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Offshoring and Unemployment in a Credit-Constrained Economy

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Offshoring and Unemployment in a Credit-Constrained Economy

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Abstract

This paper develops a two-sector small open economy model of offshoring where product markets are perfectly competitive, but capital and labor markets exhibit frictions. Individuals differ with respect to their managerial ability, and choose to become entrepreneurs or workers depending on profit opportunities and labor market conditions. The model generates three groups: low-income workers facing the prospect of unemployment; middle-income entrepreneurs producing domestically; and high-income entrepreneurs offshoring some tasks abroad. Lowering financial frictions induces more individuals to become entrepreneurs, increases the masses of offshoring firms and tasks, and improves personal income and welfare distribution. It reduces unemployment when tasks are less substitutable and labor share in production is high. The paper also investigates the impact of reducing offshoring costs and labor market frictions on the mass of entrepreneurs, decision to offshore, income distribution, and unemployment.

JEL Classification: F1, J2, J3, J6, L1

Keywords: Credit Constraints, Inequality, Occupational Choice, Offshoring, Directed Search, Unemployment

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1 Introduction

This paper develops a small-open-economy model with occupational choice to study the interactions among credit-market imperfections, offshoring, and unemployment. The economy produces two homogeneous goods using labor as the only factor of production under perfectly competitive product markets. There is a constant mass of individuals who differ with respect to their entrepreneurial (managerial) ability. Sector 1 produces output using only *domestic* workers, whereas sector 2 is populated by a continuum of firms each owned and managed by an entrepreneur producing output using her managerial ability and a fixed set of tasks that can be performed locally or abroad. Labor markets exhibit frictions stemming from job search and matching, and thus workers face a prospect of unemployment in each sector. An individual can choose to become a worker or an entrepreneur depending on labor-market conditions and profit opportunities as in Lucas (1978).

In modeling offshoring, the paper builds on Grossman and Rossi-Hansberg's (2008) model. More specifically, tasks are imperfect substitutes, and firms wishing to offshore them face both fixed and variable costs of offshoring. Fixed offshoring costs induce only more able entrepreneurs to offshore their tasks, and variable costs (which differ across tasks) induce only a subset of tasks to be performed abroad. Labor-market frictions are characterized by a directed search model where firms post costly vacancies and wage offers, and workers and firms meet randomly. To simplify the analysis, it is assumed that labor market frictions are more severe in sector 1. Firms finance their set-up and operating costs in advance of their final-good production through capital markets where they face a higher borrowing rate than lending rate. Credit-market imperfections arise from limited enforcement as in Galor and Zeira (1993). The model is used to investigate three distinct policy decisions: improving credit markets, increasing offshoring exposure, and reducing labor market frictions. I will examine how each of these policies affect occupational choice, decision to offshore, income distribution, and unemployment.

First, the model predicts that a reduction in credit-market imperfections induces more individuals to become entrepreneurs, increases the extensive and intensive margin of offshoring, raises the income of all individuals and thus improves aggregate welfare. Intuitively, reducing credit market-imperfections makes costs of production both at home and abroad cheaper, which in turn makes entrepreneurship and offshoring more profitable. Consequently, more individuals choose to become entrepreneurs, more entrepreneurs decide to offshore, and more tasks are performed abroad. Although reducing credit market imperfections decreases the supply of workers searching for jobs, its impact on the aggregate unemployment rate is ambiguous. However, when tasks are more complementary to each other and labor share in production of good 2 is high, reducing credit-market frictions increases offshoring firms' demand for the domestic labor. This, combined with an increased demand for the domestic labor by non-offshoring firms, increases the total labor employed in sector 2; as a result, aggregate unemployment falls.

Second, a further exposure to offshoring (through a reduction in fixed or variable costs of offshoring) does not affect the terms of trade (since this is a small open economy); therefore, neither wages of workers nor incomes of entrepreneurs who continue to produce domestically will change. Consequently, the supply of workers (and entrepreneurs) will remain unchanged. Lower offshoring costs, however, increase the mass of offshoring entrepreneurs as well as the number of tasks performed abroad. Furthermore, since entrepreneurs who choose to offshore will have higher income, the policy will increase the aggregate income and welfare. The model also predicts that a further exposure to offshoring is more likely to decrease (increase) the aggregate unemployment rate when tasks are less (more) substitutable and labor share in production of good 2 is high (low). Because the supply of workers searching for jobs does not change with this policy, when tasks are less substitutable and labor share is high, a reduction in offshoring costs increases the demand for domestic labor by offshoring entrepreneurs, which in turn reduces the aggregate unemployment.

Finally, reducing labor-market frictions in sector 2 makes entrepreneurship more profitable by lowering costs of production, and so the mass of entrepreneurs will increase.[1] Since

[1]For the sake brevity, I only consider a reduction in labor-market frictions in sector 2.

domestic production becomes relatively cheaper, the number of tasks performed abroad will decrease. This policy has an ambiguous affect on the mass of offshoring entrepreneurs. If tasks are highly substitutable, for example, the policy will induce some offshoring firms to produce locally. Although the policy increases the job-finding rate in sector 2, the average income of a worker does not change because labor-market conditions in sector 1 have remained the same and workers are fully mobile between the two sectors. But increased entrepreneurial income ensures an improvement in the aggregate welfare. Reducing labor-market frictions in sector 2 always lowers the aggregate unemployment.

To the best of my knowledge, this is the first paper that studies offshoring and unemployment in a credit-constrained economy with occupational choice, and enjoys support from several recent empirical studies. For example, using firm-level trade data and credit scores for Belgian manufacturing firms over the 1999–2007 period, Muûls (2015) shows that firms facing lower credit constraints import more in extensive margin. Similarly, using firm-level data from India, Bas and Berthou (2012) show that reducing credit constraints increases the probability of importing capital goods.[2] As for the impact of credit frictions on unemployment, previous studies have found that financial constraints tend to increase unemployment (e.g., Acemoglu (2001); Duygan-Bump et al. (2015)). These studies analyzed the problem in a closed-economy framework, and thus assumed away possible effects of globalization. If there were no offshoring in the present model, reducing credit constraints would indeed decrease unemployment as in these studies. However, the present model suggests that in the presence of offshoring firm production technology becomes crucial in determining the impact of credit constraints on unemployment.

In regards to offshoring policies, the prediction that offshoring firms are more productive is consistent with Kasahara and Lapham (2013) who, using Chilean plant-level data, show that firms importing intermediate goods tend to be larger and more productive. The

[2]Using firm-level data from China, Manova and Yu (2012), however, show that credit constraints induce firms to conduct more processing trade (i.e., importing inputs for re-exporting). In their study, spanning more production stages via ordinary trade (i.e., making and exporting final goods) requires higher up-front costs, which need to be externally financed.

finding that changing offshoring costs changes the set of imported intermediate goods is consistent with Goldberg et al. (2010) and Gopinath and Neiman (2013). And several studies have found that reducing input-trade costs increases firm production and exports (e.g., Bas (2012)). The finding that the impact of lowering offshoring costs on unemployment depends on the degree of substitution between inputs and the share of labor in production provides an explanation for why there has been no consensus on this issue in the empirical literature. Using firm-level data from Denmark, Hummels et al. (2014) show that offshoring is associated with a reduction in employment among low-skill workers, whereas Moser et al. (2015)), using plant-level data from Germany, find that the net employment growth of offshoring plants is higher than non-offshoring plants.

This paper relates to a growing literature that studies the nexus between financial development and globalization. One strand of this literature has studied how financial development affects the pattern of comparative advantage (e.g., Beck (2002) and Matsuyama (2005)); another strand investigates how credit constraints affect exports when firms are heterogeneous (e.g., Manova (2013)); a third line of this literature examines how financial development affects multinational firm (MNF) activities (e.g., Carluccio and Fally (2012), Antràs and Foley (2015)).[3] The present work complements this literature by investigating how financial frictions affect offshoring both in extensive and intensive margins along with their effects on income distribution and unemployment.

This paper is also related to the recent literature that explores the interactions among offshoring, income distribution, and jobs.[4] Davidson et al. (2008), for example, propose a model of offshoring with labor-market frictions to investigate how offshoring of high-tech jobs affects wages earned by low- and high-skill workers. In a two-sector model with labor market frictions, Mitra and Ranjan (2010) study the impact of offshoring on unemployment under different degrees of inter-sectoral labor mobility. Ranjan (2013) studies the impact

[3] Foley and Manova (2015) provides a comprehensive review of this literature.

[4] There is a complementary large literature that investigates the impact of trade on unemployment. Some recent contributions are Helpmand and Itkshoki (2010), Helpman et al. (2010), Davis and Harrigan (2011), Amiti and Davis (2011), Dinopoulos and Unel (2015) among many others.

of offshoring on unemployment and wages under different wage settings.

This paper is more related to a recent paper by Groizard et al. (2014) who investigate the impact of offshoring on jobs in their two-sector model, where one sector produces differentiated goods as in Melitz (2003) and the other a homogeneous good. They find that offshoring affects unemployment by relocating jobs within firms, between firms, and across sectors. In the their model the supply of workers is fixed (and thus, no occupational choice), firms in the differentiated-good sector compete with each other monopolistically, and there are no credit constraints (see Section 3.2 for more details).

This paper is also related to Egger et al. (2015) who develop a two-country model of trade with occupational choice in which heterogeneous firms in the source country can offshore routine tasks to the low-wage host country. Their main finding is that if offshoring costs are sufficiently high, an exposure to offshoring reallocates domestic labor toward less productive firms, which in turn may lead to a welfare loss. In their model, firms compete with each other monopolistically, assembly of tasks is done through a Cobb-Douglas technology, and there are no credit constraints.

The rest of this paper is organized as follows. The next section introduces the model and discusses its equilibrium properties. Section 3 investigates the impact of the aforementioned policies on entrepreneurial activity, offshoring, income distribution, and unemployment. Section 4 concludes the paper.

2 Setup of the Model

Consider a small open economy (SOE) that produces two homogeneous goods using only labor. The economy is populated by a continuum of individuals with constant mass one. Individuals differ with respect to their entrepreneurial (managerial) ability indexed by a, whose distribution is given by a common, exogenous cumulative distribution $G(a)$ with density $g(a)$ and support $[1, \infty)$. Following Helpman et al. (2010), I assume that ability levels are drawn from the following Pareto distribution

$$G(a) = 1 - a^{-k}, \tag{1}$$

where $k > 1$ is the shape parameter of the distribution. This distributional assumption is made to simplify the analysis. As will be presented below, individuals choose to become either an entrepreneur or a worker based on their ability and the labor market conditions.

