maximum function value of ∞ at $\chi = 0$ and a minimum function value of 1 at $\chi = 1$. Putting together, this implies that there exists a unique $\hat{\chi}(\eta)$ such that $\delta_0(\chi;\eta) >,=,< \delta_1(\chi)$ and thus $\delta(\chi;\eta) >,=,< 0$ if $\chi >,=,< \hat{\chi}(\eta)$. Finally, accounting for $\partial\delta_0(\chi;\eta)/\partial\eta > 0$, it follows that $\hat{\chi}(\eta)$ falls in η and reaches a minimum value of 0 at $\eta = 1$. In this case $\delta(\chi; 0) > 0$ holds for any $\chi \in (0, 1)$. Furthermore, $\hat{\chi}(\eta)$ reaches a maximum value of 1 at $\eta = 0$, implying that in this case $\delta(\chi; 0) < 0$ must hold for any $\chi \in (0, 1)$. This completes the formal discussion of the properties of $A_L(\chi)$.

A.9 Derivation of the Theil index in Eq. (32)

Applying the decomposition rule in Eq. (31), we can write

$$T = a_S T_S + a_U T_U + a_S \ln\left(a_S \frac{N}{N-L}\right) + a_U \ln\left(a_U \frac{N}{L}\right), \tag{A.30}$$

where a_S, a_U are the income shares of self-employed agents and production workers, respectively, given by Eq. (33). Accounting for Eq. (15) and considering $\sigma - 1 = \rho/(1-\rho)$, we can furthermore compute

$$a_S \frac{N}{N-L} = \frac{\bar{\zeta}\rho\gamma + 1 - \rho}{\rho\gamma + 1 - \rho}, \quad a_U \frac{N}{L} = \frac{\bar{\zeta}\rho\gamma + 1 - \rho}{\bar{\zeta}(\rho\gamma + 1 - \rho)}. \tag{A.31}$$

Substitution of Eq. (A.31) into Eq. (A.30) allows us to write

$$T = a_S T_S + a_L T_U + (a_S + a_U) \ln\left(\frac{\bar{\zeta}\rho\gamma + 1 - \rho}{\bar{\zeta}(\rho\gamma + 1 - \rho)}\right) + a_S \ln\left(\bar{\zeta}\right), \tag{A.32}$$

Finally, noting that $a_S + a_U = 1$ and $a_S/\bar{\zeta} + a_U = [\bar{\zeta}\rho\gamma + 1 - \rho]/[\bar{\zeta}(\rho\gamma + 1 - \rho)]$ hold, according to Eq. (33), we obtain Eq. (32).

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Supplement

(Not intended for publication)

If not stated differently, the formal analysis in this supplement refers to the extended model variant with $\theta > 0$.

Derivation details for the model variant with $\theta > 0$

In this subsection, we show in detail how the equations in Section 2 must be modified, when allowing for rent sharing between workers and firms. The first equation that has to be modified is Eq. (4). With rent sharing wages are firm-specific, and hence we can rewrite marginal production costs as follows:

$$c(v) = \frac{\omega^n(v)}{\varphi(v)z(v)} \qquad \text{with} \qquad z(v) \equiv \left[\frac{\omega^n(v)}{\omega^r(v)}\right]^{1-\eta}, \tag{S.1}$$

where $\omega^n(v)$ is the domestic wage rate paid by firm v to workers conducting non-routine tasks. Thereby, we have $\omega^n(v) = w^d(v)$ if the firm produces all tasks at home, while we have $\omega^n(v) = w^o(v)$ if routine tasks are produced offshore. As in Section 2, we have $z(v) = 1$ and thus $c^d(v) = w^d(v)/\varphi$ if the firm produces purely domestically. For an offshoring firm, we obtain $z(v) = z^o(v)$ and, instead of Eq. (4),

$$c^o(v) = \frac{w^o(v)}{\varphi(v)z^o(v)}, \qquad \text{where} \qquad z^o(v) \equiv \left[\frac{w^o(v)}{\tau w^*(v)}\right]^{1-\eta} = \left[\frac{(1-U)\,\bar{w}}{(1-U^*)\bar{w}^*}\right]^{(1-\eta)(1-\theta)} \tau^{\eta-1}. \tag{S.2}$$

Thereby, we have made use of the fair-wage constraint in Eq. (25) in order to substitute for $w^o(v)/w^*(v)$. Combining Eqs. (6) and (25), we can furthermore compute

$$\frac{\pi^o(v)}{\pi^d(v)} = \kappa^{(\sigma-1)} \qquad \text{and} \qquad \frac{w^o(v)}{w^d(v)} = \kappa^{\theta(\sigma-1)}, \tag{S.3}$$

where

$$\kappa \equiv \frac{c^d(v)}{c^o(v)} = \left\{\left[\frac{(1-U)\,\bar{w}}{(1-U^*)\bar{w}^*}\right]^{(1-\eta)(1-\theta)} \left(\frac{1}{\tau}\right)^{1-\eta}\right\}^{\frac{\bar{\xi}}{\sigma-1}}. \tag{S.4}$$

Using Eqs. (7) and (S.3) in indifference condition (9), and accounting for $\pi^d(\varphi^d) = s$ from Eq. (8′), we can easily verify that the link between χ and κ continues to be given by Eq. (17), with $\bar{\xi}$ assuming the role of ξ if $\theta > 0$. Labour income per capita in the source and host country are given by

$$(1-U)\bar{w} = \frac{\gamma\rho Y}{L} \qquad \text{and} \qquad (1-U^*)\bar{w}^* = \frac{(1-\gamma)\,\rho Y}{N^*}, \tag{S.5}$$

respectively. Substituting Eqs. (S.5) and (15) into Eq. (S.4) allows us to compute

$$\kappa = \left\{ \left[\frac{\gamma k(\sigma-1) + k - \bar{\xi}}{(1-\gamma)\,k(\sigma-1)} \left(\frac{N^*}{N}\right) \right]^{(1-\eta)(1-\theta)} \left(\frac{1}{\tau}\right)^{1-\eta} \right\}^{\frac{\bar{\xi}}{\sigma-1}}. \tag{S.6}$$

And combining Eqs. (17) and (S.6) we can conclude that the relationship between κ and χ in the model variant with $\theta > 0$ is characterised by the implicit function

$$F(\chi,\tau) \equiv \left\{ \left[\frac{\gamma k(\sigma-1) + k - \bar{\xi}}{(1-\gamma)\,k(\sigma-1)} \left(\frac{N^*}{N}\right) \right]^{(1-\eta)(1-\theta)} \left(\frac{1}{\tau}\right)^{1-\eta} \right\}^{\frac{\bar{\xi}}{\sigma-1}} - \left(1 + \chi^{\frac{\bar{\xi}}{k}}\right)^{\frac{1}{\sigma-1}} = 0.$$

This completes our discussion on how rent sharing affects the equations reported in Section 2.

