Offshoring Domestic Jobs*  

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Abstract  

We develop a two-country general equilibrium model, in which heterogeneous firms offshore routine tasks to a low-wage host country. In the presence of fixed costs for offshoring the most productive firms self-select into offshoring, which leads to a reallocation of domestic labor towards less productive uses if offshoring costs are high. As a consequence domestic welfare may fall. The reallocation effect is reversed and domestic welfare rises if offshoring costs are low. The aggregate income distribution, comprising wages and entrepreneurial incomes, becomes more unequal with offshoring.  

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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 (cf. Paul and Yasar, 2009; Monarch et al., 2013; Hummels et al., 2014; Moser et al., 2015).\(^2\) In particular we show that offshoring, unlike international trade in final goods, may cause a reallocation of production workers from high- to low-productivity firms, and may also lead to firm entry at the lower end of the economy’s productivity distribution. The offshoring-induced reallocation of employment shares is at the heart of our paper, and we show that this effect can be important for aggregate welfare in the source country of offshoring. The mechanism leading to the reallocation of employment from high- to low-productivity firms is straightforward: Falling trade costs, starting from their prohibitive level, lead to offshoring among the most efficient firms, which frees some domestic labor and lowers domestic wages. As a consequence, the least productive firms hire more domestic labor and thus expand.

To conduct our analysis, we set up a general equilibrium model that features monopolistic competition among 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 workers, but they differ in their entrepreneurial abilities. These abilities are instrumental for firm

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\(^1\)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 by 2015. Using survey data from Germany, Geishecker et al. (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.

\(^2\)We give an in-depth overview over the evidence relevant to our modeling approach in Section 2 below.
productivity and thus for the profit income the entrepreneur earns when becoming owner-manager of a firm. Agents are free to choose among occupations, and individual ability determines who becomes an entrepreneur and who becomes a worker. We extend the Lucas (1978) model to a two-country setting, and 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.

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 et al. (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 firms to hire foreign workers to perform 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 have to pay a fixed offshoring cost, and 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), 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 “labor supply effect”) and the productivity effect. 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 et al., 2014).

With firm heterogeneity, the firm-level effects themselves as well as their implication for the economy-wide labor allocation depend on the composition of the firm population, i.e. the relative number of offshoring and purely domestic firms (itself an endogenous variable). If variable offshoring costs are high, only the high-productivity firms benefit from shifting production of their

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3Support for the occupational choice mechanism between entrepreneurship and employment as formalized in Lucas (1978) comes from matched worker-firm-owner data, which show that individuals who are unemployed (cf. Berglann et al., 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 labor market policies (ALMP) subsidizing start-ups for unemployed (unlike other ALMP) turned out to be quite successful (cf. Caliendo and Künn, 2011).

4Grossman 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. This terms of trade effect is absent in our model with a single final good and production of this good in just one country.
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 interna-
tional relocation effect is sizable, since all offshoring firms relocate a discrete 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 labor 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, or they work
for a (new or old) purely domestic firm. When variable offshoring costs are low, the effects are
reversed: the firm-level employment effect in newly offshoring firms turns positive, and offshoring
reallocates labor towards more productive firms. The potentially unfavorable effect on the resource
allocation in the source country constitutes a fundamental difference between offshoring and in-
ternational goods trade, where standard models with firm heterogeneity (cf. Melitz, 2003) feature
an unambiguous reallocation of labor towards more productive firms; and the resulting increase
in average industry productivity has been one of the important novel insights from this strand of

Having established our main result, we show that the offshoring-induced reallocation of employ-
ment shares across firms of different productivity is directly welfare relevant. Provided the autarky
equilibrium is distorted the offshoring-induced reallocation of employment towards less productive
firms may cause a drop in domestic welfare. This finding complements a rich literature that so far
mainly has focused on negative welfare effects of offshoring that result from an offshoring-driven
deterioration of the terms of trade in multi-sector models (cf. Samuelson, 2004; Bhagwati et al.,
2004; Mankiw and Swagel, 2006; Grossman and Rossi-Hansberg, 2008; Rodriguez-Clare, 2010).
Markusen (2013) and Baldwin and Robert-Nicoud (2014) provide a systematic analysis of this
issue. Associating offshoring with an expansion of trade along the extensive margin, they show
that domestic gains from offshoring are guaranteed if a country’s terms of trade do not deterio-
rate and that the source as well as the host country of offshoring gain if relative world prices of
initially-traded goods do not change. However, as pointed out by Markusen (2013) these results
do not extend in a straightforward way to models with imperfect competition and external scale
economies, and our model with only a single final good, in which welfare losses for the source
country are a result of an unfavorable domestic reallocation effect, is a case in point.

Irrespective of the sign of the reallocation effect, offshoring in our model always leads to higher
income inequality between workers and entrepreneurs, and also to a more unequal income dis-
tribution within the group of entrepreneurs. We show that as a consequence aggregate income
inequality, as measured by the Lorenz criterion, is higher in any equilibrium with offshoring than
in autarky.
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). Only a few papers in the literature on offshoring consider firm heterogeneity. Antràs and Helpman (2004) were the first to analyze 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 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 et al. (2006) develop a model with team production, in which offshoring is synonymous with 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 labor 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 our model, in which the most able entrepreneurs gain disproportionately. Davidson et al. (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.

The remainder of the paper is organized as follows. Section 2 relates important features and key results of our analysis to existing evidence on offshoring and points to crucial differences in the economy-wide effects of exporting and offshoring originating from their different implications for

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5In very recent work, Acemoglu and Zilibotti (2015) 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 et al. (2013) use a Ricardian framework with many goods and countries to study vertical specialization of countries along the global supply chain.

6There 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 labor to produce the final output good. Unlike 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.
resource allocation. In Section 3 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 characterize 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 4 we present our main result and analyze how changes in the offshoring costs affect the allocation of factors in our model. In Section 5 we address the welfare effect of offshoring, and in Section 6 we look at its effects on the economy-wide income distribution. Section 7 concludes our analysis with a summary of the most important results.

2 Empirical evidence on offshoring with firm heterogeneity

As highlighted in the introduction, we derive as our main result that offshoring, unlike trade in final goods (cf. Melitz, 2003; Egger and Kreickemeier, 2012), has a non-monotonic effect on domestic resource allocation, and that it may therefore cause a reallocation of resources from high- to low-productivity firms, with so far unexplored consequences for welfare, employment, and income distribution. In this section, we show that the two central mechanisms of our model that are instrumental in bringing about the offshoring-induced reallocation of labor between firms are strongly supported by the existing empirical evidence: (i) There is an important similarity between exporting and offshoring in that only the most productive firms select into either activity. (ii) There is an important difference between both activities in that exporting is accompanied by higher domestic firm-level employment, while offshoring may lead to an increase or a decrease in domestic firm-level employment.

(i) Selection into offshoring: Building on the seminal contributions by Clerides et al. (1998) and Bernard and Jensen (1999), several studies have shown that the empirically well-established self-selection of high-productivity firms into exporting naturally extends to other globalisation strategies, including the importing of intermediates (cf. Bernard et al., 2007, 2012), a commonly used measure of offshoring. Combining detailed matched worker-firm data for Denmark with information on firm-level offshoring and exporting from the Danish trade statistics, Hummels et al. (2014) provide further support for this argument and show that, compared with non-offshoring firms, offshoring firms are more profitable and have larger sales. Explicit evidence on the self-selection into offshoring is provided by Paul and Yasar (2009) who focus on the Turkish textiles and apparel industry and show that firms which decided in favour of offshoring between 1990 and

7Similar patterns have been shown to hold for Germany and the US as well. Using information from the IAB Establishment Panel provided by the Institute for Employment Research in Nuremberg, Moser et al. (2015) report that only 14.9 percent of the 8,466 plants in their sample undertake some offshoring and that, on average, offshoring firms are larger, use better technology, and pay higher wages than their non-offshoring competitors. Linking offshoring-induced employment layoff events recorded in the US Trade Adjustment Assistance (TAA) program to US Census Bureau’s business register, Monarch et al. (2013) find that offshoring firms are larger and more productive. For further evidence on the US see also Sethupathy (2013), who identifies US MNEs that offshore to Mexico from confidential FDI data provided by the Bureau of Economic Analysis (BEA) of the US Department of Commerce.
1996 had on average 36 percent higher labor productivity than those firms which did not so. We interpret this evidence as supportive of our model where the best firms self-select into offshoring.

(ii) Domestic firm-level employment effect of offshoring: As shown by Hummels et al. (2014) Danish firms tend to benefit in similar ways from offshoring and exporting as both activities lead to increased firm-level outputs and profits. However, the domestic firm-level employment effects of offshoring and exporting point in different directions. While exporting leads to an employment increase, offshoring is associated with a decline in domestic employment at the firm level. A negative effect of offshoring on domestic firm-level employment is also documented by Monarch et al. (2013) for US firms. In contrast, Sethupathy (2013) does not find any significant employment effect when focusing on offshoring of US firms to Mexico, and Moser et al. (2015) even report a positive domestic firm-level employment effect of offshoring for German establishments. Our model provides a framework that is compatible with the evidence suggesting that domestic firm-level employment of newly offshoring firms can rise or fall. In the model, this outcome depends on the changing relative importance of the international relocation effect and the productivity effect at different levels of offshoring costs. The change in the sign of the domestic firm-level employment effect in turn is instrumental in explaining the non-monotonic factor reallocation effect that offshoring has in our model.

3 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 labor 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 intermediate goods industry is run by an entrepreneur, who decides on hiring workers for both tasks. We embed the economy just described into a two-county world, 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 our model and derive some preliminary results.

3.1 The final goods industry

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

$$Y = \left[ M \left( \frac{1}{\sigma - 1} \int_{v \in V} q(v) \frac{1}{\sigma - 1} dv \right) \right]^{\frac{1}{\sigma - 1}},$$

where $V$ is the set of available intermediate goods with Lebesgue measure $M$, and $\sigma > 1$ is the elasticity of substitution between the different varieties in the production of $Y$. 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:

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

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

3.2 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 $r$. Analogous 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 intermediates. Assuming that one unit of labor is needed for one unit of each task, the production function for intermediates can be written as

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

where $\varphi(v)$ denotes firm-specific productivity, $L^n(v)$ and $L^r(v)$ are the labor 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 upon request, we
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 labor for this task in the host country, the cost is equal to the effective host country wage rate $\tau w^*$, 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. The constant marginal costs of producing output $q(v)$ for the two types of firms are therefore given by

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

where $\kappa$ 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, it is only attractive for source country producers to move routine tasks abroad if by doing so they can save on marginal costs. Therefore $\kappa > 1$ holds in any equilibrium with offshoring, and we refer to $\kappa$ as the marginal cost savings factor of offshoring in the following.