Product markets are perfectly competitive, but labor markets exhibit frictions stemming from job search and matching. Production of good 1 is completely carried out at home, whereas firms producing good 2 can perform some of their tasks abroad to take advantage of cheaper labor there. Trade in final goods is free and the world interest rate is given by an exogenous, constant r. However, due to credit constraints, borrowers face a higher rate than the world interest rate ($r_b > r$).

2.1 Demand

Individuals have identical preferences over the two goods as follows:

$$u = \left(\frac{q_1}{1-\beta}\right)^{1-\beta}\left(\frac{q_2}{\beta}\right)^{\beta}, \tag{2}$$

where q_i is consumption of good i and $\beta \in (0, 1)$ is an exogenous, constant parameter.

Denoting with e individual income (expenditure), the demand for each good is

$$q_1 = (1-\beta)e/p_1, \qquad q_2 = \beta e/p_2, \tag{3}$$

where p_i is the price of good i. Good 1 is chosen as the numeraire so that its price equals one (i.e., $p_1 = 1$). I also denote the relative price of good 2 by p, and note that $p \equiv p_2/p_1 = p_2$. The relative price p is an exogenous constant because the country is a SOE.

Substituting q_i from (3) into (2) yields the indirect utility

$$\mathrm{v}(e, p) = ep^{-\beta}. \tag{4}$$

Since the indirect utility linearly depends on income, aggregation of preferences to obtain social welfare is permissible. In this case, the aggregate welfare is given by

$$\mathbb{V}(p) = \int_a \mathrm{v}(e(a), p)g(a)da = p^{-\beta}E, \tag{5}$$

where $E = \int_a e(a)g(a)da$ denotes aggregate expenditure (income).

2.2 Production

Good 1 is produced domestically using only workers under constant returns to scale technology. Specifically, one unit of labor is required to produce one unit of good 1. As will be discussed later, labor markets exhibit frictions which are formulated with directed search: firms post costly vacancies and wage offers, and workers and firms meet randomly. Letting c_1 denote the unit cost of hiring a worker, it then follows from the assumption that product markets are perfectly competitive that $c_1 = p_1 = 1$.

Good 2 is produced by a continuum of heterogeneous firms, each owned and managed by an entrepreneur under perfect competition. An entrepreneur with ability a produces output according to

$$y_2(a) = \left(\frac{a}{1-\theta}\right)^{1-\theta}\left(\frac{\mathrm{L}}{\theta}\right)^{\theta}, \tag{6}$$

where $\theta \in (0,1)$ is an exogenous parameter and L is a composite labor. Since the production technology exhibits a diminishing returns to scale in labor, firms have finite size; consequently, labor share θ measures managers' *span of control* (Lucas, 1978).

The composite labor L is produced by assembling a fixed measure of differentiated tasks (indexed by $j \in [0,1]$) by the following CES technology

$$\mathrm{L} = \left(\int_0^1 l(j)^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{\sigma}{\sigma-1}}, \tag{7}$$

where σ is the elasticity of substitution between any two pairs of tasks. Note that if $\sigma \to 0$, tasks become perfect complement as in Grossman and Rossi-Hansberg (2008); and they become perfect substitute when $\sigma \to \infty$.

Production in this sector first requires a fixed set-up cost f_d measured in terms of good 1. Firms need to finance their set-up costs through capital markets where they face a higher borrowing rate than lending rate (i.e., $r_b > r$) due to credit-market imperfections. I hereafter assume that *all* fixed costs will be paid in advance of the final production; as a result, the *effective* set-up cost will be $(1+r_b)f_d$. I will also assume that a fraction κ of any variable costs is paid in advance, the rest will be paid after the final production.[5]

Each task is produced using only workers under constant returns to scale technology, and can be performed either at home or abroad. Although tasks differ in terms of their complexity, production of one unit of any task requires one unit of labor at home. Firms wishing to offshore face both fixed and variable costs. Before starting any production, each firm must pay an irreversible fixed offshoring costs f_o measured in terms of good 1. The fixed cost f_o is paid in addition to the set-up cost f_d and covers foreign-market entry costs as well as coordinating the performance of tasks to be produced abroad. As in the previous case, firms finance these costs in advance of their final production; as a result, they effectively pay $(1+r_b)f_o$.

Upon paying the fixed offshoring costs, the production of one unit of the task j requires $\tau x(j)$ units of foreign workers as in Grossman and Rossi-Hansberg (2008). It is assumed that $\tau x(j) > 1$ for all $j \in [0,1]$ so that each task is performed in a more efficient way at home. The parameter τ reflects the overall state of communication technology with foreign producers, whereas the component $x(j)$ captures the heterogeneity in productivity across tasks. I assume that $x(j)$ is continuously differentiable, and index tasks in increasing order of complexity so that tasks with higher indexes are the ones that require close scrutiny by the headquarter, i.e. $dx(j)/dj > 0$. Let w^* denote the foreign wage rate, the marginal cost of producing task j is $\mathrm{w}^*\tau x(j)$. In this SOE context, w^* is an exogenous constant. The realized unit cost will be $(1+\kappa r_b)\mathrm{w}^*\tau x(j)$.[6]

Let $c(j)$ denote the marginal cost of producing task j at home. I will show in Section 2.4 that $c(j)$ is the same across all tasks produced locally, and is independent of the entrepreneur's ability a (i.e., $c(j) = c_2$ if task j is produced locally). Task j will be offshored

[5] Note that $\kappa = 1$ implies that all variable costs are paid in advance of the final production, and $\kappa = 0$ implies that all such costs are paid after the final-good production. Alternatively, one can assume that κ_1 and κ_2 (with $\kappa_1 \geqslant \kappa_2$) fractions of fixed and variable costs respectively should be paid in advance of the final production. However, this modification will make the analysis notationally complicated without changing the main results.

[6] Recall that firms need to finance κ fraction of their variables costs in advance, where $\kappa \in [0,1]$. In this case, the total effective unit cost will be $(1+r_b)\kappa\mathrm{w}^*\tau x(j) + (1-\kappa)\mathrm{w}^*\tau x(j) = (1+\kappa r_b)\mathrm{w}^*\tau x(j)$.

if and only if $(1+\kappa r_b)\mathrm{w}^*\tau x(j) \leqslant c_2$. The marginal offshore task (denoted by j_o) is given by

$$x(j_o) = \frac{c_2}{(1+\kappa r_b)\tau \mathrm{w}^*}. \tag{8}$$

Note that j_o is independent of entrepreneurial ability a, i.e., all offshoring firms perform the same set of tasks abroad. Note also that the task cutoff j_o decreases with r_b and τ, and increases with c_2.

Lemma 1. *$dj_o/da = 0$, $dj_o/dr_b < 0$, $dj_o/d\tau < 0$, and $dj_o/dc_2 > 0$.*

Given that tasks are ranked in increasing order of complexity, tasks with $j \in [0, j_o]$ will be offshored, and the rest will be produced domestically. In this case, the unit cost of producing task j is given by

$$c(j) = \begin{cases} (1+\kappa r_b)\mathrm{w}^*\tau x(j) & j \leqslant j_o, \\ c_2 & j > j_o. \end{cases} \tag{9}$$

An entrepreneur with ability a chooses the amount of task $l(j)$ and whether to offshore to maximize her earnings (equal firm profits):

$$e_2(a) \equiv \pi_2(a) = \max \left\{ py_2(a) - \int_0^1 c(j)l(j)dj - (1+r_b)(f_d + \mathbb{I}_o f_o) \right\}, \tag{10}$$

where $y_2(a)$ and $c(j)$ are given by (6) and (9), respectively; and $\mathbb{I}_o$ is an indicator variable that equals one if the firm offshores, and zero otherwise.

To solve the above problem, let W denote the shadow wage associated with composite labor input L so that $\int_0^1 c(j)l(j)dj = \mathrm{WL}$. The cost minimization yields[7]

$$\mathrm{W} = \begin{cases} c_2 & \text{if firm does not offshore,} \\ c_2 \mathrm{W}_o & \text{if firm offshores.} \end{cases} \tag{11}$$

[7] $\mathrm{W} = \mathrm{Min}\{\int_0^1 c(j)l(j)dj \,|\, \mathrm{L} = 1\}$, where L is given by (7). Solving this problem yields $\mathrm{W} = [\int_0^1 c(j)^{1-\sigma}dj]^{1/(1-\sigma)}$, and substituting $c(j)$ from (9) into W yields (11).

Thus, W_o measures the relative cost of offshoring, and is given by

$$\mathrm{W}_o = \left[\int_0^{j_o} \left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj + 1 - j_o\right]^{\frac{1}{1-\sigma}}, \tag{12}$$

where j_o denotes the task cutoff and $x(j_o)$ is given by (8). Two points about the aggregate wage index W_o are worth noting. First, since j_o is the same for all offshoring firms, it then follows that W_o is the same for all offshoring firms. Second, offshoring firms face a lower aggregate wage index, i.e. $\mathrm{W}_o < 1$, and thus the unit cost of production is smaller for offshoring firms.[8]

Cobb-Douglas production technology (6) implies that $y_2(a) = \mathrm{WL}/\theta p$, and substituting this back into (6) yields

$$\mathrm{L} = \frac{\theta a}{1-\theta}\left(\frac{p}{\mathrm{W}}\right)^{\frac{1}{1-\theta}}, \qquad y_2(a) = \frac{a}{1-\theta}\left(\frac{p}{\mathrm{W}}\right)^{\frac{\theta}{1-\theta}}, \tag{13}$$

where the second equation is obtained by substituting L into (6). Plugging $y_2(a)$ from (13) and $\int_0^1 c(j)l(j)dj = \mathrm{WL} = \theta p y_2(a)$ into the profit function (10) yields

$$e_2(a) = a\left(\frac{p}{\mathrm{W}^{\theta}}\right)^{\frac{1}{1-\theta}} - (1 + r_b)(f_d + \mathbb{I}_o f_o), \tag{14}$$

where W is given by equation (11). Note that labor input L, output $y_2(a)$, and profit $e_2(a)$ increase with labor share θ. Thus, each entrepreneur uses more labor input, produces more output, and makes more profits when entrepreneur's span of control increases (i.e., production becomes more labor intensive).