Further details for the derivation of Eq. (29)

Using the insights from the Appendix, we can note that

$$\begin{aligned}
\int_0^{b_L} Q_L^1(\lambda)d\lambda &= \frac{1}{\alpha(\chi;\eta)} \left[\lambda + \frac{[1-\beta(\chi;\eta)\lambda]^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k-(1-\theta)\bar{\xi}}}}{\beta(\chi;\eta)} \frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)} \right]_0^{b_L} \\
&= \frac{b_L}{\alpha(\chi;\eta)} + \frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)} \left[\frac{\chi^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k}}}{\alpha(\chi;\eta)\beta(\chi;\eta)} - \frac{1}{\alpha(\chi;\eta)\beta(\chi;\eta)} \right],
\end{aligned} \tag{S.7}$$

while

$$\int_{b_L}^{1} Q_L^2(\lambda)d\lambda = \left[\lambda + \frac{\eta(1+\chi^{\bar{\xi}/k})}{\alpha(\chi;\eta)}\left[\frac{\beta(\chi;\eta)}{\eta(1+\chi^{\bar{\xi}/k})^{1-\theta}}\right]^{\frac{k-\bar{\xi}}{k-(1-\theta)\bar{\xi}}} \frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)}(1-\lambda)^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k-(1-\theta)\bar{\xi}}}\right]_{b_L}^{1}$$
$$= 1 - b_L - \frac{\eta^2(1+\chi^{\bar{\xi}/k})^{2-\theta}}{\alpha(\chi;\eta)\beta(\chi;\eta)}\frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)}\chi^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k}}. \tag{S.8}$$

Substituting Eqs. (S.7) and (S.8) into

$$A_L = 1 - 2\int_0^{b_L} Q_L^1(\lambda)d\lambda - 2\int_{b_L}^{1} Q_L^2(\lambda)d\lambda, \tag{S.9}$$

we obtain

$$A_L = -1 + 2b_L\frac{\alpha(\chi;\eta)-1}{\alpha(\chi;\eta)} + \frac{2}{\alpha(\chi;\eta)\beta(\chi;\eta)}\frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)} + 2Z(\chi;\eta), \tag{S.10}$$

with

$$Z(\chi;\eta) \equiv \left[\frac{\eta^2\left(1+\chi^{\bar{\xi}/k}\right)^{2-\theta}}{\alpha(\chi;\eta)\beta(\chi;\eta)} - \frac{1}{\alpha(\chi;\eta)\beta(\chi;\eta)}\right]\frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)}\chi^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k}}. \tag{S.11}$$

Using the definition of b_L, we can rewrite A_L in the following way

$$A_L = \frac{\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)} + 2\frac{1+\theta(\bar{\zeta}-1)}{2+\theta(\bar{\zeta}-1)}\frac{[1-\alpha(\chi;\eta)\beta(\chi;\eta)]}{\alpha(\chi;\eta)\beta(\chi;\eta)}$$
$$+ \frac{2\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right)[\alpha(\chi;\eta)-1]}{\alpha(\chi;\eta)\beta(\chi;\eta)} + 2Z(\chi;\eta). \tag{S.12}$$

Accounting for Eq. (27), we can show that

$$1-\alpha(\chi;\eta)\beta(\chi;\eta) = -[\alpha(\chi;\eta)-1] - [\beta(\chi;\eta)-1] - [\alpha(\chi;\eta)-1][\beta(\chi;\eta)-1]$$
$$= -[\alpha(\chi;\eta)-1]\left(1-\chi^{\frac{k-(1-\theta)\bar{\xi}}{k}}\right) - [\beta(\chi;\eta)-1]\left(1-\chi^{\frac{k-\bar{\xi}}{k}}\right)$$
$$- \left[\eta^2\left(1+\chi^{\bar{\xi}/k}\right)^{2-\theta} - 1\right]\chi^{\frac{2(k-\bar{\xi})+\theta\bar{\xi}}{k}}. \tag{S.13}$$

Substituting Eq. (S.13) into Eq. (S.12), it is straightforward to compute Eq. (29).

A continuum of tasks that differ in offshorability

In this extension, we shed light on the firm-internal margin of offshoring, by considering a continuum of tasks that differ in offshorability, as suggested by Acemoglu and Autor (2011). For this purpose, we replace our production function for intermediates in Eq. (3) by

$$q(v) = \varphi(v) \exp \int_0^1 \ln \ell(v, \tilde{\eta}) d\tilde{\eta}, \tag{S.14}$$

in which $\ell(v, \tilde{\eta})$ is the input of task $\tilde{\eta} \in [0, 1]$ in the production of $q(v)$. Tasks are symmetric in the labour input they require to be performed and, as in the main text, we impose the additional assumption that one unit of labour must be employed to produce one unit of task $\tilde{\eta}$. However, as in Grossman and Ross-Hansberg (2008), tasks differ in their offshorability and this is captured by an iceberg cost parameter t that is task specific: $t(\tilde{\eta})$. An intuitive way to interpret parameter t is to think of it as task-specific trade cost parameter, implying that total costs of shipping the output of a task $\tilde{\eta}$, whose production has been moved offshore, back to the source country amounts to $t(\tilde{\eta})\tau > 1$. To facilitate the analysis, we impose the additional assumption that $t(1) = 1$, $t(0) = \infty$ and $t'(\tilde{\eta}) < 0$. This implies that tasks are ranked according to their offshorability and it allows us to identify a unique firm-specific $\eta(v)$, which separates the tasks performed at home, $\tilde{\eta} < \eta(v)$, from the tasks performed abroad $\tilde{\eta} \geq \eta(v)$.

Once a firm has decided to engage in offshoring, it is left with two further decisions on how to organise its production, which are taken in two consecutive stages. In stage one, the firm chooses how many tasks to move offshore and sets $\eta(v)$ accordingly, while in stage two, the firm chooses optimal employment in domestic and offshored tasks. As it is common practice, we solve this two stage problem through backward induction and first determine the profit-maximising employment levels for a given $\eta(v)$. For this purpose, we can recollect from the main text that wages paid to domestic and foreign workers are given $w^o(v)$ and $w^*(v)$, respectively. We can write labour demand for domestic and foreign task production as follows: $l^n(v) = \int_0^{\eta(v)} \ell^n(v, \tilde{\eta}) d\tilde{\eta} = \eta(v)\ell^n(v)$ and $l^r(v) = \int_{\eta(v)}^1 t(\tilde{\eta})\, \ell^r(v, \tilde{\eta})\, d\tilde{\eta} = \int_{\eta(v)}^1 t(\tilde{\eta})\, d\tilde{\eta} \ell^r(v)$.[42] Therefore,

[42] As in the main text, we define $l^r(v)$ such that foreign labour demand of offshoring firm v is given by $\tau l^r(v)$.

