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Entrepreneurs, jobs, and trade

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ABSTRACT

We propose a simple theory of endogenous firm productivity, unemployment, and top income inequality. High-talented individuals choose to become self-employed entrepreneurs and acquire more managerial (human) capital; whereas low-talented individuals become workers and face the prospect of equilibrium unemployment. In a two-country global economy, trade openness raises firm productivity, increases top income inequality, and may reduce welfare in the country exporting the good with lower relative labor-market frictions. Trade openness reduces firm productivity, lowers top income inequality, and necessarily raises welfare in the other country. The effect of trade on unemployment is ambiguous. Unilateral job-creating policies increase welfare in both countries. However, they reduce unemployment and raise top income inequality in the policy-active country; and reduce top income inequality while increasing unemployment in the policy-passive country.

1. Introduction

Globalization has steadily intensified in the postwar period primarily due to technological progress and reduction in trade barriers. During the same period, top income inequality in the U.S. and Europe has been increasing as well with the U.S. experiencing a steeper rise in top 10 percent inequality index (Piketty and Saez, 2014). As a result, the gap in top income inequality between the U.S. and Europe has widened. In addition, the 2007–08 financial crisis and its offspring, the great trade collapse of 2008-09, generated high persistent unemployment in the U.S. and several European countries.[2]

These concurrent developments have generated renewed interest among economists and policy makers in addressing several questions regarding the nexus among trade, inequality, and labor-market rigidities. What are the determinants of comparative advantage in a global economy with sector-specific labor-market frictions and endogenous firm productivity? What are the effects of trade openness and unilateral job-creating policies on top income inequality, unemployment,

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[2] For instance, U.S. unemployment stayed above 7.5 percent for more than five years; and Europe experienced double-digit persistent unemployment, reaching over 25 percent in Greece and Spain. Conceptually, unemployment is a source of extreme poverty and thus it constitutes a measure of bottom income inequality. In other words, top income inequality and unemployment are upper and lower bounds of *extreme* income inequality. Interestingly, during the great recession the rise in U.S. unemployment coincided with the collapse in trade and decline in top inequality.

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productivity and welfare? Are these affects similar or different across countries? And if different, what are the sources of these differences?

The present paper proposes a new tractable two-country model of inter-industry trade featuring occupational choice, endogenous firm productivity, and labor-market frictions. Sector and country-specific sources of firm productivity and labor-market frictions govern the effects of trade openness and unilateral job-creating policies through their impact on comparative advantage. These trade and job-creating policies lead to asymmetric effects across countries because they work through each country's terms of trade.

Labor is the primary factor of production in each country consisting of a unit measure of individuals differing in innate entrepreneurial ability (managerial talent). Each economy produces two homogeneous goods under perfect competition. The assumption of perfectly competitive product markets offers analytical mileage and leads to inter-industry trade based on comparative advantage. Good 1, referred as the outside good, is produced by single-worker firms as in the standard Diamond–Mortensen–Pissarides (DMP) theory of equilibrium unemployment (Pissarides, 2004). Firm productivity is exogenous and entrepreneurs play no role in the outside good. All action takes place in good 2, which we refer to as the entrepreneur-intensive good. Output is produced by multiple-worker firms managed by self-employed entrepreneurs. The entrepreneur-intensive good exhibits endogenous firm-level productivity. Firms face labor-market frictions stemming from search and matching as in Helpman and Itskhoki (2010): hiring is costly and the wage is determined through bargaining as in Stole and Zwiebel (1996).

One methodological innovation of our work is the modeling of firm-level productivity. Inspired by the work of Griliches (1979) and endogenous growth theory, we assume that firm-specific productive efficiency is modeled by a knowledge production function according to which firm productivity increases with managerial (e.g., entrepreneurial, organization, or knowledge) capital. Managerial capital is treated as a separate, firm-specific factor of production capturing all information flows and managerial decisions influencing firm productive efficiency.[3] We assume that the costs of acquiring managerial capital decline with the entrepreneurial talent of the firm's owner and increase with managerial capital.

Worker productivity is independent of managerial talent and entrepreneurial income equals firm profit as in Lucas (1978).[4] High-talented individuals choose to become self-employed entrepreneurs, whereas individuals with low managerial talent choose to become workers facing the threat of unemployment. In addition, entrepreneurs acquire more managerial capital; manage larger, more productive, and more profitable firms and enjoy higher earnings. Differences in entrepreneurial ability generate firm and income heterogeneity among entrepreneurs which translates into top income inequality.

We begin our analysis by characterizing the closed-economy equilibrium which serves as a benchmark case for studying the effects of trade openness. We then analyze a global economy with two countries differing in the degree of labor-market frictions and cost of managerial capital. We also identify parameter restrictions under which the global economy features two regions, Home (America) with more flexible labor markets and Foreign (Europe) with less flexible labor markets. The use of America–Europe dichotomy follows the spirit of the theoretical literature analyzing the effects of cross-country asymmetries in labor-market frictions (e.g., Davis, 1998a, 1998b).[5] Specifically, we identify sufficient conditions under which Home has comparative advantage in the entrepreneur-intensive good.

The model delivers several novel results. The closed-economy market equilibrium is inefficient entailing an under-supply of entrepreneurs and leading to a lower relative price of good 2. The source of this welfare distortion comes from the Stole and Zwiebel (1996) wage bargaining solution, the standard modeling bargaining framework in multiple-worker firms. The Stole and Zwiebel solution requires that the negotiated wage is set lower than the value of the marginal product of labor. In other words, each entrepreneur acts as if she faces a lower demand for her product resulting in lower earnings and inducing less individuals to become entrepreneurs.

Trade openness (captured by a move from autarky to free trade) improves each country's terms of trade by increasing the relative price of the entrepreneur-intensive good in Home and lowering it in Foreign. Home experiences an increase in firm productivity, firm profit and top income inequality. Trade openness causes a decline in firm productivity, firm profit, and top income inequality in Foreign. Thus trade openness has asymmetric effects across the two countries because it works through changes in each country's terms of trade.

The effect of trade openness on unemployment is ambiguous. It affects unemployment through the occupational-choice channel and the worker-reallocation channel. A trade-triggered increase in the relative price of good 2 leads to a reduction in aggregate unemployment by inducing more workers, who face the threat of unemployment, to become self-employed entrepreneurs. However, the relative price increase leads to a reallocation of workers from the outside-good sector to the

[3] Gennaioli et al. (2013), using establishment-specific and regional data from 110 countries, find a robust positive correlation between entrepreneurial inputs including human capital and firm-level productivity. They conclude that human capital acquired by workers and especially entrepreneurs accounts significantly for regional differences in economic development.

[4] Firm profits and the related return on capital have played a central role in emerging models of top income inequality. One reason is that capital income including rent, dividends, business profits, capital gains accounts for much of the rise in top income inequality in the U.S. (Jones, 2015).

[5] This dichotomy is made for purely expositional purposes. Cross-country differences in labor market frictions are more complex. For instance, Botero et al. (2004) argue convincingly that countries with socialist, French, and Scandinavian legal origins have more regulated and thus less flexible labor markets than English-speaking countries. Nickell (1997) provides an empirical discussion and assessment of labor-market rigidities between Europe and North America.

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entrepreneur-intensive sector, as in Helpman and Itskhoki (2010). This channel reduces unemployment if and only if the entrepreneur-intensive sector exhibits lower labor-market frictions. In this case, trade openness reduces unemployment in the country exporting the entrepreneur-intensive good and increases unemployment in the other country. However, if the entrepreneur-intensive sector exhibits higher labor-market frictions, these two channels work in opposite directions and result in an ambiguous effect of trade on unemployment.

Trade openness raises the possibility of welfare loss in the country exporting good 2 (Home) and always raises welfare in the other country (Foreign). An increase in the relative price lowers welfare directly by increasing the price index and raises welfare indirectly by increasing consumer income. For low initial prices the price effect dominates whereas for high prices the income effect prevails. Thus welfare is a U-shaped function of the relative price and attains its minimum at a price which is higher than the autarky price, thanks to the wage-bargaining distortion mentioned earlier. This reasoning implies that each country's autarky price is located on the downward-sloping segment of its welfare function. Consequently, a small increase in the relative price of good 2, caused by trade openness as in the case of weak comparative advantage, reduces Home welfare, whereas a sufficiently large increase in the relative price increases Home welfare. Foreign experiences a decline in the relative price of good 2, as a result of trade openness, moves away from its welfare-minimizing price, and thus witness a welfare improvement independently of the price decline magnitude.

Governments implement job-creating policies in response to high unemployment rates. We model these policies as a reduction in the costs of job vacancies or a reduction in the costs of managerial capital. Starting in the free-trade equilibrium these policies increase labor-market flexibility and strengthen the comparative advantage of the policy implementing country. As such, unilateral job-creating policies implemented by Home share some of the same features as trade openness: they reduce unemployment, raise firm productivity, and increase top income inequality in Home; and increase unemployment, lower firm productivity, and reduce top income inequality in Foreign.

However, these policies reduce the common free-trade price for both countries leading to an increase in each country's welfare despite the presence of labor-market frictions. Home welfare rises because job-creating policies increase its income and reduce the price index. Foreign is located in the downward-sloping segment of its welfare function. As a result, a reduction in the relative price moves Foreign away from its welfare-minimizing price and leads to higher Foreign welfare.

Our main findings are consistent with empirical evidence. The finding that more talented entrepreneurs manage larger firms and receive higher income is consistent with the study of Gabaix and Landier (2008) according to which CEO pay in the U.S. between 1980 and 2003 can be fully explained by the increase in the size of large companies. The finding that trade affects firm-level productivity is consistent with recent studies documenting a positive correlation between exporting and firm productivity stemming from technology adoption (i.e., more managerial capital in our model).[6]

The finding that trade openness increases the gap in top inequality between Home and Foreign is consistent with the study of Piketty and Saez (2014). They report that the gap in top income inequality between the U.S. and Europe increased steadily from 4 percent in the 1970s to 11 percent in 2010.

The result that the effect of trade on unemployment is generally ambiguous and depends on sector-specific labor-market frictions is consistent with the empirical literature on trade and unemployment. For instance, according to Felbermayr et al. (2011b), higher trade openness is associated with lower structural unemployment in OECD countries. Autor et al. (2013) argue that import competition raises U.S. unemployment. Finally, Carrere et al. (2014) find that trade liberalization increases unemployment in countries exporting goods with strong labor-market frictions and decreases unemployment in countries exporting goods with weak labor-market frictions.

The rest of the paper is organized as follows. Section 2 offers a discussion of related studies. Section 3 presents the model and establishes the properties of the closed-economy equilibrium. Section 4 introduces the structure of a two-country global economy and analyzes the effects of trade openness and unilateral job-creating policies. Section 5 concludes.

2. Related literature

Our paper relates and contributes to several strands of literature. One strand of literature analyzes the effects of trade on firm-level productivity in the context of intra-industry trade and heterogeneous firms. For instance, Bustos (2011), Lileeva and Trefer (2010), and Unel (2013) analyze how exporting encourages the adoption of technology and raises firm productivity; and Gopinath and Neiman (2014) examine how economic crises reduce firm-level and aggregate productivity by increasing the costs of intermediate imported inputs. These studies treat technology as a binary choice according to which a firm incurs fixed costs to adopt a project that raises firm productivity by an exogenous amount. In contrast, the present model views technology adoption as a continuous process with variable costs which decline with managerial talent of the firm's owner.

