Intermediated Trade*

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Abstract

This paper develops a simple model of international trade with intermediation. We consider an economy with two islands and two types of agents, farmers and traders. Farmers can produce two goods, but in order to sell these goods into a centralized (Walrasian) market, they need to be matched with a trader, and this requires costly search. In the absence of search frictions, our model reduces to a standard Ricardian model of trade. We use this simple model to contrast the implications of changes in the integration of Walrasian markets, which allow traders from different islands to exchange their goods, and changes in the access to these Walrasian markets, which allow farmers to trade with traders from different islands. Compared to a standard Ricardian model, we find, among other things, that intermediation always magnifies the gains from trade under the former type of integration, but leads to more nuanced welfare results (including the possibility of aggregate losses) under the latter. We conclude by discussing optimal policy in our framework.

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1 Introduction

Intermediaries are the grease that allows the wheels of commerce to spin. From small itinerant traders picking up coffee in rural Uganda to large Asian trading companies matching Western manufacturers with local suppliers of goods or services, intermediaries are instrumental in bringing to life the gains from international exchange.[1] The public opinion, however, does not always view these intermediaries as the unsung heroes of globalization. Instead, they are sometimes portrayed as villains that exploit producers in less developed countries and siphon all gains from trade away from these economies and towards developed countries. For instance, a recent Oxfam International report on the coffee industry states that "without roads or transport to local markets, without technical backup, credit, or information about prices, the vast majority of farmers are at the mercy of itinerant traders offering a 'take it or leave it' price" (Oxfam, 2002).

What does the theory of international trade have to tell us about the role of these intermediaries? Unfortunately, very little. Neoclassical trade theory assumes the existence of centralized markets where homogeneous goods are exchanged at a common, market-clearing price. New trade theory emphasizes product differentiation and monopolistic behavior within industries, but how supply meets demand is again not specified in those models. The purpose of this paper is to develop a stylized but explicit model of intermediation in trade, and to use this model to shed light on the role of intermediaries in materializing the gains from international trade as well as in affecting the world distribution of these gains.

Our starting point is a simple Ricardian model with two geographically separated islands, North and South, and two homogeneous goods, coffee and sugar. Each island is populated by a continuum of farmers who must decide, at any point in time, whether to grow coffee or sugar. We depart from the standard Ricardian model in assuming that farmers do not have direct access to centralized or Walrasian markets where goods can be costlessly exchanged. Instead, farmers need to resort to traders to conduct these transactions on their behalf. Farmers' trading opportunities arise randomly at a rate determined by the ratio of traders to farmers seeking trades on each island at any point in time. We refer to this ratio as the island's level of intermediation. The number of traders active on each island is itself endogenous and pinned down by a free-entry condition.

Unlike farmers, traders are assumed to have direct access to Walrasian markets where all trades occur at a common, market-clearing relative price. Nevertheless, the terms of exchange between farmers and traders differ from those in the centralized market, since traders exploit the lock-in effect created by search frictions to charge a positive margin to farmers and thereby recoup the costs they incur when intermediating trade. We model the determination of prices in bilateral exchanges as the outcome of a generalized Nash bargaining game between each farmer and the trader he or

[1] Though it is not straightforward to quantify the importance of intermediaries in market economies, Feenstra, Hanson and Lin (2004) estimate that, during the 1990s, Hong Kong intermediated over fifty percent of the volume of China's exports to the rest of the world. The early work of Wallis and North (1986) suggests that the size of the private "transaction sector" was around 41% of U.S. GNP in 1970. More recently, Spulber (1996a) provides a conservative estimate indicating that intermediation activities account for about 25% of U.S. GDP. Such estimates are, of course, very sensitive to the definition of "intermediation activities."

she is matched with.

Using this simple theoretical framework we revisit the consequences of economic integration when trade is intermediated. We let the two islands differ in their available production technologies to grow coffee and sugar, as well as their "market institutions," which we model as exogenous characteristics of the traders populating the two islands. More specifically, we let Northern traders be more efficient than Southern traders in intermediating trade, and we also allow the primitive bargaining power of Northern traders to be higher than that of Southern traders. For simplicity, we further let the Northern island be large relative to the Southern one, so that we can (for the most part) focus on the effects of integration for the Southern island and ignore the feedback effects that this may have on the rest of the world.

How does one think about economic integration in a world economy where trading opportunities are constrained by such market institutions? A first possibility is to consider the case in which the centralized market where traders exchange goods becomes global rather than local, while maintaining the assumption that farmers can only find trading opportunities with local traders. In the rest of the paper, we refer to this first type of integration—the integration of two initially isolated Walrasian markets—as *W-integration*. Our model, however, also allows for a different type of integration involving the internationalization of trading opportunities, so that traders worldwide are allowed to intermediate trade in either of the two islands. We refer to this second type of integration—the integration of two initially isolated matching markets—as *M-integration*. It aims to capture changes in the access to Walrasian markets.

The first type of market integration is analogous to the one considered by standard trade models. Since our economy features domestic distortions associated with the bilateral exchanges between farmers and traders, one might have anticipated the possibility of W-integration having ambiguous welfare effects; see e.g., Bhagwati (1971). Our first results demonstrate that this is not the case: W-integration generates Pareto gains from trade, just as in the standard Ricardian model. This is true regardless of the parameters governing market institutions in the two islands. Rather than aggravating distortions, we show that the endogeneity of intermediation necessarily magnifies the aggregate gains from trade and reduces the margins charged by traders. The integration of Walrasian markets increases the level of intermediation in the South, which generates growth along the transition path towards the new steady state. Furthermore, under mild regularity conditions, this growth effect is larger in economies with lower levels of intermediation under autarky, thereby leading to convergence across countries.