Firms set prices as a constant markup $\sigma/(\sigma - 1) > 1$ over marginal cost, giving

$$p^i(v) = \frac{\sigma}{\sigma - 1} c^i(v) \quad i \in \{d, o\}. \quad (5)$$

Using Eqs. (2), (4) and (5), we can compute relative operating profits of two firms with the same offshoring status but differing productivities $\varphi_1$ and $\varphi_2$. We get:

$$\frac{\pi^i(\varphi_1)}{\pi^i(\varphi_2)} = \left( \frac{\varphi_1}{\varphi_2} \right)^{\sigma-1}, \quad i \in \{d, o\}. \quad (6)$$

Therefore, given their offshoring status, more productive firms make higher operating profits. Analogously, the relative operating profits of two firms with the same productivity but differing offshoring status are given by

$$\frac{\pi^o(\varphi)}{\pi^d(\varphi)} = \kappa^{\sigma-1}. \quad (7)$$

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 rather than on the intensive margin. 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 et al. (2014).

\footnote{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.}
With \( \kappa > 1 \), Eq. (7) implies that an offshoring firm makes higher operating profits than a purely domestic firm with identical productivity.

### 3.3 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 to become either entrepreneurs or workers, where the latter are used both in production and in supplying the input into the fixed cost activity of those firms that choose to engage in offshoring. Entrepreneurs are owner-managers of firms, and their 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, \( \varphi \), 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 distribution, for which the lower bound is normalised to one: \( G(\varphi) = 1 - \varphi^{-k} \), and where both \( k > 1 \) and \( k > \sigma - 1 \) are assumed in order to guarantee that the mean of firm-level productivities and the mean of firm-level profits, respectively, are positive and finite.

Entrepreneurial ability is irrelevant for the productivity of individuals that choose to become workers instead of entrepreneurs, and therefore all workers are paid the same 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 \( \varphi^d \), we can characterize the marginal entrepreneur by indifference condition

\[
\pi^d(\varphi^d) = w. \tag{8}
\]

We assume that offshoring involves a fixed input requirement of one unit of labor. The indifference condition for the entrepreneur running the marginal offshoring firm with productivity \( \varphi^o \) is then given by

\[
\pi^o(\varphi^o) - \pi^d(\varphi^o) = w. \tag{9}
\]

In the remainder of this section we use indifference conditions (8) and (9) to solve for the domestic factor allocation as a function of model parameters and a single endogenous variable, the fraction of offshoring firms \( \chi \equiv [1 - G(\varphi^o)]/[1 - G(\varphi^d)] \).

Consider indifference condition (8) first. We start by deriving a link between profits of the marginal firm \( \pi^d(\varphi^d) \) and aggregate variables. For this purpose, we introduce three operating profit
averages: namely average operating profits \( \bar{\pi} \); average operating profits for the counterfactual situation in which all firms 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 \( k/[k - \sigma + 1] > 1 \). This allows us to write

\[
\bar{\pi} = \frac{k}{k - \sigma + 1} \left[ \pi^d(\varphi^d) + \chi \pi^{\text{off}}(\varphi^o) \right] = \frac{k}{k - \sigma + 1} (1 + \chi) \pi^d(\varphi^d),
\]

(10)

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 \( w \). Using the relation \( \sigma \bar{\pi} = Y/M \), we finally get:

\[
\pi^d(\varphi^d) = \frac{k - \sigma + 1}{k} \frac{1}{1 + \chi} \frac{1}{\sigma} \frac{Y}{M}.
\]

(11)

Ceteris paribus, an increase in the mass of firms reduces the income of the marginal entrepreneur in Eq. (11), since adding firms to the economy means that the marginal entrepreneur is now of lower ability.

Analogously, we now seek to link \( w \) to aggregate variables, making use of the fact that due to constant markup pricing the wage bill of each source country firm is a constant fraction \( (\sigma - 1)/\sigma \in (0, 1) \) of the firm’s revenues. Taking into account the fact that for offshoring firms only a fraction \( \eta \) 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

\[
w = \gamma \frac{\sigma - 1}{\sigma} \frac{Y}{L}, \quad \gamma \equiv \frac{(1 - \chi) \bar{\pi}^d + \chi \eta \bar{\pi}^o}{\bar{\pi}},
\]

(12)

where \( \gamma \) is the share of the overall production worker income allotted to the source county, and \( L \) is the endogenous supply of source country production workers.\(^{11}\) An increase in \( L \) reduces the wage rate in Eq. (12), ceteris paribus, since only at a lower wage are firms willing to employ more production workers. We show in the Appendix that \( \gamma \) can be written as

\[
\gamma(\chi; \eta) = \frac{1 + \eta \chi - (1 - \eta) \chi^{k - (\sigma - 1)/k}}{1 + \chi}.
\]

It is easily confirmed that \( \gamma(\chi; \eta) \) decreases monotonically in \( \chi \), falling from the maximum value

\(^{11}\)To simplify notation, we suppress the arguments of functions when the dependence is clear from the context.
of 1 at $\chi = 0$ to the minimum value of $\eta$ at $\chi = 1$.

Having derived, in Eqs. (11) and (12), expressions for the wage rate of production workers and the profit income of the marginal entrepreneur, respectively, we can now rewrite indifference condition (8) in terms of $M$ and $L$:

$$L = \gamma (1 + \chi) \frac{k(\sigma - 1)}{k - \sigma + 1} M.$$  \hfill (13)

The indifference condition is upward sloping in $(M, L)$ space since an increase in $M$, which reduces the profits of the marginal firm, requires an increase in $L$, which reduces the wage rate, in order to restore indifference of the marginal entrepreneur between occupations.

A second equation linking $M$ and $L$ is the resource constraint

$$L = N - (1 + \chi) M,$$  \hfill (14)

which is downward sloping in $(M, L)$ space since with an exogenous supply of individuals $N$ an increase in the mass of entrepreneurs, accompanied by higher employment in the fixed offshoring cost activity ($\chi M$), is only possible if the mass of production workers decreases. Together, Eqs. (13) and (14) 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 offshoring firms $\chi$:

$$M = \frac{k - \sigma + 1}{(1 + \chi) [k - \sigma + 1 + \gamma k(\sigma - 1)]} N,$$  \hfill (15)

$$L = \frac{\gamma k(\sigma - 1)}{k - \sigma + 1 + \gamma k(\sigma - 1)} N.$$  \hfill (16)

### 3.4 Determining the share of offshoring firms

In this section, 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 $\chi$ varies with the cost of offshoring $\tau$ 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 $\chi$ and the marginal cost savings factor $\kappa$. Substituting from Eqs. (7) to (8), we get the offshoring indifference condition

$$\kappa = A(\chi) \equiv \left(1 + \chi \frac{\sigma - 1}{\kappa} \right)^{\frac{1}{\sigma - 1}}.$$  \hfill (17)

Intuitively, a larger marginal cost savings factor $\kappa$ 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 \( 1 < \kappa < 2^{1/(\sigma-1)} \).

A second link between \( \chi \) and \( \kappa \) can be derived from the condition for labor market equilibrium in both countries. Labour market equilibrium in the source country follows from Eqs. (12) and (16) as

\[
w = \frac{k - \sigma + 1 + \gamma k(\sigma - 1) Y}{k\sigma} \frac{Y}{N},
\]

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

\[
w^* = (1 - \gamma) \frac{\sigma - 1}{\sigma} \frac{Y}{N^*}.
\]

Substitution of the two labor market equilibrium conditions into the definition of \( \kappa \) in Eq. (4) leads to:

\[
\kappa = B(\chi, \tau) \equiv \left[ \frac{k - \sigma + 1 + \gamma k(\sigma - 1) N^*}{\tau (1 - \gamma) k(\sigma - 1)} \right]^{1-\eta},
\]

which we label the labor market constraint since it gives combinations between between \( \kappa \) and \( \chi \) that are compatible with labor market equilibrium in both countries. With \( \gamma \) decreasing monotonically from 1 to \( \eta \) as \( \chi \) increases from zero to one, we know that the labor market constraint is monotonically decreasing in \( \chi \), 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 \( \kappa \) infinitely large. Holding \( \tau \) constant, as more firms start to offshore production, effective wages in the host country are bid up, thereby reducing \( \kappa \).

Figure 1 illustrates that the offshoring indifference condition and the labor market constraint together determine \( \kappa \) and \( \chi \). It can be easily checked that an interior equilibrium with \( \chi < 1 \), as shown, results if \( B(1, \tau) \) is smaller than \( 2^{1/(\sigma-1)} \), which is guaranteed if

\[
\tau > 2^{1/(\sigma-1)} \frac{k - \sigma + 1 + \eta k(\sigma - 1) N^*}{(1 - \eta) k(\sigma - 1) N}.
\]

This is the case we are considering in the following.

The link between \( \tau \) and \( \chi \) in an interior equilibrium is given by the implicit function

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

Implicit differentiation yields \( d\chi/d\tau < 0 \), showing the immediately plausible result that there is a monotonic negative relationship between the variable cost of offshoring and the share of firms that choose to move production of their routine tasks offshore. The result can also be read off Figure 1: An increase in \( \tau \) leads to a downward shift in the labor market constraint (for given \( \chi \), a higher transport cost reduces the cost advantage of the host country), but does not affect
the offshoring indifference condition (the marginal entrepreneur only cares about $\kappa$, not about its components). Adjustment to the new equilibrium with a smaller share of offshoring firms and a lower cost advantage of the host country occurs along the offshoring indifference condition.

Having shown that there is a monotonic relationship between $\tau$ and $\chi$, we will now derive all our results as a function of $\chi$, in the understanding that $\chi$ is uniquely determined by exogenous parameters (in particular $\tau$) and that a decrease in $\chi$ can be thought of as following from an increase in $\tau$, and vice versa.\footnote{One can see in Eq. (18) that the limiting case $\chi \to 0$ is induced by $\tau \to \infty$.} In addition to simplifying the analysis, discussing the consequences of offshoring by means of comparative static effects of changes in $\chi$ highlights that all results of our analysis remain unchanged in other model variants in which the monotonic negative relationship between $\tau$ and $\chi$ is preserved.\footnote{In a supplement, available from the authors upon request, we demonstrate that our results carry over to a small-open-economy version of our model. Of course, with an exogenously given wage in the destination country, we have to assume that this wage is sufficiently low to support an offshoring equilibrium.}

4 Offshoring and 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. We proceed in two steps. First, we show how domestic firm-level employment of production workers in the source country is affected by the choice of a firm to be either a national firm or an offshoring firm. This is a counterfactual
effect in the sense that for any given level of offshoring cost all firms but the marginal offshoring firm strictly prefer to be of one type or the other. We show that the domestic firm-level employment effect is equi-proportional for all firms and that its sign as well as its strength depend on $\chi$. In a second step, we use this effect to show how a change in offshoring cost affects the allocation of production workers across firms.