Several studies have documented the pattern and role of entrepreneurial activities across advanced and developing countries (Reynolds et al., 2003; Acs and Virgill, 2010; Acs and Szerb, 2012). Our paper complements this literature by proposing a theoretical framework that can be used to analyze patterns of entrepreneurial activities and their contribution to extreme income inequality.

[6] See, for example, De Locker (2007) for Croatian firms, Lileeva and Trefer (2010) for Canadian firms, Bustos (2011) and Gopinath and Neiman (2014) for Argentinean firms.

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Another strand of literature analyzes the evolution and causes of top income inequality. This literature investigates a variety of dynamic factors shaping the evolution of top income and wealth inequality. These factors include institutions and the difference between the rates of return on capital and economic growth (e.g., Piketty and Saez, 2014; Acemoglu and Robinson, 2015; Jones, 2015, among many others). As far as we know, our study is the first to analyze the role of trade openness and labor-market frictions on top income inequality.

The effects of trade on income distribution and unemployment have been the focus of many studies. Most of them have employed the framework of monopolistic competition and heterogeneous firms (Melitz, 2003). One feature of Melitz-type models is lack of analytical tractability. Thus Manasse and Turrini (2001) and Monte (2011) study the effects of trade on income distribution in the context of two identical countries. Similarly, Egger and Kreickemeier (2009, 2012), Felbermayr et al. (2011a), and Dinopoulos and Unel (2014) study the effects of trade on income inequality and unemployment in models with symmetric countries. Our model contributes to this strand of literature by focusing on the effects of trade on *asymmetric* countries and on the impact of *unilateral* (as opposed to multilateral) job-creating policies.

Our paper is more closely related to the strand of literature that uses the standard Diamond–Mortensen–Pissarides (DMP) theory of equilibrium unemployment in the context of a global economy with asymmetric countries. In an important contribution, Davidson et al. (1999) developed a general-equilibrium search model of trade between two countries to investigate the robustness of the main results obtained in traditional, full-employment trade models.[7] In their model, differences in labor-market frictions across sectors and countries determine the pattern of trade as in our model. However, their work abstracts from occupational-choice considerations and endogenous firm productivity, both of which are fundamental features of our model. For instance, in our analysis, managerial-capital costs constitute a determinant of comparative advantage, and influences extreme income distribution.[8]

Another strand of literature addresses the impact of trade and technological change on wages and unemployment in the context of a global economy consisting of countries differing in labor-market rigidities. Davis (1998a, 1998b) analyzes the effects of trade openness and technical change in an integrated global economy with one country having minimum-wage based unemployment and another full employment and flexible wages. Felbermayr et al. (2013) analyze a two-country global economy and establish that unilateral reductions in economy-wide labor-market frictions reduce unemployment in both countries. In contrast, our model features endogenous factor supplies, endogenous firm productivity and occupational choice considerations leading to asymmetric effects of trade and unilateral job-creating policies. For instance, trade increases productivity in one country and reduces it in the other; and unilateral job-creating policies associated with sector-specific reductions in labor-market frictions create jobs in the country implementing the policy but destroy jobs in the policy-passive country.

Finally, Helpman and Itskhoki (2010) introduce search and matching frictions leading to equilibrium unemployment in a trade model with heterogeneous firms producing differentiated products. Helpman et al. (2010) introduce match-specific heterogeneity in ability across workers to study the impact of trade on wage distribution. Although modeling of labor-market frictions is the same as in Helpman and Itskhoki (2010) and Helpman et al. (2010), our model features occupational choice, endogenous firm productivity and perfectly competitive product markets. These features are absent from these two studies and lead to different results. Occupational choice allows us to study the effects of trade openness on top income inequality in the context of asymmetric countries. Endogenous firm productivity reveals another source of comparative advantage, that is country and sector-specific differences in the cost of managerial (human) capital. And perfectly competitive markets lead to the possibility of welfare reducing trade stemming from the interactions between wage-bargaining and occupational choice considerations.

3. The model

Consider an economy producing two homogeneous goods indexed by $i=1,2$. The economy is populated by a unit mass of identical families. Each family supplies labor, consisting of all family members, and has size equal to one. Family members differ in managerial talent (ability) indexed by a. In the present context, *managerial talent* is a broad generic term accounting for innate entrepreneurial ability, level of training or education, and any other attribute helping an individual to create and/or manage a firm. The distribution of talent is given by cumulative distribution $G(a)$ with density $g(a)$ and support $[1,\infty)$.

Decisions are made sequentially. An individual first decides whether to become an entrepreneur or a worker. A firm-owner with a given entrepreneurial talent chooses the optimal level of managerial capital, followed by how many workers to employ. The latter choice is conditioned to the presence of hiring costs stemming from search-related frictions. Each entrepreneur bargains with hired workers to determine the negotiated wage while treating the level of managerial capital and hiring costs as sunk. Entrepreneurial income equals firm profits as in Lucas (1978).

Each worker decides first in which sector to search for a job based on wage and job-finding considerations. Workers are ex-ante perfectly mobile between the two sectors but not ex-post, as in Helpman and Itskhoki (2010). Thus, once

[7] Davidson et al. (1999) build on Davidson et al. (1988) that study two-sector, closed-economy, general equilibrium models with frictional unemployment. Davidson and Matusz (2010) provides several extensions of the Davidson et al. (1999) model to study how international trade affects labor markets and how structural differences in labor markets affect international trade.

[8] Dutt et al. (2009) develop and test a model with equilibrium unemployment and trade based on comparative advantage. Their model abstracts from occupational-choice and managerial-capital considerations, and addresses different issues.

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committed, a worker can not switch sectors. Ex-post worker mobility across sectors leads to equalization of sector-specific unemployment rates contrary to evidence.[9] We also assume that, ex-post, unemployed workers could not change occupations and become self-employed entrepreneurs driving the rate of unemployment down to zero. Finally, we assume that each family engages in transfers among its members allowing unemployed workers to survive in the absence of unemployment compensation.

3.1. Preferences

Family members have identical preferences described by the following Cobb–Douglas utility function

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

where q_i is the consumption of good $i = 1, 2$, and $0 < \beta < 1$ is a parameter.

Denoting with e individual income (expenditure), the demand for good i is given by

$$q_i = \beta_i e / p_i, \tag{2}$$

where $\beta_1 = 1-\beta$, $\beta_2 = \beta$, and p_i is the price of good i. We choose good 1 as the model's numeraire by setting its price equal to one (i.e., $p_1 = 1$). To further simplify notation, we use p to denote the relative price of good 2.

Substituting q_i from (2) in (1) delivers the indirect utility function

$$v(e, p) = ep^{-\beta}, \tag{3}$$

which increases with income e and decreases with relative price p. The linear dependence of indirect utility on income indicates that individuals are risk neutral allowing aggregation among family members independently of intra-family income distribution. As a result, replacing individual with aggregate expenditure and taking into account that there is a unit mass of population in (3) yields an index of welfare.[10]

3.2. Firm productivity and wage bargaining

Production of outside good 1 is carried under perfect competition by identical, single-worker firms.[11] Each firm posts a job vacancy and hires one worker, but vacancies are not filled instantaneously due to labor-market frictions. When a firm hires a worker, the worker produces one unit of output independently of managerial talent. Upon matching, firm and worker bargain over revenue earned by selling one unit of output at $p_1 = 1$. Assuming equal bargaining power and zero value of outside options (e.g., no unemployment insurance provided by the government or firm), the worker receives $w_1 = 1/2$.

Good 2, which is the entrepreneur-intensive good, is produced by a continuum of heterogeneous firms under perfect competition with each firm created, owned, and managed by a single entrepreneur. The production function depends on the level of managerial (organization) capital and the number of hired workers. The former is modeled as a separate factor of production and denoted by z. As in Lucas (1978), we postulate that output exhibits diminishing returns with respect to managerial capital capturing "span of control" features. The production function of a firm with managerial capital z is given by

$$y_2(z) = \left(\frac{z}{1-\eta}\right)^{1-\eta}\left(\frac{l}{\eta}\right)^{\eta}, \tag{4}$$

where l is the number of workers employed and $\eta \in (0, 1)$ is an exogenous parameter capturing the share of labor in production. According to (4), firm productivity depends positively on managerial capital z and exhibits diminishing returns for any given number of hired workers l.

Following the insights of human capital theory (e.g., Becker, 1994), we postulate that an individual with managerial talent a faces $\lambda z^2/2a$ costs of acquiring z units of managerial capital, where $\lambda > 0$ is an exogenous shift parameter. The cost of managerial capital is measured in units of the outside good, declines with managerial talent a, and increases with managerial capital z. The proposed cost function captures, albeit in a reduced form, the idea that managerial capital formation is costly involving various inputs, experience, schooling, on-the-job training, etc. These dynamic elements are not explicitly modeled but captured by shift parameter λ. In what follows, we loosely refer to λ as the cost of managerial capital.

[9] According to the US Bureau of Labor Statistics (Table A-14), US unemployment rate varied substantially across industries. For instance, in February 2015, 10.6 percent of construction workers were unemployed compared to 3.1 percent workers in financial activities.

[10] Note that the indirect utility function is in the Gorman form, and thus allows aggregation of individual preferences to obtain social welfare which is independent of income distribution. However, in the absence of unemployment insurance and family transfers unemployed workers would not be able to survive and search for jobs.

[11] The concept of single-worker firms has been used extensively in the DMP literature of unemployment (e.g., Chapter 1 in Pissarides, 2004)

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The presence of managerial capital formation adds two features to our analysis. First, as we will show below, differences in the cost of managerial capital across countries constitute a source of comparative advantage. Second, it makes firm-level productivity endogenous and thus dependent on trade openness.

An entrepreneur with managerial talent a maximizes earnings $e_2(a)$, equal to firm profits, by choosing the level of managerial capital z and the number of employees l. Hiring in sector 2 is costly due to labor-market frictions. An entrepreneur with managerial capital z may hire l workers instantaneously by incurring hiring costs $c_2 l$, measured in units of good 1. We will establish below that derived parameter c_2 depends on sectorwide labor-market conditions, and therefore is common across all firms producing good 2. In addition to hiring costs, each firm incurs a wage bill $w_2 l$, where w_2 denotes the negotiated wage. This discussion leads to the following expression for entrepreneurial income (firm profit):

$$e_2(a) \equiv \max\left\{py_2(z) - w_2 l - c_2 l - \frac{\lambda z^2}{2a}\right\}, \tag{5}$$

where firm output $y_2(z)$ is given by (4).

Recognizing that wage bargaining occurs after hiring and managerial-capital formation, we next describe the determination of negotiated wage rate w_2 and hired workers l. Specifically, upon a match an employee cannot be replaced without costs, and thus a hired worker is not interchangeable with an outside worker. Consequently, hired workers have bargaining power. Following Helpman and Itskhoki (2010), we employ the Stole and Zwiebel (1996) solution to intrafirm wage bargaining: the entrepreneur engages in bilateral bargaining with each worker and internalizes the effect of a worker departure on the wage of remaining workers. In our model all workers have the same productivity, as the latter is independent of managerial talent by assumption.[12] As a result, a firm treats each worker as marginal; and firm surplus from a worker departure equals the marginal change in firm value (profits) with respect to labor.

We assume that the value of outside options for each party is zero, and thus worker surplus equals the negotiated wage. The Stole and Zwiebel solution yields[13]

$$w_2 = \frac{p}{(1+\eta)}\left[\frac{\eta z}{(1-\eta)l}\right]^{1-\eta}. \tag{6}$$

Eq. (6) states that the negotiated wage w_2 decreases with the number of hired workers l, and increases with relative price p and managerial capital z.