Our analysis of the effects of M-integration, however, produces much more nuanced results. The relatively higher profitability of Northern traders (due to their lower intermediation costs and higher bargaining power) allow them to penetrate the Southern island and intermediate trade there. Such process of entry naturally leads to an increase in the level of intermediation in the South over and above the one brought about by W-integration. Nevertheless, the higher bargaining power of Northern traders now implies an ambiguous effect of M-integration on intermediation margins. Accordingly, social welfare in South may go up or down following M-integration. When the (primitive) bargaining strength of traders is similar across countries and the costs of intermediation differ significantly, then M-integration is necessarily associated with an increase in social welfare in South that is in excess of the aforementioned gains from W-integration. Intuitively, M-integration improves the technology of intermediation in South with no adverse distributional consequences.

Conversely, when the (primitive) bargaining power of Northern traders is disproportionately large and the costs of intermediation are similar across countries, then M-integration necessarily reduces social welfare in South. Even though Southern farmers (and the South as a whole) would be better off if farmers could collectively commit to refuse any trade with Northern traders, each individual Southern farmer has an incentive to deviate from this cooperative equilibrium and accept trades with Northern traders. Importantly, this is true ex-post (once a trading opportunity with a Northern trader arises) as well as ex-ante (when a farmer decides whether to actively seek trades with Northern agents or not). The key behind this "prisoner's dilemma" situation and the implied possibility of aggregate losses from trade is the trading externality underlying the search friction in goods markets. In this environment, the bilateral negotiations between a trader and a farmer not only affect the division of surplus among these two agents, but also affect the entry of traders and thus the rate at which trading possibilities arise for farmers that have not yet found a match. However, farmers and traders only bargain after they have found a match and thus their negotiations fail to internalize this externality. We find that a necessary (though not sufficient) condition for there to be aggregate losses from M-integration in South is for the margins charged by Northern traders to be larger than those charged by Southern traders before M-integration.

At this point, it may appear that our model captures some of the concerns regarding intermediaries expressed by activists and exemplified in our Oxfam quote above. In particular, losses from trade seem to be associated with the "marginalization" of Southern producers (in the sense that they only find trading opportunities at a limited rate), and with the fact that Northern traders charge exceedingly high margins for intermediating trade. A few observations are however in order. First, and most obviously, our model only demonstrates the possibility of aggregate losses, and at the same time it illustrates that integration can be a powerful mechanism to lift economies with weak levels of intermediation out of poverty. Second, in our model, in situations in which M-integration reduces welfare in the South, it also reduces welfare in the world because, by free entry, the (large) North is unaffected by M-integration. Hence, our model does not suggest that M-integration will amount to a transfer of surplus from the South to the North.[2] Third, our model is perfectly consistent with the South benefitting from M-integration while at the same time Northern traders' margins being higher than those charged by Southern traders before M-integration. In our model, we show that a sufficient statistic for welfare analysis is the margin charged by *Southern* traders before and after M-integration.

The previous observations have important consequences for the optimal design of policies as

[2] In Section 5, we briefly discuss the case where South is no longer small compared to North. In this situation, Matching integration tends to increase welfare in the North while reducing it in the South. The mechanism at play, however, is a standard general-equilibrium terms-of-trade effect. By improving the intermediation technology in the South, Matching integration increases the relative supply of Southern goods, and in turn, worsens its terms of trade.

dictated by our model. For instance, although price controls in the form of floor prices or caps on margins may help reduce the likelihood of M-integration being welfare-reducing, they can also hinder the gains of such integration in South whenever these price controls do not appropriately discriminate between Northern and Southern traders. In that respect, we show that taxing the entry of traders can achieve the same goal as price controls without requiring discrimination between the two types of traders, in line with WTO's national treatment principle. Of course, both price controls and entry taxes are informationally intensive. Setting them at the right level requires a detailed knowledge of several parameters of the model, or at the very least, a detailed knowledge of how changes in prices and taxes (on Northern traders) affect the Southern traders' margins, which may still be hard for a government to observe in practice. We finally explore an alternative policy that allows the government to circumvent informational constraints. It consists in creating segmented matching markets and providing farmers with information about their existence. If Southern farmers can *direct* their search towards different types of traders, then we show that aggregate losses from M-integration can no longer arise. The obvious drawback of this policy intervention is that in the context of a developing country, allowing producers to direct their search may be extremely costly as it may require investments in transportation or infrastructure, a cost from which the present analysis abstracts.

Our model of intermediation is admittedly stylized and does not aspire to capture the precise workings of any particular market. The search frictions in our model merely aim to reflect, in a somewhat reduced-form way, the set of frictions that inhibit the ability of producers to costlessly place their goods in world markets, whether such frictions actually derive from time-consuming search, from incomplete information about quality or prices, or from working-capital needs. Notwithstanding, readers insisting on a literal interpretation of our framework may find our model useful in analyzing the role of itinerant traders in certain agricultural markets in Africa. In Uganda, for instance, 85% of coffee farmers sell to itinerant traders despite the existence of nearby centralized markets; see Fafchamps and Vargas Hill (2005).[3]

Our paper is related to several strands of the literature. First, we draw some ideas from a small literature that has studied the emergence and characteristics of intermediaries in closed-economy (and mostly partial-equilibrium) models. Important early contributions to this literature include the work of Rubinstein and Wolinsky (1987), Biglaiser (1993), and Spulber (1996b). As in Rubinstein and Wolinsky (1987), we also emphasize the importance of search frictions in determining the margins charged by intermediaries, though we do so in a general-equilibrium, open-economy setup.[4] In terms of the structure of our model, we borrow some tools from the sizeable literature on search-theoretic approaches to the analysis of labor markets, which builds on the seminal paper by Diamond (1982) and the influential work of Mortensen and Pissarides (2004).[5] In that respect,

[3]More broadly, one can think of the significant presence of foreign firms in coffee production in Uganda as a real-world counterpart to M-integration in our model. For example, the Kaweri coffee plantation, which is Uganda's largest coffee farm, is owned by the Neumann Kaffee Gruppe based in Hamburg, Germany.