Firm-level employment in the source country for an offshoring firm and for a purely domestic firm, respectively, follows from applying Shephard’s Lemma to the firm-specific variable unit cost functions in Eq. (4), and multiplying the resulting labor input coefficients by firm-level output. This gives:

$$l^o(\varphi) = \eta q_o(\varphi)$$

and

$$l^d(\varphi) = q_d(\varphi),$$

respectively. The domestic 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 (total) employment of a purely domestic firm with the same productivity. The domestic firm-level employment effect thus measured compares for each firm the actual domestic employment level with the domestic 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 domestic firm-level employment effect as the sum of two partial effects – the effect of offshoring on domestic 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 domestic 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 (total) employment – induced by the reduction in marginal cost. Using the link between $\kappa$ and $\chi$ given in offshoring indifference condition Eq. (17), we obtain

$$\ln l^o(\varphi) - \ln l^d(\varphi) = \ln \left[ \frac{\eta}{\varphi} \left( 1 + \chi \frac{\sigma - 1}{\sigma} \right) \frac{1}{\sigma - 1} \right] + \ln \left[ \left( 1 + \chi \frac{\sigma - 1}{\sigma} \right) \frac{\sigma}{\sigma - 1} \right].$$  \hspace{1cm} (19)

The international relocation effect is negative for any $\chi \geq 0$, since on the one hand the routine task is now produced by foreign labor and on the other hand the input ratio changes in favor of this – now relatively cheaper – task. The effect becomes more negative as $\chi$ increases. In contrast to the international relocation effect, the firm-level productivity effect is zero if evaluated at $\chi = 0$.

\hspace{1cm} \textit{The effects are directly analogous to the labor 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.}
(since the marginal cost savings factor $\kappa$ is zero), and it increases monotonically with increasing $\kappa$, i.e. with increasing $\chi$.

Two aspects of the IR and FP effects are noteworthy. First, Eq. (19) shows that neither effect depends on firm productivity. Hence, for a given level of offshoring costs, implying some value of $\chi$, the percentage difference in domestic firm-level 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 $\chi$, means that the international relocation effect determines the overall effect at low levels of offshoring. Inspection of Eq. (19) 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 $\eta$ is greater than $1/2$. 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.\textsuperscript{15}

The domestic firm-level employment effect derived in Eq. (19) is an important element in a comprehensive analysis of the consequences of an increase in $\chi$ for domestic factor allocation, since it shows the effect on the source country employment in marginal (newly) offshoring firms. To complete the picture, we need to derive the effect on the employment in infra-marginal firms (purely domestic firms and incumbent offshoring firms), and also on the productivity cutoffs $\varphi^d$ and $\varphi^o$.

Due to constant-markup pricing, the wage bill of all firms is a multiple $\sigma - 1$ of their respective operating profits. This directly gives us two useful results: First, using the indifference condition $w = \pi^d(\varphi^d)$ we find that employment of the marginal firm is independent of $\varphi^d$, and it is given by $l^d(\varphi^d) = \sigma - 1$. Second, analogous to Eq. (6) the elasticity of domestic firm-level employment $l^i(\varphi)$ with respect to $\varphi$ is constant and also equal to $\sigma - 1$. The cutoff productivity $\varphi^d$ is linked to the mass of firms by the condition $M = [1 - G(\varphi^d)]N$, and therefore it is given by

$$\varphi^d = \left\{ \frac{(1 + \chi)[k - \sigma + 1 + \gamma k(\sigma - 1)]}{k - \sigma + 1} \right\}^{\frac{1}{\pi}},$$

(20) showing that $\varphi^d$ is only a function of $\chi$ and model parameters. The same holds true for $\varphi^o$, which \textsuperscript{15}While this number is not a perfect match for our cost-share parameter $\eta$, the fact that the Blinder-Krueger measure considers potential offshorability rather than actual offshoring renders our parameter constraint of $\eta > 1/2$ a rather conservative assumption. Empirical evidence for the effect of offshoring on firm-level employment comes from Moser et al. (2015), Hummels et al. (2014) and Monarch et al. (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 et al. (2014) and Monarch et al. (2013), respectively.
is equal to $\varphi^d/\chi^k$. As shown in Appendix A.2, $\varphi^d$ has a unique lower bound, which is reached at

$$\hat{\chi}_d \equiv \frac{(k - \sigma + 1)(\sigma - 1)(1 - \eta)}{k[k - \sigma + 1 + k(\sigma - 1)\eta]}^{\frac{k-1}{\sigma-1}} \in (0,1),$$

(21)

with $d\varphi^d/d\chi < 0$ for $\chi < \hat{\chi}_d$ and $d\varphi^d/d\chi > 0$ for $\chi > \hat{\chi}_d$. In the Appendix we also show that $\varphi^o$ decreases monotonically in $\chi$.

Using all these results, Figure 2 illustrates the effects of an increase in $\chi$ on the allocation of production labor, where the top panel shows the case of a low $\chi$ (high $\tau$), the bottom panel shows the case of a high $\chi$ (low $\tau$), and subscripts 1 and 2 denote the old and new equilibrium values, respectively. If $\chi$ is low, a reduction in $\tau$ reduces domestic employment in newly offshoring firms. Domestic employment in all purely domestic firms (of which there are relatively many) and in all incumbent offshoring firms (of which there are relatively few) increases. If $\chi$ is high the picture is different: following a decrease in $\tau$ domestic 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. The threshold $\hat{\chi}_d$ separates the case where more offshoring increases employment in all purely domestic firms (including some new entrants) from the case where it decreases employment in all purely domestic firms (forcing the least productive of them to exit the market). Since these firms are the least productive firms in our model, we call the case where they experience an increase in employment a reallocation of labor towards less productive uses, and the case where employment in these firms decreases a reallocation of labor towards more productive uses.

Using this terminology, we get to the following proposition:

**Proposition 1** If the share of offshoring firms $\chi$ is below the threshold level $\hat{\chi}_d \in (0,1)$, a reduction in marginal offshoring costs $\tau$ reallocates production workers towards less productive uses, and new firms enter the market in the lower tail of the productivity distribution. For $\chi$ above $\hat{\chi}_d \in (0,1)$, a reduction in $\tau$ reallocates production workers towards more productive uses, and firms in the lower tail of the productivity distribution leave the market.

**Proof** See Appendix A.2 and the analysis in the text.

The potentially unfavorable effect of offshoring on the resource allocation in the source country is our main result, and it shows an important dimension in which offshoring is different from international trade in goods, which in a comparable setting always reallocates labor 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 reason for this difference is easy to see if we compare what happens to firms that self-select into international activity (trade or offshoring)
Figure 2: Offshoring and the allocation of production workers
at very high levels of $\tau$ in each of the two scenarios. In both scenarios the firms choosing to become international are the highest-productivity firms, and their profits, revenues, and (total) employment go up. But while in the case of goods trade the extra employment in these firms is created at home, in the case of offshoring all the extra employment in these firms is created abroad, with their employment in the source country actually falling. In the former case, the best firms have to bid workers away from less productive competitors, in the latter case the workers set free by the best firms need to find employment elsewhere. At low levels of $\tau$ offshoring becomes similar to trade in goods, since the firms newly selecting into international activity (as well as those firms already active in international markets) actually increase their domestic employment.

The finding that offshoring in our setting has a non-monotonic effect on labor allocation is a direct 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 $\chi$ and, according to Eq. (19), 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 domestic employment than in the model variant with heterogeneous producers. A reduction in $\tau$ therefore reallocates production workers towards offshoring firms, and some firms leave the market for any $\chi \in (0, 1)$.

5 Offshoring and welfare

With just a single global consumption good, welfare for the source country is equal to its income per capita. Since the mass of individuals in the source country is fixed at $N$, we will simplify notation and terminology further, and track welfare changes for the source country by changes in its aggregate income. Aggregate income in the source country is given by $I = [(1/\sigma) + \gamma(\sigma - 1)/\sigma]Y$, where $(1/\sigma)Y$ is the sum of profit income and offshoring service income, and $\gamma[(\sigma - 1)/\sigma]Y$ is domestic labor 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 $\varphi^d$, as well as Eqs. (8) and (11), we get

$$I(\chi) = (\sigma - 1) \left( \frac{1}{\sigma} + \frac{\sigma - 1}{\sigma} \right) \left( \frac{k}{k - \sigma + 1} \right)^{\frac{\varepsilon - 1}{\sigma - 1}} (1 + \chi)^{\frac{\sigma - 1}{\sigma - 1}} M \varphi^d M^{\frac{\sigma - 1}{\sigma - 1}},$$

and a solution for $I$ in terms of model parameters and $\chi$ follows by substituting for $M$ and $\varphi^d$ from Eqs. (15) and (20), respectively. The effect of offshoring on aggregate income in the source
country turns out to depend on whether $\varepsilon$ is higher or lower than $\bar{\varepsilon} \equiv (\sigma - 1)/(\sigma k) \in (0, 1)$, and in the following we speak of weak external increasing returns to scale if $\varepsilon < \bar{\varepsilon}$ and of strong external increasing returns to scale if $\varepsilon > \bar{\varepsilon}$. Using this terminology, we have the following result:

**Proposition 2** For weak external increasing returns to scale, welfare in the source country decreases in the share of offshoring firms at low levels of $\chi$. The effect is reversed as more firms offshore, and welfare surpasses its autarky level if $\chi$ is sufficiently large. If external increasing returns are strong, an increase in the share of offshoring firms leads to a monotonic increase in source-country welfare.

**Proof** See Appendix A.3.

Intuitively, offshoring affects source-country welfare via three partial effects: (i) a positive effect resulting from the use of cheaper foreign labor, (ii) a negative effect resulting from the outflow of labor income to pay foreign production workers, and (iii) a variety effect that is positive whenever the mass of produced varieties $M$ increases. The size of the variety effect is increasing in the extent of external increasing returns to scale $\varepsilon$, as illustrated in Eq. (22).

In the case of weak external increasing returns to scale, when the variety effect is small, the overall welfare effect is determined by effects (i) and (ii). As shown above, offshoring reallocates labor towards less productive uses if $\chi$ is low, and in this case the negative effect (ii) dominates, leading to a decrease in source country welfare. By contrast, offshoring reallocates labor towards more productive uses if $\chi$ is high, the positive effect (i) dominates, and source country welfare increases. When external increasing returns are strong, welfare unambiguously increases with offshoring since now the variety effect becomes important. The variety effect increases welfare, ceteris paribus, exactly in those situations where without it welfare would fall: at low levels of $\chi$, when labor is reallocated to less productive uses, thereby increasing the mass of firms and hence the mass of varieties produced. We show in Appendix A.4 that in one special case of strong external increasing returns to scale, the case of $\varepsilon = 1$, factor allocation under autarky is efficient. It is therefore clear that in this special case opening up the possibility of offshoring cannot reduce source country welfare. This is of course compatible with our analysis that derives the more general result of a critical value $\bar{\varepsilon} \in (0, 1)$ separating gains and losses of offshoring for the source country.

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. This feature of the model relates our analysis to Dhingra and Morrow (2013) who construct a model with monopolistic competition among heterogeneous firms in which endogenous markups lead to a misallocation of resources that can be amplified by trade.

6 Offshoring and inequality

To analyse the impact of offshoring on economy-wide inequality, we adopt an approach similar to Helpman et al. (2010) and show that the economy-wide income distribution under autarky displays mean-normalized second-order stochastic dominance (also known as Lorenz dominance) over the economy-wide distribution resulting in an offshoring equilibrium. As a consequence, the income distribution in the open economy is ranked more unequal than the income distribution under autarky according to all measures of inequality that respect second-order stochastic dominance, such as the Gini coefficient or the Theil index. Focusing on the empirically relevant parameter space $\eta > 1/2$, we summarize our results in Proposition 3.