firm v's cost minimisation problem can be expressed as follows:

$$\min_{l^n(v),\, l^r(v)} \omega^n(v)\, l^n(v) + \omega^r(v) l^r(v) \;\; \text{s.t. } 1 = \varphi\epsilon[\eta(v)]^{1-\eta(v)} \left[\frac{l^n(v)}{\eta(v)}\right]^{\eta(v)} \left[\frac{l^r(v)}{1-\eta(v)}\right]^{1-\eta(v)}, \tag{S.15}$$

where $\omega^n(v) = w^o(v)$, $\omega^r(v) = \tau w^*(v)$ hold according to the main text and

$$\epsilon[\eta(v)] \equiv \frac{1-\eta(v)}{\int_{\eta(v)}^{1} t(\tilde{\eta})\, d\tilde{\eta}} \tag{S.16}$$

reflects the *average* productivity loss arising from the extra labour costs $t(\tilde{\eta})$, when producing a task abroad. Solving maximisation problem (S.15) gives marginal production costs $c(v) = w^o(v) / [\varphi(v)\, \tilde{z}(v)]$, where[43]

$$\tilde{z}(v) \equiv \left\{\frac{w^o(v)}{w^*(v)\tau}\epsilon[\eta(v)]\right\}^{1-\eta(v)}. \tag{S.17}$$

At stage one, the firm sets $\eta(v)$ to minimise its marginal cost $c(v)$. Thus, for the optimal $\eta(v)$-level the following first-order condition must hold: $\partial c(v)/\partial\eta(v) \overset{!}{=} 0$. In view of Eqs. (S.16) and (S.17), this is equivalent to

$$\frac{\partial \ln \tilde{z}(v)}{\partial \eta(v)} = -\ln\left(\frac{w^o(v)}{w^*(v)\tau}\epsilon[\eta(v)]\right) + t[\eta(v)]\epsilon[\eta(v)] - 1 \overset{!}{=} 0. \tag{S.18}$$

Acknowledging Eq. (25) in the main text, we know that $w^o(v)/w^*(v)$ is the same for all producers, and hence Eq. (S.18) determines the same cost-minimising η for all firms. Since the second-order condition of the stage one cost-minimisation problem requires $\partial^2 \ln \tilde{z}(v)/\partial\eta(v)^2 < 0$, while $\partial^2 \ln \tilde{z}(v)/\partial\eta(v)\partial\tau > 0$ follows from inspection of Eq. (S.18), we can finally conclude that $d\eta/d\tau > 0$, and hence firms offshore a lower share of tasks if the costs of shipping foreign output back to the source country increase. This completes our formal discussion.

While this definition of $l^r(v)$ might seem awkward at a first glance, it is useful for our purpose because it allows us to directly compare the production technology in Eq. (S.15) with the respective technology in Eq. (3).

[43] It is notable that $\tilde{z}(v)$ degenerates to $z(v)$, when considering a discrete offshoring technology, with

$$t(\tilde{\eta}) = \begin{cases} \infty & \forall\ \tilde{\eta} \in [0, \eta) \\ 1 & \forall\ \tilde{\eta} \in [\eta, 1] \end{cases}.$$

Alternative measures of income inequality

In Footnotes 19 and 32 we discuss broader measures of income inequality. The following two subsections present derivation details for the respective Gini coefficients.

Income inequality among self-employed agents

To characterise income inequality among *all* self-employed agents, we rely on the Lorenz curve for this income group, which now has three segments.[44] The first segment captures the share of income attributed to service providers. It is given by $Q_S^0(\mu) = \mu/\zeta$ and relevant for all $\mu \in [0, \chi/(1+\chi))$. The second segment of the Lorenz curve captures the income of service providers plus cumulative profits of purely domestic firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$. Following the derivation steps in Appendix A.2, we can compute

$$\hat{\Psi}(\bar{\varphi}) = M\pi^d(\varphi^d) \left\{ \chi + \zeta \left[1 - \left(\frac{\bar{\varphi}}{\varphi^d} \right)^{\xi-k} \right] \right\}. \tag{S.19}$$

Economy-wide profits plus service fees add up to total operating profits $\hat{\Psi} = M\pi^d(\varphi^d)(1 + \chi)\left[k/\left(k-\xi\right)\right]$. Hence, the cumulative share of (profit) income realised by service providers and firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$ is given by

$$\frac{\hat{\Psi}\left(\bar{\varphi}\right)}{\hat{\Psi}} = \frac{1}{\zeta}\frac{\chi}{1+\chi} + \frac{1}{1+\chi}\left[1 - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{\xi-k}\right]. \tag{S.20}$$

We have to link Eq. (S.20) with the ratio of self-employed agents receiving the respective income share. Denoting the fraction of these agents by $\mu \equiv (1+\chi)^{-1}\left[1+\chi-(\bar{\varphi}/\varphi^d)^{-k}\right]$, Eq. (S.20) can be reformulated to the second segment of the Lorenz curve

$$Q_S^1\left(\mu\right) = \frac{1}{\zeta}\frac{\chi}{1+\chi} + \frac{1}{1+\chi}\left\{1 - \left[\,(1+\chi)\left(1-\mu\right)\right]^{\frac{k-\xi}{k}}\right\}, \tag{S.21}$$

which is relevant for parameter domain $\mu \in [\chi/(1+\chi), 1/(1+\chi))$.

In a final step, we compute the cumulative income of all service providers and entrepreneurs

[44] In this subsection, we consider the basic model variant without rent sharing. The respective results for the model variant with rent sharing are obtained when replacing ξ by $\bar{\xi}$.

with an ability up to $\bar{\varphi} \in [\varphi^o, \infty)$ as a share of the total income of self-employed agents, $\hat{\Psi}$. Substituting μ from above, this gives the third segment of the Lorenz curve

$$Q_S^2(\mu) = Q_S^1\left(\frac{1}{1+\chi}\right) + \frac{1}{1+\chi}\left\{\left(1+\chi^{\xi/k}\right)\left[\chi^{\frac{k-\xi}{k}} - [(1+\chi)(1-\mu)]^{\frac{k-\xi}{k}}\right] - \frac{1}{\zeta}[\chi - (1+\chi)(1-\mu)]\right\}. \quad \text{(S.22)}$$

Putting the three segments together, we obtain the new Lorenz curve

$$Q_S(\mu) \equiv \begin{cases} Q_S^0(\mu) & \text{if} \quad \mu \in \left[0, \frac{\chi}{1+\chi}\right) \\ Q_S^1(\mu) & \text{if} \quad \mu \in \left[\frac{\chi}{1+\chi}, \frac{1}{1+\chi}\right) \\ Q_S^2(\mu) & \text{if} \quad \mu \in \left[\frac{1}{1+\chi}, 1\right] \end{cases}. \quad \text{(S.23)}$$

The Gini coefficient for the distribution of income among self-employed agents can then be calculated according to $A_S(\chi) \equiv 1 - 2\int_0^1 Q_S(\mu)d\mu$. Substituting Eq. (S.23), we can compute the respective expression in Footnote 19.

Income inequality among employed and unemployed production workers

To characterise income inequality among *all* production workers, we rely on the Lorenz curve for labour income. Since this Lorenz curve now also captures unemployed individuals, it consists of three segments. The first segment represents the share of income attributed to those who do not have a job. Abstracting from unemployment compensation, it is clear that the income share of this group is zero, and we can thus note that the respective Lorenz curve segment is given by $Q_U^0(\lambda) = 0$ and relevant for all $\lambda \in [0, U)$.