2.3 Capital Markets

Individuals choosing to become entrepreneurs can finance the upfront costs through an international financial market with risk-neutral lenders. Credit markets are imperfect due to the limited enforcement as in Galor and Zeira (1993). It is assumed that a borrower can

[8]Suppose that tasks are complements, i.e. $\sigma < 1$. Since tasks are indexed in increasing order of complexity, $x(j)/t(j_0) < 1$ for $j < j_o$. It then follows that $\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj + 1 - j_o < j_o + 1 - j_o = 1$, and hence $\mathrm{W}_o < 1$. If $\sigma \geqslant 1$, then $\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj + 1 - j_o > j_o + 1 - j_o = 1$ and thus $\mathrm{W}_o < 1$.

default on his debt, but doing so is costly for him. The financial market can prevent such defaults by keeping track of borrowers, however this is also a costly activity.

To fix ideas, let $r > 0$ denote the exogenous world interest rate. Individuals can lend any amount at this rate, but borrowers face a higher rate r_b. An entrepreneur with ability a borrows $b(a)$ from the financial market and pays an interest $r_b b(a)$ which covers lender's interest $rb(a)$ and tracking costs $t(a)$ (measured in terms of good 1). Since lenders are risk-neutral, the arbitrage condition yields

$$r_b b(a) = rb(a) + t(a). \tag{15}$$

The borrower can still default on his debt, but this will cost him $\phi t(a)$, where $\phi > 1$ is an exogenous constant. The incentive compatibility constraint then becomes

$$(1 + r_b)b(a) = \phi t(a). \tag{16}$$

Combining equations (15) and (16) yields

$$r_b = \frac{1 + \phi r}{\phi - 1}. \tag{17}$$

Note that the borrowing rate is independent of the amount borrowed. Furthermore, as ϕ approaches to infinity, r_b approaches to r; as a result, credit-market imperfections decrease as ϕ increases. In the subsequent analysis, "a reduction in r_b" should be understood as an improvement in credit-market imperfections through an increase in ϕ.

2.4 Labor Markets

Labor markets exhibit frictions stemming from job search and matching; as a result, workers face the prospect of unemployment. Labor-market frictions are modeled with *directed search*: firms post costly vacancies and wage offers, and workers and firms meet randomly (Rogerson et al. (2010), Groizard et al. (2014)).[9] Let δ_i denote the costs of posting each

[9] In an important work, Hall and Krueger (2012) surveyed a sample of US workers to investigate the wage determination at the time they were hired, and found that about a third of workers had take-it-or-leave-it wage offer. They also found that a third of workers had bargained over pay before they were hired; and bargaining is more common among educated workers. Since worker ability does not play any role in the present model, wage posting seems a more appropriate approach.

vacancy (measured in terms of good 1) in sector $i = 1, 2$. As discussed earlier, firms need to finance κ fraction of these costs externally; as a result, the effective costs of posting each vacancy is $(1 + \kappa r_b)\delta_i$.

Let n_i denote the number of workers seeking jobs at a typical firm in sector i that posted v_i vacancies. Workers and firms match with each other according to the following Cobb-Douglas matching function:

$$\ell_i(n_i, v_i) = \mu_i n_i^{\gamma} v_i^{1-\gamma}, \tag{18}$$

where μ_i is an exogenous constant that represents matching efficiency and $\gamma \in (0, 1)$. The probability of a successful match between a worker and the firm is given by $\zeta_i = \ell_i/n_i = \mu_i(v_i/n_i)^{1-\gamma}$.

Let w denote the expected wage that workers obtain in equilibrium. Each firm must offer at least w, otherwise no workers will apply for the jobs that the firm posts. In addition, firms have no incentive to offer more than w. Let w_i denote the target wage offered by a firm with v_i vacancies that has attracted n_i workers. Since workers are risk-neutral, they must be indifferent between this offer and w, i.e. $\zeta_i \mathrm{w}_i = \mathrm{w}$. Substituting ζ_i into the latter yields

$$\frac{n_i}{v_i} = \left(\frac{\mu_i \mathrm{w}}{\mathrm{w}_i}\right)^{\frac{1}{1-\gamma}}. \tag{19}$$

Combining equations (18) and (19) yields

$$\ell_i = \mu_i^{\frac{1}{1-\gamma}} \left(\frac{\mathrm{w}_i}{\mathrm{w}}\right)^{\frac{\gamma}{1-\gamma}} v_i. \tag{20}$$

Variables w_i and v_i are control variables: once they are determined through profit maximization problem, the number of workers hired will be determined by the above equation. The total cost of employing ℓ_i workers then is $(1 + \kappa r_b)[\mathrm{w}_i \ell_i + \delta_i v_i] = c_i \ell_i$, where

$$c_i = (1 + \kappa r_b)\left[\mathrm{w}_i + \delta_i \mu_i^{-\frac{1}{1-\gamma}} \left(\frac{\mathrm{w}}{\mathrm{w}_i}\right)^{\frac{\gamma}{1-\gamma}}\right], \tag{21}$$

c_i denotes the unit-labor cost in sector i.[10]

[10] The results remain qualitatively the same if one assumes that the wage rate w_i will be paid once the final

With the above transformation, it turns out that maximizing profits by choosing wage w_i and the number of vacancies v_i is equivalent to choosing wage rate w_i and the number of workers hired ℓ_i. Under the second approach, each firm first chooses the wage per worker w_i to minimize its unit-labor costs c_i, which yields

$$\mathrm{w}_i = \frac{\mathrm{w}^\gamma}{\mu_i}\left(\frac{\gamma\delta_i}{1-\gamma}\right)^{1-\gamma}, \qquad c_i = \frac{(1+\kappa r_b)\mathrm{w}^\gamma}{\mu_i\gamma}\left(\frac{\gamma\delta_i}{1-\gamma}\right)^{1-\gamma}. \tag{22}$$

Since good 1 is numeraire and product markets are perfectly competitive, it then follows that $c_1 = 1$; and using (22) yields

$$\mathrm{w} = \left(\frac{\mu_1\gamma}{1+\kappa r_b}\right)^{\frac{1}{\gamma}}\left(\frac{1-\gamma}{\gamma\delta_1}\right)^{\frac{1-\gamma}{\gamma}}, \tag{23}$$

and substituting w back into (22) yields

$$\mathrm{w}_1 = \frac{\gamma}{1+\kappa r_b}, \qquad c_1 = 1; \tag{24a}$$

$$\mathrm{w}_2 = \frac{\gamma\mu_1}{(1+\kappa r_b)\mu_2}\left(\frac{\delta_2}{\delta_1}\right)^{1-\gamma}, \qquad c_2 = \frac{\mu_1}{\mu_2}\left(\frac{\delta_2}{\delta_1}\right)^{1-\gamma}. \tag{24b}$$

Finally, using the no-arbitrage condition $\zeta_i\mathrm{w}_i = \mathrm{w}$ yields

$$\zeta_1 = \mu_1^{\frac{1}{\gamma}}\left[\frac{1-\gamma}{(1+\kappa r_b)\delta_1}\right]^{\frac{1-\gamma}{\gamma}}, \qquad \zeta_2 = \mu_2\left[\frac{(1-\gamma)\mu_1}{(1+\kappa r_b)\delta_1^{1-\gamma}\delta_2^{\gamma}}\right]^{\frac{1-\gamma}{\gamma}}. \tag{25}$$

Several remarks are in order. First, reducing credit-market imperfections makes workers better off since they face higher job-finding rates and earn higher wages. Second, credit-market imperfections do not affect the unit-labor cost of producing each task. Third, improving labor-market conditions of sector 2 relative to that in sector 1 (i.e., increasing μ_2/μ_1 or decreasing δ_2/δ_1) increases the job-finding rate in sector 2 ($\zeta_2 \uparrow$) and decreases the unit-labor cost ($c_2 \downarrow$). In the subsequent analysis, the parameters μ_1 and δ_1 will be held constant, and thus "reducing c_2" means lowering δ_2 and/or raising μ_2 (i.e., improvements in the labor-market conditions in sector 2). Finally, note that the relative job-finding rate ζ_1/ζ_2

production is done. In this case, the total cost of employing ℓ_i workers will be $\mathrm{w}_i\ell_i + (1+\kappa r_b)\delta_i v_i$. Following the subsequent steps, it is easy to show that $\mathrm{w}_i^n = (1+\kappa r_b)\mathrm{w}_i$ and $\mathrm{w}^n = (1+\kappa r_b)\mathrm{w}$, where superscript n denotes the new approach. Note that w decreases with r_b, but w_i is independent of r_b. However, c_1 and c_2 still remain the same.

is independent of the borrowing rate r_b. Therefore, to simplify the subsequent exposition, I hereafter assume that the parameters related to labor-market frictions are chosen in such a way that sector 2 is more job friendly, i.e. $\zeta_2 > \zeta_1$.

Using job finding rates ζ_1 and ζ_2, one can easily calculate the aggregate unemployment rate as

$$\mathrm{u} = (1-\zeta_1)N_1 + (1-\zeta_2)N_2, \tag{26}$$

where N_i is the number of workers searching jobs in sector i.

2.5 Equilibrium Analysis

I begin the equilibrium analysis with ability allocation. Note that an individual chooses to become an entrepreneur if her entrepreneurial income is greater than the income she earns as worker, i.e. an individual with ability a becomes entrepreneur if $e_2(a) \geqslant \mathrm{w}$, where w is given by equation (23). The ability cutoff (a_d) at which an individual is indifferent between being an entrepreneur or a worker is given by $e_2(a_d) = \mathrm{w}$. Substituting $e_2(a)$ from (14) with $\mathbb{I}_o = 0$ and $\mathrm{W} = c_2$ into $e_2(a_d) = \mathrm{w}$ yields

$$a_d = [\mathrm{w} + (1+r_b)f_d]\left(\frac{c_2^{\theta}}{p}\right)^{\frac{1}{1-\theta}}, \tag{27}$$

where w and c_2 are given by (23) and (24b), respectively, and p is the world relative price of good 2. The average wage w decreases with r_b, whereas the set-up cost $(1+r_b)f_d$ increases with it. I will assume that f_d is high enough so that $\mathrm{w} + (1+r_b)f_d$ increases with r_d.[11]

According to (27), the ability cutoff a_d increases with capital-market imperfections (captured by an increase in r_b) and the unit cost c_2, and is independent of offshoring costs τ and f_o.[12] Although a reduction in r_b makes workers better off by increasing their wages and job-finding rates, it decreases the fixed cost of production f_d more substantially, and thus makes entrepreneurship more profitable. In this case, more able workers become entrepreneurs.