**Proposition 3** According to the criterion of Lorenz dominance, inequality in the open economy is strictly larger than under autarky.

**Proof** See Appendix A.5.

For a graphical illustration, we depict the Lorenz curve $Q(\mu; \chi)$ for autarky ($\chi = 0$) and the offshoring equilibrium ($\chi > 0$) in Figure 3, where $Q(\mu; \chi)$ captures the proportion of total income received by the bottom fraction $\mu \in [0, 1]$ of individuals in the income distribution. Under autarky the Lorenz curve has two segments. The first segment is relevant for the group of workers and it is linear because all workers receive the same wage. The second segment is convex because high ability managers receive higher income than low ability ones, and $b_1(0) = 1 - M/N$ captures the share of workers in the total population of the source country under autarky. With offshoring, the Lorenz curve has three segments: The first segment is again relevant for workers and is linear. The second segment is convex because managerial income in non-offshoring firms increases with entrepreneurial ability. The third segment is steeper and even more convex because offshoring firms are larger, ceteris paribus, and managers can therefore make use of their abilities on a larger scale. The three segments are separated by $b_1(\chi) = 1 - M/N$ and $b_2(\chi) = 1 - \chi M/N$.

As illustrated in Figure 3, Lorenz curve $Q(\mu; 0)$ lies strictly above Lorenz curve $Q(\mu; \chi)$ for $\chi > 0$, and this is the requirement for the the income distribution under autarky to Lorenz dominate the income distribution with offshoring (see Atkinson, 1970). Access to offshoring provides an income stimulus for those entrepreneurs who make use of this option, and due to this income gain
they see their incomes rise both relative to the non-offshoring entrepreneurs and relative to workers, whose income is tied to the income of the least-productive entrepreneur by virtue of Eq. (8). While the formal proof of Lorenz dominance is deferred to the Appendix, it is intuitively plausible that this effect on relative incomes leads to a decrease in wages relative to average incomes, while the income of the highest-income entrepreneurs, who choose offshoring, goes up relative to average incomes. Therefore, the Lorenz curve under offshoring lies below the Lorenz curve under offshoring at both very low and very high incomes.

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 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 at the same time destroys domestic jobs in which workers perform routine tasks. The relative strength of these two opposing effects on domestic 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 routine-task jobs dominates the establishment of new jobs in which workers perform non-routine tasks, and hence offshoring lowers domestic 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 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 can therefore render the source country worse off with offshoring than in autarky. The situation is more favorable 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 increases relative to autarky if the costs of offshoring are sufficiently small. Economy-wide income inequality increases unambiguously with offshoring, and this is due to a disproportionate gain of entrepreneurs with high abilities who can make use of the offshoring option in the open economy.

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 welfare and income inequality. 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.

References


23


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 $\pi^d(\varphi^o)$. 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 $k/[k-\sigma+1]$ of the marginal offshoring firm’s operating profits $\pi^o(\varphi^o)$. Hence, we can write:

$$
\bar{\pi}^o = \frac{k}{k-\sigma+1} \pi^o(\varphi^o) = \frac{k}{k-\sigma+1} \left[ \frac{\pi^o(\varphi^o)}{\pi^d(\varphi^o)} \right] \bar{\pi}^d(\varphi^d)
$$

where $\pi^o(\varphi^o)/\pi^d(\varphi^o) = 1 + \chi^{(\sigma-1)/k}$ from Eq. (7) and the definition of $\chi$ reflects the firm-level productivity effect, while $\pi^d(\varphi^o)/\pi^d(\varphi^d) = (\varphi^d/\varphi^o)^{-(\sigma-1)} = \chi^{-(\sigma-1)/k}$ from Eq. (6) and the definition of $\chi$ 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 $\bar{\pi}^o$ and $\bar{\pi}^d$ in terms of $\pi^d(\varphi^d)$, we get:

$$
\bar{\pi} = \frac{\bar{\pi} - \chi\bar{\pi}^o}{1-\chi} = \frac{k}{k-\sigma+1} \frac{1 - \chi^{1-\frac{\sigma-1}{k}}}{1-\chi} \pi^d(\varphi^d).
$$

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

A.2 Derivation of Eq. (21) and proof of Proposition 1

Differentiation of Eq. (15) and substitution of

$$
\frac{\partial \gamma}{\partial \chi} = - \frac{(k-\sigma+1)(1-\eta)\chi^{-\frac{\sigma-1}{k}} + k(\gamma-\eta)}{k(1+\chi)}
$$

(A.3)

gives

$$
\frac{dM}{d\chi} = - \frac{k - \sigma + 1 + k(\sigma - 1)\eta - (k-\sigma+1)(\sigma - 1)(1-\eta)\chi^{-\frac{\sigma-1}{k}}}{(1+\chi)^2[k-\sigma+1+k(\sigma-1)\gamma]^2}.
$$

(A.4)

Setting the derivative in Eq. (A.4) equal to zero, allows us to solve for $\hat{\chi}_d$ in Eq. (21). In view of $k > \sigma - 1$ and $\eta > 1/2$, we have $\hat{\chi}_d \in (0, 1)$. Furthermore, $k > \sigma - 1$ implies that the numerator on the right-hand side of Eq. (A.4) increases in $\chi$, and this proves that $M$ reaches its upper bound at $\hat{\chi}_d$. Since $M$ and $\varphi^d$ are negatively linked, the cutoff productivity level reaches its lower bound at $\hat{\chi}_d \in (0, 1)$. Finally, from the definition of $\chi \equiv [1 - G(\varphi^o)]/[1 - G(\varphi^d)] = (\varphi^d/\varphi^o)^k$ in Eq. (17) it follows that $\varphi^o = \varphi^d/\chi^{\frac{1}{k}}$. Replacing $\varphi^d$ by Eq. (20) and differentiating with respect to $\chi$ establishes $d\varphi^o/d\chi < 0$. This completes the proof.

A.3 Proof of Proposition 2

Substitution of Eqs. (15) and (20) for $M$ and $\varphi^d$, respectively, in Eq. (22) 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

$$T_1(\chi) \equiv \left\{ \frac{1 + \gamma(\sigma - 1)[k - \sigma + 1 + k(\sigma - 1)]}{\sigma [k - \sigma + 1 + \gamma k(\sigma - 1)]}, \quad T_2(\chi) \equiv \left\{ \frac{1 + \chi}[k - \sigma + 1 + \gamma k(\sigma - 1)] \right\} \frac{\sigma - 1}{k(\sigma - 1)},$$

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

$$\Phi'(\chi) = \frac{\Phi(\chi)}{1 + \gamma(\sigma - 1)} \left\{ - \frac{k(\chi; \epsilon) + (\sigma - 1)^2}{k(\sigma - 1) + k - \sigma + 1} \right\} \left\{ \frac{\partial\gamma}{\partial\chi} \right\} + \left\{ \frac{1 + \epsilon/k + \sigma - 1 + \gamma(\sigma - 1)}{k(\sigma - 1)} \right\},$$

with $$k(\chi; \epsilon) \equiv [k\epsilon - \sigma + 1][1 + \gamma(\chi; \eta)(\sigma - 1)]. \text{ In view of } \partial\gamma/\partial\chi < 0, \text{ it is immediate that}$$

$$k(\chi; \epsilon) + (\sigma - 1)^2 \geq 0 \text{ is sufficient for } \Phi'(\chi) > 0. \text{ Hence we can thus safely conclude that}$$

$$\Phi'(\chi) > 0 \text{ is guaranteed if } \epsilon \geq \bar{\epsilon}. \text{ Put differently, if } \epsilon \geq \bar{\epsilon} \text{ source country welfare is monotonically increasing in the share of offshoring firms, and hence welfare in the source country is unambiguously higher with offshoring than in autarky.}$$

We now consider the parameter domain $$\epsilon < \bar{\epsilon}. \text{ In this case, } \Phi'(0) < 0 \text{ follows from}$$

$$k(0; \epsilon) + (\sigma - 1)^2 < 0 \text{ and the fact that } \lim_{\chi \to 0} \partial\gamma/\partial\chi = -\infty, \text{ and hence offshoring lowers source country welfare relative to autarky if } \chi \text{ is small.}$$

Further, evaluating the derivative in Eq. (A.6) at $$\chi = 1$$, we obtain

$$\Phi'(1) = \frac{\Phi(1)}{2k} \left\{ [b(\eta) + k(\sigma - 1)(1 - \eta)] \frac{1 + \eta(\sigma - 1) + (\sigma - 1)^2(k - \sigma + 1)(1 - \eta)}{[1 + \eta(\sigma - 1)][\eta k(\sigma - 1) + k - \sigma + 1]} \right\},$$

with $$b(\eta) \equiv [(1 - \epsilon)k + \sigma - 1][(2\eta - 1)k + (\sigma - 1)(1 - \eta) + (k - \sigma + 1)/(\sigma - 1)]. \text{ It is immediate that}$$

$$\eta > 1/2 \text{ is sufficient for } b(\eta) > 0 \text{ and in this case we have } \Phi'(1) > 0. \text{ Hence, if } \eta > 1/2, \text{ offshoring exerts a non-monotonic effect on source country welfare. Noting that}$$

$$T_1(\chi) > 1 \text{ and } T_3(\chi) > 1 \text{ hold for any } \chi > 0, \text{ whereas } \eta > 1/2 \text{ is sufficient for } T_2(1) > 1 \text{ if } \epsilon < (\sigma - 1)/k, \text{ we can safely conclude that}$$

$$\Phi(1) > 1, \text{ and hence the source country benefits from offshoring if } \chi \text{ is large.} \text{ This completes the proof.}$$

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

In autarky, the social planner sets $$\varphi^d$$ 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 $$\varphi^d$$. Holding $$\varphi^d$$ 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 $$Y = \int_{v \in V} q(v) \varphi^d \frac{1}{\varphi^d} dv$$ 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 $$\varphi^d$$. 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

\[
\max_{\varphi^d, a} \quad Y = \left[ N \int_{\varphi^d}^{\infty} q(\varphi) \frac{dG(\varphi)}{\varphi} \right]^{\frac{1}{\sigma-1}} \quad \text{s.t.} \quad \int_{\varphi^d}^{\infty} \frac{q(\varphi)}{\varphi} dG(\varphi) = G(\varphi^d), \quad q(\varphi) = a\varphi^\sigma. \tag{A.8}
\]

Applying \( q(\varphi) = a\varphi^\sigma \), we can rewrite the resource constraint as follows: \[ k/(k-\sigma+1)a(\varphi^d)^{\sigma-1-k} = 1 - (\varphi^d)^{-k} \]. Furthermore, total output can be written as \( Y = \{ N[k/(k-\sigma+1)]a^{\frac{\sigma-1}{\sigma}}(\varphi^d)^{\sigma-1-k} \}^{\frac{1}{\sigma-1}} \).