[4]This aspect of our analysis also is related to the work of Duffie et al. (2005) who study how the bid and ask prices charged by marketmakers in over-the-counter markets are shaped by search frictions.

[5]See Pissarides (2000) for a survey of the early contributions to this literature and Rogerson et al. (2005) for an

the inefficiency underlying our non-standard welfare results bears a close relationship to Hosios' (1990a) analysis of the efficiency of labor markets equilibria.[6] Search-theoretic models have been applied to the study of international trade issues before, but with very different goals in mind. For instance, Davidson et al. (1988, 1999) and Hosios (1990b) study the workings of two-sector, general equilibrium models featuring asymmetric search frictions in the two sectors, and revisit the determination of comparative advantage and the effects of trade integration on labor market outcomes (see also Costinot, 2009, and Helpman et al., 2009). Instead, in our model, search frictions are symmetric in the two sectors.

In terms of focus, our paper is more closely related to a recent, burgeoning empirical literature on the role of intermediaries in world trade. On the empirical side, this literature builds on the insights of Rauch (2001), Anderson and Van Wincoop (2004), and Feenstra and Hanson (2004) about the importance of intermediation and networks in determining the effective costs of conducting international trade across countries.[7] More recent approaches have used firm-level data to shed further light on the factors that drive a firm to seek the help of an intermediary when engaging in international trade (see, for instance, Ahn et al., 2009, and Blum et al., 2009).

While some of these contributions offer simple models to motivate the empirical analysis, the modeling of intermediaries tends to focus on technological differences across firms and on their implications for cross-sectional predictions (at the firm- or industry-level). Instead, we develop a general equilibrium model where the reason of being of intermediaries and the margins they charge are shaped by a search friction in the goods market. By explicitly modeling market institutions we are able to draw welfare implications for the effects of integration in a world in which middlemen intermediate trade, and we are also able to discuss the optimal design of policies within our framework. In that respect, our work is most closely related to the earlier work of Rauch and Watson (2004) and recent working papers by Bardhan et al. (2009) and Chau et al. (2009), who develop complementary theories of intermediation. Our work is however distinct in three key dimensions. First, our model introduces costly intermediation in an otherwise standard Ricardian model of trade: when intermediation costs go to zero, traders' margins vanish, and the equilibrium is analogous to that of the standard model. Second, we develop a dynamic framework where traders' margins are shaped by both the current and future trading opportunities of farmers. Finally, we depart from these previous authors in studying the welfare consequences of two distinct types of economic integration.[8]

The rest of the paper is organized as follows. Section 2 describes the basic environment. Sec-

account of more recent developments.

[6] Our results about optimal policy in economies where trade is intermediated also echo some earlier results on the effects of minimum wages in the labor literature; see e.g. Flinn (2006).

[7] Morriset (1998) studies the role of intermediaries margins in shaping the gap between the retail price of seven major commodities and the price obtained by the producers of these commodities. McMillan et al. (2003) also argue that these intermediation margins are important for understanding the small recorded welfare gains from trade liberalization of the cashew sector in Mozambique. Hummels et al. (2009) offer evidence of price discrimination in the shipping industry. See Stahl (1988) for an early, simple model of market power in international trading.

[8] Bardhan et al. (2009) also consider two types of economic integration (trade and offshoring) but their focus is on their effect on income inequality.

tion 3 characterizes the equilibrium under autarky. Section 4 and 5 analyze the consequences of Walrasian and matching market integration, respectively. Section 6 discusses policy implications. Section 7 offers some concluding remarks. All proofs can be found in the appendix.

2 The Basic Environment

Consider an island inhabited by a continuum of infinitely lived agents consuming two goods, coffee (C) and sugar (S). Agents aim to maximize the expected value of their lifetime utility

$$V = E\left[\int_0^{+\infty} e^{-rt} v\left(C(t), S(t)\right) dt\right],$$

where $r > 0$ is the common discount factor; $C(t) \geq 0$ and $S(t) \geq 0$ are the consumption of good C and S at date t, respectively; and v is increasing, concave, homogeneous of degree one and satisfies the two Inada conditions: $\lim_{C \to 0} v_C = \lim_{S \to 0} v_S = +\infty$ and $\lim_{C \to +\infty} v_C = \lim_{S \to +\infty} v_S = 0$. The assumption that the utility function v is homogeneous of degree one guarantees that agents are risk neutral. Combined with the Inada conditions, it also implies that both goods are essential: $v(0, S) = v(C, 0) = 0$ for all C and S.

An exogenous measure N_F of the island inhabitants are engaged in production. We refer to this set of agents as *farmers* and assume that they (and only they) have access to production technologies that allow them to produce an amount $1/a_C$ of coffee or an amount $1/a_S$ of sugar per unit of time. A farmer cannot produce both goods at the same date t and goods are not storable. We denote by $\gamma \in [0, 1]$ the share of coffee farmers at a given date.

Our main point of departure from the classical Ricardian model is that farmers do not have direct access to a Walrasian market where their output can be exchanged for that of other farmers. In order to be able to sell part of their output and consume both goods, a farmer needs to find a *trader*, and doing so may take time as described below. Traders do not spend any time engaged in production but have access to a Walrasian market in which both goods are exchanged competitively. We denote by $p \equiv p_C/p_S$ the relative price of coffee in this Walrasian market. Somewhat allegorically, we envision a situation in which, at each date, traders (and only they) are informed about the location on the island where trade can take place.[9]

The pool of potential traders on the island is large. At any point in time, potential traders can become active or inactive. In order to remain connected to the Walrasian market, an active trader must incur an intermediation cost equal to τ at each date, but stands to obtain some remuneration when intermediating a trade for a farmer. By contrast, inactive traders are involved in an activity that generates no income but also no disutility of effort, e.g., laying in a hammock. We assume that the pool of potential traders is large enough to ensure that the measure of traders operating on the island, N_T, is not constrained by population size and some agents are always laying in hammocks.