To calculate the second segment of the Lorenz curve, we follow the steps in Appendix A.7 and combine the labour income share of workers employed in purely domestic firms with a productivity level up to $\bar{\varphi} \in [\varphi^d, \varphi^o)$ – as determined by Eq. (A.19) – with the share of *all* production workers who are either unemployed or employed in firms up to productivity $\bar{\varphi}$:

$$\lambda = U + \frac{1-U}{\beta(\chi;\eta)}\left[1 - \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{(1-\theta)\bar{\xi}-k}\right]. \quad \text{(S.24)}$$

This gives the second segment of the Lorenz curve for the distribution of labour income

$$Q_U^1(\lambda) = \frac{1 - \left[1 - \beta(\chi;\eta)\frac{\lambda - U}{1-U}\right]^{\frac{k-\bar{\xi}}{k-(1-\theta)\xi}}}{\alpha(\chi;\eta)}, \tag{S.25}$$

which is relevant for $\lambda \in [U, b_U)$, with $b_U \equiv U + (1-U)(1 - \chi^{1-(1-\theta)\bar{\xi}/k})/\beta(\chi;\eta)$.

To determine the third segment of the Lorenz curve, we compute the share of total domestic labour income accruing to workers who are either unemployed or employed in firms with a productivity level up to $\bar{\varphi} \in [\varphi^o, \infty)$ – as represented by Eq. (A.23) – with the share of production workers who are either unemployed or employed by these firms:

$$\lambda = 1 - \eta\left(1 + \chi^{\bar{\xi}/k}\right)^{1-\theta} \frac{1-U}{\beta(\chi;\eta)} \left(\frac{\bar{\varphi}}{\varphi^d}\right)^{(1-\theta)\bar{\xi}-k}. \tag{S.26}$$

This allows us to calculate the third segment of the Lorenz curve

$$Q_U^2(\lambda) = 1 - \frac{\eta\left(1+\chi^{\bar{\xi}/k}\right)}{\alpha(\chi;\eta)} \left[\left(\frac{1-\lambda}{1-U}\right) \frac{\beta(\chi;\eta)}{\eta\left(1+\chi^{\bar{\xi}/k}\right)^{1-\theta}}\right]^{\frac{k-\bar{\xi}}{k-(1-\theta)\xi}}, \tag{S.27}$$

which is relevant if $\lambda > b_U$. Putting the three segments together, gives the (extended) Lorenz curve for labour income distribution

$$Q_U(\lambda) \equiv \begin{cases} 0 & \text{if} \quad \lambda \in [0, U) \\ Q_U^1(\lambda) & \text{if} \quad \lambda \in [U, b_U) \\ Q_L^2(\lambda) & \text{if} \quad \lambda \in [b_U, 1] \end{cases}. \tag{S.28}$$

The Gini coefficient for the distribution of labour income can then be computed according to $A_U(\chi) \equiv 1 - 2\int_0^1 Q_U(\lambda)d\lambda$, and is given by the respective expression in Footnote 32.

The concept of Lorenz dominance

We now consider a second criterion for ranking distributions and look at the criterion of Lorenz dominance. Thereby, we say that distribution A Lorenz dominates distribution B if the Lorenz curve of A lies above the Lorenz curve of B for any cumulative share of the population. Since the Lorenz dominance is equivalent to mean-preserving second-order stochastic dominance, all measures of inequality that respect this criterion – such as the Gini coefficient or the Theil index – rank A as a more equal distribution than B if A Lorenz dominates B.

Self-employed agents

The Lorenz curve for the income distribution of self-employed agents under autarky is given by

$$Q_S^a(\mu) = 1 - (1-\mu)^{\frac{k-\bar{\xi}}{k}}. \tag{S.29}$$

Hence, the income distribution of self-employed agents under autarky Lorenz dominates the respective income distribution under partial offshoring if $Q_S(\mu) < Q_S^a(\mu)$ holds for any $\mu \in (0,1)$. We have to check this inequality separately for the three segments of $Q_S(\mu)$. Let us first look at domain $\mu \in \left(0, \chi/(1+\chi)\right)$. In this case, $Q_S(\mu) < Q_S^a(\mu)$, is equivalent to $D_S^0(\mu, b) \equiv b\mu - 1 + (1-\mu)^b < 0$, with $b \equiv 1/\zeta$. Twice differentiating $D_S^0(\mu, b)$ with respect to b gives

$$\frac{\partial D_S^0(\mu, b)}{\partial b} = \mu + \ln(1-\mu)(1-\mu)^b, \qquad \frac{\partial^2 D_S^0(\mu, b)}{\partial b^2} = \left[\ln(1-\mu)\right]^2 (1-\mu)^b. \tag{S.30}$$

with $\partial D_S^0(\mu, 0)/\partial b = \mu + \ln(1-\mu) < 0$, $\partial D_S^0(\mu, 1)/\partial b = \mu + \ln(1-\mu)(1-\mu) > 0$, and $\partial^2 D_S^1(\mu, b)/\partial b^2 > 0$. Accounting for $D_S^0(\mu, 0) = D_S^0(\mu, 1) = 0$, we can therefore conclude that $D_S^0(\mu, b) < 0$ and thus $Q_S(\mu) < Q_S^a(\mu)$ must hold in the relevant parameter range.

For domain $\mu \in \left[\chi/(1+\chi), 1/(1+\chi)\right)$, it follows from Eqs. (S.21) and (S.29) that $Q_S(\mu) < Q_S^a(\mu)$ is equivalent to $D_S^1(\mu, b) \equiv (b-1)\chi + [1-(1+\chi)^{b-1}](1+\chi)(1-\mu)^b < 0$. Therefore, $\partial D_S^1(\mu, b)/\partial \mu < 0$ implies that $D_S^1(\chi/(1+\chi), b) \equiv \hat{D}_S^1(b) = (b-1)\chi + (1+\chi)^{1-b} - 1 < 0$ is sufficient for $Q_S^1(\mu) < Q_S^a(\mu)$ to hold in the relevant parameter domain. Twice differentiating $\hat{D}_S^1(b)$ yields $d\hat{D}_S^1(b)/db = \chi - \ln(1+\chi)(1+\chi)^{1-b}$, $d^2\hat{D}_S^1(b)/db = \left[\ln(1+\chi)\right]^2(1+\chi)^{1-b}$. Accounting for $d\hat{D}_S^1(0)/db = \chi - \ln(1+\chi)(1+\chi) < 0$, $d\hat{D}_S^1(1)/db = \chi - \ln(1+\chi) > 0$, and $d^2\hat{D}_S^1(b)/db^2 > 0$, it follows from $\hat{D}_S^1(0) = \hat{D}_S^1(1) = 0$ that $\hat{D}_S^1(b) < 0$ and thus $Q_S(\mu) < Q_S^a(\mu)$ must hold for all $\mu \in \left[\chi/(1+\chi), 1/(1+\chi)\right)$.