[11] More precisely, $d\mathrm{w}/dr_b + f_d > 0$ if and only if $f_d > \kappa \mathrm{w}/[\gamma(1+\kappa r_b)]$, it is assumed that the last inequality always holds.

[12] In this paper, I focus only on the implications of reducing credit-market imperfections ($r_b \downarrow$), furthering exposure to offshoring ($\tau \downarrow$ and $f_o \downarrow$), and reducing labor-market frictions in sector 2 ($c_2 \downarrow$). Investigating implications of changing other exogenous variables is a straightforward exercise, and thus will not be presented.

Lemma 2. *The unique ability cutoff for becoming an entrepreneur is given by (27). Furthermore, (i) $da_d/dr_b > 0$; (ii) $da_d/d\tau = 0$, $da_d/df_o = 0$; (iii) $da_d/dc_2 > 0$.*

Now consider the decision to offshore tasks. An entrepreneur chooses to offshore if $e_2(a)\{\mathbb{I}_o = 1\} \geqslant e_2(a)\{\mathbb{I}_o = 0\}$, where $e_2(a)$ is given by (14). The ability level (a_o) at which an entrepreneur is indifferent between offshoring or domestic production is determined when the inequality holds with equality, which yields

$$a_o = \frac{(1 + r_b)f_0}{\mathrm{W}_o^{-\theta/(1-\theta)} - 1} \left(\frac{c_2^{\theta}}{p}\right)^{\frac{1}{1-\theta}}, \tag{28}$$

where W_o is the wage index and given by (12). Combining equations (27) and (28) yields

$$a_o = Aa_d, \qquad\qquad A \equiv \frac{(1 + r_b)f_o}{[\mathrm{w} + (1 + r_b)f_d]\left(\mathrm{W}_o^{-\theta/(1-\theta)} - 1\right)}. \tag{29}$$

It is assumed that the parameters of the model (in particular, f_o) are chosen high enough to ensure $A > 1$ so that $a_o > a_d$, i.e. only more able entrepreneurs offshore their tasks. The following lemma characterizes the ability cutoff for offshoring a_o (see Appendix A.3 for the formal proof).

Lemma 3. *The unique ability cutoff for offshoring a_o is given by (28). Furthermore, (i) $da_o/dr_b > 0$; (ii) $da_o/d\tau > 0$, $da_o/df_o > 0$; (iii) $da_o/dc_2 < 0$ if and only if $(1 - j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} < 1$.*

Note that the condition $\sigma \geqslant 1/(1-\theta)$ is sufficient for $(1 - j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} < 1$ (since j_o, $\mathrm{W}_o < 1$). In this case, a reduction in c_2 increases the ability cutoff a_o. As argued in Appendix A.3, the inequality $(1 - j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} > 1$ is likely to hold if σ is small and θ is high, i.e. $\sigma \ll 1/(1-\theta)$. In this case, a reduction in c_2 decreases the ability cutoff a_o.

Intuitively, reducing credit-market imperfections encourages offshoring through two channels. First, note that foreign-market entry cost $(1 + r_b)f_o$ will be lower. Second, lowering r_b increases both the set of tasks offshored (see equation (8)) and the unit cost of producing each task abroad. Consequently, offshoring becomes more profitable and more entrepreneurs choose to offshore. Similarly, lowering offshoring costs (τ or f_o) makes offshoring more profitable, which induces more entrepreneur to offshore. Finally, reducing labor-market frictions in sector 2 makes local production of tasks cheaper. If the elasticity of substitution between tasks σ is high and/or labor share θ is small, some firms will find producing locally more profitable, and thus exit offshoring. However, if tasks are more complementary and/or labor share θ is high, some non-offshoring firms start to offshore, and thus a_o will decrease.

Once these cutoffs are determined, one can determine other endogenous variables. If an individual becomes a worker, she earns w_i in sector i; and if she becomes an entrepreneur her income is given by (14). Thus, the income distribution is given by

$$e(a) = \begin{cases} \mathrm{w}_1 & \text{if } a < a_d \text{ and works in sector 1,} \\ \mathrm{w}_2 & \text{if } a < a_d \text{ and works in sector 2,} \\ a\left(\frac{p}{c_2^\theta}\right)^{\frac{1}{1-\theta}} - (1+r_b)f_d & \text{if } a \in [a_d, a_o), \\ a\left(\frac{p}{(c_2 \mathrm{W}_o)^\theta}\right)^{\frac{1}{1-\theta}} - (1+r_b)(f_d+f_o) & \text{if } a \geqslant a_o. \end{cases} \tag{30}$$

Thus, individuals with $a \in [1, a_d)$ choose to become workers earning expected wage income w; those with $a \in [a_d, a_o)$ become entrepreneurs producing domestically and earning income which increases linearly with their ability a; finally, entrepreneurs with $a \geqslant a_o$ offshore and earn a higher income which also increases linearly with their entrepreneurial ability. Aggregating these incomes across all individuals yields aggregate income

$$E = \mathrm{w} + \frac{\mathrm{w} + (1+r_b)(f_d + f_o A^{-k})}{(k-1)a_d^k}, \tag{31}$$

where w, a_d, and A are given by (23), (27), and (29), respectively (see Appendix A.4 for the derivation).

Welfare distribution is given by $\mathrm{v}(a,p) = p^{-\beta}e(a)$, where $e(a)$ is given by (30). In the same way, aggregate welfare is given by $\mathbb{V} = p^{-\beta}E$, where E is given by (31). Note that since the relative price p is exogenous and constant, income and welfare distributions are isomorphic to each other. Consequently, analyzing the impact of a policy on income distribution is the same as analyzing its impact on welfare distribution.

Finally, to determine the aggregate unemployment rate, one needs to calculate the number of workers employed in each sector. The number of domestic workers employed by an entrepreneur with ability a is given by

$$\ell_2(a) = \frac{a\theta^{1-\sigma}}{1-\theta}\left(\frac{p}{c_2}\right)^{\frac{1}{1-\theta}} \begin{cases} 1 & \text{if } a \in [a_d, a_o), \\ (1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} & \text{if } a \geqslant a_o, \end{cases} \tag{32}$$

where W_o and c_2 are given by (12) and (24b), respectively.[13] The expression $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)}$ can be less than or greater than one. If it is greater [less] than one, then the amount of domestic labor employed by an offshoring entrepreneur will be higher [lower] than that by this entrepreneur if she had produced all tasks domestically. As discussed earlier, the former inequality is more likely to hold when $\sigma \ll 1/(1-\theta)$, and the latter inequality always holds if $\sigma \geqslant 1/(1-\theta)$.

Integrating (32) across all entrepreneurs under Pareto distribution (1) yields the number of domestic workers employed in sector 2:

$$L_2 = \int_{a_d}^{\infty} \ell_2(a)g(a)da = \frac{k\theta^{1-\sigma}p^{1/(1-\theta)}(a_d^{1-k} + a_o^{1-k}[(1-j_o)\mathrm{W}_o^{\sigma-\frac{1}{1-\theta}} - 1])}{(k-1)(1-\theta)c_2^{1/(1-\theta)}}. \tag{33}$$

The total supply of workers is given by $N_1 + N_2 = G(a_d)$, since the mass of population is normalized to one. The number of workers looking for a job in sector 1 then is $N_1 = G(a_d) - N_2$, and substituting N_1 into (26) and using $L_2 = \zeta_2 N_2$ yields the aggregate unemployment rate

$$\mathrm{u} = (1-\zeta_1)G(a_d) - (1-\zeta_1/\zeta_2)L_2, \tag{34}$$

where the coefficient of L_2 is positive, because it is assumed that $\zeta_1 < \zeta_2$.

[13]Substituting $py_2(a) = \mathrm{WL}/\theta$ into the profit function (10), and then maximizing the resulting expression with respect to $l(j;a)$ yields

$$l(j;a) = \frac{\theta^{1-\sigma}py_2(a)c(j)^{-\sigma}}{\mathrm{W}^{1-\sigma}} = \frac{\theta^{1-\sigma}c_2^{-\sigma}p^{1/(1-\theta)}a}{(1-\theta)\mathrm{W}^{-\sigma+1/(1-\theta)}},$$

where the second equality follows from $c(j) = c_2$ and (13). Substituting $\mathrm{W} = c_2$ for non-offshoring firms and $\mathrm{W} = c_2\mathrm{W}_o$ for offshoring firms into $l(j;a)$, and then aggregating the resulting expressions respectively over $[0,1]$ and $[j_o, 1]$ yields equation (32).

3 Policy Implications

This section investigates the implications of a series of policy changes for this small open economy. I consider policies related to credit market imperfections, offshoring, and labor-market frictions.

3.1 Improving Credit Markets

Easing credit constraints through a reduction in the borrowing rate r_b induces offshoring firms to increase the number of tasks performed abroad (see Lemma 1). In addition, according to Lemmas 2 and 3, this policy increases the masses of both non-offshoring and offshoring entrepreneurs.

Reducing credit-market imperfections raises wages w_1 and w_2 as indicated by equations (24a) and (24b). In addition, workers are more likely to find a job in each sector (i.e., $\zeta_i \uparrow$). Consequently, the average wage w increases. According to (30), it increases the income of non-offshoring entrepreneurs by reducing their fixed set-up costs $(1 + r_b)f_d$. The income of offshoring entrepreneurs increases as well, because it decreases both their fixed and variable costs. Figure 1 represents the impact of reducing credit constraints on income distribution.[14] Note that the slope of the non-offshoring firms does not change, but that of offshoring firms becomes steeper. Clearly such a shift in the income distribution increases aggregate income E as well.