[9] With this stark assumption we seek to capture the more realistic notion that because of their informational advantage, specialized traders have the ability to reduce the time period that buyers and sellers have to wait to carry out a transaction.

Hence, in equilibrium, N_T will be endogenously pinned down by free entry.[10]

The process through which farmers find traders involves search frictions. Farmers and traders can be in two states, matched (M) or unmatched (U). We denote by u_F and u_T the mass of unmatched farmers and traders at any point in time. Unmatched farmers and traders come together randomly. The number of matches per unit of time is given by a matching function, $m(u_F, u_T)$, which is increasing, concave, homogeneous of degree one and satisfies the two Inada conditions: $\lim_{u_F \to 0} m_{u_F} = \lim_{u_T \to 0} m_{u_T} = +\infty$ and $\lim_{u_F \to +\infty} m_{u_F} = \lim_{u_T \to +\infty} m_{u_T} = 0$. The associated (Poisson) rate at which unmatched farmers meet unmatched traders is equal to $\mu_F(\theta) \equiv m(1, \theta)$, with $\theta \equiv u_T/u_F$. Similarly, the rate at which unmatched traders meet unmatched farmers is given by $\mu_T(\theta) \equiv m(1/\theta, 1) = \mu_F(\theta)/\theta$. The variable θ is a sufficient statistic for the matching rates of both agents, which we refer to as the level of "intermediation" on the island. We also assume that existing matches are destroyed at an exogenous Poisson rate $\lambda > 0$.

When a farmer and a trader form a match, they negotiate the terms of exchange of the output in the hands of the farmer. Although the trader has access to a Walrasian market where coffee and sugar are exchanged at a relative price p, the bilateral terms of trade will depart from this competitive price and will reflect the (primitive) bargaining power of agents as well as their outside options. Rather than explicitly modeling these negotiations through an extensive form game, we simply posit that generalized Nash bargaining leaves traders with a fraction β of the ex-post gains from trade (with the latter naturally depending on outside opportunities). Both parties observe the type of good that the farmer carries, so bargaining occurs under complete information. Let $V_{F_i}^M$ denote the value function of a farmer matched with a trader and producing good $i = C, S$; and let V_F^U denote the value function of an unmatched farmer.[11] Similarly, let $V_{T_i}^M$ denote the value function of a trader matched with a farmer carrying good i; and V_T^U denote the value function of an unmatched trader. Formally, the Nash bargaining consumption levels of a farmer-trader match with good i, $(C_{F_i}, S_{F_i}, C_{T_i}, S_{T_i})$, solve

$$\begin{array}{ll} \max\limits_{C_{F_i}, S_{F_i}, C_{T_i}, S_{T_i}} & \left(V_{T_i}^M - V_T^U\right)^{\beta} \left(V_{F_i}^M - V_F^U\right)^{1-\beta} \\ \text{s.t.} & pC_{F_i} + S_{F_i} + pC_{T_i} + S_{T_i} \leq (p/a_C) \cdot \mathcal{I}_C + (1/a_S)(1 - \mathcal{I}_C), \end{array}$$

where $\mathcal{I}_C = 1$ if the farmer carries coffee and $\mathcal{I}_C = 0$, otherwise. As we shall see, the implicit bilateral relative price at which goods are exchanged can easily be retrieved from these consumption levels.

Each date t is divided into three periods. First, farmers decide which goods to produce. Second, matched farmers and traders bargain over the exchange of goods. Finally, matched traders carry out transactions in the Walrasian market, consumption takes place, new matches are formed among unmatched agents, and a fraction of existing matches is dissolved exogenously.

[10] We model traders as economic agents with preferences represented by the utility function V. The equilibrium would be essentially identical if we were to model traders as profit-maximizing firms.

[11] Given that both goods are essential in consumption, it is clearly the case that unmatched farmers will attain the same welfare level when unemployed, independently of the good they produce. For notational convenience, we then simply write $V_{F_C}^U \equiv V_{F_S}^U \equiv V_F^U$.

3 Autarky Equilibrium

3.1 Definition

We define the equilibrium at any point in time of an isolated island of the type described above as: (i) a relative price, p; (ii) a measure of traders, N_T; (iii) a share of coffee farmers, γ; (iv) a vector of consumption levels, $(C_{F_i}, S_{F_i}, C_{T_i}, S_{T_i})$ for $i = C, S$; (v) a level of intermediation, θ; and (vi) measures of unmatched farmers and traders, u_F and u_T, such that: (i) agents choose their occupations to maximize their utility; (ii) consumption levels are determined by Nash bargaining; (iii) matches are created and destroyed according to the aforementioned Poisson process; and (iv) the Walrasian market clears.