Finally, we look at domain $\mu \in \left[1/(1+\chi), 1\right]$. In this case, $Q_S(\mu) < Q_S^a(\mu)$ is equivalent to

$D_S^2(\mu, b) \equiv -(1+\chi)^b(1-\mu)^b + b(1+\chi)(1-\mu) < 0$, according to Eqs. (S.22) and (S.29). Twice differentiating $D_S^2(\mu, b)$ with respect to μ gives $\partial D_S^2(\mu, b)/\partial\mu = b(1+\chi)^b(1-\mu)^{b-1}[1-(1+\chi)^{1-b}(1-\mu)^{1-b}]$, $\partial^2 D_S^2(\mu, b)/\partial\mu^2 = b(1-b)(1+\chi)^b(1-\mu)^{b-2} > 0$. Accounting for $\partial D_S^2(1/(1+\chi), b)/\partial\mu = b(1+\chi)(\chi^{b-1}-1) > 0$, it is thus immediate that $D_S^2(1, b) = 0$ is sufficient for $Q_S(\mu) < Q_S^a(\mu)$ to hold in the relevant parameter domain.

Putting together, we can thus conclude that $Q_S(\mu) < Q_S^a(\mu)$ holds for any $\mu \in (0, 1)$, which proves that the income distribution of self-employed agents under autarky Lorenz dominates the respective income distribution in an offshoring equilibrium for arbitrary values of $\chi \in (0, 1)$.

Production workers

The Lorenz curve for the distribution of labour income under autarky has two segments and is given by

$$Q_U^a(\lambda) = \begin{cases} 0 & \text{if} \quad \lambda \in [0, U^a) \\ 1 - \left(\frac{1-\lambda}{1-U^a}\right)^{\frac{k-\bar{\xi}}{k-(1-\theta)\bar{\xi}}} & \text{if} \quad \lambda \in [U^a, 1] \end{cases}, \tag{S.31}$$

where $U^a = \theta(\bar{\zeta}-1)/[1+\theta(\bar{\zeta}-1)]$, according to Eq. (26). The ranking of $Q_U^a(\lambda)$ and $Q_U(\lambda)$ depends on the unemployment rate of production workers in the offshoring scenario relative to autarky. Furthermore, as outlined in the main text, the ranking of $U >,=,< U^a$ is equivalent to the ranking of $1 >,=,< \Delta(\chi;\eta)$ and thus equivalent to the ranking of $\alpha(\chi;\eta) >,=,< \beta(\chi;\eta)$. From Appendix A.6 we know that there exists a unique $\hat{\chi} \in (0, 1)$, such that $\alpha(\chi;\eta) >,=,< \beta(\chi;\eta)$ if $\chi >,=,< \hat{\chi}$.

Let us first consider $\chi \geq \hat{\chi}$, which corresponds to an offshoring equilibrium with $U \geq U^a$. In this case, we have $Q_U^a(\lambda) = Q_U(\lambda) = 0$ for all $\lambda \in [0, U^a)$ and $Q_U^a(\lambda) > Q_U(\lambda) = 0$ for all $\lambda \in [U^a, U)$. Furthermore, combining Eqs. (S.25) and (S.31), it follows that, for domain $\lambda \in [U, b_U)$, the ranking of $Q_U(\lambda) >,=,< Q_U^a(\lambda)$ is equivalent to the ranking of

$$D_U^1(\hat{\lambda}) \equiv 1 - \alpha(\chi;\eta) + \alpha(\chi;\eta)\left(1-\hat{\lambda}\right)^{\hat{b}}\Delta(\chi;\eta)^{\hat{b}} - \left[1-\beta(\chi;\eta)\hat{\lambda}\right]^{\hat{b}} >,=,< 0, \tag{S.32}$$

where $\hat{b} \equiv 1/[1+\theta(\bar{\zeta}-1)]$ and $\hat{\lambda} \equiv (\lambda - U)/(1-U)$. Differentiating $D_U^1(\hat{\lambda})$ gives

$$\frac{dD_U^1(\hat{\lambda})}{d\hat{\lambda}} = \frac{\hat{b}\alpha(\chi;\eta)\Delta(\chi;\eta)^{\hat{b}}}{\left(1-\hat{\lambda}\right)^{1-\hat{b}}}\left[\Delta(\chi;\eta)^{1-\hat{b}}\left(\frac{1-\hat{\lambda}}{1-\beta(\chi;\eta)\hat{\lambda}}\right)^{1-\hat{b}} - 1\right]. \tag{S.33}$$

Consider first the case of $\beta(\chi;\eta) \leq 1$. Since $\chi \geq \hat{\chi}$ implies $\beta(\chi;\eta) \leq \alpha(\chi;\eta)$ and thus $\Delta(\chi;\eta) \leq 1$, it is immediate that $\beta(\chi;\eta) \leq 1$ is sufficient for $dD_U^1(\hat{\lambda})/d\hat{\lambda} < 0$. Noting further that $\lambda = U$ implies $\hat{\lambda} = 0$ and thus $D_U^1(0) = \alpha(\chi;\eta)[\Delta(\chi;\eta)^{\hat{b}} - 1] < 0$, we can therefore safely conclude that $Q_U(\lambda) < Q_U^a(\lambda)$ holds for all $\lambda \in [U, b_U)$ in this case.

But what happens if $\beta\left(\chi;\eta\right) > 1$? In this case, we cannot rule out that $dD_U^1(\hat{\lambda})/d\hat{\lambda} > 0$. However, computing the second derivative of $D_U^1(\hat{\lambda})$, we obtain

$$\frac{d^2 D_U^1(\hat{\lambda})}{d\hat{\lambda}^2} = \frac{1-\hat{b}}{1-\hat{\lambda}}\left\{\frac{dD_U^1(\hat{\lambda})}{d\hat{\lambda}} - \frac{\hat{b}\alpha(\chi;\eta)\Delta(\chi;\eta)}{\left(1-\hat{\lambda}\right)^{1-\hat{b}}}\left(\frac{1-\hat{\lambda}}{1-\beta(\chi;\eta)\hat{\lambda}}\right)^{1-\hat{b}}\frac{1-\beta(\chi;\eta)}{1-\beta(\chi;\eta)\hat{\lambda}}\right\}. \tag{S.34}$$

From inspection of Eqs. (S.33) and (S.34) we can therefore conclude that $dD_U^1(\hat{\lambda})/d\hat{\lambda} \geq 0$ is sufficient for $d^2D_U^1(\hat{\lambda})/d\hat{\lambda}^2 > 0$ if $\beta(\chi;\eta) > 1$. To see this, note that $\beta(\chi;\eta)\hat{\lambda} < \beta(\chi;\eta)\hat{\lambda}_U$, with $\hat{\lambda}_U \equiv (b_U - U)/(1-\lambda)$ must hold on the relevant parameter domain. Substituting for b_U, we obtain $\beta(\chi;\eta)\hat{\lambda} < 1 - \chi^{1-(1-\theta)\bar{\xi}/k} < 1$. From inspection of Eqs. (S.33) and (S.34) it therefore follows that if $dD_U^1(\hat{\lambda})/d\hat{\lambda} \geq 0$ holds for some $\hat{\lambda}_0 \in (0, \hat{\lambda}_U)$, then $dD_U^1(\hat{\lambda})/d\hat{\lambda} > 0$ must hold for all $\hat{\lambda} \in (\hat{\lambda}_0, \hat{\lambda}_U)$. Furthermore, recollecting from above that $D_U^1(0) < 0$, this implies that if $D_U^1(\hat{\lambda}) \geq 0$ holds for some $\hat{\lambda} \in (0, \hat{\lambda}_U)$, then $D_U^1(\hat{\lambda}_U) > 0$ must hold as well. Accordingly, we can infer insights on the sign of $D_U^1(\hat{\lambda})$ by evaluating Eq. (S.32) at $\hat{\lambda} = \hat{\lambda}_U$. This gives