The Stole and Zwiebel solution introduces a welfare distortion by creating a divergence between wage w_2 and the value of marginal product of labor $p[\eta z/[(1-\eta)l]]^{1-\eta}$: the negotiated wage is set *lower* than the value of the marginal product of labor. Since product markets are perfectly competitive, this distortion implies that each firm behaves like a perfectly competitive firm taking the wage as given but facing a *lower* price $p/(1+\eta)$ instead of p for its product. This distortion, which increases with the share of labor in production η, capturing the importance of labor in production and bargaining, leads to lower number of hired workers and lower level of managerial capital compared to an economy without labor-market frictions. It also generates lower firm profits and lower mass of individuals who choose to become entrepreneurs, as we will see later.

Faced with the negotiated wage, an entrepreneur chooses the number of employees l by taking into account hiring costs $c_2 l$ to maximize firm profits for a given level of managerial capital z. This maximization leads to $c_2 = w_2$, where the wage is given by (6). Consequently, all entrepreneurs (irrespective of firm size) pay the same wage to workers, as in Helpman and Itskhoki (2010). Substituting $c_2 = w_2$ in (6), one can solve for the number of workers hired by a firm with productivity z:

$$l = \frac{\eta}{(1-\eta)}\left[\frac{p}{(1+\eta)c_2}\right]^{1/(1-\eta)} z. \tag{7}$$

An entrepreneur with managerial talent a maximizes earnings (firm profits) by choosing the level of managerial capital z after taking into account labor costs. Substituting (7) and $w_2 = c_2$ in (5) (firm profits), and maximizing the resulting expression with respect to managerial capital z yields

$$z(a) = \frac{a}{\lambda}\left[\frac{p}{(1+\eta)c_2^{\eta}}\right]^{1/(1-\eta)}. \tag{8}$$

At this point it is useful to derive similar expressions for the number of firm employees and firm earnings. Substituting (8) into (7) yields

$$l(a) = \frac{a}{\lambda}\frac{\eta}{(1-\eta)c_2}\left[\frac{p}{(1+\eta)c_2^{\eta}}\right]^{2/(1-\eta)}, \tag{9}$$

[12] Helpman et al. (2010) develop a model of unemployment and inequality where worker productivity is endogenous and depends on worker ability and costly worker screening. Screening leads to more productive firms offering higher wages. Our model complements their analysis by focusing on equally productive workers and unequally productive entrepreneurs As a result our model is more appropriate to analyze top income inequality.

[13] In the case of equal bargaining between an entrepreneur and a worker, the Stole and Zwibel solution requires that total surplus be equally divided between the two parties according to $\partial[py_2 - w_2 l]/\partial l = w_2$. It is straightforward to show by substitution that (6) satisfies the Stole and Zwiebel solution.

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and substituting $w_2 = c_2$, (9) and (8) into Eq. (5) delivers a closed-form expression for income earned by an entrepreneur with managerial talent a:

$$e_2(a) = \frac{a}{2\lambda}\left[\frac{p}{(1+\eta)c_2^{\eta}}\right]^{2/(1-\eta)}. \tag{10}$$

Managerial capital $z(a)$, number of hired workers $l(a)$ and entrepreneurial income $e_2(a)$ are increasing linear functions of managerial talent a. They also increase with relative price p, and decline with costs of managerial capital λ and per-worker hiring costs c_2. The following lemma summarizes the main results.

Lemma 1. *All entrepreneurs* (*irrespective of managerial talent a*) *offer the same negotiated wage which equals hiring costs per worker in sector 2* ($w_2 = c_2$). *Entrepreneurs with higher managerial talent employ more workers, acquire more managerial capital, and manage larger and more productive firms.*

Lemma 1 is consistent with empirical evidence. Bloom and Reenen (2010) using survey firm-level data spanning across many countries, document that higher-quality "better" management practices are correlated with larger, more productive, and faster growing firms.[14]

3.3. Occupational choice

The choice of becoming an entrepreneur or a worker reflects expected-income considerations. Entrepreneurs are fully employed and receive $e_2(a)$ with certainty. Worker income is independent of managerial talent a by assumption, whereas entrepreneurial income increases with managerial talent as indicated by (10). As a result, there exists a cutoff level of managerial talent $a^* > 0$ such that all individuals with talent a^* are indifferent between becoming entrepreneurs or workers. Furthermore, the assumptions of risk neutrality and ex-ante inter-industry worker mobility imply equalization of expected worker income across the two sectors. Let ζ_1 denote the job-finding probability in the outside good. This derived parameter will be determined in the next section as a function of primitive parameters reflecting labor-market frictions. Expected worker income then is $\zeta_1 w_1 = \zeta_1/2$, where $w_1 = 1/2$ is worker income in sector 1.

The cutoff level of managerial talent a^* is then determined by setting entrepreneurial income equal to expected worker income, that is $e_2(a^*) = \zeta_1/2$. Substituting (10) yields the following expression for the cutoff level of managerial talent

$$a^* = \lambda\zeta_1\left[\frac{(1+\eta)c_2^{\eta}}{p}\right]^{2/(1-\eta)}. \tag{11}$$

As in Lucas (1978), only the most talented individuals become entrepreneurs. Specifically, all individuals with talent $a < a^*$ choose to become workers, whereas all individuals with talent $a \geq a^*$ choose to become self-employed entrepreneurs. Unlike Lucas (1978), entrepreneurs in our model acquire managerial capital and workers face the threat of unemployment.

Eq. (11) reveals two important features of the model. First, it establishes an inverse relationship between the relative price of the entrepreneur-intensive good p and the cutoff level of managerial talent a^*. An increase in p raises entrepreneurial income and thus induces more individuals to become entrepreneurs. This leads to a lower cutoff level of managerial talent. Second, ceteris paribus, the presence of wage bargaining leads to a higher cutoff level of managerial talent. As mentioned, firms in the present economy behave as perfectly competitive firms facing an effective price $p/(1+\eta)$ instead of p. Thus wage bargaining generates a higher cutoff level of managerial talent and a lower supply of entrepreneurs.

Solving for p in Eq. (11) and substituting the resulting expression in Eqs. (8)–(10) yields the following expressions for managerial capital, workers hired, and the entrepreneurial income:

$$z(a) = \left(\frac{\zeta_1}{\lambda a^*}\right)^{1/2} a, \quad l(a) = \left(\frac{\eta\zeta_1}{(1-\eta)c_2 a^*}\right)a, \quad e_2(a) = \left(\frac{\zeta_1}{2a^*}\right)a. \tag{12}$$

Thus, managerial capital $z(a)$, demand for labor per firm $l(a)$, and entrepreneurial income $e_2(a)$ increase with job-finding rate ζ_1, rise linearly with the level of managerial talent a, and decrease with the talent cutoff level a^*.

The last equation in (12) expresses entrepreneurial income $e_2(a)$ as a product of two terms, expected worker income $\zeta_1/2$ and relative ability measured in worker-equivalent units a/a^*. In other words, an entrepreneur with ability a^* earns the same income as expected wage $\zeta_1/2$; thus an entrepreneur with ability a earns the same income as a/a^* workers. As a result, $e_2(a)$ measures entrepreneurial income in worker-income equivalents.

Equations in (12) imply that, within a country or region, entrepreneurs with higher managerial talent invest more in entrepreneurial (managerial) capital and enjoy higher earnings. This implication, in conjunction with Lemma 1, is consistent with the work of Gabaix and Landier (2008) who argue that CEO pay in the U.S. between 1980 and 2003 can be fully explained by the increase in size of large companies (i.e., managers of larger firms receive higher compensation). It is also consistent with the findings of Gennaioli et al. (2012) who establish that entrepreneurial human capital (measured by

[14] Sylverson (2011), Section 3.1, offers an excellent literature survey on managerial incentives and talent as determinants of firm productivity.

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education) accounts for a large fraction of firm productivity and constitutes an important determinant of national and regional development in more than 1500 regions located in 110 countries.

3.4. Equilibrium unemployment

Workers are risk neutral and decide whether to search for a job in the outside or the entrepreneur-intensive good. The labor market exhibits search frictions as in the standard Diamond–Mortensen–Pissarides (DMP) theory of unemployment. As mentioned previously, there is no ex-post occupational or inter-sectoral labor mobility. The absence of ex-post labor mobility generates ex-post differences in wages across sectors and positive equilibrium unemployment rates.[15]

Following Blanchard and Gali (2010) and Helpman and Itskhoki (2010), we assume that a firm can hire workers instantaneously by incurring costs expressed in units of the outside good. Hiring costs per worker in sector i are given by

$$c_i(\zeta_i) = \tau_i \zeta_i^{\gamma}, \tag{13}$$

where exogenous parameter τ_i is an index of labor-market frictions in sector i; ζ_i is the job-finding rate or the labor-market tightness index; and $\gamma > 0$ is a parameter. According to Eq. (13), higher market tightness ζ_i implies greater instantaneous hiring costs per worker c_i, for any given degree of labor-market frictions τ_i.

Market entry is unrestricted in each sector, and, as shown in Appendix A.1, the free-entry condition determines the equilibrium values for the job-finding rate and hiring costs in sector 1 as

$$\zeta_1 = (2\tau_1)^{-1/\gamma}, \quad c_1 = \frac{1}{2}. \tag{14}$$

We assume that $\tau_1 > 1/2$ to ensure that job-finding rate ζ_1 is smaller than one. Note that ζ_1 decreases with the degree of labor-market frictions τ_1 implying that greater labor-market frictions lead to lower labor-market tightness. Furthermore, the assumption of ex-ante worker mobility implies that $\zeta_1/2 = \zeta_2 c_2$, where $\zeta_2 c_2 = \zeta_2 w_2$ is the expected wage in sector 2. Expected-wage equalization yields the following job-finding rate and hiring costs in sector 2:

$$\zeta_2 = \zeta_1 \left(\frac{\tau_1}{\tau_2}\right)^{1/(1+\gamma)}, \quad c_2 = \frac{1}{2}\left(\frac{\tau_2}{\tau_1}\right)^{1/(1+\gamma)}. \tag{15}$$

Obviously, when labor-market frictions in sector 2 are less severe than that in sector 1 (i.e., $\tau_2 < \tau_1$), the job-finding rate in the former is higher (i.e., $\zeta_2 > \zeta_1$); and the corresponding hiring costs are lower (i.e., $c_2 < c_1$ if $\tau_2 < \tau_1$).

Armed with these results, we can derive an expression for the unemployment rate. Let N_i denote the mass of workers searching for jobs in sector i. It then follows that $G(a^*) = N_1 + N_2$ is the aggregate supply of workers because the mass of population is normalized to unity and the mass of workers assigned to sector 2 is given by

$$N_2 = \frac{2\eta}{(1-\eta)} \frac{\mathbb{A}(a^*)}{a^*}, \tag{16}$$

where $\mathbb{A}(a^*) = \int_{a^*}^{\infty} a g(a)\, da$ is the aggregate level of managerial talent.[16]

Expression $\mathbb{A}(a^*)/a^*$ is the "effective" supply (mass) of entrepreneurs measured in worker equivalents. The term effective refers to two features: first, the mass of entrepreneurs is weighted by the talent of each entrepreneur; and second, the talent-adjusted supply of entrepreneurial labor $\mathbb{A}(a^*)$ is measured in worker-equivalent units, that is, in units of entrepreneurs with managerial talent equal to a^*. Because $\mathbb{A}(a^*)$ declines with a^*,[17] the effective supply of entrepreneurs $\mathbb{A}(a^*)/a^*$ and the mass of workers assigned to sector 2 N_2 decrease with managerial talent cutoff a^*.