3.2 Equilibrium Conditions

In order to understand the occupational choice decisions of agents, we need to describe how expected lifetime utilities, $\left(V_{F_i}^M, V_F^U, V_{T_i}^M, V_T^U\right)$ for $i = C, S$, are determined. These value functions must satisfy the following Bellman equations:

$$rV_F^U = \mu_F(\theta)\left[\max\left\{V_{F_C}^M, V_{F_S}^M\right\} - V_F^U\right] + \dot{V}_F^U, \tag{1}$$

$$rV_{F_i}^M = v(C_{F_i}, S_{F_i}) + \lambda\left(V_F^U - V_{F_i}^M\right) + \dot{V}_{F_i}^M, \tag{2}$$

$$rV_T^U = -\tau + \mu_T(\theta)\left[\gamma\left(V_{T_C}^M - V_T^U\right) + (1-\gamma)\left(V_{T_S}^M - V_T^U\right)\right] + \dot{V}_T^U, \tag{3}$$

$$rV_{T_i}^M = v(C_{T_i}, S_{T_i}) - \tau + \lambda\left(V_T^U - V_{T_i}^M\right) + \dot{V}_{T_i}^M. \tag{4}$$

Equations (1) and (2) reflect the fact that unmatched farmers get zero instantaneous utility and become matched at rate $\mu_F(\theta)$ (at which point they obtain a gain of $\max\left\{V_{F_C}^M, V_{F_S}^M\right\} - V_{F_i}^U$) whereas matched farmers with good i get utility $v(C_{F_i}, S_{F_i})$ and become unmatched at rate λ (at which point they incur a loss of $V_{F_i}^M - V_F^U$). Both equations incorporate a potential capital gain or loss of remaining in the farmer's current state ($\dot{V}_{F_i}^U$, $\dot{V}_{F_i}^M$). Equations (3) and (4) are derived similarly and follow from the fact that unmatched traders are subject to an intermediation cost τ and get matched to a coffee farmer with probability $\gamma\mu_T(\theta)$ and to a sugar farmer with probability $(1-\gamma)\mu_T(\theta)$, whereas traders matched with a farmer carrying good $i = C, S$ get utility $v(C_{T_i}, S_{T_i}) - \tau$ and become unmatched at rate λ.

We can now describe how the process of intermediation and Nash bargaining between farmers and traders affect the division of surplus and the implied terms of exchange of goods C and S. As we formally show in the Appendix, Nash bargaining between farmers and traders further implies that, at any point in time,

$$V_{T_i}^M - V_T^U = \beta\left(V_{T_i}^M + V_{F_i}^M - V_T^U - V_F^U\right) \tag{5}$$

as well as

$$\frac{v_C(C_{F_i}, S_{F_i})}{v_S(C_{F_i}, S_{F_i})} = \frac{v_C(C_{T_i}, S_{T_i})}{v_S(C_{T_i}, S_{T_i})} = p \tag{6}$$

and

$$pC_{F_i} + S_{F_i} + pC_{T_i} + S_{T_i} = (p/a_C) \cdot \mathcal{I}_C + (1/a_S)(1 - \mathcal{I}_C). \tag{7}$$

Equation (5) simply states that traders get a share β of the surplus of any match, while equations (6) and (7) reflect the fact that Nash bargaining outcomes are (Pareto) efficient.

Equilibrium in the island also requires that the Walrasian markets for coffee and sugar clear at any point in time. This in turn requires that

$$\gamma \bar{C}_C + (1-\gamma)\bar{C}_S = \gamma / a_C, \tag{8}$$

$$\gamma \bar{S}_C + (1-\gamma)\bar{S}_S = (1-\gamma)/a_S, \tag{9}$$

where $\bar{C}_i \equiv C_{F_i} + C_{T_i}$ and $\bar{S}_i \equiv S_{F_i} + S_{T_i}$ denote the joint consumption of coffee and sugar by each farmer-trader match producing good $i = C, S$, respectively. These two equations then simply equate *average* consumption of each good by each matched pair to the *average* production of this good among matched pairs participating in the Walrasian market.

The last set of equilibrium conditions relate to the evolution of the measure of matched and unmatched farmers and traders in the island. Free entry into the trading activity ensures that the expected utility of an unmatched trader exactly equals the expected utility of an inactive trader at all points in time, that is,

$$V_T^U = 0. \tag{10}$$

Finally, matching frictions imply that the measure of unmatched farmers u_F evolves according to the following law of motion:

$$\dot{u}_F = \lambda (N_F - u_F) - \mu_F(\theta) u_F. \tag{11}$$

The first term in the right-hand-side corresponds the measure of farmers entering the unmatched state through exogenous separations, while the second term is the measure of farmers finding a match at a given point in time. The overall measure of active traders can then be determined by the fact that the measure of matched traders must be equal to the measure of matched farmers at any point in time:

$$N_F - u_F = N_T - u_T. \tag{12}$$

3.3 Characterization, Existence, and Uniqueness

We next briefly characterize some key features the autarkic equilibrium and outline a proof of its existence and uniqueness, with most technical details being relegated to the Appendix.

Because farmers are free to choose which good to produce at any point in time, it must be the case that $V_{F_C}^M = V_{F_S}^M \equiv V_F^M$ at all times if both goods are produced in the autarkic equilibrium. Given our Inada conditions, we know that this must be the case. Equation (5) then directly implies $V_{T_C}^M = V_{T_S}^M \equiv V_T^M$ at all times. Combining this observation with equations (2) and (6), we obtain $(C_{F_C}, S_{F_C}) = (C_{F_S}, S_{F_S}) \equiv (C_F, S_F)$. Similarly, equations (4) and (6) imply $(C_{T_C}, S_{T_C}) = (C_{T_S}, S_{T_S}) \equiv (C_T, S_T)$. In words, farmers should attain the same utility level when matched regardless of which good they carry, which in turn implies that traders are also indifferent as to the type of farmer that they get matched with. As we shall see below, this does not imply that the *effective* relative price faced by a farmer is independent of the good that he or she produces.