Solving the resource constraint for \( a \) and substituting the resulting expression into \( Y \), we can simplify the social planner’s problem to

\[
\max_{\varphi^d} \quad N^{\frac{1}{\sigma-1}} \left( \frac{k}{k-\sigma+1} \right)^{\frac{1}{\sigma-1}} \left[ 1 - \left( \frac{\varphi^d}{1} \right)^{-k} \right] \left( \varphi^d \right)^{1-\frac{k}{\sigma}}. \tag{A.9}
\]

The first-order condition to this maximization problem establishes \( \varphi^d = \{(k - \sigma + 1)\}^{1/k} \) and this coincides with the outcome of decentralized firm entry in Eq. (20), when considering \( \chi = 0 \). Hence, for \( \varepsilon = 1 \) the market equilibrium under autarky is allocational efficient.

### A.5 Economy-wide inequality

To measure economy-wide inequality in the source country, we look at the Lorenz curve. With offshoring, the Lorenz curve has three segments. The first one measures the income share of (production and non-production) workers. Accounting for indifference condition \( \pi(\varphi^d) = w = s \), we can express economy-wide income as follows: \( I = \pi(\varphi^d)[L + (1 + \chi)k/(k - \sigma + 1)M] \). Substitution of \( M \) and \( L \) from Eqs. (15) and (16) allows us to compute the first segment of the Lorenz curve

\[
Q_1(\mu; \chi) = \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{\gamma k(\sigma - 1) + k} \mu, \tag{A.10}
\]

which gives the income share earned by fraction \( \mu \in [0, b_1(\chi)) \) of the source-country population, where

\[
b_1(\chi) \equiv 1 - \frac{M}{N} = \frac{(1 + \chi)\gamma \sigma}{\gamma k(\sigma - 1) + \chi k - \sigma + 1}, \tag{A.11}
\]

To compute the second segment of the Lorenz curve, we add up income over all individuals earning less than or equal to \( \pi(\varphi) \), \( \varphi \in [\varphi^d, \varphi^o] \). In view of indifference condition (8), this gives \( I_2(\varphi) = \pi(\varphi^d) \{ L + \chi M + M[1 - (\varphi^d/\varphi^o)^{\sigma-1-k}]k/(k - \sigma + 1) \} \). Dividing by economy-wide income \( I \), we obtain

\[
\frac{I_2(\varphi)}{I} = Q_1(b_1(\chi); \chi) + \frac{k}{(1 + \chi)[\gamma k(\sigma - 1) + k]} \left[ 1 - \left( \frac{\varphi}{\varphi^d} \right)^{-k} \right]. \tag{A.12}
\]

The share of population that earns less than or equal to \( \pi(\varphi) \) is given by \( \mu = 1 - (\varphi^d/\varphi^o)^{-k} M/N \) or, equivalently,

\[
\mu = b_1(\chi) + \frac{k - \sigma + 1}{(1 + \chi)[\gamma k(\sigma - 1) + k - \sigma + 1]} \left[ 1 - \left( \frac{\varphi}{\varphi^d} \right)^{-k} \right]. \tag{A.13}
\]
Solving for \( \tilde{\varphi}/\varphi^d \) and substituting the resulting expression in (A.12) gives the second segment of the Lorenz curve

\[
Q_2(\mu; \chi) = 1 - \frac{\chi}{1 + \chi} \frac{\sigma - 1}{\gamma k(\sigma - 1) + k} \left[ 1 + \chi \frac{\sigma - 1}{\gamma k(\sigma - 1) + k} \right]^{1 - \frac{\sigma - 1}{k}} (1 - \mu)^{1 - \frac{\sigma - 1}{k}},
\]

(A.14)

and this is relevant for \( \mu \in [b_1(\chi), b_2(\chi)] \), with

\[
b_2(\chi) = \frac{N - \chi M}{N} = (1 + \chi)\gamma k(\sigma - 1) + k - \sigma + 1 \left[ (1 + \chi)\gamma k(\sigma - 1) + k - \sigma + 1 \right]
\]

(A.15)

To compute the third segment of the Lorenz curve, we add up total non-profit income plus the cumulative profits of firms with a productivity up to \( \tilde{\varphi} \in [\varphi^o, \infty) \). Accounting for Eqs. (6), (7), and (17) and dividing the resulting expression by \( I \), gives the income share accruing to individuals who earn less than or equal to \( \pi(\varphi^o) \):

\[
\frac{I_3(\tilde{\varphi})}{I} = Q_2(b_2(\chi); \chi) + \frac{k}{(1 + \chi)\gamma k(\sigma - 1) + k} \left[ 1 + \chi \frac{\sigma - 1}{\gamma k(\sigma - 1) + k} \right] \left[ \chi - \left( \frac{\tilde{\varphi}}{\varphi^o} \right)^{-k} \right]
\]

(A.16)

Substitution of \( \mu \) from Eq. (A.13) we obtain for the third segment of the Lorenz curve

\[
Q_3(\mu; \chi) = 1 + \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{\gamma k(\sigma - 1) + k} (1 - \mu)
\]

\[
- \frac{1 + \chi \frac{\sigma - 1}{\gamma k(\sigma - 1) + k}}{1 + \chi \frac{\sigma - 1}{\gamma k(\sigma - 1) + k}} \left[ \gamma k(\sigma - 1) + k - \sigma + 1 \right]^{1 - \frac{\sigma - 1}{k}} (1 - \mu)^{1 - \frac{\sigma - 1}{k}},
\]

(A.17)

which is relevant for \( \mu \in [b_2(\chi), 1] \).

Together Eqs. (A.10), (A.14), and (A.17) form the Lorenz curve

\[
Q(\mu; \chi) = \begin{cases} 
Q_1(\mu; \chi) & \text{if } \mu \in [0, b_1(\chi)) \\
Q_2(\mu; \chi) & \text{if } \mu \in [b_1(\chi), b_2(\chi)) \\
Q_3(\mu; \chi) & \text{if } \mu \in [b_2(\chi), 1] 
\end{cases}
\]

(A.18)

The Lorenz curve \( Q(\mu; \chi) \) has the usual properties. \( Q(\mu; \chi) \) is increasing and convex with \( Q(0; \chi) = 0 \) and \( Q(1; \chi) = 1 \). The Lorenz curve under autarky is obtained by setting \( \chi = 0 \). In this case, we have \( b_2(0) = 1 \), and the third segment of the Lorenz curve vanishes.

We are interested in the position of the Lorenz curve with offshoring (\( \chi > 0 \)) relative to the position of the Lorenz curve under autarky (\( \chi = 0 \)), since the relative position of Lorenz curves can inform us about the ranking of income distributions, provided that the curves do not intersect.

To determine the relative positions of the two Lorenz curves, we have to distinguish three possible scenarios: (i) \( b_1(0) \leq b_1(\chi) < b_2(\chi) \), (ii) \( b_1(\chi) < b_1(0) < b_2(\chi) \), and (iii) \( b_1(\chi) < b_2(\chi) \leq b_1(0) \). Thereby, we can note that \( b_1(0) \geq b_2(\chi) \) is equivalent to \( k(\sigma - 1)[\chi - (1 + \chi)\gamma] - k + \sigma - 1 \geq 0 \).

Substitution of \( \gamma \), shows that this in turn is equivalent to \( k(\sigma - 1)[(1 - \eta)(\chi + \chi^{1-(\sigma-1)/k}) - 1] - \).
\( k + \sigma - 1 \geq 0 \), which is not possible if \( \eta \geq 1/2 \). This excludes the third scenario and allows us to focus on scenarios (i) and (ii) in the subsequent analysis.

**Scenario (i):** \( b_1(0) \leq b_1(\chi) < b_2(\chi) \)

We define \( D(\mu; \chi) \equiv Q(\mu; 0) - Q(\mu; \chi) > 0 \), with

\[
D(\mu; \chi) = \begin{cases} 
D_{11}(\mu; \chi) \equiv Q_1(\mu; 0) - Q_1(\mu; \chi) > 0 & \text{if } \mu \in [0, b_1(0)) \\
D_{21}(\mu; \chi) \equiv Q_2(\mu; 0) - Q_1(\mu; \chi) > 0 & \text{if } \mu \in [b_1(0), b_1(\chi)) \\
D_{22}(\mu; \chi) \equiv Q_2(\mu; 0) - Q_2(\mu; \chi) > 0 & \text{if } \mu \in [b_1(\chi), b_2(\chi)) \\
D_{23}(\mu; \chi) \equiv Q_2(\mu; 0) - Q_3(\mu; \chi) > 0 & \text{if } \mu \in [b_2(\chi), 1].
\end{cases}
\] (A.19)

From Eq. (A.11) it follows that \( \partial Q_1(\mu; \chi)/\partial \chi < 0 \). Together with \( Q_1(0; 0) = Q_1(0; \chi) = 0 \), this establishes \( D_{11}(0; \chi) \) and \( D_{11}(\mu; \chi) > 0 \) for all \( \mu \in (0, b_1(0)) \). To determine the sign of \( D_{21}(\mu; \chi) \), we can note that \( D_{11}(b_1(0); \chi) = D_{21}(b_1(0); \chi) > 0 \), \( \partial D_{11}(b_1(0); \chi)/\partial \mu = \partial D_{21}(b_1(0); \chi)/\partial \mu > 0 \), and \( \partial^2 D_{21}(\mu; \chi)/\partial \mu^2 > 0 \). This implies that \( D_{21}(\mu; \chi) > 0 \) holds for all \( \mu \in [b_1(0), b_1(\chi)) \). In view of Eq. (A.14), the third segment of \( D(\mu; \chi) \) is given by

\[
D_{22}(\mu; \chi) = \frac{\chi}{1 + \chi} \frac{\sigma - 1}{\gamma k(\sigma - 1) + k} - d_{22}(\chi)(1 - \mu)^{1 - \frac{\sigma - 1}{k}},
\] (A.20)

with

\[
d_{22}(\chi) = \frac{1}{\sigma} \left[ \frac{k \sigma - \sigma + 1}{k - \sigma + 1} \right]^{1 - \frac{\sigma - 1}{k}} - \frac{1}{(1 + \chi)^{\frac{\sigma - 1}{k}}} \frac{k}{\gamma k(\sigma - 1) + k} \left[ \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{k - \sigma + 1} \right]^{1 - \frac{\sigma - 1}{k}} (1 - \mu)^{1 - \frac{\sigma - 1}{k}}.\] (A.21)