The aggregate unemployment rate is defined as the measure of unemployed workers (searching for jobs) in both sectors divided by total labor supply $L = 1$. The unemployment rate in sector i is $U_i = (1-\zeta_i)N_i$ and therefore the economy-wide unemployment rate $\mathcal{U} = U_1 + U_2$ can be written as

$$\mathcal{U} = (1-\zeta_1)G(a^*) + (\zeta_1 - \zeta_2)N_2 = (1-\zeta_1)G(a^*) - \frac{2(\zeta_2 - \zeta_1)\eta \mathbb{A}(a^*)}{(1-\eta)a^*}, \tag{17}$$

where the sector-specific job-finding rates ζ_1 and ζ_2 are given by (14) and (15).

Eq. (17) identifies two channels transmitting the effects of policies to aggregate unemployment: the first is the occupational-choice channel, captured by $G(a^*)$, which works through the supply of workers seeking jobs; and the second is the worker-reallocation channel, captured by (16), which operates through the relative demand for labor in sector 2. The latter is proportional to the worker-equivalent supply of entrepreneurs $\mathbb{A}(a^*)/a^*$. Consider, for example, the effects of a decline in the cutoff level of managerial talent a^*. This change induces high-talented workers to become entrepreneurs and thus reduces the rate of unemployment though a decrease in $G(a^*)$. In addition, a reduction in a^* raises the demand for labor in sector 2 attracting more workers from sector 1.

[15] Eq. (10) indicates that even individuals with the lowest managerial talent $a = 1$ earn positive income by becoming self-employed entrepreneurs. As a result, ex-post occupational mobility leads to the elimination of unemployment in the present model.

[16] We derive Eq. (16) as follows. Use expression $l(a)$ from (12) with $\zeta_2 c_2 = \zeta_1/2$ to obtain $l(a) = (2\eta\zeta_2/(1-\eta))(a/a^*)$. Aggregating $l(a)$ across all entrepreneurs and setting the resulting expression equal to the mass of employed workers in the modern sector $\zeta_2 N_2$ yields (16) in the main text.

[17] $d\mathbb{A}(a^*)/da^* = d[\int_{a^*}^{\infty} a g(a)\, da]/da^* = -a^* g(a^*) < 0$.

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The effect of sectoral worker redistribution on unemployment depends on the ranking of job-finding rates: a decline in a^* increases $\mathbb{A}(a^*)/a^*$ and reduces unemployment if the job-finding rate is equal or higher in sector 2, i.e., $\zeta_1 \leq \zeta_2$. The effect of a reduction in a^* on unemployment is ambiguous if the entrepreneur-intensive sector is not job friendly ($\zeta_2 < \zeta_1$). In this case, the occupational-choice and worker-reallocation channels work in opposite directions.

3.5. Closed-economy equilibrium

This subsection characterizes the closed-economy equilibrium by determining the cutoff level of managerial talent a_A. The latter is a decreasing function of autarky relative price p_A according to (11). In the closed-economy equilibrium, the supply of good 2 must equal its demand. This is equivalent to the requirement that the share of aggregate income spent on good 2 must equal to constant expenditure share β in accordance to (2):

$$\frac{E_2}{E} = \beta, \tag{18}$$

where E_2 is the economy's income spent on good 2 and E is aggregate expenditure (income).

Income spent on good 2 is equal to firm revenue aggregated across all firms in sector 2.[18]

$$E_2(a^*) = \frac{\zeta_1(1+\eta)}{(1-\eta)}\frac{\mathbb{A}(a^*)}{a^*}. \tag{19}$$

Aggregate income spent on both goods E is the sum of employed worker income and aggregate entrepreneurial income. The former equals the supply of workers $G(a^*)$ times expected (average) worker wage $\zeta_1/2$. The latter equals $\int_{a^*}^{\infty} e_2(a)g(a)\,da = [\zeta_1 \mathbb{A}(a^*)]/2a^*$, because $e_2(a) = \zeta_1 a/2a^*$ from (12). Adding these two income components yields

$$E(a^*) = \frac{\zeta_1}{2}\left[G(a^*) + \frac{\mathbb{A}(a^*)}{a^*}\right]. \tag{20}$$

The square-bracket expression depends solely on the distribution of managerial talent and cutoff level a^*. Intuitively, the term in square brackets captures the supply of labor measured in worker equivalents. $G(a^*)$ is the supply of workers and $\mathbb{A}(a^*)/a^*$ is the talent-weighted supply of worker-equivalent entrepreneurs. Observe that aggregate income E increases with job-finding rate ζ_1 implying that an economy with higher unemployment and thus lower ζ_1 produces less output and has lower income.

Substituting E_2 from (19) and E from (20) in (18) delivers the closed-economy managerial talent cutoff

$$\frac{\mathbb{A}(a_A^*)}{a_A^* G(a_A^*)} = B, \quad B \equiv \frac{\beta(1-\eta)}{2(1+\eta)-\beta(1-\eta)}. \tag{21}$$

The left-hand side (LHS) is the relative effective supply of entrepreneurs or the economy's abundance of effective entrepreneurs measured in worker equivalents. It is a decreasing function of managerial talent cutoff a^* (see footnote 16), approaching infinity as $a_A^* \to 1$ and zero as $a_A^* \to \infty$. The right-hand side (RHS) is a strictly positive parameter, and thus Eq. (21) determines the unique closed-economy equilibrium cutoff level of managerial talent a_A^*. Because $0 < B < 1$, the equilibrium cutoff level ensures that both goods are produced, i.e., $N_i > 0$ for $i = 1, 2$.[19]

The autarky equilibrium cutoff level a_A^* does not depend on parameters capturing labor-market frictions τ_i or cost of managerial capital λ. The reason can be traced to Cobb–Douglas preferences and occupational-choice considerations. The former implies that the share of income spent on each good is constant. The latter means that E_2 and E depend on worker-equivalent units of labor and each of them is proportional to expected wage $\zeta_1/2$. Thus the ratio E_2/E depends only on technology parameter η and the distribution of managerial talent. The independence of a_A^* from parameters capturing job-finding rates, cost of managerial capital and hiring costs per worker facilitates the analysis of comparative advantage.

Lemma 2. *The unique closed-economy equilibrium cutoff level of managerial talent a_A^* exists and satisfies* Eq. (21). *The cutoff managerial talent a_A^* is independent of parameters capturing labor-market frictions τ_i and cost of managerial capital λ.*

Once a_A^* is determined, the model's remaining endogenous variables can be readily determined. In particular, autarky price p_A can be written as a function of a_A^* from (11):

$$p_A = (1+\eta)c_2^{\eta}\left[\frac{\lambda\zeta_1}{a_A^*}\right]^{(1-\eta)/2}, \tag{22}$$

where ζ_1 and c_2 are given by (14) and (15).

[18] Firm revenue is given by $r(a) = py_2(a) = [\zeta_1(1+\eta)a]/[(1-\eta)a^*]$. The measure of entrepreneurs is $1-G(a^*)$ which is also the ex-ante probability that an individual becomes an entrepreneur. Thus the ex-post density of managerial talent is $h(a) = g(a)/[1-G(a^*)]$ and aggregate spending on good 2 is $E_2 = \int_{a^*}^{\infty}[1-G(a^*)]r(a)h(a)\,da = \int_{a^*}^{\infty} r(a)g(a)\,da$. Substituting firm revenue $r(a)$ in this integral delivers E_2.

[19] Eq. (21) can be written as $N_2/G(a_A^*) = 2\eta\mathbb{A}(a_A^*)/[(1-\eta)a_A^* G(a_A^*)] = 2\eta B/(1-\eta) < 1$ implying that the fraction of workers assigned to sector 2 is strictly positive and strictly less than one. This result combined with the supply of workers $G(a_A^*) = N_1 + N_2$ implies $N_i > 0$, i.e. the closed-economy equilibrium is characterized by incomplete specialization of production.

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Lemma 2 and Eq. (22) imply that p_A increases with parameters reflecting labor-market frictions and the cost of managerial capital. The intuition behind this result stems from the occupational-choice condition $e(a_A^*)=\zeta_1/2$ and (10) which implies that entrepreneurial income $e(a_A^*)$ decreases with c_2 and λ, and increases with p_A. Thus, for a given a_A^*, an increase in the job hiring rate ζ_1, cost of managerial capital λ, or hiring cost per worker c_2, requires higher entrepreneurial income. This can be achieved with an increase in p_A.

3.6. Top income inequality

The model is well suited to address the impact of trade openness on top income inequality which has been rising in many countries. For example, Piketty and Saez (2014), report that the share of total U.S. income going to top 10 percent income earners has increased dramatically from 34 percent in the 1970s to 46 percent in 2010. These authors report that a very large part of top U.S. income inequality comes from the top 1 percent (or even the top 0.1 percent) of income earners. This is largely due to the increase in top executive compensation in large U.S. corporations and capital income both of which are correlated with firm profits.

Searching for causes of increased top income inequality, a growing body of literature has focused on the dynamic interplay between the supply and demand for skill caused by technological progress, capital accumulation, institutions, and globalization (e.g., Piketty and Saez (2014), Acemoglu and Robinson (2015), Jones (2015)). Our model features static interactions among the supply of skill in the form of occupational choice, endogenous technology in the form of managerial capital, and business income (CEO compensation) in the form of entrepreneurial income. It is thus instructive to analyze the model's implications for the effects of trade openness on top income inequality. This analysis is missing from the aforementioned studies.

Under the assumption that all top income earners are entrepreneurs, Appendix A.2 derives the following index of top income inequality:

$$T(x,a^*)=\frac{\varphi(x)}{a^*G(a^*)+\mathbb{A}(a^*)}, \tag{23}$$

where x denotes the exogenous measure of top income earners as a fraction of population. Numerator $\varphi(x)$ is aggregate managerial talent of top x percent of income earners with $\varphi(0)=0$ and $\partial\varphi(x)/\partial x>0$. In addition, differentiating (23) yields $\partial T/\partial a^*<0$, i.e. an increase in a^* reduces top income inequality.

The literature on top income inequality uses frequently the assumption that top incomes are Pareto distributed (Jones, 2015). It also uses power laws to calculate missing values for top incomes through extrapolation (Piketty and Saez, 2014). Applying the Pareto distribution $G(a)=1-a^{-k}$, with $a\in(1,\infty)$ and shape parameter $k>1$, to the index of top income inequality yields

$$T(x,a^*)=\frac{kx^{(k-1)/k}}{(k-1)a^*+a^{*(1-k)}}. \tag{24}$$

Since the denominator increases with $a^*>1$, top income inequality declines with cutoff talent a^*.

Substituting the autarky cutoff level of managerial talent a_A^*, determined in (21), yields the closed-economy index of inequality $T(x,a_A^*)$ which depends only on parameters β and η. The first parameter captures preferences and the second one two distinct forces: the labor intensity of production (biased technological change) and wage bargaining (labor market institutions). Specifically, an increase in B caused by an increase in β or a reduction in η raises top income inequality by reducing a_A^*. Thus top income inequality in a closed economy increases with taste shift towards the entrepreneur-intensive good, with skill- (entrepreneurship) biased technological change, or with the elimination of labor-market regulations leading to perfectly competitive labor markets.