As discussed in the previous section, since the relative price p is constant, the impact of reducing r_b on welfare is identical to that on the income distribution shown in Figure 1. Workers and entrepreneurs become better off; as a result, the aggregate welfare $\mathbb{V}$ increases

[14] According to Figure 1, this policy has a two competing effects on the income distribution of offshoring entrepreneurs. On one hand, it increases the income of existing offshoring entrepreneurs. On the other hand, it increases the supply of offshoring entrepreneurs, and the new entrants have lower income than the existing ones. In the equilibrium, the second effect dominates the first one, and the average income of offshoring entrepreneurs will be lower when r_b is lower. Since this policy increases the average wage w, it then follows that the inequality between offshoring entrepreneurs and workers declines. Along the same lines, one can show that the impact of reducing credit imperfections has an ambiguous effect on the average income of non-offshoring entrepreneurs, and thus the inequality between this group and the two other groups may increase or decrease. Overall, the impact of reducing credit constraints has an ambiguous effect on the inequality between *all* entrepreneurs and workers (and formal proofs are available upon request).

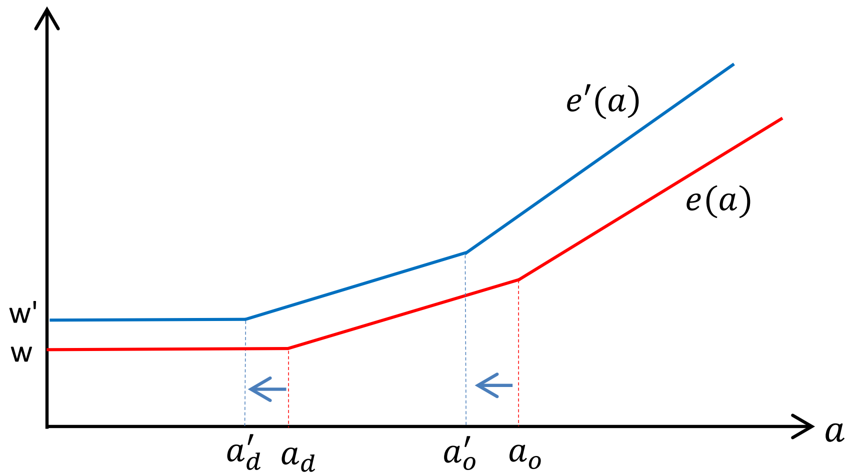


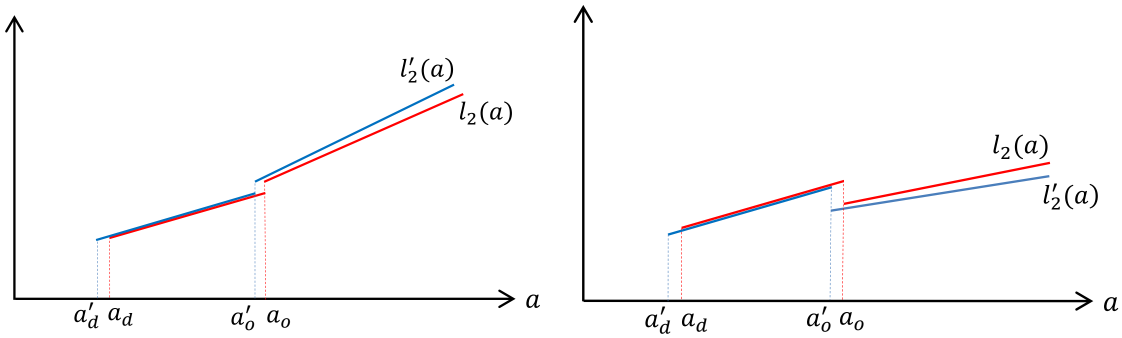
Figure 1: Impact of Reducing Credit Constraints on Income Distribution

as well.

To determine the impact of this policy on aggregate unemployment, consider equation (34). Note that reducing credit constraints decreases the supply of workers $G(a_d)$ as indicated by Lemma 2, but increases job-finding rate ζ_1 as indicated by the first equation in (25); as a result, the first term on the RHS of (34) decreases. It then follows that aggregate unemployment rate u always falls if L_2 increases (it was assumed that $\zeta_2 > \zeta_1$).

Figure 2.a shows the impact of a reduction in r_b on the domestic labor demand function $\ell_2(a)$ when $(1 - j_o)\mathrm{W}_o^{\sigma - 1/(1-\theta)} > 1$. Recall that the inequality is likely to hold when $\sigma \ll 1/(1-\theta)$, and Appendix A.5 shows that under the latter condition $(1 - j_o)\mathrm{W}_o^{\sigma - 1/(1-\theta)}$ is also likely to increase when r_b decreases. According to Figure 2.a, the total area under solid blue lines is greater than that under the red ones; as a result, reducing r_b increases L_2. This, combined with a decrease in $(1 - \zeta_1)G(a_d)$, implies that reducing credit-market imperfections decreases aggregate unemployment rate if $\sigma \ll 1/(1-\theta)$.

In all other cases, the impact of a reduction in r_b has an ambiguous effect on the aggregate unemployment. Consider, for example, Figure 2.b that shows the impact of this policy on labor demand function $\ell_2(a)$ if $\sigma \geqslant 1/(1-\theta)$, which ensures that $(1 - j_o)\mathrm{W}_o^{\sigma - 1/(1-\theta)} < 1$. A reduction in credit constraints decreases the demand for domestic



a. $\sigma \ll 1/(1-\theta)$

b. $\sigma \geqslant 1/(1-\theta)$

Figure 2: Impact of Reducing r_b on $\ell_2(a)$

labor by offshoring firms, but increases the demand for the domestic labor by non-offshoring firms; as a result, the net effect on L_2 is ambiguous.

Proposition 1. *Consider the small open economy as described. A reduction in credit-market imperfections*

a. induces more individuals to become entrepreneurs;

b. increases the mass of offshoring entrepreneurs and the number of tasks offshored;

c. makes everyone better off, and thus improves the aggregate welfare;

e. more likely decreases the aggregate unemployment rate if $\sigma \ll 1/(1-\theta)$; otherwise, has an ambiguous effect on it.

Intuitively, reducing credit-market imperfections increases the mass of entrepreneurs in sector 2, which in turn increases the demand for aggregate labor L. Note that the increase in labor demand will be higher if the labor share θ is higher. Entrepreneurs choosing to produce domestically will clearly have a higher demand for the domestic labor, which puts a downward pressure on unemployment. Although offshoring firms will perform more tasks abroad, if tasks are less substitutable with each other and labor share is high, their demand for the domestic labor will also increase. These factors combined with a higher job-finding rates in sector 2 will increase the total domestic labor employed in sector 2, and thus, the aggregate unemployment rate will fall.

The prediction that lower credit constraints induce firms to offshore more is consistent with Muûls (2015) who, using firm-level trade data and credit scores for Belgian manufacturing firms over the 1999–2007 period, shows that firms facing lower credit constraints import more in extensive margin. Similarly, Bas and Berthou (2012) use firm-level data from India and show that reducing credit constraints increases the probability of importing capital goods. Muûls also shows that firms facing better credit conditions also export more both in extensive and intensive margins (see also Minetti and Zhu (2011) and Manova (2013) among others). In the present set-up, reducing credit constraints increases the total output produced in sector 2, and thus increases the total export as well.

How do the above predictions about unemployment relate to the previous work? Acemoglu (2001) proposes a model of unemployment with credit constraints, and shows that credit-market frictions may be an important contributing factor to high unemployment rate in Europe. In his model, technical progress necessitates creation of new firms (and jobs), but this will be constrained by credit-market imperfections, so unemployment rises. In a recent paper, Duygan-Bump et al. (2015) study the impact of the 2007–2009 recession on the unemployment in the United States, and they find that workers employed in sectors with high external finance dependence are more likely to become unemployed. They also find that the impact becomes stronger for workers in smaller firms.

If there were no offshoring activities, the present model would also predict that reducing credit constraints reduces the aggregate unemployment rate.[15] But note that even in the presence of offshoring, firms producing locally (which are smaller in size) demand more for labor, and thus put downward pressure on the unemployment. The present analysis suggests that reducing credit frictions will work against workers in offshoring firms when

[15] If there is no offshoring, the term $a_o^{1-k}[(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)}-1])$ in (33) drops. In this case, L_2 will be proportional with a_d^{1-k}. Since reducing r_b decreases with a_d, the policy will increase L_2, which in turn lowers the unemployment rate.

tasks are highly substitutable and/or the production is less labor intensive.

3.2 Further Exposure to Offshoring

This section investigates the impact of a further exposure to offshoring in the form of a reduction in the variable and fixed offshoring costs (i.e., $\tau \downarrow$ and $f_o \downarrow$) on the mass of entrepreneurs, income distribution, and unemployment. Since most of the implications of these policies are the same, I will discuss the implications of a reduction in the fixed offshoring costs f_o in the appendix. A reduction in the variable offshoring cost τ increases the task cutoff j_o, and thus increases the number of tasks performed abroad. Although reducing τ does not affect the mass of entrepreneurs, it increases the mass of offshoring entrepreneurs (see Lemmas 2 and Lemma 3).

According to equations (24) and (25), reducing the variable offshoring cost τ does not affect either wage w_i or job-finding rate ζ_i, and thus the average wage income of workers remains the same. Since a_d and w remain the same, equation (30) implies that the income of entrepreneurs who produce domestically does not change either. However, a further exposure to offshoring increases the income of offshoring entrepreneurs as indicated by equation (30). Figure 3 shows the impact of reducing τ on the income distribution.[16] Clearly such a shift in the income distribution will also increase aggregate income E. The welfare implications of this policy are the same.

Since reducing τ does not affect the ability cutoff a_d and the job-finding rate ζ_1, a reduction in τ decreases the aggregate unemployment rate if and only if it increases the labor input L_2 as indicated by equation (34). To find how L_2 responds to this policy, consider again the labor demand function $\ell_2(a)$ given by (32). As discussed in Section 2.5, $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} > 1$ is likely to hold when $\sigma \ll 1/(1-\theta)$, and $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} < 1$

[16] Although a reduction in τ increases the income of existing offshoring entrepreneurs, it also expands this pool with new entrepreneurs who have lower earnings. In the equilibrium, the latter effect dominates the first one, and thus the average income of *offshoring* entrepreneurs decreases. However, since the income of each entrepreneur either stays the same or increases while the mass of entrepreneurs remains the same, the average income of *all* entrepreneurs increases; consequently, the inequality between entrepreneurs and workers will increase.