Armed with the previous equilibrium conditions, it is easy to characterize the relative price, p, the share of coffee farmers, γ, and the total consumption among matched pairs, $\bar{C} \equiv \bar{C}_C = \bar{C}_S$ and $\bar{S} \equiv \bar{S}_C = \bar{S}_S$, which are all determined in the Walrasian market. Since consumption levels are identical for both types of farmer-trader match, equation (7) implies that the only relative price p of coffee consistent with equilibrium is

$$p = a_C/a_S. \tag{13}$$

Note that p is time-invariant and identical to the relative price that would apply in a frictionless Ricardian model in which farmers had direct access to Walrasian markets. Intuitively, search frictions create a wedge between competitive prices and those prevailing in bilateral exchanges and thus affect the distribution of income between farmers and traders, but these frictions have a symmetric effect on both sectors, and thus do not distort the relative supply or demand for coffee or sugar. Similarly, because farmers and traders have identical homothetic preferences, equations (6), (8), and (9) imply that the share of farmers producing coffee is also time invariant and unaffected by search frictions, and is given by

$$\frac{\gamma}{1-\gamma} = \frac{a_C}{a_S}\psi\left(\frac{a_C}{a_S}\right), \tag{14}$$

where $\psi\left(\cdot\right) \equiv \left[v_C(\cdot,1)/\, v_S(\cdot,1)\right]^{-1}$ is the relative demand for coffee. Combining this expression with (8), and (9), we can obtain the total consumption of coffee and sugar among matched pairs:

$$\bar{C} = \frac{\psi\left(\frac{a_C}{a_S}\right)}{a_S + a_C\psi\left(\frac{a_C}{a_S}\right)}, \tag{15}$$

$$\bar{S} = \frac{1}{a_S + a_C\psi\left(\frac{a_C}{a_S}\right)}. \tag{16}$$

The joint instantaneous utility enjoyed by a matched farmer-trader pair is thus given by $v\left(\bar{C},\bar{S}\right)-\tau$ and is time invariant. Because the function $v\left(\cdot\right)$ is homogeneous of degree one, it is also necessarily the case that $v\left(\cdot\right)$ is proportional to the value of farmer's good in the Walrasian market (i.e., the joint spending of the matched pair). In the rest of the paper, we slightly abuse notation and denote by $v\left(p\right) \equiv v\left(\bar{C},\bar{S}\right)$ the joint utility level (net of effort costs) of a matched farmer-trade pair when the relative price of coffee is equal to p.

We next turn to a discussion of the terms of trade in bilateral exchanges, which is at the heart of our contribution. Throughout the paper, we will denote by $\alpha \in (0,1)$ the share of joint consumption $\bar{C}$ and $\bar{S}$ that is captured by the trader, with the remaining share $1-\alpha$ accruing to the farmer. Equation (6) ensures that this share is common for both goods. Naturally, a higher α is associated with a distribution of surplus that is more favorable to the trader. As shown in the Appendix, equations (1)-(5) imply that in the autarky equilibrium, the share α is given by

$$\alpha = \beta - \frac{(1-\beta)(\theta-1)\tau}{v(p)} \tag{17}$$

at all points in time. Not surprisingly, the previous expression states that the share α of goods captured by the trader is decreasing in the ratio θ of unmatched traders to unmatched farmers. Straightforward manipulation of equation (17) also demonstrates that, for a given value of θ, α is necessarily increasing in the primitive bargaining power β.

The value of α is closely related to the "traders' margins," that is the (percentage) difference between the world relative price, p, and the effective relative price at which a farmer sells his or her good to a trader, p^{bid}. To see the formal connection between α and the traders' margins, $\left(p - p^{bid}/\, p\right)$, consider the price at which a trader buys coffee from a farmer growing that commodity. Noting that the farmer obtains an amount $(1-\alpha)\bar{S}$ of sugar in exchange for $1/a_C - (1-\alpha)\bar{C}$ units of coffee, we can conclude that the traders' margin is such that

$$\frac{p - p^{bid}}{p} = \frac{\alpha\left[1 + p\psi(p)\right]}{1 + \alpha p\psi(p)} > 0.$$

This margin is increasing in α and vanishes when α goes to 0. So without risk of confusion, we will sometimes simply refer to changes in α as changes in the traders' margins.

Having discussed the determination of prices in our model, we next move to characterizing the dynamics of the level of intermediation, the value functions, and the measures of matched and unmatched traders and farmers on the island. Using equation (3), we can rearrange the free entry condition, equation (10), as

$$V_T^M = \frac{\tau}{\mu_T(\theta)}. \tag{18}$$

Equation (18) simply states that the present discounted utility of a matched trader should be equal to the present discounted utility cost of remaining active while searching for a match. It implicitly defines the level of intermediation θ as an increasing function of the value function V_T^M. In order to characterize the dynamics of the level of intermediation, we can therefore focus on the dynamics of V_T^M. Combining the Bellman equation of matched traders, equation (4), with the free entry condition, equation (10), and the Nash bargaining outcome, equation (17), we obtain

$$\dot{V}_T^M = (r+\lambda)V_T^M + (1-\beta)\theta\left(V_T^M\right) - \beta\left[v(p) - \tau\right] \tag{19}$$

Since we know that $\theta'\left(V_T^M\right) > 0$ by (18), we can conclude that the dynamics of V_T^M in (19) are unstable. The only rational expectations equilibrium is thus one in which $\dot{V}_T^M = 0$, which further implies $\dot{\theta} = \dot{\alpha} = 0$. Using the fact that $\dot{V}_T^M = 0$ with equations (18) and (19), the equilibrium level of intermediation θ can then be expressed, at any point in time, as the implicit solution of

$$\frac{v(p)-\tau}{\tau}=\frac{r+\lambda+(1-\beta)\,\mu_F(\theta)}{\beta\mu_T(\theta)}. \tag{20}$$

Note that the right-hand side is an increasing function of θ. Thus intermediation is higher in economies with higher surplus levels $v(p)$, lower intermediation costs τ, and higher primitive bargaining power of traders, β. When the cost of intermediation τ goes to 0, the level of θ implicit in equation (20) goes to $+\infty$ and α goes to 0, hence implying that farmers capture all the surplus, just as in the Ricardian model.