3.7. Welfare

Aggregating the indirect utility function (3) across all individuals yields aggregate welfare index

$$\mathbb{V}=Ep^{-\beta}, \tag{25}$$

where aggregate expenditure E is given by (20). Because the measure of population is equal to one, $\mathbb{V}$ denotes per-capita welfare as well. Observe that an increase in the relative price p has two opposing effects on welfare $\mathbb{V}$: an increase in p reduces welfare by raising price index p^β (price effect) and raises welfare by increasing aggregate expenditure E.[20]

[20] Aggregate expenditure $E(p)$ is increasing convex function of p. To see this, note that differentiating (20) leads to

$$\frac{dE}{da^*}=-\frac{\zeta_1}{2}\frac{\mathbb{A}(a^*)}{a^{*2}}<0 \quad \text{and} \quad \frac{d^2E}{da^{*2}}=\frac{\zeta_1 g(a^*)}{2a^*}+\frac{\zeta_1\mathbb{A}(a^*)}{a^{*3}}>0.$$

This implies that E is a decreasing convex function of a^*. Because a^* declines with p, aggregate expenditure E is an increasing and convex function of relative price p.

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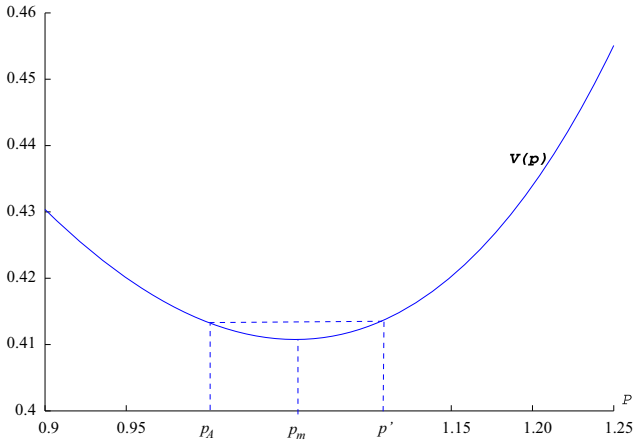

Fig. 1. The welfare function.

Aggregate expenditure E is a *convex* function of price, whereas price index p^{β} is a *concave* function of price.[21] It then follows that a marginal increase in price reduces welfare when evaluated at a low initial price and raises welfare when evaluated at a high initial price. Thus welfare is a U–shaped (not necessarily convex) function of relative price p. Formally, differentiating $\mathbb{V} = p^{-\beta}E$ (where E is given by (20)) with respect to p and using $da^*/dp = -2a^*/(1-\eta)p$ (obtained from (11)) yields

$$\frac{d\mathbb{V}}{dp} = \frac{\beta G(a^*)}{p^{1+\beta}}\left[\left(\frac{2-\beta(1-\eta)}{\beta(1-\eta)}\right)\frac{\mathbb{A}(a^*)}{G(a^*)a^*} - 1\right].$$

Because $\mathbb{A}(a^*)/[G(a^*)a^*]$ increases monotonically with the relative price p from zero to infinity, the term in square brackets is negative for low values and positive for high values of relative price p, and thus $\mathbb{V}(p)$ is a U-shaped function of p.

Setting the above equation to zero yields the welfare-minimizing cutoff level of managerial talent denoted by a_m^*

$$\frac{\mathbb{A}(a_m^*)}{a_m^* G(a_m^*)} = B_m, \quad B_m \equiv \frac{\beta(1-\eta)}{2-\beta(1-\eta)} > 0. \tag{26}$$

Eq. (26) defines implicitly the welfare-minimizing price p_m because a_m^* decreases monotonically with the relative price p according to (11).[22]

Proposition 1. *Aggregate welfare is a U-shaped function of relative price p, and attains its minimum at the price* p_m *which solves* Eqs. (26) *and* (11).

Although the welfare-minimizing cutoff talent a_m^* depends only on taste and technology parameters β and η, the welfare-minimizing price p_m increases with the cost of managerial capital λ, job-finding rate ζ_1 and per-worker hiring costs c_2, reflecting occupational choice considerations as indicated by (11).

Fig. 1 plots the welfare function $\mathbb{V}(p)$ under the assumption that the distribution of managerial talent is Pareto $G(a) = 1 - a^{-k}$ with shape parameter $k > 1$.[23] In this case, $\mathbb{V}$ is a U–shaped, *convex* (as opposed to a general U-shaped) function of p as shown in Fig. 1. Variable p_A in Fig. 1 denotes the autarkic price of good 2 and it is always lower than the welfare-minimizing price p_m. In addition, the shape of the welfare function ensures that there exists a p' (shown in Fig. 1) such that

$$\mathbb{V}(p') = \mathbb{V}(p_A) \quad \text{and} \quad p_A < p_m < p'. \tag{27}$$

According to (27), if the prevailing relative price under free trade is between the autarky price p_A and p', the economy's free-trade welfare level is below the autarky welfare level. In other words, a move from autarky to trade may be immiserizing. This possibility is consistent with the generalized theory of distortions and deserves a few remarks.

[21] Expenditure is a convex, decreasing function of a^*. The intuition behind this property can be described as follows. Consider an increase in price which induces an individual with managerial talent $a = a^* + da$ to switch from being a worker to an entrepreneur, where da denotes an infinitesimal change in managerial talent. Because expected worker income is $\zeta_1/2$ and entrepreneurial income is $e_2(a^*) = \zeta_1 a/2a^*$, this reallocation increases aggregate expenditure by $dE = e_2(a^*) - \zeta_1/2 = (\zeta_1/2a^*)\,da$. Thus the marginal increase in aggregate expenditure declines with the cutoff managerial talent a^*.Thus the change in aggregate expenditure caused by marginal change in a^* declines in the cutoff level of managerial talent. Since the latter decreases with the relative price, aggregate income is a convex increasing function of relative price p.

[22] Appendix A.3 establishes the existence of an upper bound on the relative price $p^{\max}$ as long as the economy remains incompletely specialized. This implies that there is an upper bound on the welfare function, i.e. $\mathbb{V}(p) \le \mathbb{V}(p^{\max})$, for any $p \in [p_A, p^{\max}]$.

[23] In plotting Fig. 1, we set $k = 2.5, \beta = 0.75, \eta = 1/3, \lambda = 3, \tau_1 = 0.65, \tau_2 = 0.55$, and $\gamma = 1$. To enhance the presentation, Fig. 1 plots welfare $\mathbb{V}(p)$ over $p \in [0.9, 1.25]$.

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A comparison of (26) to (21) reveals that $a_m^* < a_A^*$ because $B_m > B$ for any $0<\eta<1$ and $0<\beta<1$. This implies that $p_A < p_m$, i.e., aggregate welfare is not minimized at the autarky price. In the absence of labor-market frictions leading to full employment and flexible wages, welfare is a U-shaped function of relative price p, lies above the welfare curve presented in Fig. 1, and attains its minimum at $p_A = p_m$. In other words, eliminating labor market frictions raises welfare and eliminates the discrepancy between autarky and welfare-minimizing prices (see Appendix A.3 for more details).

What is the source of divergence between market and welfare-minimizing prices? As mentioned earlier, the Stole and Zwiebel (1996) solution to intrafirm wage bargaining creates a welfare distortion by setting the negotiated wage w_2 below the value of the marginal product of labor. Because product markets are perfectly competitive, this distortion implies that firms value the marginal product of labor at the lower price $p/(1+\eta)$ instead of p. Recall that parameter η captures the share of labor in production and thus reflects worker bargaining power. The lower effective price reduces the level of entrepreneurial income $e_2(a)$, in accordance to Eq. (10) and leads to a higher cutoff level of managerial talent ($a_m^* < a_A^*$) and thus lower autarky price ($p_A < p_m$).[24] In other words, the market equilibrium is inefficient leading to undersupply of entrepreneurs and the entrepreneur-intensive good.[25]

The divergence between autarky and welfare-minimizing prices has implications for the welfare effects of trade openness. In the absence of labor-market distortions (i.e., $p_A = p_m$), trade openness resulting in a different price than p_A is welfare improving due to better terms of trade. The gains from trade are independent of the pattern of trade in this case and both countries reach higher welfare.

In contrast, in the presence of labor-market distortions, trade openness may reduce welfare for one country! Where trade raises the relative price of good 2 from p_A to a price which is less than p' in Fig. 1, the gains from trade captured by a rise in aggregate income E are not sufficient to overcome the welfare loss due to an increase in the relative price p. For a sufficiently large increase in the relative price (exceeding p') the standard gains from trade dominate the welfare distortion caused by labor market frictions and welfare rises above its autarky level, as illustrated in Fig. 1.

4. A global economy

In this section, we analyze a global economy with two trading countries, Home and Foreign. Following standard practice, we assume that preferences, country size, and production functions are identical between the two countries. According to Lemma 2, the closed-economy managerial talent cutoff level a^* does not depend on labor-market frictions, captured by primitive parameters τ_1 and τ_2; nor it depends on the costs of managerial capital λ. As a result, both Home and Foreign exhibit equal managerial talent cutoffs in autarky (i.e., $a_{AH}^* = a_{AF}^* = a_A^*$), determined by (21).

Eq. (22) indicates that Home, despite having the same managerial talent cutoff level as Foreign, produces good 2 cheaper in autarky (i.e., $p_{AH} < p_{AF}$) if and only if the following inequality holds:

$$f_H \equiv \tau_{1H}^{-\delta}\tau_{2H}^{\eta/(1+\gamma)}\lambda_H^{(1-\eta)/2} < \tau_{1F}^{-\delta}\tau_{2F}^{\eta/(1+\gamma)}\lambda_F^{(1-\eta)/2} \equiv f_F, \tag{28}$$

where $\delta = [\eta/(1+\gamma)] + [(1-\eta)/(2\gamma)] > 0$ is an inconsequential constant. Parameter f_j ($j = H, F$) captures country j's relative cost advantage in production of good 2 which is reflected on its autarkic price. Thus, ceteris paribus, each country exports the good with lower relative labor-market frictions captured by term $\tau_{2j}^{\eta/(1+\gamma)}/\tau_{1j}^{\delta}$ and/or lower relative costs of managerial capital captured by λ_H/λ_F.

In order to enhance the presentation of the main results, we consider the case where Home represents a country with more flexible labor markets and lower costs of managerial capital. Loosely speaking, one can think of Home as America and Foreign as Europe with the outside good representing agriculture and the entrepreneur-intensive good high tech industries. Without loss of generality, assume that both regions exhibit the same degree of labor-market frictions in sector 1 and Home exhibits lower labor-market frictions in sector 2 ($\tau_{1H} = \tau_{1F} = \tau_1$ and $\tau_{2H} < \tau_{2F}$). In addition, assume that, within each country, sector 2 is job-friendly ($\tau_2 < \tau_1$). This assumption implies that $\zeta_1 < \zeta_2$ and regulates the effects of policies on unemployment. Moreover, assume that the cost of managerial capital in Home does not exceed that in Foreign ($\lambda_H \le \lambda_F$). These parameter restrictions ensure that condition (28) holds and thus Home exports good 2. In other words, the country with more flexible labor markets exports the entrepreneur-intensive good.