$$D_U^1(\hat{\lambda}_U) = \alpha(\chi;\eta)^{1-\hat{b}}\chi^{1-\bar{\xi}/k}\left[\eta\left(1+\chi^{\bar{\xi}/k}\right)\right]^{\hat{b}}\left[\left(1+\chi^{\bar{\xi}/k}\right)^{-\theta\hat{b}} - \left(\frac{\eta\left(1+\chi^{\bar{\xi}/k}\right)}{\alpha(\chi;\eta)}\right)^{1-\hat{b}}\right]. \tag{S.35}$$

Since $\beta(\chi;\eta) > 1$ implies $\alpha(\chi;\eta) > 1$ if $\chi \geq \hat{\chi}$, it is immediate that $\alpha(\chi;\eta) < \eta(1+\chi^{\bar{\xi}/k})$, and this implies $D_U^1(\hat{\lambda}_U) < 0$. Putting together, we can therefore safely conclude that $Q_U(\lambda) < Q_U^a(\lambda)$ holds for all $\lambda \in [U, b_U)$ irrespective of the ranking of $\beta\left(\chi;\eta\right) >, =, < 1$.

In a final step, we have to look at domain $\lambda \in [b_U, 1]$. According to Eqs. (S.27) and (S.31), for this parameter domain the ranking of $Q_U(\lambda) >,=,< Q_U^a(\lambda)$ is equivalent to the ranking of

$$D_U^2(\hat{\lambda}) \equiv \left[1 - \left(1+\chi^{\bar{\xi}/k}\right)^{\theta\hat{b}} \left(\frac{\eta\left(1+\chi^{\bar{\xi}/k}\right)}{\alpha(\chi;\eta)}\right)^{1-\hat{b}}\right] \left(1-\hat{\lambda}\right)^{\hat{b}} \Delta(\chi;\eta)^{\hat{b}} >,=,< 0. \tag{S.36}$$

Notably, the sign of $D_U^2(\hat{\lambda})$ does not depend on the specific level of $\hat{\lambda}$, so that $\text{sgn}[D_U^2(\hat{\lambda})] = \text{sgn}[D_U^2(\hat{\lambda}_U)]$. However, since $D_U^1(\hat{\lambda}_U) = D_U^2(\hat{\lambda}_U)$ holds by definition, it follows that $Q_U(\lambda) < Q_U^a(\lambda)$ extends to interval $\lambda \in [b_U, 1]$. Summing up, we can thus conclude that the income distribution of production workers under autarky Lorenz dominates the income distribution of production workers in the offshoring equilibrium if the share of offshoring firms is sufficiently high, i.e. if $\chi \geq \hat{\chi}$.

Let us now consider $\chi < \hat{\chi}$, which implies $\Delta(\chi;\eta) > 1$ and thus $U < U^a$. In this case, we have $Q_U(\lambda) = Q_U^a(\lambda) = 0$ for all $\lambda \in [0, U]$ and $Q_U(\lambda) > Q_U^a(\lambda) = 0$ for all $\lambda \in (U, U^a)$. For domain $\lambda \in (U, b_U)$, the ranking of $Q_U(\lambda) >,=,< Q_U^a(\lambda)$ depends on the sign of $D_U^1(\hat{\lambda})$, where $D_U^1(0) = \alpha(\chi;\eta)[\Delta(\chi;\eta)^{\hat{b}} - 1] > 0$ holds if $\chi < \hat{\chi}$. But what can we say about the sign of $D_U^1(\hat{\lambda})$ if $\hat{\lambda} > U$? To answer this question, it is worth looking at Eq. (S.34). From the formal discussion in Appendix A.6, we know that $\Delta(\chi;\eta) > 1$ requires $\hat{\Omega}(\bar{\eta}) \equiv (\bar{\eta}\vartheta^{-\theta} - 1)(\vartheta - 1)^{\theta} - \bar{\eta} + 1 > 0$, where $\vartheta \equiv 1 + \chi^{\bar{\xi}/k}$ and $\bar{\eta} \equiv \eta\vartheta$. In view of $\hat{\Omega}'(\bar{\eta}) = (1 - 1/\vartheta)^{\theta} - 1 < 0$ and $\hat{\Omega}(1) = (\vartheta^{-\theta} - 1)(\vartheta - 1) < 0$, we can conclude that $\bar{\eta} = \eta(1 + \chi^{\bar{\xi}/k}) < 1$ is necessary for $\Delta(\chi;\eta) > 1$. This implies that $\beta(\chi;\eta) < 1$ must hold for all $\chi < \hat{\chi}$. Hence, if $D_U^1(\hat{\lambda})$ has an extremum at $\hat{\lambda} \in (0, \hat{\lambda}_U)$, this extremum must be a maximum. In view of $D_U^1(0) > 0$, we can therefore conclude that $D_U^1(\hat{\lambda})$ is positive for all $\lambda \in [U, b_U)$ if $D_U^1(\hat{\lambda}_U) \geq 0$, while $D_U^1(\hat{\lambda}_U) < 0$ implies that there exists a unique $\lambda_0 \in [U, b_U)$ such that $D_U^1(\hat{\lambda}) >,=,< 0$ if $\lambda_0 >,=,< \lambda$. Noting finally that $\text{sgn}[D_U^1(\hat{\lambda}_U)] = \text{sgn}[D_U^2(\hat{\lambda})]$ holds for all $\lambda \in [b_U, 1)$ and accounting for $\lim_{\chi\to 0} D_U^2(\hat{\lambda}_U) = (1 - \eta^{1-\hat{b}})(1-\hat{\lambda})^{\hat{b}}\Delta(\chi;\eta)^{\hat{b}} > 0$, $\lim_{\chi\to\hat{\chi}} D_U^2(\hat{\lambda}_U;\beta) < 0$ (see our extensive discussion for domain $\chi \geq \hat{\chi}$), the following conclusion is immediate: For sufficiently small χ, the distribution of labour income with offshoring Lorenz dominates the respective distribution without offshoring. For χ smaller than but close to $\hat{\chi}$, Lorenz curves Q_U^a and Q_U intersect and it is therefore not possible to rank the distributions of labour income with and without offshoring according to the criterion of Lorenz dominance. This completes our discussion on Lorenz curve dominance.