Because θ is time-invariant, V_F^U and V_F^M now are the solution of a linear system of ODE, equations (1) and (2). Since the eigenvalues of that system are both strictly positive, we must also have $\dot{V}_F^U=\dot{V}_F^M=0$ in equilibrium. In other words, all value functions must immediately jump to their steady state values and remain constant thereafter. Combining equations (1), (2), (17), and (20) we obtain at any point in time

$$rV_F^U = \frac{\mu_F(\theta)\,(1-\beta)v(p)}{r+\lambda+\beta\mu_T(\theta)+(1-\beta)\,\mu_F(\theta)}, \tag{21}$$

$$rV_F^M = \frac{[r+\mu_F(\theta)]\,(1-\beta)v(p)}{r+\lambda+\beta\mu_T(\theta)+(1-\beta)\,\mu_F(\theta)}. \tag{22}$$

By contrast, the dynamics of u_F in equation (11) are globally stable and u_F slowly converges to its steady state value given by

$$u_F=\frac{\lambda}{\lambda+\mu_F(\theta)}N_F. \tag{23}$$

Once the dynamics of u_F is known, the dynamics of u_T and N_T can be computed using the definition of $\theta=u_T/u_F$ and equation (12). Since θ is a "jump" variable, both u_T and N_T must jump as well in order to ensure that equation (20) holds at any point in time. In the steady-state, we have

$$u_T = \frac{\lambda\theta}{\lambda+\mu_F}N_F, \tag{24}$$

$$N_T = \frac{\lambda\theta+\mu_F}{\lambda+\mu_F}N_F. \tag{25}$$

As shown in the Appendix, the right-hand-side of this last equation is increasing in θ and hence, the steady-state measure of traders is higher in economies with better production technologies, lower intermediation costs and higher bargaining power β of traders.

The previous discussion has demonstrated, by construction, the existence and uniqueness of an autarkic equilibrium. It has also characterized some of its key features, as summarized in Proposition 1.

Proposition 1 *An autarkic equilibrium exists and is unique. The relative price of coffee, p, the share of coffee farmers, γ, the vector of consumption levels, (C_F,S_F,C_T,S_T), and the level of intermediation, θ, are constant over time and determined by equations* (13)-(17) *and* (20)*. Similarly,* *the lifetime utilities of all agents are time-invariant and given by equations* (10)*,* (18)*,* (21)*, and* (22)*. By contrast, the measures of matched and unmatched farmers and traders slowly converge to their steady-state value, equations* (23)-(25)*.*

4 Integration of Walrasian Markets

4.1 Assumptions

In the rest of this paper, we assume that the island described in section 2, which we now refer to as "South", opens up to trade with another island, which we call "North". As in a standard Ricardian model, the two islands differ in the production technologies these farmers have access to. To fix ideas, we assume that South has a comparative advantage in coffee, so that $a_C/a_S < a^*_C/a^*_S$, where asterisks denote variables related to the Northern island. In addition to these technological differences, we allow the Southern and the Northern island to differ in terms of their "market institutions" by which we mean: (*i*) their intermediation costs, τ and τ^*; and (*ii*) the primitive bargaining power of their traders, β^* and β. Finally, we assume that the number of Southern farmers, N_F, is (infinitely) small compared to the number of Northern farmers, N^*_F. Thus the Southern island can be viewed as a small open economy.

Throughout this section, we focus on a situation in which farmers are only able to meet traders from their own island, as in section 2, but traders from both islands now have access to a common Walrasian market (located, at each date, in one of many possible desert islands). This is the situation which we refer to as *W-integration*. Our goal is to analyze how (unexpected) W-integration affects the levels of intermediation, production, and welfare in the Southern island.[12]

4.2 Equilibrium Conditions

Since the Northern island is large compared to the Southern island, the relative price of coffee under W-integration, p^W, must be equal to the Northern autarky relative price:

$$p^W = a^*_C/a^*_S.$$

By assumption, we know that $p^W = a^*_C/a^*_S > a_C/a_S$. Hence Southern traders are able to exchange coffee at a higher relative price under W-integration than under autarky. The income of matched farmer-trader pairs is therefore strictly higher if they produce coffee rather than sugar; see equation (7). As a result, all Southern farmers will immediately specialize in coffee production, which will raise the indirect utility all matched farmer-trader pairs from $v(p)$ to $v\left(p^W\right) > v(p)$. The mechanism is the same as in a standard Ricardian model.[13]

[12] Given our assumptions on the relative size of the two islands, it is easy to check that W-integration necessarily leaves all equilibrium variables unchanged in the Northern island.

[13] Recall that by equations (6) and (7), $\left(\bar{C}, \bar{S}\right)$ maximizes $v(C,S)$ subject to $pC + S \leq (p/a_C)$. Thus an increase in p from a_C/a_S to a^*_C/a^*_S necessarily expands the "budget set" of a farmer-trader match specialized in coffee.

Since Southern farmers can only match with traders from their own island, we can use the same argument as in section 3 to show that the traders' terms of trade, α^W, and the level of intermediation, θ^W, will immediately jump to their new steady state values given by:

$$\alpha^W = \beta - \frac{(1-\beta)\left(\theta^W - 1\right)\tau}{v\left(p^W\right)}, \tag{26}$$

$$\frac{v\left(p^W\right) - \tau}{\tau} = \frac{r + \lambda + (1-\beta)\,\mu_F\left(\theta^W\right)}{\beta \mu_T\left(\theta^W\right)}. \tag{27}$$

Using the two previous expressions, all other equilibrium variables can then be computed by simple substitutions. In particular, all value functions must directly jump to their new steady state values after W-integration.[14]

4.3 Intermediation, Growth, and Distributional Consequences

According to equations (20) and (27), the jump in utility levels caused by W-integration will be associated with a jump in the level of intermediation θ triggered by the instantaneous entry of new traders. Quite intuitively, by free entry, an increase in the gains from trade must be accompanied by an expansion of the trading activity in the Southern island. As we now demonstrate, this new effect has important implications for both growth and the distribution of the gains from trade in that island.