Assumption 1. In each country $j = H, F$:

a. sector 2 exhibits lower labor-market frictions ($\tau_{2j} < \tau_{1j}$),
b. both countries exhibit the same labor-market frictions in sector 1 ($\tau_{1j} = \tau_1$),
c. Home exhibits lower labor-market frictions than Foreign in sector 2 ($\tau_{2H} < \tau_{2F}$),
d. the cost of managerial capital in Home does not exceed that in Foreign ($\lambda_H \le \lambda_F$).

[24] See, for instance, Eqs. (11) and (22) where the wage-bargaining distortion is captured by term $1+\eta$. Setting this term equal to 1 leads to $a_A = a_m$ and $p_A = p_m$. This can be confirmed by replacing term $1+\eta$ with 1 in the definition of B which leads to $B = B_m$.

[25] Another way to express this point is as follows. The wage-bargaining distortion augments firm revenue because the latter is proportional to the value of the marginal product of labor which in turn is set equal to $(1+\eta)w_2$. As a result, wage-bargaining augments the ratio $E_2/E = (1+\eta)(1-\eta)^{-1}(1+G a^*/\mathbb{A})^{-1}$. This ratio declines with a^*, thus requiring a higher level of managerial talent to satisfy equilibrium condition (12). This implies that $a_m^* < a_A^*$; as a result, the autarky price is lower than the welfare-minimizing price.

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Despite Assumption 1, Home and Foreign exhibit the same cutoff levels of managerial talent under autarky ($a^*_{AH} = a^*_{AF} = a^*_A$) implying identical abundance of entrepreneurs. In addition, ζ_1 depends only on τ_1, and thus both countries share the same expected wage $\zeta_1/2 = \zeta_2 c_2$. Eq. (20) implies that autarky income E_A is the same in both countries, and so is the index of top income inequality $T(x, a^*_A)$.

Assumption 1 generates differences between the two closed economies as well. Lower labor-market frictions in Home's sector 2 ($\tau_{2H} < \tau_{2F}$) imply that the corresponding Home job-finding rate is higher ($\zeta_{2H} > \zeta_{2F}$) leading to a lower rate of Home unemployment since $\zeta_{1H} = \zeta_{1F}$. In addition, Home produces good 2 cheaper than Foreign ($p_{AH} < p_{AF}$). Because both countries have the same aggregate income, Home enjoys a higher level of welfare thanks to its lower autarky price. Finally, the welfare-minimizing price is lower in Home than in Foreign: both countries share the same welfare-minimizing cutoff level of managerial talent a_m; and $f_H < f_F$ implies that $p_{mH} < p_{mF}$ via (11). The following proposition summarizes the main properties of autarky equilibrium.

Proposition 2. *Consider two countries, Home and Foreign with Home exhibiting lower market frictions. Under Assumption 1, the closed-economy equilibrium has the following properties*:

a. *Home has comparative advantage in good 2*;
b. *both countries have identical expected wage, abundance of entrepreneurs, firm productivity, and aggregate income*;
c. *both countries exhibit the same top income inequality*;
d. *Home has lower unemployment than Foreign*;
e. *and Home enjoys higher welfare than Foreign.*

4.1. Free-trade equilibrium

Denote with E_{2j} the expenditure (income) spent on good 2 by country $j = H, F$ and with E_j aggregate expenditure given by (20). Let p_T denote the common free-trade price of good 2. Under free trade, the share of global income spent on good 2 must be equal to consumption share β according to (18), which holds for the (closed) global economy as well:

$$E_{2H} + E_{2F} = \beta(E_H + E_F) \tag{29}$$

Substituting $E_{2j}(a^*_j)$ from (19) and $E_j(a^*_j)$ from (20) into market-clearing condition (29) yields

$$\frac{\mathbb{A}(a^*_H)}{a^*_H} - BG(a^*_H) = BG(a^*_F) - \frac{\mathbb{A}(a^*_F)}{a^*_F}, \tag{30}$$

where B is given by (21).

Notice that $\mathbb{A}(a^*_H)/a^*_H$ is Home's effective supply of entrepreneurs measured in worker equivalents and $BG(a^*_H)$ is its effective supply of labor services. Thus, the LHS of market-clearing condition equates Home's excess supply of effective entrepreneurial services to Foreign's excess supply of effective labor services. In other words, the market clearing condition requires balanced trade expressed in terms of factor content: the country with comparative advantage in the entrepreneur-intensive good exports entrepreneurs and imports labor.

Under autarky, each side of the market-clearing condition must equal to zero implying $a^*_{AH} = a^*_{AF}$. Under free trade each side is positive if home has comparative advantage in good 2 and $a^*_H < a^*_F$. This result can be established by inspecting (11) which indicates that if two countries face the same price p_T (as in the case of free trade), the country with comparative advantage in good 2 ($f_H < f_F$), has a lower cutoff level of managerial talent.

Cutoff managerial talent a^*_j decreases with relative price p, as indicated by Eq. (11). This means that the LHS of (30) increases with p, whereas the RHS decreases with p. Thus, the above condition yields the unique solution to the free-trade equilibrium price p_T such that both sides of (30) are strictly positive if and only if Home has a comparative advantage in good 2 ($f_H < f_F$). Substituting p_T in Eq. (11) determines the unique managerial talent cutoff a^*_j in each country. Notice that the closed-economy managerial talent cutoffs are equal in both countries and that the free-trade price must be between the two autarky prices ($p_{AH} < p_T < p_{AF}$).

Lemma 3. *There exists a free-trade equilibrium* (a^*_H, a^*_F) *which is unique and satisfies condition* (30) *such that* $a^*_H < a^*_F$ *if and only if Home has a comparative advantage in the entrepreneur-intensive good* ($f_H < f_F$).

Assumption 1 is a sufficient condition for Lemma 3. Under Assumption 1, the free-trade equilibrium exhibits several additional novel features. According to (12), each Home entrepreneur invests more in managerial capital leading to higher firm productivity and profitability; and enjoys higher earnings compared to a Foreign entrepreneur with equal managerial talent ($e_N(a) > e_S(a)$). This feature implies that Home exhibits higher top income inequality than Foreign $T_H(x, a^*_H) > T_F(x, a^*_F)$. In addition, using $\zeta_{1H} = \zeta_{1F}$ and $a^*_H < a^*_F$, Eq. (20) implies that Home has higher per-capita income than Foreign ($E_H > E_F$).

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Because Home has higher income and the same relative price as Foreign, Eq. (25) yields $\mathbb{V}_H > \mathbb{V}_F$: under free trade Home enjoys higher welfare than Foreign. Finally, Assumption 1 implies that the unemployment rate in Home is lower than that in Foreign according to Eq. (17). Intuitively, Home has less workers facing the threat of unemployment ($G(a_H^*) < G(a_F^*)$); more workers assigned to job-friendly sector 2 ($\zeta_2 > \zeta_1$); and a higher effective supply of self-employed entrepreneurs.

Proposition 3. *Consider two freely trading countries, Home and Foreign. Under Assumption 1,*

a. *Home becomes the entrepreneur abundant country and exports the entrepreneur-intensive good*;
b. *Home entrepreneurs acquire more managerial capital leading to higher Home firm productivity*;
c. *Home has lower unemployment*;
d. *Top income inequality is higher in Home*;
e. *and Home enjoys higher welfare.*

In sum, under free trade, Home (the country with more flexible labor markets) has higher per-capita GDP, higher welfare, more entrepreneurs, lower unemployment, and higher top income inequality than Foreign. The post-war experience of the U.S. and Europe is consistent with these predictions. U.S. labor markets are more flexible and combined with lower costs of human (managerial) capital. Unemployment has been lower in the US than Europe; The U.S. is a net exporter of high tech (managerial-intensive) goods and services to Europe such as computers, pharmaceuticals and internet services. In addition, post-war top income inequality in the U.S. has exceeded that of Europe.

4.2. Trade openness

The analysis of trade openness, captured by a move from autarky to free trade, echoes the essence of Proposition 3 because it operates through changes in relative price p. However, there are important differences as well that are not apparent from comparing autarky and free trade. For instance, although Home enjoys higher welfare than Foreign under autarky and free trade, a move from autarky to trade may decrease Home welfare leading to convergence of per capital income between the two countries.

Under Assumption 1, trade openness raises the relative price of good 2 in Home and reduces it in Foreign improving each country's terms of trade. An increase in p raises firm profit in Home and reduces the cutoff level of managerial talent a^*, according to (11). The opposite holds in Foreign resulting in $a_{AH}^* < a_{AF}^*$. Consequently, Home becomes entrepreneur abundant and Foreign worker abundant. In addition, each Home entrepreneur acquires more managerial capital z in accordance to (12) thus Home firm productivity increases. The opposite holds in Foreign leading to trade-induced divergence in firm productivity between the two countries. Trade openness creates divergence in top income inequality between Home and Foreign raising $T(x, a^*)$ in the former and reducing it in the latter.

Similar considerations apply to the rate of unemployment. Assumption 1 implies that the country with more flexible labor markets, Home, has lower unemployment than Foreign under autarky. Trade openness reduces a^* in Home inducing more individuals to become self-employed entrepreneurs and workers employed in the job-friendly sector 2. The opposite occurs in Foreign. As a result, trade openness decreases Home unemployment and raises unemployment in Foreign. The assumption that good 2 is job friendly ($\tau_2 < \tau_1$) guarantees divergence in unemployment between Home and Foreign.

Propositions 1 and 2 highlight the case where the entrepreneur-intensive good is job friendly leading to trade-offs between top and bottom income inequality. The latter is measured by the rate of unemployment. In this case, a move from autarky to free trade increases top income inequality and reduces unemployment in the country with more flexible labor markets (Home); and has the opposite effect on the country with less flexible labor markets (Foreign). Loosely speaking, Home *exports* bottom income inequality and *imports* top income inequality. The opposite holds for Foreign. As a result, the impact of trade openness on extreme income inequality is ambiguous in this case and depends on model parameters.

Where the outside good is sufficiently more job friendly, the model raises the possibility that top and bottom inequality are *complements*. In this case, a move from autarky to free trade increases top income inequality and unemployment in the country with comparative advantage in the entrepreneur-intensive good (Home) leading to an increase in extreme income inequality. It has the opposite effects on the country importing the entrepreneur-intensive good. In this case, Foreign *exports* extreme income inequality to Home.

What type of parameter restrictions lead to the case where the two components of extreme income inequality are complements? For sufficiently high values of job-finding rate ζ_1, trade openness raises unemployment in the country with comparative advantage in good 2 (Home) and reduces unemployment in its trading partner.

In Helpman and Itskhoki (2010), the absence of occupational choice implies that aggregate unemployment is affected only by worker reallocation between the two sectors. Thus, if labor market frictions are the same across sectors in each country ($\zeta_1 = \zeta_2$), trade does not have any effect on unemployment in Helpman and Itskhoki; whereas, in our model, trade reduces unemployment in the country with comparative advantage in the entrepreneur-intensive good and increases unemployment in the other country.

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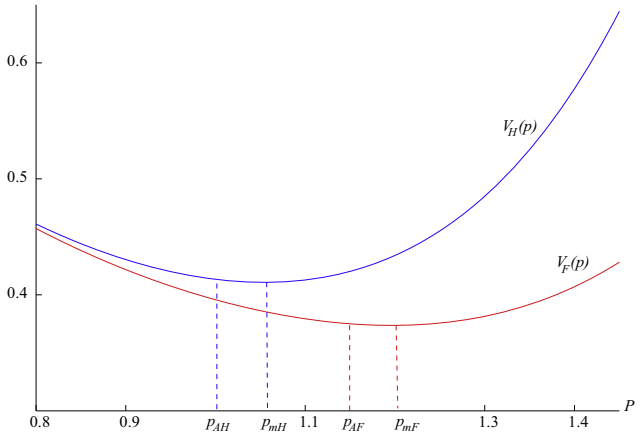

Fig. 2. Home and Foreign welfare functions.