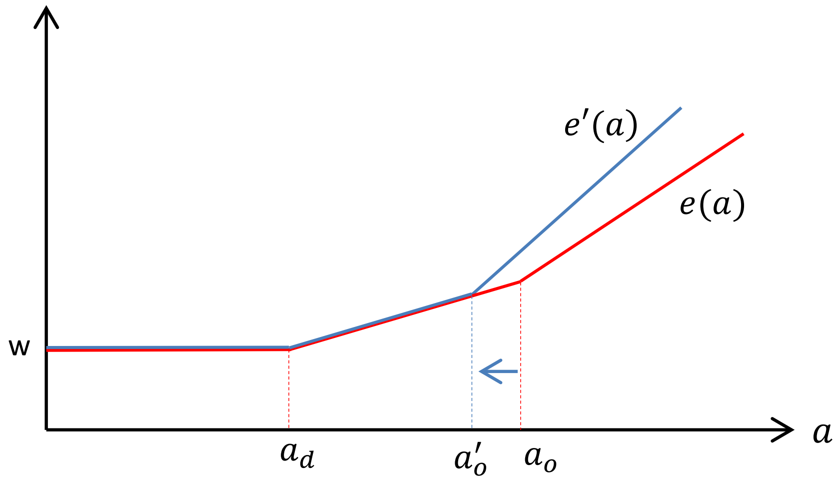


Figure 3: Impact of Reducing Offshoring Cost τ on Income Distribution

always holds if $\sigma \geqslant 1/(1-\theta)$. Furthermore, Appendix A.6 shows that a reduction in τ is likely to increase $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)}$ when $\sigma \ll 1/(1-\theta)$; and always decreases it if $\sigma \geqslant 1/(1-\theta)$.

Figures 4.a and 4.b show the impact of this policy on labor demand function $\ell_2(a)$ when $\sigma \ll 1/(1-\theta)$ and $\sigma \geqslant 1/(1-\theta)$, respectively. These figures are similar to Figures 2.a and 2.b, except now there is no change in the ability cutoff a_d. In Figure 4.a, the total area under solid blue lines is greater than that under the solid red lines, and thus the policy increases L_2. In this case, the aggregate unemployment rate falls (recall that $\zeta_2 > \zeta_1$). According to Figure 4.b, reducing τ decreases the demand for domestic labor by the offshoring entrepreneurs, and thus L_2 decreases. In this case, a reduction in τ always increases the aggregate unemployment rate. In all other cases, this policy has an ambiguous effect on the unemployment rate.

Proposition 2. *Consider the small open economy as described. A reduction in the variable offshoring cost* τ

a. does not affect the supply of workers and entrepreneurs;

b. increases the mass of offshoring entrepreneurs and the number of tasks offshored;

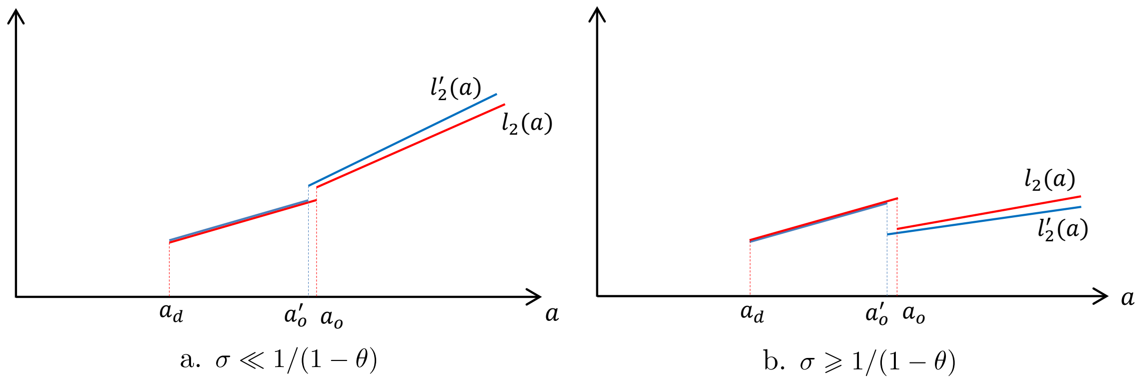


Figure 4: Impact of Reducingτ on $\ell_2(a)$

c. *makes both new and existing entrepreneurs better off, while having no impact on the well-beings of other individuals;*

d. *improves aggregate welfare;*

e. *more likely decreases* [increases] *aggregate unemployment rate if* $\sigma \ll 1/(1-\theta)$ $[\sigma \geqslant 1/(1-\theta)]$.

The prediction that offshoring firms are more productive is consistent with Kasahara and Lapham (2013) who, using Chilean plant-level data, show that firms importing intermediate goods tend to be larger and more productive, a finding that support the model's prediction. Their analysis also suggest that policies that impede import of intermediate goods have a large negative effect on the export of final goods since imports and exports complement each other. This finding is also largely consistent with the model's prediction. In the present model, when tasks are more complementary with each other, a reduction in variable offshoring cost τ will reduce the relative cost of offshoring W_o more substantially, which in turn increases total output produced by offshoring firms as indicated by (13). The increased output presumably contributes to the country's total export.[17]

[17]In the present model, perfectly competitive product market assumption makes the identity of exporting firms indeterminate; consequently, it is possible that offshoring firms just sell their output in the domestic market, whereas some non-offshoring firms may just export their output.

The finding that changing offshoring costs changes the set of imported intermediate goods is consistent with Goldberg et al. (2010) who, using a detailed trade and firm-level data from India, show that a reduction in trade costs induce firms to increase their import of intermediate goods, which in turn helps firms to introduce new products. Similarly, Gopinath and Neiman (2013) report that the majority of the import collapse in the Argentine 2001–2002 crisis stemmed from a decline in intermediate-good imports.

Finally, the model's prediction that the impact of offshoring on labor demand in each sector crucially depends on the elasticity of substitution between tasks and the labor share θ provides an explanation for why empirical studies are inconclusive about the impact of offshoring on employment. For example, using a detail firm-level data from Denmark, Hummels et al. (2014) show that offshoring is associated with a reduction in employment among low-skill workers. However, using plant-level data from Germany, Moser et al. (2015) find that offshoring increases the employment at plant-level; and in particular, the net employment growth of offshoring plants is higher than non-offshoring plants.

Groizard et al. (2014) also highlight the importance of several factors in determining the impact of offshoring on unemployment. In their two-sector model, preferences are non-homothetic over a homogeneous good (which used only domestic labor) and a set of differentiated products (which can use both domestic and foreign labor); worker supply is fixed, and differentiated products are produced monopolistically by heterogeneous firms as in Melitz (2003). They show that the impact of a reduction in offshoring costs on the aggregate unemployment rate crucially depends on two parameters: elasticity of substitution between two tasks (denoted by ρ in the paper), and the elasticity of demand for the composite differentiated product (denoted by η). In particular, they show that when the differentiated-good sector exhibits less labor-market frictions, reducing offshoring costs is likely to decrease the aggregate unemployment rate if ρ is low and η is high.

In the present model, preferences are Cobb-Douglas over two homogeneous goods, product markets are perfectly competitive, and the supply of workers are endogenously determined. As indicated in Proposition 2, a reduction in offshoring costs is likely to reduce the aggregate unemployment rate when the elasticity of substitution between two tasks (σ) is low and labor share θ is high (assuming that sector 2 exhibits less labor-market frictions). Thus, in Groizard et al.'s model the structure of preferences over two goods and the production technology of intermediate goods determine the impact of offshoring on unemployment, whereas in the present model the production technology used by entrepreneurs becomes an important factor in results.

Egger et al. (2015) also investigate the implications of offshoring in a firm heterogeneity trade model with occupational choice.[18] In their setting, firms are monopolistically competitive, and each is owned and managed by an entrepreneur with different managerial ability. They show that if the share of offshoring firms is below a certain level, a reduction in τ induces less able individuals to become entrepreneurs and reallocates workers towards them. This reallocation in turn leads to a welfare loss when a country moves from autarky to offshoring. They also find that offshoring always increases the income inequality between entrepreneurs and workers a conclusion that the present model also predicts (see footnote 16).

In my model, if there were no offshoring, the aggregate welfare would be lower.[19] Why does not offshoring have a negative impact on the welfare? As shown by Baldwin and Robert-Nicoud (2014) in the Heckscher-Ohlin model, the negative impact of offshoring is not present when there is no change in the the terms of trade. In the present setting, since the relative price of good 2 is exogenously fixed, exposure (and further exposure) to offshoring neither affects wages nor the income of non-offshoring entrepreneurs, and thus does not induce less productive firms enter to the market.

[18] In an earlier version of their paper, Egger et al. introduce unemployment stemming from *fair-wage* considerations to their model. However, since tasks are aggregated through a Cobb-Douglas technology, the key role that the elasticity of substitution between tasks plays in unemployment is not captured in their model.

[19] The aggregate income without offshoring can be found by setting $f_o \to \infty$ in (31). In this case, $f_o A^{-k} \to 0$, and thus E becomes smaller and so does $\mathbb{V}$ (recall that p is fixed).

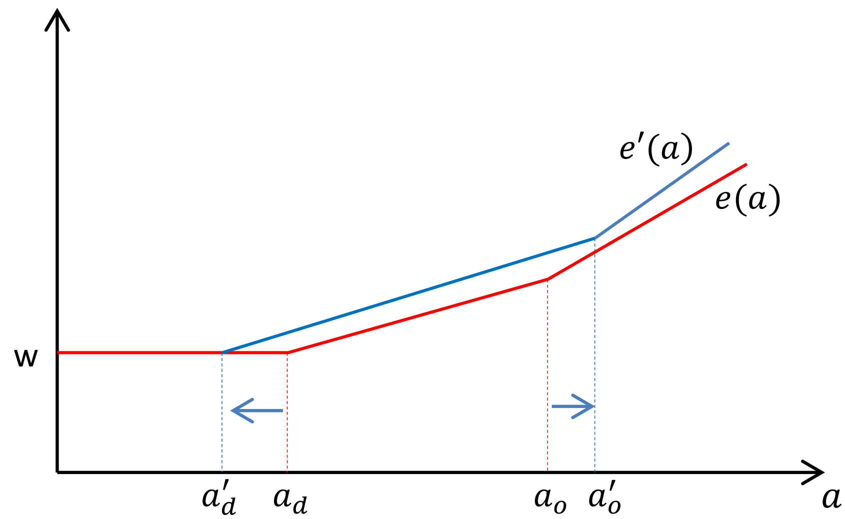


Figure 5: Impact of Reducing Frictions in Sector 2 on Income Distribution

3.3 Reducing Labor-Market Frictions

In this section, I will investigate the impact of reducing labor-market frictions in Sector 2. This policy is achieved through a reduction in δ_2 and/or an increase in μ_2; and in either case, the unit-labor cost of domestic production c_2 will decrease. According to Lemma 1, a reduction in c_2 induces offshoring firms to decrease the number of tasks that they offshore. In addition, lower cost of production makes entrepreneurship more attractive; as a result, more individuals become entrepreneurs (i.e., $a_d \downarrow$). But the impact of this policy on the mass of offshoring entrepreneurs is ambiguous as indicated by Lemma 3.