Economy-wide income distribution if $\theta > 0$

In the subsequent analysis it is useful to introduce the Theil index for the income distribution within the group of employed production workers, which we denote by T_L. Thereby, T_L is linked to T_U according to $T_U = T_L - \ln(1-U)$. This allows us to rewrite Eq. (A.30) as follows:

$$T = a_S T_S + a_U T_L + a_S \ln\left(a_S \frac{N}{N-L}\right) + a_U \ln\left(a_U \frac{N}{L(1-U)}\right), \tag{S.37}$$

Following the analysis in the main text step by step and substituting Eq. (26) for U, we thus obtain

$$\begin{aligned} T = \frac{1-\rho}{\rho\gamma+1-\rho} T_S + \frac{\rho\gamma}{\rho\gamma+1-\rho} T_L + \ln\left(\frac{\bar{\zeta}\rho\gamma+1-\rho}{\bar{\zeta}(\rho\gamma+1-\rho)}\right) \\ + \frac{1-\rho}{\rho\gamma+1-\rho}\ln\bar{\zeta} - \frac{\rho\gamma}{\rho\gamma+1-\rho}\ln\left(\frac{\Delta(\chi;\eta)}{1+\theta(\bar{\zeta}-1)}\right). \end{aligned} \tag{S.38}$$

In autarky, we can explicitly compute the Theil indices for the income distribution of self-employed agents and production workers, respectively:

$$T_S^a = \frac{1}{\bar{\zeta}-1}\int_1^\infty x^{-\frac{k}{\xi}}\left[\ln x - \ln\bar{\zeta}\right] dx = \bar{\zeta} - 1 - \ln\bar{\zeta}, \tag{S.39}$$

and

$$\begin{aligned} T_L^a &= \frac{1}{1+\theta(\bar{\zeta}-1)}\int_1^\infty y^{-\frac{1+\theta(\bar{\zeta}-1)}{\theta(\bar{\zeta}-1)}}\left\{\ln y - \ln\left[1+\theta(\bar{\zeta}-1)\right]\right\} dy \\ &= \theta(\bar{\zeta}-1) - \ln\left[1+\theta(\bar{\zeta}-1)\right]. \end{aligned} \tag{S.40}$$

Substituting for T_S, T_L and setting $\chi = 0$ then yields

$$T^a = [1-\rho(1-\theta)](\bar{\zeta}-1] + \ln\left(\frac{1+\rho(\bar{\zeta}-1)}{\bar{\zeta}}\right). \tag{S.41}$$

While we are not able to rank T and T^a for arbitrary levels of χ, we can at least compare Theil indices for the two limiting cases $\chi = 0$ and $\chi = 1$. Since $T_L = T_L^a$ and $T_S > T_S^a$ hold if $\chi = 1$, we can safely conclude that $T - T_a > \hat{\Delta}_T(\theta; \hat{a})$, with

$$\hat{\Delta}_T(\theta;\hat{a}) \equiv \underbrace{\frac{\rho(1-\rho)(1-\eta)}{\rho\eta+1-\rho}\frac{\hat{a}}{1-\hat{a}} + \ln\left(\frac{\rho\eta+(1-\rho)(1-\hat{a})}{[\rho\eta+1-\rho]\,[1-(1-\rho)\hat{a}]}\right)}_{\hat{\Delta}_T^1(\hat{a})} + \underbrace{\frac{\rho\theta}{\rho\eta+1-\rho}\left[\eta\ln 2 - \frac{(1-\rho)(1-\eta)\hat{a}\theta}{1-\hat{a}}\right]}_{\hat{\Delta}_T^2(\theta;\hat{a})} \tag{S.42}$$

and $\hat{a} \equiv 1 - 1/\bar{\zeta}$. Differentiating $\Delta_T^1(\hat{a})$ gives

$$\frac{d\hat{\Delta}_T^1(\hat{a})}{d\hat{a}} = \frac{\rho^2(1-\rho)(1-\eta)\hat{a}\,[\rho\eta+(1-\rho)(1-\hat{a})+\eta(1-\hat{a})]}{[\rho\eta+1-\rho]\,[\rho\eta+(1-\rho)(1-\hat{a})]\,[1-(1-\rho)\hat{a}]\,(1-\hat{a})^2} > 0. \tag{S.43}$$

In view of $\hat{\Delta}_T^1(0) = 0$, this implies that $\hat{\Delta}_T^1(\hat{a}) > 0$ holds for all $\hat{a} \in (0,1)$. While the sign of $\hat{\Delta}_T^2(\theta;\hat{a})$ is not clear in general, it is immediate that $\hat{\Delta}_T(\theta;\hat{a}) > 0$ holds for sufficiently small levels of θ. This completes our discussion on the Theil index in this supplement.

Source code for the calibration exercises in Section 6

The calibration exercise has been executed in *Mathematica*.[45] We offer here the source code as well as the parameter estimates used in our calibration. At first, we set parameter values: $k = 4.306$, $\sigma = 6.698$ and $\theta = 0.102$, based on the results in Egger, Egger, and Kreickemeier (2013), and $\eta = 0.75$, based on Blinder (2009) and Blinder and Krueger (2013).

```
k=4.306;
σ=6.698;
θ=0.102;
η=0.75;
```

[45] A self-contained Computable-Data-File (CDF), which can be run on the free to use CDF-player offered by Wolfram Research, Inc. under `http://www.wolfram.com/cdf-player/`, can be obtained from the authors upon request.

Furthermore, regarding the extent of external increasing returns to scale, we consider the two polar cases $\varepsilon = 0$ and $\varepsilon = 1$. In addition, we account for $\varepsilon = 0.56$ as reported by Ardelean (2011).

```
ε={0,0.56,1}
```

As all variables of interest can be expressed in terms of the share of offshoring firms, χ, we define

```
χ=.;
χG=1265/8466;
```

where χG is the share of offshoring firms in Germany as reported by Moser, Urban, and Weder di Mauro (2009). We then define ρ, ξ and ζ and check that $k > \xi$ holds.[46]

```
ρ=(σ-1)/σ;
ξ=(σ-1)/(1+θ(σ-1));
ζ=k/(k-ξ);
If[k<=ξ, Print["Error:k<=ξ"]];
```

We also define $\alpha(\chi;\eta)$ and $\beta(\chi;\eta)$ from Eq. (27) as well as $\gamma(\chi;\eta)$ and $\Delta(\chi,\eta)$ as specified in the main text.

```
α=1+χ^((k-ξ)/k)(η(1+χ^(ξ/k))-1);
β=1+χ^((k-(1-θ)ξ)/k)(η(1+χ^(ξ/k))^(1-θ)-1);
γ=(1+η*χ-(1-η)χ^(1-ξ/k))/(1+χ);
Δ=β/α;
```

Now we can turn to aggregate income in the source country relative to autarky, see the proof of Proposition 3:

```
T1=(1+γ(σ-1))(1+ζ(σ-1))/(σ(1+γ*ζ(σ-1)));
T2=((1+χ)(1+γ*ζ(σ-1))/(1+ζ(σ-1)))^((σ-1-ε*k)/(k(σ-1)));
T3=(1+χ)^(1/(σ-1));
Φ=T1*T2*T3;
```

[46] In the source code, we use ξ instead of $\bar{\xi}$ and ζ instead of $\bar{\zeta}$ to save on notation.