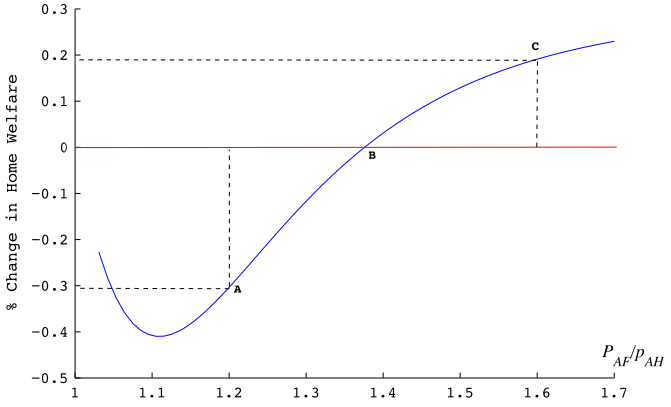

Fig. 3. Changes in Home welfare.

In Dinopoulos and Unel (2014), the assumptions of symmetric countries and aggregate Cobb–Douglas preferences imply that the demand for labor in each sector is invariant to changes in intra-industry trade; thus more trade necessarily increases unemployment by inducing low-talented entrepreneurs to become workers. In contrast, in the present model the effect of trade on unemployment is ambiguous because trade affects aggregate income.

Finally, we analyze the impact of trade openness on welfare. The presence of labor-market distortions combined with perfectly competitive product markets lead to an ambiguous effect of trade openness on Home welfare. Fig. 2 illustrates this ambiguity.[26] Curve $\mathbb{V}_H$ shows Home welfare, which is a U-shaped function of relative price p as in Fig. 1. Home welfare reaches it minimum at price p_{mH} which exceeds Home autarky price p_{AH}. Curve $\mathbb{V}_F$ shows Foreign welfare as a function of price p under Assumption 1. Foreign welfare is also a U-shaped function of p reaching its minimum at p_{mF} which is greater than Foreign autarky price p_{AF}.

Assumption 1 has three novel implications: first, Foreign welfare is lower than Home welfare at any price p (i.e., $\mathbb{V}_F(p) < \mathbb{V}_H(p)$); second, Home has a lower autarky price that Foreign (i.e., $p_{AH} < p_{AF}$); and third, Home has a lower welfare-minimizing price than Foreign (i.e., $p_{mH} < p_{mF}$). The ranking between Home welfare-minimizing price p_{mH} and Foreign autarky price p_{AF} is ambiguous. Fig. 2 illustrates the case where the former is lower than the latter ($p_{mH} < p_{AF}$). A move from autarky to free trade establishes a common price p_T (not shown in Fig. 2) which is located between the two autarky prices. Since the trade price is always less than the Foreign autarky price, trade openness always improves Foreign welfare.

However, trade openness may reduce Home welfare. If the model's parameters are such that $p_{AF} \leq p_{mH}$, then trade openness *necessarily* reduces Home welfare. If autarky prices are sufficiently different (the case of strong comparative advantage), then trade price p_T will be greater than price p' (illustrated in Fig. 1 and defined in (27)) and Home free-trade welfare will exceed its autarky welfare.

[26] In plotting Fig. 2, we set $k = 2.5, \beta = 0.75, \eta = 1/3, \lambda_H = 3, \lambda_F = 4, \tau_{1H} = \tau_{1F} = 0.65, \tau_{2H} = 0.50, \tau_{2F} = 0.60$, and $\gamma = 1$. Note that parameter restrictions for Home are the same as those in Fig. 1.

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Fig. 3 illustrates the effects of trade openness on Home welfare. Specifically, for each ratio of autarky prices p_{AF}/p_{AH}, which indicates differences in comparative advantage, the graph illustrates the percentage change in Home welfare associated with a move from autarky to trade.[27] The autarky price ratio is greater than one, as we assume that Home has a comparative advantage in the entrepreneur-intensive good.

Point *A* illustrates the case where Foreign autarky price is 20 percent higher than Home autarky price ($p_{AF}/p_{AH}=1.2$). In this case, moving from autarky to free trade *decreases* Home welfare by 0.3 percent. Point *B* illustrates the case $p_{AF}/p_{AH}=1.4$ where a move from autarky to free trade does not change Home welfare. Finally, Point *C* shows the case $p_{AF}/p_{AH}=1.6$ where a move from autarky to free trade increases Home welfare by 0.2 percent. In all these cases Foreign welfare increases substantially. Point A corresponds to a 4.5 percent increase in Foreign welfare, point B to a 12.2 percent welfare increase, and point C to a 24 percent increase, respectively. Thus, in the presence of labor-market frictions and endogenous firm productivity, trade can generate substantial welfare gains for the country with comparative advantage in the outside good.[28]

The possibility that trade can reduce welfare is not present in other related studies (e.g., Helpman and Itskhoki, 2010; Helpman et al., 2010; Dinopoulos and Unel, 2014). These studies assume that sector 2 produces differentiated goods under monopolistic competition. As a result, trade increases the mass of varieties available for consumption and lowers average production costs raising welfare despite the presence of labor-market frictions. In contrast, the present model assumes that good 2 is produced under perfect competition and thus trade may lead to a welfare loss due to the wage-bargaining distortion. In other words, in economies with labor-market frictions, Melitz (2003) type models of intra-industry trade generate additional gains from trade stemming from love for variety and scale economies, which are not present here. These additional gains from trade dominate the welfare losses stemming from labor-market frictions such as Stole and Zwiebel (1996) type wage bargaining. The following proposition summarizes the main effects of trade openness.

Proposition 4. *Under Assumption 1, a move from autarky to free-trade*:

a. *increases the mass of entrepreneurs and firm productivity in Home, and reduces the mass of entrepreneurs and firm productivity in Foreign*;
b. *raises top income inequality in Home and reduces top income inequality in Foreign*;
c. *lowers Home unemployment and increases Foreign unemployment*;
d. *raises Foreign welfare and has an ambiguous effect on Home welfare.*

4.3. Unilateral job-creating policies

A large body of literature addresses the effects of trade and technical change on wages and unemployment in the presence of national labor-market institutions. For instance, Davis (1998a) studied the effects of trade openness on wages and unemployment in an integrated Heckscher–Ohlin global economy with one country (Europe) having a binding minimum wage leading to unemployment and another country (America) having flexible wages. A move from autarky to free trade raises American wages and increases European unemployment. Davis (1998b) employs the America–Europe integrated global economy to analyze the effects of exogenous technical change on relative wages and unemployment. Felbermayr et al. (2013) set up a two-country trade model to analyze how changes in labor-market frictions in one country affect national unemployment rates. They establish that a reduction in labor-market frictions in one country reduce unemployment in both trading countries and provide econometric evidence supporting this finding. These studies do not consider trade-triggered changes in terms of trade (Davis, 1998a, 1998b); interactions between trade and endogenous firm productivity (Davis, 1998b); and sector specific differences in labor-market frictions (Felbermayr et al., 2013).

In this subsection we consider a related but distinct question: what is the general-equilibrium impact of unilateral job-creating policies implemented by Home? The model's tractability allows us to consider discrete (as opposed to marginal) changes in a two-country model without factor price equalization and endogenous technological change. Job-creating policies are captured by lower market frictions in the entrepreneur-intensive sector. We consider two cases: a reduction in the cost of managerial capital λ;[29] and a reduction in labor-market rigidities in sector 2 τ_2.[30] The following lemma

[27] Fig. 3 is created under the assumption that the distribution of managerial ability is Pareto, and we set $k=2.5, \beta=0.75, \eta=1/3$, $\lambda_H=3, \tau_{1H}=\tau_{1F}=0.65, \tau_{2H}=0.50$, $\tau_{2F}=0.60$, and $\gamma=1$ as in Fig. 2. We choose $\lambda_F \in [3, 13.5]$ so that $p_{AF}/p_{AH} \in (1.0, 1.7)$.

[28] Interestingly, these numerical predictions fall within the range of empirical findings regarding the effect of trade openness on national welfare. For example, Bernhoven and Brown (2005) using historical data from Japan estimate that a move from autarky to free trade resulted in gains from trade of about 8–9 percent of Japan's GDP during 1851–53. In addition, Carrasco-Gallego (2012) uses data from post-war Spain to argue that a move from free trade to autarky (approximated with very restricted trade and no foreign aid under the Marshall Plan) resulted in a welfare loss between 8 and 26 percent of Spanish GDP during 1947–55. In sum, this numerical example illustrates that labor-market frictions can amplify the effect of trade on welfare by conferring substantial gains to Foreign and reducing, even reversing, the potentially beneficial impact of trade on Home welfare.

[29] This exercise complements Unel (2015) who investigates the impact of a unilateral change in the cost of forming human capital on inequality and welfare in each country in the absence of labor-market frictions.

[30] A reduction in λ_H or τ_{2H} lowers f_H and thus reinforces Home's comparative advantage in good 2 captured by $f_H < f_F$.

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summarizes the impact of such policies on the equilibrium talent cutoff a_j^* in each country (see Appendix A.4 for the proof).[31]

Lemma 4. *Consider two freely trading countries Home and Foreign as described. A unilateral job-creating policy adopted by Home (in the form of a reduction in λ_H or τ_{2H}) decreases the managerial talent cutoff level in Home a_H^*, while increasing managerial talent cutoff level a_F^* in Foreign. In addition, it reduces free-trade price p_T.*

The intuition behind Lemma 4 is as follows. For any initial free-trade price p_T a reduction in λ_H or τ_{2H} reduces talent cutoff in Home a_H^* in accordance to (11). A decline in a_H^* raises the LHS of market-clearing condition (30) without affecting its RHS. To restore equilibrium, a reduction in free-trade price p_T is required which raises the ability cutoff level a_F^* in Foreign and dampens, without reversing though, the original decline in a_H^*.

Armed with these results, analyzing unilateral job-creating policies is similar to the analysis of trade openness, and will not be repeated here. However, we briefly mention how such unilateral job-creating policies affect extreme income inequality and welfare. Under Assumption 1, Home has more managerial capital than Foreign under the initial free-trade equilibrium. Eq. (12) implies that unilateral job-creating policies increase the Home–Foreign managerial-capital gap. In addition, Lemma 15 implies that top income inequality rises in Home and falls in Foreign implying that the gap in top income inequality between Home and Foreign increases as well. As Home has higher initial expenditure and GDP, Eq. (20) implies that these policies increase the Home–Foreign gap in aggregate spending and GDP. Using Eq. (17), it can be shown that such policies create jobs in Home and destroy jobs in Foreign.

As Appendix A.4 elaborates, a reduction in free-trade price p_T improves welfare in both countries. The intuition behind this result is as follows. A unilateral job-creating policy reduces the cutoff level of managerial talent in Home leading to an increase in its expenditure E_H. It also generates a lower price p_T, and thus Home consumers are better off because they have a higher real income.