According to equations (24a) and (24b), reducing frictions in sector 2 reduces the wage rate w_2, and has no impact on the wage rate w_1 paid in sector 1. However, the reduction in w_2 is compensated by a proportional increase in the job-finding rate ζ_2; as a result, the average wage income of workers w does not change. Since a reduction in c_2 lowers aggregate wage index W as shown in Appendix A.3, this policy increases the income of all entrepreneurs. Figure 5 presents the impact of reducing labor-market frictions on income distribution where it also increases the ability cutoff a_o.[20] Such a shift in the income

[20]Although reducing labor-market frictions in sector 2 increases the average income of *offshoring* entrepreneurs, it decreases the average income of *all* entrepreneurs. Thus, the inequality between offshoring

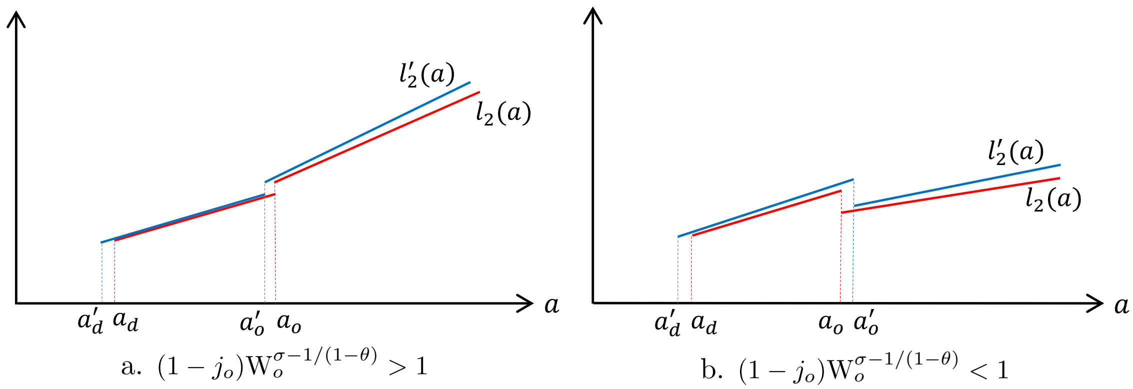


Figure 6: Impact of Reducing c_2 on $\ell_2(a)$

distribution clearly increases aggregate income and welfare (see also Appendix A.8).

Reducing labor-market frictions in sector 2 has no impact on the job-finding rate ζ_1, but it reduces the ability cutoff a_d; as a result, the first term $(1-\zeta_1)G(a_d)$ in equation (34) decreases. It clearly increases the job-finding rate ζ_2, and thus the coefficient $(1-\zeta_1/\zeta_2)$ as well. To see how this policy affects the aggregate labor input L_2, consider again the labor demand function $\ell_2(a)$ given by (32). As shown in Appendix A.8, a reduction in c_2 increases the demand for the domestic labor both for non-offshoring and offshoring firms.

Figures 6.a and 6.b represent the impact of this policy on the demand function $\ell_2(a)$ for $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} > 1$ and $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} < 1$, respectively. According to Lemma 3, this policy reduces the ability cutoff a_o in Figure 6.a and increases it in Figure 6.b. In either case, the total amount of labor employed in sector 2 increases, i.e. $L_2 \uparrow$. Consequently, unlike the two previous policies, reducing labor-market frictions in sector 2 always lowers the aggregate unemployment rate (it was assumed that $\zeta_2 > \zeta_1$).

Proposition 3. *Consider the small open economy as described. A reduction in labor-market frictions in sector 2*

a. induces more individuals to become entrepreneurs;

entrepreneurs and workers increases, and that between all entrepreneurs and workers decreases (proofs are available upon request).

b. increases the mass of offshoring entrepreneurs, but reduces the number of tasks offshored;

c. has no impact on well-being of workers in sector 1, makes workers in sector 2 worse off and entrepreneurs better off;

d. improves aggregate welfare;

e. reduces the aggregate unemployment rate.

The model's prediction that reducing labor-market frictions in sector 2 reduces the aggregate unemployment is similar to Groizard et al. (2014). This result is also consistent with other recent trade models that have investigated the impact of reducing labor-market frictions on unemployment (see, e.g., Helpman and Itskhoki (2010); Dinopoulos and Unel (2015 and 2016) among others).

4 Conclusion

This paper develops a two-sector, small-open-economy model of offshoring where product markets are perfectly competitive, labor markets exhibit frictions stemming from job search and matching, and firms face credit constraints. Individuals are heterogeneous with respect to their managerial ability, and depending on their skills and labor market conditions, they choose to become a worker or an entrepreneur.

The paper finds that reducing credit constraints induce more individuals to become entrepreneurs, increases offshoring both extensive and intensive margins, and makes both workers and entrepreneurs better off. It lowers the aggregate unemployment, if the tasks are more complementary and entrepreneurs' span of control is high. The paper also find that a further exposure to offshoring increases offshoring both at the extensive and intensive margins, makes offshoring entrepreneurs better off while having no impact on the rest of individuals, and increases the aggregate welfare. It decreases (increases) the aggregate unemployment if tasks are less (more) substitutable and entrepreneurs' span of control is high (low). Finally, reducing labor-market frictions in sector 2 induces more individuals to become entrepreneurs. It increases offshoring in intensive margin, but its impact on the mass of offshoring entrepreneurs is ambiguous. Reducing frictions also makes all entrepreneurs better off, increases the aggregate welfare, and reduces the unemployment.

The present model considers offshoring in a small open economy context, and thus assumes away the impact of changes in the terms of trade on allocation of resources. It will be interesting to study how credit constraints affect decision to offshore, income distribution and welfare, and unemployment in a two-country model. Another possible extension is to introduce human capital formation into the model. Unel (2015) and Dinopoulos and Unel (2016) introduce human capital formation into a two-sector trade model and study the impact of trade on human capital acquisition and income distribution. This extension will be interesting because human capital formation affects the decision to offshore and unemployment rate, and may uncover several interesting points related to offshoring and unemployment.

Appendix

A.1. Proof of Lemma 1

Differentiating (8) with respect to r_b, τ, f_o, and c_2 yields

$$\frac{dj_o}{dr_b} = -\frac{\kappa x(j_o)}{(1+\kappa r_b)x'(j_o)} < 0, \quad \frac{dj_o}{d\tau} = -\frac{x(j_o)}{\tau x'(j_o)} < 0, \quad \frac{dj_o}{df_o} = 0, \quad \frac{dj_o}{dc_2} = \frac{x(j_o)}{c_2 x'(j_o)} > 0. \quad \text{(A.1)}$$

A.2. Proof of Lemma 2

Differentiating the ability cutoff a_d from (27) with respect to r_b, τ, f_o, and c_2 yields

$$\frac{da_d}{dr_b} = \frac{\gamma(1+\kappa r_b)f_b - \kappa \mathrm{w}}{\gamma(1+\kappa r_b)} > 0, \quad \frac{da_d}{d\tau} = \frac{da_d}{df_o} = 0, \quad \frac{da_d}{dc_2} = \frac{\theta a_d}{(1-\theta)c_2} > 0, \qquad \text{(A.2)}$$

where I assumed that $\gamma(1+r_b)f_b > \mathrm{w}$.

A.3. Proof of Lemma 3

Differentiating W_o from (12) with respect to r_b and using $dx(j_o)/dr_b = -\kappa x(j_o)/(1+\kappa r_b)$ yields

$$\frac{d\mathrm{W}_o}{dr_b} = \frac{\kappa \mathrm{W}_o^{\sigma}}{1+\kappa r_b}\int_0^{j_o}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj > 0. \qquad \text{(A.3)}$$

Differentiating a_o from (28) with respect to r_b and using (A.3) yields

$$\frac{da_o}{dr_b} = \frac{a_o}{1+r_b} + \frac{a_o\theta\kappa \mathrm{W}_o^{\sigma-1}\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj}{(1-\theta)(1+\kappa r_b)\left(1-\mathrm{W}_o^{\theta/(1-\theta)}\right)} > 0. \qquad \text{(A.4)}$$

Differentiating W_o from (12) with respect to τ and using $dx(j_o)/d\tau = -x(j_o)/\tau$ yields

$$\frac{d\mathrm{W}_o}{d\tau} = \frac{\mathrm{W}_o^{\sigma}}{\tau}\int_0^{j_o}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj > 0. \qquad \text{(A.5)}$$

Now differentiating a_o from (28) with respect to τ and using the above equation yields

$$\frac{da_o}{d\tau} = \frac{a_o\theta \mathrm{W}_o^{\sigma-1}\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj}{\tau(1-\theta)\left(1-\mathrm{W}_o^{\theta/(1-\theta)}\right)} > 0. \qquad \text{(A.6)}$$

Since j_o is independent of f_o, it then follows that W_o is independent of f_o as well. Differentiating (28) with respect to f_o yields

$$\frac{da_o}{df_o} = \frac{a_o}{f_o} > 0. \qquad \text{(A.7)}$$

Finally, differentiating W_o with respect to c_2 and using $dx(j_o)/dc_2 = x(j_o)/c_2$ yields

$$\frac{d\mathrm{W}_o}{dc_2} = -\frac{\mathrm{W}_o^\sigma}{c_2}\int_0^{j_o}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj < 0. \tag{A.8}$$

Consider now aggregate wage index W given by (11). It is easy to show that

$$\frac{d\mathrm{W}}{dc_2} = \begin{cases} 1 & a \in [a_d, a_o) \\ (1-j_o)\mathrm{W}_o^\sigma & a \geqslant a_o \end{cases}$$

Thus, $d\mathrm{W}/dc_2 > 0$.