It follows from Eq. (A.20) that \( d_{22}(\chi) < 0 \) establishes \( D_{22}(\mu; \chi) > 0 \). Furthermore, twice differentiating \( D_{22}(\mu; \chi) \) with respect to \( \mu \) establishes \( \partial^2 D_{22}(\cdot)/\partial \mu > 0 \) and \( \partial^2 D_{22}(\cdot)/\partial \mu^2 > 0 \) if \( d_{22}(\chi) > 0 \). Accounting for \( D_{22}(b_1(\chi); \chi) = D_{21}(b_1(\chi); \chi) > 0 \), we can thus safely conclude that \( D_{22}(\mu; \chi) > 0 \) holds for all \( \mu \in [b_1(\chi), b_2(\chi)) \). Finally, in view of Eq. (A.17), the fourth segment of \( D(\mu; \chi) \) is given by

\[
D_{23}(\mu; \chi) = d_{23}(\chi)(1 - \mu)^{1 - \frac{\sigma - 1}{k}} - \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{\gamma k(\sigma - 1) + k} (1 - \mu),
\] (A.22)

with

\[
d_{23}(\chi) = -\frac{1}{\sigma} \left[ \frac{k \sigma - \sigma + 1}{k - \sigma + 1} \right]^{1 - \frac{\sigma - 1}{k}} + \frac{1 + \chi^{\frac{\sigma - 1}{k}}}{(1 + \chi)^{\frac{\sigma - 1}{k}}} \frac{k}{\gamma k(\sigma - 1) + k} \left[ \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{k - \sigma + 1} \right]^{1 - \frac{\sigma - 1}{k}}.
\] (A.23)
Twice differentiating $D_{23}(\mu; \chi)$ with respect to $\mu$ yields
\[
\frac{\partial D_{23}}{\partial \mu} = - \left( 1 - \frac{\sigma - 1}{k} \right) d_{23}(\chi)(1 - \mu) + \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{\gamma k(\sigma - 1) + k} \tag{A.24}
\]
\[
\frac{\partial^2 D_{23}}{\partial \mu^2} = - \left( 1 - \frac{\sigma - 1}{k} \right) \frac{\sigma - 1}{k} d_{23}(\chi)(1 - \mu)^{\frac{\sigma - 1}{k} - 1} \tag{A.25}
\]
If $d_{23} \leq 0$, we have $\partial D_{23}/\partial \mu > 0$ for all $\mu > b_2(\chi)$. In view of $D_{23}(b_2(\chi); \chi) = D_{23}(b_2(\chi); \chi) > 0$, this is inconsistent with $D_{23}(1; \chi) = 0$. Hence, $d_{23}(\chi) > 0$ must hold, implying that $\partial^2 D_{23}/\partial \mu^2 < 0$. In view of $D_{23}(b_2(\chi); \chi) > D_{23}(1; \chi) = 0$, this implies that either $D_{23}(\mu; \chi)$ is monotonically decreasing or it has a unique maximum in the relevant $\mu$-interval. In both cases, $D_{23}(\mu; \chi) > 0$ holds for all $\mu \in [b_2(\chi), 1)$. Putting together, we have shown that $D(\mu; \chi) > 0$ holds for all $\mu \in (0, 1)$ if $b_1(0) \leq b_1(\chi) < b_2(\chi)$, implying that the income distribution under autarky Lorenz dominates the income distribution with offshoring in this scenario.

**Scenario (ii):** $b_1(\chi) < b_1(0) < b_2(\chi)$

For this scenario, we can write
\[
D(\mu; \chi) = \begin{cases} 
D_{11}(\mu; \chi) = Q_1(\mu; 0) - Q_1(\mu; \chi) > 0 \quad \forall \ \mu \in [0, b_1(\chi)) \\
D_{12}(\mu; \chi) = Q_1(\mu; 0) - Q_2(\mu; \chi) > 0 \quad \forall \ \mu \in [b_1(\chi), b_1(0)) \\
D_{22}(\mu; \chi) = Q_2(\mu; 0) - Q_2(\mu; \chi) > 0 \quad \forall \ \mu \in [b_1(0), b_2(\chi)) \\
D_{23}(\mu; \chi) = Q_2(\mu; 0) - Q_3(\mu; \chi) > 0 \quad \forall \ \mu \in [b_2(\chi), 1].
\end{cases} \tag{A.26}
\]

From the analysis of scenario (i), we know that $D_{11}(\mu; \chi) = 0$ if $\mu = 0$ and $D_{11}(\mu; \chi) > 0$ if $\mu > 0$. To determine the sign of the second segment, we can write
\[
D_{12}(\mu; \chi) = \frac{k\sigma - \sigma + 1}{k\sigma} \mu - 1 + \frac{\chi}{1 + \chi} \frac{\sigma - 1}{\gamma k(\sigma - 1) + k} + d_{12}(\chi)(1 - \mu)^{\frac{\sigma - 1}{k}}, \tag{A.27}
\]
with
\[
d_{12}(\chi) = \frac{1}{(1 + \chi)^{\frac{\sigma - 1}{k}}} \frac{k}{\gamma k(\sigma - 1) + k} \left[ \frac{\gamma k(\sigma - 1) + k - \sigma + 1}{k - \sigma + 1} \right]^{1 - \frac{\sigma - 1}{k}} > 0. \tag{A.28}
\]
Twice differentiating $D_{12}(\mu; \chi)$ with respect to $\mu$ establishes
\[
\frac{\partial D_{12}}{\partial \mu} = \frac{k\sigma - \sigma + 1}{k\sigma} - \left( 1 - \frac{\sigma - 1}{k} \right) \frac{\sigma - 1}{k} d_{12}(\chi)(1 - \mu)^{\frac{\sigma - 1}{k} - 1},
\]
\[
\frac{\partial^2 D_{12}}{\partial \mu^2} = - \left( 1 - \frac{\sigma - 1}{k} \right) \frac{\sigma - 1}{k} d_{12}(\chi)(1 - \mu)^{\frac{\sigma - 1}{k} - 1} < 0. \tag{A.29}
\]
There are two relevant cases. If $\partial D_{12}/\partial \mu \geq 0$ holds for all $\mu \in [b_1(\chi), b_1(0))$, then $D_{12}(b_1(\chi); \chi) = D_{11}(b_1(\chi); \chi) > 0$, is sufficient for $D_{12}(\mu; \chi)$ to be positive over the relevant $\mu$-interval. If, however, $D_{12}(\mu; \chi)$ is either monotonically decreasing or at least decreasing at high levels of $\mu$—i.e., at $\mu$ close to $b_1(0)$—then $\partial D_{12}/\partial \mu < 0$ establishes $d_{12} > (k\sigma - \sigma + 1)/[\sigma(k - \sigma + 1)](1 - \mu)^{-(\sigma - 1)/k}$. In
view of Eq. (A.11), this implies

\[ D_{12}(b_1(0); \chi) > \sigma - 1 + \frac{1}{\sigma} + \frac{\chi}{1 + \chi \gamma k(\sigma - 1) + k} > 0. \]  (A.30)

We can thus safely conclude that \( D_{12}(\mu; \chi) > 0 \) holds in the relevant \( \mu \)-domain. Following the formal proof for scenario (i), we can also show that \( D_{22}(\mu; \chi) > 0 \) if \( \mu \in [b_1(0), b_2(\chi)) \) and that \( D_{23}(\mu; \chi) > 0 \) if \( \mu \in [b_2(\chi), 1) \). Putting together, this proves that \( D(\mu; \chi) > 0 \) holds for all \( \mu \in (0, 1) \), which implies that the income distribution without offshoring Lorenz dominates the income distribution with offshoring in scenario (ii). This completes the proof.
Supplement
(Not intended for publication)

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

\[ q(v) = \varphi(v) \exp \int_0^1 \ln \ell(v, \tilde{\eta}) d\tilde{\eta}, \]  

(S.1)

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 labor input they require to be performed and, as in the main text, we impose the additional assumption that one unit of labor must be employed to produce one unit of task \( \tilde{\eta} \). However, as in Grossman and Rossi-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 organize 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-maximizing 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 \( w \) and \( w^* \), respectively. We can write labor demand for domestic and foreign task production as follows:

\[ l^n(v) = \int_{0}^{\eta(v)} \ell^n(v, \tilde{\eta}) d\tilde{\eta} = \eta(v) l^n(v) \quad \text{and} \quad l^r(v) = \int_{\tilde{\eta}(v)}^{1} \ell^r(v, \tilde{\eta}) d\tilde{\eta} = \int_{\tilde{\eta}(v)}^{1} \ell^r(v, \tilde{\eta}) d\tilde{\eta} l^r(v). \]

\( 16 \)

Therefore, firm \( v \)'s cost minimization problem can be expressed as follows:

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

(S.2)

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

\[
\epsilon(\eta(v)) \equiv \frac{1 - \eta(v)}{\int_{\tilde{\eta}(v)}^{1} t(\tilde{\eta}) d\tilde{\eta}} \]  

(S.3)

reflects the average productivity loss arising from the extra labor costs \( t(\tilde{\eta}) \), when producing

\( 16 \)As in the main text, we define \( l^r(v) \) such that foreign labor demand of offshoring firm \( v \) is given by \( \tau l^r(v) \). 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.2) with the respective technology in Eq. (3).
a task abroad. Solving maximisation problem (S.2) gives marginal production costs $c^\eta(v) = w(v)/[\varphi(v)\tilde{k}(v)]$, where\footnote{It is notable that $\tilde{k}(v)$ degenerates to $z\kappa(v)$, when considering a discrete offshoring technology, with}

$$
\tilde{k}(v) = \left\{ \frac{w}{\tau w^*} \epsilon[\eta(v)] \right\}^{1-\eta(v)}.
$$

At stage one, the firm sets $\eta(v)$ to minimise its marginal cost $c^\eta(v)$. Thus, for the optimal $\eta(v)$-level the following first-order condition must hold: $\partial c^\eta(v)/\partial \eta(v) = 0$. In view of Eqs. (S.3) and (S.4), this is equivalent to

$$
\frac{\partial \ln \tilde{k}(v)}{\partial \eta(v)} = -\ln \left( \frac{w}{\tau w^*} \epsilon[\eta(v)] \right) + t[\eta(v)] \epsilon[\eta(v)] - 1 = 0.
$$

Eq. (S.5) determines the same cost-minimising $\eta$ for all firms. Since the second-order condition of the stage one cost-minimisation problem requires $\partial^2 \ln \tilde{k}(v)/\partial \eta(v)^2 < 0$, while $\partial^2 \ln \tilde{k}(v)/\partial \eta(v)\partial \tau > 0$ follows from inspection of Eq. (S.5), 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.

The case of a small open economy

Being interested to what extent the results from our model depend on the adjustment of wages in the host country of offshoring, we can look at a model variant in which the source country is a small economy. This changes the labor market constraint (LC) in our model because foreign wages are now exogenous. Starting from Eq. (12), we have $w = \gamma[(\sigma - 1)/\sigma]Y/L$. Accounting for $I = Y[1 + \gamma(\sigma - 1)]/\sigma$, and substituting Eqs. (13) and (22) for $L$ and $I$, respectively, we can compute

$$
w(\chi) = \frac{\sigma - 1}{\sigma} \left( \frac{1}{k} \right)^{\frac{1}{\sigma}} \left[ \frac{k}{k - \sigma + 1} \right]^{\frac{k + \sigma - 1}{\sigma - 1}} \left\{ (1 + \chi) \frac{k + \sigma - 1}{\kappa - \sigma + 1} [k - \sigma + 1 + \gamma k (\sigma - 1)] \right\}^{\frac{1}{\sigma}},
$$

provided that $\varepsilon = 0$. With the foreign wage being exogenous, we lose a stabilising force in our model, and hence the interior equilibrium might become unstable. Excluding external scale economies in the production of final goods helps avoiding this problem. Furthermore, the simplification seems justified as the main purpose of this section is to see whether key results of our model, such as welfare losses for the source country of offshoring at low levels of $\chi$, extend to a model variant in which the source country is small.