Eq. (28) establishes

```
Λ=((θ(ζ-1)+1-Δ)/(θ(ζ-1)))*((1+ζ(σ-1))γ)/(1+ζ(σ-1)γ);
```

where $u/u^a = \Lambda$ and

```
ua=(θ(ζ-1)/(1+θ(ζ-1))*ζ(σ-1)/(1+ζ(σ-1));
```

Finally, inter-group inequality between entrepreneurs and workers as well as intra-group inequality within both groups, each normalised to one for its respective autarky level, follow from Eqs. (22), (23) and (29).

```
ω=1+(1-1/ζ)χ;
AM=1+χ(2-χ)/(ζ+(ζ-1)χ);
AL=1+(2(1-χ^((k-(1-θ)ξ)/k))(α-1)-2(1+θ(ζ-1))(1-χ^((k-ξ)/k))(β-1))/(α*β*θ(ζ-1));
```

We now turn to the determination of the Theil indices. Therefore, we first need to specify the income share of entrepreneurs, freelance offshoring workers and production workers. This gives

```
aM=(1-ρ)/(ζ(ρ*γ+1-ρ))*((ζ+χ(ζ-1))/(1+χ);
aF=(1-ρ)/(ζ(ρ*γ+1-ρ))*(χ/(1+χ));
aU=(ρ*γ)/(ρ*γ+1-ρ);
```

respectively. Furthermore, we also determine the income share of self-employed agents, as defined in Eq. (33):

```
aS=(1-ρ)/(ρ*γ+1-ρ);
```

Average income of the three subgroups – entrepreneurs, agents in the offshoring service sector, and production workers – relative to the economy-wide income average is given by

```
vM=((ζ*ρ*γ+1-ρ)/(ρ*γ+1-ρ))*(1+(1-1/ζ)χ);
vF=(ζ*ρ*γ+1-ρ)/(ζ*(ρ*γ+1-ρ));
vU=(ζ*ρ*γ+1-ρ)/(ζ*(ρ*γ+1-ρ));
```

while for the self-employed we obtain

```
vS=(ζ*ρ*γ+1-ρ)/(ρ*γ+1-ρ);
```

We now determine the product of income ratios and log income ratios for entrepreneurial income multiplied by the relative frequency the respective income ratios are realized. For purely domestic firms, this gives

```
Alt1=(k*x^(ξ-k-1)/(ζ+χ(ζ-1)))*Log[(x^ξ)/(ζ+χ(ζ-1))];
```

while for offshoring firms, we obtain

```
Alt2=((k*((1+χ^(ξ/k))*x^ξ-1)x^(-k-1))/(ζ+χ(ζ-1)))*Log[(((1+χ^(ξ/k))*x^ξ)
-1)/(ζ+χ(ζ-1))];
```

We can compute similar expressions for production workers and obtain

```
Alt3=(Δ/(θ(ζ-1)β))y^(((1-θ)*ξ-k)/(θ*ξ))*Log[y*Δ/(1+θ(ζ-1))];
```

for workers employed in purely domestic firms and

```
Alt4=(Δ/(θ(ζ-1)β))*η*((1+χ^(ξ/k))^(k/ξ))y^(((1-θ)*ξ-k)/(θ*ξ))*Log[y*Δ/(1
+θ(ζ-1))];
```

for workers employed in exporting firms.

In a last step we evaluate the above defined functions at $\chi = 0.001, 0.01, 0.1, 0.25, 0.5, 0.75, 0.9$ and $\chi = \chi_G$ to produce the results in Tables 1 and 2.

```
Do[z=z0;
```

We start with the two Gini coefficients and the measure for inter-group inequality and evaluate

```
nω=ω/.{χ->z};
nAM=AM /.{χ->z};
nAL=AL /.{χ->z};
```

We now turn to the Theil index for entrepreneurial income, which in autarky can be computed according to

```
Alt00=Alt1/.{χ->0};
TMa= NIntegrate[Alt00, {x,1,Infinity}];
```

The respective Theil index in the case of offshoring can be determined according to

```
Alt11=Alt1/.{χ->z};
Alt22=Alt2/.{χ->z};
TM=NIntegrate[Alt11, {x,1,z^(-1/k)}]+NIntegrate[Alt22, {x,z^(-1/k),Infinity}];
```

In a similar vein, we can compute the Theil index for income of employed production workers under autarky and in the scenario with offshoring. This gives

```
Alt55=Alt3/.{χ->0};
TLa=NIntegrate[Alt55, {y,1,Infinity}];
```

and

```
Alt33=Alt3/.{χ->z};
Alt44=Alt4/.{χ->z};
TL=NIntegrate[Alt33, {y,1,z^(-θ*ξ/k)}]+NIntegrate[Alt44,
{y,z^(-θ*ξ/k)(1+z^(ξ/k))^θ, Infinity}];
```

respectively. Thereby, it is notable that in the scenario with offshoring, firms which shift production abroad pay a wage premium to their domestic workers, and this wage premium is captured by an upward shift of the lower bound of the second integral in the equation for `TL`.

The economy-wide Theil index under autarky is then given by

```
Ta1=aM*TMa+aU*TLa+aM*Log[vM]+aF*Log[vF]+aU*Log[vU]-aU*Log[Δ/(1+θ(ζ-1)];
Ta=Ta1/.{χ->0};
```

where $1 - U^a = \Delta^a/[1 + \theta(\zeta - 1)]$ has been considered, according to (26). The economy-wide Theil index in the scenario with offshoring is given by

```
T1=aM*TM+aU*TL+aM*Log[vM]+aF*Log[vF]+aU*Log[vU]-aU*Log[Δ/(1+θ(ζ-1)];
T=T1/.{χ->z};
```

To avoid rounding errors, we can manipulate the result in the following way

```
If[TL<TLa + 0.1^(10)&&TL>TLa - 0.1^(10), TL=TLa];
```

Finally, we can compute T_U, considering the calibrated values of T_L. Accounting for

```
Δa=Δ/.{χ->0};
Δ1=Δ/.{χ->z};
```

we can compute

```
TUa=TLa-Log[Δa/(1+θ(ζ-1))];
TU=TL-Log[Δ1/(1+θ(ζ-1))];
```

In a similar vein, we can compute T_S, relying on the calibrated values of T_M:

```
TS1=(aM*TM+aM*Log[vM]+aF*Log[vF]-(aM+aF)*Log[vS])/aS;
TSa=TMa;
TS=TS1/.{χ->z};
```

In a final step, we determine the income and unemployment effects of offshoring by computing

```
nΦ=Φ/.{χ->z};
nu=ua*Λ/.{χ->z};
```

To complete the calibration exercise, we finally add

```
Print["χ=", z, " A_M= ", 100 (nAM-1), " A_L= ", 100 (nAL-1)," ΔTS=", 100*(TS -
TSa)/TSa, " ΔTU=", 100*(TU-TUa)/TUa, " ΔT=", 100*(T-Ta)/Ta," I= ", 100*(nΦ-1),
" u= ", 100*(nu-u_a)];
,{z0, {0.001, 0.01,0.1, 0.25, 0.5, 0.75, 0.9, N[χG]}}]
```

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