Differentiating a_o with respect to c_2 and using (A.8) yields

$$\frac{da_o}{dc_2} = \frac{\theta a_o}{(1-\theta)c_2}\left[1 - \frac{\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj}{(1-\mathrm{W}_o^{\theta/(1-\theta)})\mathrm{W}_o^{1-\sigma}}\right]. \tag{A.9}$$

Note that $da_o/dc_2 < 0$ if and only if the expression in the square brackets is negative:

$$\frac{da_o}{dc_2} < 0 \;\Leftrightarrow\; \frac{\int_0^{j_o} x(j)dj/x(j_o)}{\mathrm{W}_o^{1-\sigma}} > 1 - \mathrm{W}_o^{\theta/(1-\theta)} \;\Leftrightarrow\; (1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} < 1.$$

If $\sigma \geqslant 1/(1-\theta)$, the last inequality always holds (since $\mathrm{W}_o < 1$). For $\sigma < 1/(1-\theta)$, the last inequality may not hold, and thus $da_o/dc_2 \gtrless 0$. However, note that the expression $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\eta)}$ can be written as

$$(1-j_o)\mathrm{W}_o^{\sigma-\frac{1}{1-\theta}} = \left(\frac{1-j_o}{\mathrm{W}_o^{1-\sigma}}\right)\mathrm{W}_o^{-\frac{\theta}{1-\theta}} = \left(\frac{1-j_o}{\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj + 1 - j_o}\right)\mathrm{W}_o^{-\frac{\theta}{1-\theta}}.$$

First, consider the ratio in parentheses in front of $\mathrm{W}_o^{-\theta/(1-\theta)}$. It is less than 1, and decreases with σ (since $x(j)/x(j_o) < 1$). Second, consider $\mathrm{W}_o^{-\theta/(1-\theta)}$ which is greater than 1 because $\mathrm{W}_o < 1$. Note that it increases with θ. It then follows from these findings that the expression $(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} > 1$ is likely to hold if σ is small and θ is high.

A.4. Aggregate Income

By the law of large numbers, the number of individuals who work in sector i is given by $\zeta_i N_i$. The total payment to workers then is

$$\mathrm{w}_1\zeta_1 N_1 + \mathrm{w}_2\zeta_2 N_2 = \mathrm{w}(N_1 + N_2) = \mathrm{w}G(a_d) = \mathrm{w} - \mathrm{w}a_d^{-k}.$$

The aggregate income of domestic entrepreneurs is given

$$\int_{a_d}^{a_o} e_2(a)g(a)da = \frac{k[\mathrm{w} + (1+r_b)f_d](1 - A^{-k+1})}{(k-1)a_d^k} - (1+r_b)f_d(a_d^{-k} - a_o^{-k}).$$

The aggregate income of offshoring entrepreneurs is

$$\int_{a_o}^{\infty} e_2(a)g(a)da = \frac{k[\mathrm{w} + (1+r_b)f_d]A^{-k+1}}{(k-1)a_d^k \mathrm{W}_o^{\theta/(1-\theta)}} - (1+r_b)(f_o+f_d)a_o^k.$$

Adding these aggregate incomes and using $A[\mathrm{w}+(1+r_b)f_d][\mathrm{W}_o^{\theta/(1-\theta)} - 1] = (1+r_b)f_o$ from (29) yields (31).

A.5. Proof of Proposition 1

Let $\hat{\mathrm{W}}_o = (1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)} - 1$, and differentiating it with respect to r_b and using (A.1) and (A.3) yields

$$\frac{d\hat{\mathrm{W}}_o}{dr_b} = \frac{\kappa \mathrm{W}_o^{\sigma-\frac{1}{1-\theta}}}{1+\kappa r_b}\left[\frac{x(j_o)}{x'(j_o)} + (\sigma - 1/(1-\theta))(1-j_o)\mathrm{W}_o^{\sigma-1}\int_0^{j_0}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj\right].$$

Note that $d\hat{\mathrm{W}}_o/dr_b$ is always positive if $\sigma \geqslant 1/(1-\theta)$. It can be negative only if $\sigma < 1/(1-\theta)$, because $x(j_o)/x'(j_o) > 0$. Since $(1-j_o)\mathrm{W}_o^{\sigma-1}\int_0^{j_0}[x(j)/x(j_o)]^{1-\sigma}$ is smaller than one, it then follows that the RHS can be negative when σ is small and θ is high, i.e. $d\hat{\mathrm{W}}_o/dr_b < 0$ if $\sigma \ll 1/(1-\eta)$.

Differentiating L_2 with respect to r_b yields

$$\text{Sign}\left\{\frac{dL_2}{dr_b}\right\} = \text{Sign}\left\{(1-k)a_d^{-k-1}\frac{da_d}{dr_b} + (1-k)\hat{\mathrm{W}}_o a_o^{-k-1}\frac{da_o}{dr_b} + a_o^{-k}\frac{d\hat{\mathrm{W}}_o}{dr_b}\right\}.$$

Note that $da_d/dr_b > 0$ and $da_o/dr_b > 0$ from equations (A.2) and (A.4), and $k > 1$. Thus, if $\hat{\mathrm{W}}_o > 0$, then $d\hat{\mathrm{W}}_o/dr_b < 0$ is a sufficient condition for $dL_2/dr_b < 0$. If $\hat{\mathrm{W}}_o < 0$, then the second term on the RHS is positive; and this case, $dL_2/dr_b \gtrless 0$.

A.6. Proof of Proposition 2

Differentiating $\hat{\mathrm{W}}_o$ with respect to τ and using (A.1) and (A.5) yields

$$\frac{d\hat{\mathrm{W}}_o}{d\tau} = \frac{\mathrm{W}_o^{\sigma-\frac{1}{1-\theta}}}{\tau}\left[\frac{x(j_o)}{x'(j_o)} + (\sigma - 1/(1-\theta))(1-j_o)\mathrm{W}_o^{\sigma-1}\int_0^{j_0}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj\right].$$

Note that the above expression can be negative when σ is small and θ is high, i.e. $\sigma \ll 1/(1-\theta)$. It is always positive when $\sigma \geqslant 1/(1-\theta)$.

Differentiating L_2 with respect to τ yields

$$\text{Sign}\left\{\frac{dL_2}{d\tau}\right\} = \text{Sign}\left\{(1-k)\hat{\mathrm{W}}_o a_o^{-k-1}\frac{da_o}{d\tau} + a_o^{-k}\frac{d\hat{\mathrm{W}}_o}{d\tau}\right\}.$$

Note that $da_o/d\tau > 0$ and $k > 1$. If $\hat{\mathrm{W}}_o > 0$, then $d\hat{\mathrm{W}}_o/d\tau < 0$ is a sufficient condition for $dL_2/d\tau < 0$. It then follows that $dL_2/d\tau < 0$, if $\sigma \ll 1/(1-\theta)$. When $\sigma \geqslant 1/(1-\sigma)$, it then follows $\hat{\mathrm{W}}_o < 0$ and $d\hat{\mathrm{W}}_o/d\tau > 0$. In this case, $dL_2/d\tau > 0$.

A.7. Reducing Fixed Offshoring Cost f_o

In this section, I will investigate the impact of a reduction in fixed offshoring cost f_o on this economy. Note that this policy does not change the ability cutoff a_d, but decreases offshoring ability cutoff a_o. Consequently, its income distribution and welfare implications are the same as that of reducing variable offshoring cost τ (see also Figure 4).

A reduction in f_o does not affect the task cutoff j_o, and thus $\hat{\mathrm{W}}_o$ does not change. Since a_o decreases, it then follows from equation (34) that L_2 increases [decreases] if $\hat{\mathrm{W}}_o > 1$ [$\hat{\mathrm{W}}_o < 1$]. But recall that $\hat{\mathrm{W}}_o > 1$ is more likely to hold when $\sigma \ll 1/(1-\theta)$, and $\hat{\mathrm{W}}_o < 1$ always holds if $\sigma \geqslant 1/(1-\theta)$. It then follows that a reduction in f_o is likely to decrease unemployment if $\sigma \ll 1/(1-\theta)$, and always increases unemployment if $\sigma \geqslant 1/(1-\theta)$ as in the case of a reduction in the variable trade cost τ.

A.8. Proof of Proposition 3

Differentiating E from (31) with respect to c_2 yields

$$(k-1)\frac{dE}{dc_2} = -k[\mathrm{w} + (1+r_b)f_d]a_d^{-k-1}\frac{da_d}{dc_2} - k(1+r_b)f_o a_o^{-k-1}\frac{da_o}{dc_2}.$$

Substituting da_d/dc_2 from (A.2) and da_o/dc_2 from (A.9) into the above equation and rearranging the terms yields

$$\frac{dE}{dc_2} = -\frac{k\theta[A^{k-1} - 1 + (1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)}]}{(k-1)(1-\theta)c_2(\mathrm{W}_o^{-\theta/(1-\theta)} - 1)a_d^k} < 0,$$

where the inequality follows from $A > 1$.

Let $Z = c_2^{-1/(1-\theta)}(1-j_o)\mathrm{W}_o^{\sigma-1/(1-\theta)}$, and differentiating Z with respect to c_2 and using (A.1) and (A.8) yields

$$\frac{dZ}{dc_2} = -\frac{Z}{(1-\theta)c_2}\left\{\frac{(1-\theta)x(j_o)}{(1-j_o)x'(j_o)} + 1 + [\sigma(1-\theta)-1]\mathrm{W}_o^{\sigma-1}\int_0^{j_o}\left[\frac{x(j)}{x(j_o)}\right]^{1-\sigma} dj\right\}.$$

Note that $\mathrm{W}_o^{\sigma-1}\int_0^{j_o}[x(j)/x(j_o)]^{1-\sigma}dj \in (0,1)$, and $\sigma(1-\theta) \geqslant 0$. It then follows that the expression in curly brackets is always positive, and thus $dZ/dc_2 < 0$.

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