Substituting Eq. (S.6) into $\kappa = (w/\tau w^*)^{1-\eta}$ gives the labor market constraint

$$
k = \left[ \frac{\sigma - 1}{\sigma} \left( \frac{1}{k} \right)^{\frac{1}{\sigma}} \left[ \frac{k}{k - \sigma + 1} \right]^{\frac{k + \sigma - 1}{\sigma - 1}} \frac{1}{\tau w^*} \right]^{1-\eta} \left\{ (1 + \chi) \frac{k + \sigma - 1}{\kappa - \sigma + 1} [k - \sigma + 1 + \gamma k (\sigma - 1)] \right\}^{\frac{1-\eta}{\sigma}},
$$

\begin{equation}
t(\bar{\eta}) = \begin{cases} \infty & \forall \bar{\eta} \in [0, \eta) \\ 1 & \forall \bar{\eta} \in [\eta, 1] \end{cases}
\end{equation}
where $\bar{w}^*$ is a constant. Differentiating Eq. (S.7), we obtain
\[
\frac{d\kappa}{d\chi} = \frac{\kappa(1-\eta) \{(k+\sigma-1)[k-\sigma+1+\gamma k(\sigma-1)] + k(\sigma-1)^2(1+\chi)\partial\gamma/\partial\chi\}}{k(\sigma-1)(1+\chi)[k-\sigma+1+\gamma k(\sigma-1)]},
\]
with
\[
\frac{\partial\gamma(\chi;\eta)}{\partial\chi} = -\frac{(k-\sigma+1)(1-\eta)\chi^{-(\sigma-1)\kappa} + k(\gamma-\eta)}{k(1+\chi)} < 0.
\]
We can thus safely conclude that $d\kappa/d\chi >, =, < 0$ is equivalent to $\zeta(\chi) >, =, < 0$, with
\[
\zeta(\chi) \equiv (k+\sigma-1)[k-\sigma+1+\gamma k(\sigma-1)]
- (\sigma-1)^2 \left[(k-\sigma+1)(1-\eta)\chi^{-(\sigma-1)\kappa} + k(\gamma-\eta)\right].
\]
We can compute $\lim_{\chi \to 0} \zeta(\chi) = -\infty$ and $\zeta(1) = (k+\sigma-1)[k-\sigma+1+\eta k(\sigma-1)] - (\sigma-1)^2(k-\sigma+1)(1-\eta)$, where the latter is positive if $\eta \geq 1/2$. This implies that in the model variant of a small source country, LC establishes a negative link between $\chi$ and $\kappa$ for small levels of $\chi$, but a positive one if $\chi$ is close to 1. It is the positive slope of the LC locus in $(\chi,\kappa)$-space, which provides a source of instability in our setting. To see this, we can look at Figure S.1, which depicts the upward-sloping offshoring indifference curve (OC) from Eq. (17) and the u-shaped labor market constraint (LC) from Eq. (S.7). The figure is constructed such that an interior equilibrium exists. However, with an upward-sloping segment of LC at high levels of $\chi$, there are now two intersection points of OC and LC in Figure S.1. Thereby, intersection point A characterizes a stable interior equilibrium because LC intersects OC from above. In contrast, intersection point A' depicts an unstable interior equilibrium because in this point LC intersects OC from below. Of course, it is in general not warranted that an intersection point of OC and LC exists, nor is it clear that OC and LC intersect more than once. However, the illustration in Figure S.1 makes clear that existence and uniqueness of a stable interior equilibrium requires a detailed formal analysis. And this is what we provide next.

Let us for the moment assume that an intersection point of LC and OC and thus an interior equilibrium exists. Then, the interior equilibrium is stable and unique if in any intersection point the slope of OC is larger than the slope of LC. Our aim is to identify a sufficient condition for such an outcome. For this purpose, we combine Eqs. (17) and (S.7) to the following function
\[
F(\chi;\tau) \equiv \left[\frac{\sigma-1}{\sigma} \frac{1}{k} \left(\frac{\frac{k+\sigma-1}{k(\sigma-1)}}{k-\sigma+1} \frac{1}{\tau \bar{w}^*}\right)^{1-\eta}\right]
\left\{\left(1+\chi\right)^{\frac{k+\sigma-1}{\sigma-1}} \left[k-\sigma+1+\gamma k(\sigma-1)\right]\right\}^{\frac{1-\eta}{\sigma-1}} - \left(1+\chi\left(\frac{\sigma-1}{k}\right)^{\frac{1-\eta}{\sigma-1}}\right)^{\frac{1-\eta}{\sigma-1}}
\]
with $F(\chi;\tau) = 0$ for some $\chi \in (0,1)$ characterizing an interior equilibrium. Differentiating $F(\chi;\tau)$ with respect to $\chi$ and evaluating the resulting expression at $F(\chi;\tau) = 0$ gives
\[
\frac{\partial F(\cdot)}{\partial \chi} \bigg|_{F(\cdot)=0} = -\frac{\kappa f(\chi)}{k(1+\chi)^2(1+\chi^{(\sigma-1)/k})[k-\sigma+1+\gamma k(\sigma-1)]},
\]
where $\bar{w}^*$ is a constant.
Figure S.1: Stable and unstable equilibria

with

\[ f(\chi) = \chi^{(\sigma-1)/k-1}(1+\chi)\left\{ [k-\sigma+1]+k(\sigma-1)\gamma \right\} - \frac{1-\eta}{\sigma-1}\left( 1 + \chi^{(\sigma-1)/k} \right) \left( k + \sigma - 1 \right) \]

\[ + (k-\sigma+1) + k^2(\sigma-1)\gamma + k(\sigma-1)^2\eta - (1-\eta)(\sigma-1)^2(k-\sigma+1)\chi^{-(\sigma-1)/k} \]  

(S.13)

Thereby, \( f(\chi) > 0 \) is sufficient for the interior equilibrium to be stable and unique. To facilitate the analysis, it is worth noting that \( \chi^{(\sigma-1)/k-1}(1+\chi) \geq 1 + \chi^{(\sigma-1)/k} \) and thus \( f(\chi) \geq \hat{f}(\chi) \), with

\[ \hat{f}(\chi) \equiv k - \sigma + 1 + k(\sigma-1)\gamma - \frac{1-\eta}{\sigma-1}\left( k + \sigma - 1 \right) + k^2(\sigma-1)\gamma \]

\[ + k(\sigma-1)^2\eta - (1-\eta)(\sigma-1)^2(k-\sigma+1)\chi^{-(\sigma-1)/k} \].

Rearranging terms establishes

\[ \hat{f}(\chi) = [k - \sigma + 1 + \gamma k(\sigma-1)] \left[ 1 - \frac{1-\eta}{\sigma-1}(k + \sigma - 1) \right] \]

\[ + (1-\eta)k(\sigma-1)(\gamma-\eta) + (1-\eta)^2(\sigma-1)(k-\sigma+1)\chi^{-(\sigma-1)/k}, \]

(S.14)

and this is unambiguously positive if

\[ 1 - \frac{1-\eta}{\sigma-1}(k + \sigma - 1) \geq 0 \quad \iff \quad \eta \geq \frac{k}{k + \sigma - 1} \equiv \eta_{SE}. \]

(S.15)

where \( \eta_{SE} \in (1/2, 1) \) if \( k > \sigma - 1 \). Taking stock, we have shown that if an interior equilibrium exists, \( \eta \geq \eta_{SE} \) is sufficient for the respective equilibrium to be stable and unique.

It remains to be shown is that an interior equilibrium does exist. This is the case, if \( F(0; \tau) > 0 \)
and $F(1; \tau) < 0$. In view of Eq. (S.11), we find that $F(0; \tau) > 0$ is equivalent to

$$\tau \bar{w}^{*} < \frac{\sigma - 1}{\sigma} \left( \frac{1}{k} \right)^\frac{1}{\tau} \left[ \frac{k}{k - \sigma + 1} \right]^{\frac{\kappa + \sigma - 1}{\kappa (\sigma + 1)}} [k - \sigma + 1 + k (\sigma - 1)]^\frac{1}{\tau} \equiv \bar{w}^c_u$$

(S.16)

whereas $F(1; \tau) < 0$ is equivalent to

$$\tau \bar{w}^{*} > \frac{\sigma - 1}{\sigma} \left( \frac{1}{k} \right)^\frac{1}{\tau} \left[ \frac{k}{k - \sigma + 1} \right]^{\frac{\kappa + \sigma - 1}{\kappa (\sigma + 1)}} [k - \sigma + 1 + \eta k (\sigma - 1)]^\frac{1}{\tau} \equiv \bar{w}^c_l.$$  

Hence, an interior equilibrium exists if the effective foreign wage rate $\tau \bar{w}^*$ is neither too small nor too large, i.e. if it lies in interval $(\bar{w}^c_l, \bar{w}^c_u)$. Otherwise, we would end up in a corner solution with full offshoring ($\chi = 1$) if $\tau \bar{w}^* < \bar{w}^c_l$ and no offshoring ($\chi = 0$) if $\tau \bar{w}^* > \bar{w}^c_u$.

Taking stock, we have shown that the two conditions $\eta \geq \eta_{SE}$ and $\tau \bar{w}^* \in (\bar{w}^c_l, \bar{w}^c_u)$ describe a parameter domain for which a unique stable interior equilibrium exists. Crucially, starting from such an interior equilibrium, an increase in $\tau$ shifts the LC locus downwards in Figure S.1, according to Eq. (S.7), and hence it is associated with a decline in both $\chi$ and $\kappa$. The comparative static effects of changes in $\tau$ on the two offshoring variables of interest are therefore the same as in our benchmark model of two large economies, implying that the main insights from our analysis extend to a scenario with a small open economy. In particular, there are welfare losses due to a detrimental reallocation of labor to less productive uses in the source country at early stages of offshoring (low levels of $\chi$), and the income distribution becomes more unequal with offshoring than in the absence of offshoring. To complete the discussion of the small open economy, we can finally note that our insight that the small open economy assumption does not change our results regarding the comparative static effects of changes in $\chi$ on key general equilibrium variables of interest is more generally valid and in particular also holds if $\varepsilon > 1$. Abstracting from external scale economies in final goods production is relevant for establishing a unique stable interior offshoring equilibrium, and hence for the effects of changes in $\tau$ on $\chi$ and $\kappa$ if the source country is small. However, the effects that a change in $\chi$ exerts on the general equilibrium variables of interest do not depend on whether the source country is small or large, irrespective of the size of $\varepsilon$.