Foreign consumers face a reduction in price and a reduction in expenditure E_F as a result of a unilateral job-creating policy implemented by Home. The income effect is welfare reducing whereas the price effect is welfare improving. However, Foreign (the country with a comparative advantage in the outside good) is located in the downward-sloping segment of its welfare curve (see Fig. 2). Thus the beneficial welfare effect caused by a price reduction dominates the negative welfare effect caused by an income reduction in this case leading to higher Foreign welfare. In other words, whereas trade openness may reduce Home welfare because it leads to an *increase* in the price of good 2 moving it closer to the welfare-minimizing price, a unilateral job-creating policy necessarily raises Foreign welfare because it leads to a *decline* in the price of good 2 moving Foreign away from its welfare-minimizing price.

Proposition 5. *Consider two freely trading countries Home and Foreign. Under Assumption 1, unilateral job-creating policies in the form of lower λ_H or τ_{2H} implemented by* Home:

a. *lead to divergence in managerial capital, firm productivity, unemployment, and top income inequality between Home and Foreign*;
b. *and raise welfare in both countries.*

In sum, although unilateral job-creating policies improve welfare in both countries by either lowering labor-market frictions or the costs of managerial capital in Home, they exhibit "beggar-thy-neighbor" features: they reduce unemployment, raise firm productivity, and enhance entrepreneurship and firm formation in Home; while they raise unemployment, reduce firm productivity, and discourage entrepreneurship and new firm formation in Foreign.[32]

5. Concluding remarks

We developed a simple and tractable theory highlighting the complex interactions among inter-industry trade, endogenous firm productivity, extreme income distribution, and welfare. The key features of the theory consist of individuals differing in managerial talent and choosing optimally their occupation, perfectly competitive product markets generating inter-industry trade, and labor-market frictions leading to equilibrium unemployment.

The theory emphasizes the role of managerial capital and labor-market frictions as determinants of comparative advantage and extreme income inequality. We find that, ceteris-paribus, a country exports the good exhibiting lower relative labor-market frictions and/or lower costs of managerial capital. We also find that, under autarky, the country with

[31] Lemma 4 considers a unilateral job-creating policy implemented by Home. A unilateral job-creating policy adopted by Foreign decreases a_F^* while increasing a_H^*.

[32] The effects of unilateral job-creating policies on unemployment differ from Felbermayr et al. (2013) who find that a unilateral reduction in economy-wide (as opposed to sector-specific) labor-market frictions decrease unemployment in both trading countries.There are many differences between the two models including the bargaining solution employed and the use of a CES production function in Felbermayr et al. (2013). The nature of labor-market frictions matters for the transmission of policy spillovers on unemployment!

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higher labor-market frictions has lower firm productivity, lower top income inequality; and, under reasonable parameter restrictions, higher unemployment. Trade openness, captured by a move from autarky to free trade, amplifies most of these differences and creates divergence in firm productivity, supply of entrepreneurs, top income inequality and unemployment. Trade openness increases welfare in the country importing the entrepreneur-intensive good and might reduce welfare in the country exporting the entrepreneur-intensive good. Starting at the free-trade equilibrium, unilateral job-creating policies improve national and global welfare; and lead to further divergence in firm-productivity, top income inequality and unemployment (bottom income inequality) between the two economies.

The proposed framework can be extended along several directions. One can examine the case where both workers and entrepreneurs face the prospect of search-based unemployment. The assumption that worker productivity is independent of worker ability is restrictive and could be replaced with one where worker productivity increases with ability. One can introduce another factor of production, such as capital, and assume that entrepreneurs are active in both sectors, to analyze the role of factor endowments in conjunction with labor-market frictions and managerial capital as determinants of comparative advantage. These generalizations constitute fruitful directions for further research.

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Appendix A

A.1. Equilibrium unemployment

Consider first sector 1 where each firm employs one worker. Market entry is unrestricted, but each firm faces entry costs equal to the cost of posting a vacancy (denoted by ν_1 and measured in units of good 1). Note that $\chi_1 = \nu_1/c_1$ represents the probability that a firm fills a vacancy, that is, χ_1 is the hiring rate in sector 1. Because each firm receives half of generated revenue, expected firm profit is $\chi_1/2$. As a result, free-entry condition $\chi_1/2 = \nu_1$ implies $c_1 = 1/2$. Substituting $c_1 = 1/2$ in (13) yields (14).

Now consider sector 2. Ex-ante inter-sectoral labor mobility leads to the equalization of expected wage income across the two sectors: $\zeta_1 w_1 = \zeta_2 w_2$. Using $w_1 = 1/2$ and $w_2 = c_2$ yields $\zeta_2 c_2 = \zeta_1/2$. Substituting c_2 from (13) and ζ_1 from (14) in $\zeta_2 c_2 = \zeta_1/2$ yields (15).

A.2. Top income inequality

Define a_x as the minimum managerial talent of entrepreneurs earning top income, where x is the corresponding exogenous percent of population. Observe that the probability that an individual's managerial talent exceeds a_x is given by $\Pr(a \geq a_x) = 1 - G(a_x)$. Since the measure of population is one this means that the proportion of top income earners is also $x = 1 - G(a_x)$ and that the lowest managerial talent of a top earner is given by $a_x = G^{-1}(1-x)$ for $a_x \in [a^*, \infty)$.

Aggregate income earned by top income earners equals all income earned by entrepreneurs with managerial talent greater or equal to a_x and given by $\mathbb{E}(a_x) = \int_{a_x}^{\infty} e_2(a) g(a)\, da = (\zeta_1/2a^*)\mathbb{A}(a_x)$, where $e_2(a) = (\zeta_1/2a^*)a$ is entrepreneurial income. Dividing top income $\mathbb{E}(a_x)$ by total income $E = (\zeta_1/2)[G(a^*) + \mathbb{A}(a^*)/a^*]$, and denoting with $\varphi(x) = \mathbb{A}(a_x) = \mathbb{A}[G^{-1}(1-x)]$ aggregate managerial talent of top income earners, yields

$$T(x, a^*) = \frac{\varphi(x)}{a^* G(a^*) + \mathbb{A}(a^*)},$$

which is Eq. (23) in the text. Observe that $\varphi(0) = \mathbb{A}(\infty) = 0$.

A.3. Welfare

If the economy produces both goods, then there must be an upper bound, denoted by $p^{\max}$, on the relative price of good 2. To see this, notice that Eq. (11) states that a^* is monotonically decreasing with p. As the relative price of good 2 increases the cutoff level of managerial talent declines. This process in turn increases the fraction of workers assigned to sector 2 $N_2/G(a^*) \leq 1$. Note that $N_2/G(a^*) = 2\eta\mathbb{A}[a \geq a^*]/[(1-\eta)a^* G(a^*)]$ declines monotonically in a^*, and approaches unity for a sufficiently small value $a^* = a^*_{\min}$. Replacing a^* in (11) with $a^*_{\min}$ yields $p^{\max}$. Thus, $p \in [p_A, p^{\max}]$, where p_A is the relative price of good 2 in autarky. Since the welfare function is U-shaped, it then follows that $\mathbb{V}(p) \leq \mathbb{V}(p^{\max})$ for any $p \in [p_A, p^{\max}]$.

Finally, we show that the autarky price under no labor-market frictions is identical to p_m, i.e. welfare is minimized at the closed-economy price p_A. In this case, we have

$$E_2 = \frac{\zeta_1 \mathbb{A}(a^*)}{(1-\eta)a^*},$$

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Details of this derivation are available upon request. Substituting these variables into the closed-economy equilibrium condition, $E_2/E=\beta$, where aggregate income E is given by (20), yields

$$\frac{\mathbb{A}(a^*)}{a^*G(a^*)}=B_m,\quad B_m\equiv\frac{\beta(1-\eta)}{2-\beta(1-\eta)}>0,$$

which is identical to Eq. (26) in the text.

A.4. Unilateral job-creating policies

Proof of Lemma 4. Note that a reduction in τ_j implies a reduction in c_j, and thus we hereafter assume a reduction in c_{2j}. Let x_H denote λ_H or c_{2H}. Totally differentiating (30) with respect to x_H yields

$$\sum_j \Gamma_j da_j^*/dx_H=0,\quad \Gamma_j=(1+B)g(a_j^*)+\mathbb{A}(a_j^*)/a_j^*. \tag{A.1}$$

where B is given by (21).

Differentiating (11) with respect to λ_H and c_{2H} yields

$$\frac{da_H^*}{d\lambda_H}=\frac{a_H^*}{\lambda_H}-\frac{2a_H^*}{(1-\eta)p_T}\frac{dp_T}{d\lambda_H},\quad \frac{da_F^*}{d\lambda_H}=-\frac{2a_F^*}{(1-\eta)p_T}\frac{dp_T}{d\lambda_H} \tag{A.2a}$$

$$\frac{da_H^*}{dc_{2\,H}}=\frac{2\eta a_H^*}{(1-\eta)c_{2H}}-\frac{2a_H^*}{(1-\eta)p_T}\frac{dp_T}{dc_{2H}},\quad \frac{da_F^*}{dc_{2H}}=-\frac{2a_F^*}{(1-\eta)p_T}\frac{dp_T}{dc_{2H}}, \tag{A.2b}$$

where p_T is the world relative price of good 2. Substituting these into (A.1) yields

$$\frac{dp_T}{d\lambda_H}=\frac{(1-\eta)\Gamma_H a_H^* p_T}{2\lambda_H\sum_j\Gamma_j a_j^*}>0, \tag{A.3a}$$

$$\frac{dp_T}{dc_{2H}}=\frac{\eta\Gamma_H a_H^* p_T}{c_{2H}\sum_j\Gamma_j a_j^*}>0. \tag{A.3b}$$

The first equations in (A.2a) and (A.2b) imply $da_F^*/dx_H<0$ for $x_H=\lambda_H,c_{2H}$. Finally, substituting (A.3a) and (A.3b) into the second equations in (A.2a) and (A.2b) yields

$$\frac{da_H^*}{d\lambda_H}=\frac{a_F^*a_H^*\Gamma_F}{\lambda_H\sum_j\Gamma_j a_j^*}>0,\quad \frac{da_H^*}{dc_{2H}}=\frac{2\eta a_F^*a_H^*\Gamma_F}{(1-\eta)c_{2H}\sum_j\Gamma_j a_j^*}>0, \tag{A.4}$$

as indicated in Lemma 4. □

Consider the welfare effects of unilateral job-creating policies. Differentiating $\mathbb{V}_j=p_T^{-\beta}E_j$ with respect to $x_H=\{\lambda_H,c_{2H}\}$ and using Eqs. (A.2), (A.3) and (A.4) yields

$$\frac{d\mathbb{V}_H}{dx_H}=-\frac{\beta\zeta_1}{2p_T^{1+\beta}}\left[G(a_H^*)+\left(1+\frac{2a_F^*\Gamma_F}{\beta(1-\eta)a_H^*\Gamma_H}\right)\frac{\mathbb{A}(a_H^*)}{a_H^*}\right]\frac{dp_T}{dx_H}<0, \tag{A.5a}$$

$$\frac{d\mathbb{V}_F}{dx_H}=-\frac{\beta\zeta_1}{2p_T^{1+\beta}}\left[G(a_F^*)-\frac{\mathbb{A}(a_F^*)}{B_m a_F^*}\right]\frac{dp_T}{dx_H}<0, \tag{A.5b}$$

where B_m is given by (26). Using $a_F^*>a_{AF}^*$ and $B_m>B$ implies that the expression in the square brackets in (A.5b) is positive. This, combined with $dp_T/dx_F>0$, implies that $d\mathbb{V}_F/dx_H<0$ for $x_H=\{\lambda_H,c_{2H}\}$.

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