A “partial equilibrium” approach

In this section we consider a partial equilibrium setting, in which we exclude income effects and at the same time assume that relative wages in the source and host country of offshoring are exogenous: $w/w^* = a > 1$. This establishes $\kappa = (a/\tau)^{1-\eta}$. The simplest way to capture this feature is to add an (agricultural) outside good, $q_0$, which is linear in labor input, produced under perfect competition, and freely tradable in the world market. We assume that the labor input coefficient is one in the source country and $a > 1$ in the host country of offshoring. Taking the outside good as numéraire and setting its price equal to one, therefore establishes $w = 1$ and $w^* = 1/a$, provided that both countries produce the outside good (which can be enforced by considering appropriate population sizes $N$ and $N^*$). We combine this technology assumption with a quasilinear upper-tier utility function. For agent $z$ from the source country, we write $u(z) = c_0(z) + c_Y(z)^{\alpha}$, with $\alpha \in (0,1)$, where $c_0(z)$ and $c_Y(z)$ refer to the agent’s consumption of good $q_0$ and $Y$, respectively. Maximizing $u(z)$ subject to the agent’s budget constraint, $c_0(z) + P_Y c_Y(z) = I(z)$ gives the Marshallian demand
functions
\[ c_0(z) = I(z) - \alpha^{\frac{1}{1-\alpha}} \left( \frac{1}{P_Y} \right)^{\frac{\alpha}{1-\alpha}}, \quad c_Y(z) = \left( \frac{\alpha}{P_Y} \right)^{\frac{1}{1-\alpha}}. \] (S.18)

Substitution into \( u(z) \) gives indirect utility \( v(z) = I(z) + (1 - \alpha) \left( \frac{\alpha}{P_Y} \right)^{\frac{1}{1-\alpha}} \). Global consumption of good \( Y \) is given by \( C_Y = (N + N^*) \left( \frac{\alpha}{P_Y} \right)^{\frac{1}{1-\alpha}} \) and due to market clearing equals total output \( Y \).

Producers of good \( Y \) are also perfectly competitive and maximize profits \( P_Y Y - \int_{v \in V} P(v) q(v) dv \), with \( Y \) being given by Eq. (1). Solving this maximization problem establishes demand for intermediate good \( v \):
\[ q(v) = \frac{Y}{M^{1-\varepsilon}} \left[ \frac{p(v)}{P_Y} \right]^{-\sigma}, \] (S.19)
which in view of \( C_Y = Y \) can be rewritten as follows:
\[ q(v) = (N + N^*)\alpha^{\frac{1}{1-\alpha}} M^{\sigma-1} P_Y^{\sigma-\frac{1}{1-\alpha}} p(v)^{-\sigma}. \] (S.20)

Thereby \( P_Y \) is a CES price index and equals \( P_Y = M^{\frac{\sigma-1}{\sigma}} (\int_{v \in V} p(v)^{1-\sigma} dv)^{\frac{1}{\sigma}} \). Using the insights from the main text, we can write
\[ P_Y = M^{\frac{\sigma-1}{\sigma}} \left\{ M \int_{\varphi^\sigma} p^d(\varphi)^{1-\sigma} \frac{dG(\varphi)}{1 - G(\varphi^d)} + M \int_{\varphi^\sigma} p^d(\varphi)^{1-\sigma} \frac{dG(\varphi)}{1 - G(\varphi^d)} \right\}^{\frac{1}{\sigma}}, \]
\[ = M^{\frac{\sigma-1}{\sigma}} p^d(\varphi^d)(1 + \chi)^{\frac{1}{\sigma}} \left( \frac{k}{k - \sigma + 1} \right)^{\frac{1}{1-\sigma}}. \] (S.21)

With these insights at hand, we can now look at the profits of the least productive producer. In view of Eqs. (S.20) and (S.21), these profits are given by
\[ \pi^d(\varphi^d) = \frac{1}{\sigma} (N + N^*)\alpha^{\frac{1}{1-\alpha}} M^{\sigma-1} P_Y^{\sigma-\frac{1}{1-\alpha}} p^d(\varphi^d)^{1-\sigma}, \]
\[ = \frac{1}{\sigma} (N + N^*)\alpha^{\frac{1}{1-\alpha}} \left( \frac{k}{k - \sigma + 1} \right)^{\frac{1-\sigma(1-\alpha)}{\sigma - 1} \frac{1}{\sigma-1}(1-\alpha)} M^{\frac{\alpha}{\sigma-1}(1-\alpha)-1} (1 + \chi)^{\frac{1-\sigma(1-\alpha)}{\sigma(\sigma-1)(1-\alpha)} p^d(\varphi^d)^{-\frac{1}{1-\alpha}}. \]

Substitution of \( M = N(\varphi^d)^{-k} \) and \( p^d(\varphi^d) = (\varphi^d)^{-1}\sigma/(\sigma - 1) \) gives
\[ \pi^d(\varphi^d) = Z \left[ (1 + \chi)^{1-\sigma(1-\alpha)} (\varphi^d)^{\mu} \right]^{\frac{1}{\sigma-1}(1-\alpha)}, \] (S.22)
with
\[ Z = \frac{1}{\sigma} (N + N^*)\alpha^{\frac{1}{1-\alpha}} \left( \frac{k}{k - \sigma + 1} \right)^{\frac{1-\sigma(1-\alpha)}{\sigma - 1} \frac{1}{\sigma-1}(1-\alpha)} (\sigma - 1)^{\frac{\alpha}{\sigma}} N^{\frac{\sigma}{(\sigma-1)(1-\alpha)} - 1} \] (S.23)
and
\[ \mu = k(1 - \alpha)(\sigma - 1) + \alpha(\sigma - 1) - k\alpha \varepsilon \] (S.24)
being two constants. Accounting for the indifference condition \( \pi^d(\varphi^d) = w = 1 \), we can compute

\[
\varphi^d = Z^{-\sigma/(1-\sigma)\mu} (1 + \chi)^{\sigma/(1-\sigma) - 1}/\mu.
\] (S.25)

Noting that \( \chi = (\kappa^{\sigma-1} - 1)^{k/(\sigma-1)} \) from Eq. (17) remains valid in the partial equilibrium setting and accounting for \( \kappa = (a/\tau)^{1-\eta} \), Eq. (S.25) gives an explicit solution for the cutoff productivity level. A higher \( \tau \) lowers \( \kappa \) and \( \chi \), and it may have a positive or negative impact on \( \varphi^d \), depending on the ranking of \( \sigma >, =, < 1/(1-\alpha) \) and \( \mu >, =, < 0 \). The two rankings are not independent. We can show that \( \sigma \geq 1/(1-\alpha) \) is sufficient for \( \mu > 0 \). In this case, \( \varphi^d \) increases while \( M \) decreases with the share of offshoring firms \( \chi \). Only if the elasticity of substitution between \( Y \) and \( q_0 \) in consumers’ preferences, as given by \( 1/(1-\alpha) \), is larger than the elasticity of substitution between different varieties in the production of good \( Y \), it is possible that \( \varphi^d \) shrinks, whereas \( M \) increases in \( \chi \). To put it formally, an outcome with \( d\varphi^d/d\chi < 0 \) and \( dM/d\chi > 0 \) is only possible if \( \sigma < 1/(1-\alpha) \) and \( \mu > 0 \) hold simultaneously.

We can in a final step determine domestic welfare by looking at utility of the representative consumer in the source country, which is given by

\[
V^S = I^S + N(1-\alpha)(\alpha/P_Y)^{(1-a)/(1-\sigma)}(1-\alpha).
\] (S.26)

where \( I^S \) denotes total income in the source country. Total source country income is given by \( I^S = \Pi + w[N - M(1+\chi)] \), with \( \Pi \) being aggregate operating profits in the production of intermediates and \( L = N - M(1+\chi) \) being total labor input. Total operating profits can be computed according to

\[
\Pi = M \int_{\varphi^d}^{\varphi^*} \pi^d(\varphi) \frac{dG(\varphi)}{1-G(\varphi)} + M \int_{\varphi^d}^{\varphi^*} \pi^d(\varphi) \frac{dG(\varphi)}{1-G(\varphi^d)} = M \pi^d(\varphi^d) \frac{k}{k-\sigma+1}(1+\chi).
\] (S.27)

Accounting for indifference condition \( \pi^d(\varphi^d) = w = 1 \), then establishes

\[
I^S = N + M\frac{(\sigma-1)(1+\chi)}{k-\sigma+1} = N \left[ 1 + \frac{(\sigma-1)(1+\chi)(\varphi^d)^{-k}}{k-\sigma+1} \right].
\] (S.28)

Substitution of Eq. (S.25) further implies

\[
I^S = N \left[ 1 + \frac{(\sigma-1)}{k+\sigma-1} \frac{Z^{k(\sigma-1)/\mu}}{(1+\chi)^{\sigma(\sigma-1)/\mu}} \right].
\] (S.29)

Total source country income \( I^S \) increases in \( \chi \) if \( \mu > 0 \) and decreases in \( \chi \) if \( \mu < 0 \). Furthermore, we can combine Eqs. (S.21) and (S.25) with \( M = N(\varphi^d)^{-k} \) to compute

\[
P_Y = N^{1-\sigma} \frac{\sigma}{\sigma-1} \left( \frac{k}{k-\sigma+1} \right)^{\frac{1-\sigma}{\sigma-1}} Z^{-\sigma/(1-\sigma)\mu} (1+\chi)^{-\frac{[k(1-\alpha)+\alpha(k-\sigma+1)](1-\alpha)\mu}{\sigma(k-\sigma+1)}}.
\] (S.30)

where \( P_Y \) decreases in \( \chi \) if \( \mu > 0 \) and increases in \( \chi \) if \( \mu < 0 \). Putting together, we can thus conclude that source country welfare increases (decreases) monotonically in \( \chi \) if \( \mu > 0 \) (\( \mu < 0 \)). This implies that welfare losses from offshoring are only possible in the partial equilibrium setting.
if $\varepsilon$ is sufficiently large.

Whereas the general insight from our analysis that the source country may be worse off with offshoring than in the absence of offshoring extends to a partial equilibrium environment, the role played by external scale economies changes considerably relative to the benchmark model. To understand this difference, we can make use of insights from Plüger and Südekum (2013) who study a model, in which heterogeneous firms are active under monopolistic competition in a differentiated goods industry, and labor is used as the only production input in this industry as well as in a linear, perfectly competitive outside sector. Plüger and Südekum (2013) consider a quasilinear utility function and show that too few firms enter in the differentiated goods industry if $\varepsilon = 1$. This is a consequence of under-consumption of the industrial good in the presence of mark-up pricing. If $\sigma > 1/(1 - \alpha)$ holds in our setting, offshoring enforces firm exit and one may therefore be tempted to conclude that it can lower welfare in the source country due to an even stronger distortion of the decentralized entry process. However, this is not true because the strong substitutability of intermediates in the production of $Y$ implies that those varieties lost due to exit of low-productivity producers can easily be replaced by other varieties supplied by high-productivity firms. Welfare losses are only possible if $\mu < 0$, and this requires $\sigma < 1/(1 - \alpha)$ (see above). If $\sigma < 1/(1 - \alpha)$, an increase in $\chi$ also induces firm exit and thus further distorts the decentralized entry process. Without a strong substitutability of intermediates, the loss of varieties can however not be compensated by the cost reduction for newly offshoring firms. As a consequence offshoring lowers welfare if $\mu < 0$, and $\mu < 0$ is only possible if $\varepsilon$ is sufficiently large. For $\varepsilon < 1$, insufficient firm entry due to under-consumption of industrial goods is counteracted by excessive firm entry due to lower external scale effects in the production of $Y$, and hence it is a priori not clear that too few firms enter from a social planner’s point of view at low levels of $\varepsilon$.

**References**