First, the instantaneous increase in θ will slowly increase the number of matched farmers in the economy, as illustrated by equation (11). Starting from the autarky equilibrium, W-integration therefore leads to growth along the transition path towards the new steady state equilibrium.[15] The magnitude of this "growth effect" depends on the initial level of intermediation as well as the properties of the matching technology. If the matching elasticity $\varepsilon \equiv \frac{d \ln m(u_F, u_T)}{d \ln u_T}$ is non-increasing in the level of intermediation, then *ceteris paribus*, islands with lower levels of intermediation always grow faster after W-integration (see Appendix). In this situation, trade integration may lead to convergence across countries. The above condition on the matching function is fairly weak: in particular, it is satisfied for all CES matching functions.[16]

Second, the endogenous increase in the level of intermediation due to W-integration has distri-

[14] It is worth pointing out that the simple dynamics after W-integration hinge heavily on the fact that the Northern island is large compared to the Southern island. If North was sufficiently small to start specializing in sugar, the relative price of coffee and the levels of intermediation would now depend on one another: a high price of coffee would lead to more entry in the Southern island, which would increase the world relative supply of coffee, and in turn, decrease its price. Hence, p^W, θ, θ^* slowly (and interdependently) vary over time. As we later discuss, our main results about the welfare consequences of W-integration would, however, remain unchanged.

[15] Although trade integration causes growth in our model, the import penetration ratio remains constant along the transition path as the number of matched traders affect proportionally Southern GDP and Southern imports.

[16] CES matching functions correspond to $m(u_F, u_T) \equiv \left[(A_F u_F)^{\frac{\sigma-1}{\sigma}} + (A_T u_T)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ with $0 \leq \sigma \leq 1$, where the restriction, $0 \leq \sigma \leq 1$, is necessary for the Inada conditions to hold.

butional consequences. Combining equations (26) and (27), we get

$$\alpha^W = \beta \cdot \left[\frac{r + \lambda + \mu_T\left(\theta^W\right)}{r + \lambda + (1-\beta)\,\mu_F\left(\theta^W\right) + \beta\mu_T\left(\theta^W\right)} \right], \tag{28}$$

where the bracket term is decreasing in θ^W. Thus the instantaneous entry of new traders reduces α^W, and this implies an instantaneous improvement of the farmers' terms of trade and an instantaneous worsening of the traders' terms of trade.

4.4 Welfare Consequences

Changes in the level of intermediation caused by W-integration also have interesting welfare consequences. As we have already mentioned, all value functions will immediately jump to their new steady-state value after W-integration. Hence the expressions for the expected lifetime utilities of the different agents are still given by equations (10), (18), (21), and (22), but with the level of intermediation now given by $\theta^W > \theta$. Because all these expressions are (weakly) increasing in the level of intermediation, we can conclude that all agents in the economy are (weakly) better off, and thus W-integration generates Pareto gains from trade just as in the standard Ricardian model.

It is intuitively clear why the increased matching rate and enhanced bargaining power associated with W-integration will benefit farmers. Furthermore, by free entry, it is obvious that unmatched traders are unaffected by W-integration. The free entry condition is also important for understanding why matched traders will benefit from W-integration despite the decrease in their consumption share α and their margins. The key is that because W-integration increases intermediation and reduces the probability with which traders find matches, free entry dictates that the welfare level they must attain when being matched has to be higher. Hence, matched traders also benefit from W-integration.

What happens to social welfare? The fact that all agents are (weakly) better off implies, a fortiori, that social welfare goes up with W-integration. We can, however, make sharper predictions. For the sake of clarity, let us reintroduce time indices explicitly. At any date t before W-integration, there are $N_F - u_F(t)$ matched pairs attaining a joint expected lifetime utility $V_F^M(t) + V_T^M(t)$, a measure $u_F(t)$ of farmers obtaining $V_F^U(t)$, and a measure $u_T(t)$ of unmatched traders with zero expected lifetime utility. Social welfare $W(t)$ is therefore equal to

$$W(t) = u_F(t)\,V_F^U(t) + \left[N_F - u_F(t)\right]\left[V_F^M(t) + V_T^M(t)\right],$$

where $u_F(t)$ is predetermined at date t, but $V_F^U(t)$, $V_F^M(t)$, and $V_T^M(t)$ are jump variables. By our four Bellman equations (1)-(4) and the free entry condition (10), we also know that

$$V_F^M(t) + V_T^M(t) = \frac{v\left[p(t)\right] - \tau + \lambda V_F^U(t)}{r + \lambda}.$$

Thus we can rearrange the social welfare function as

$$W(t) = V_F^U(t)\left[u_F(t) + \frac{\lambda\left[N_F - u_F(t)\right]}{r+\lambda}\right] + \left[v\left[p(t)\right] - \tau\right]\left[\frac{N_F - u_F(t)}{r+\lambda}\right]. \tag{29}$$

Since $u_F(t)$ is predetermined at date t, equation (29) implies that in order to compute the changes in $W(t)$ associated with W-integration, we can focus on changes in the two jump variables, $V_F^U(t)$ and $v[p(t)] - \tau$. Using equations (20) and (21) into equation (29), we can express social welfare in the South before W-integration as:

$$W(t) = \Omega(t) \cdot \frac{v\left[p(t)\right]}{r},$$

where

$$\Omega(t) \equiv \frac{(1-\beta)\mu_F\left[\theta(t)\right]u_F(t)}{r+\lambda+\beta\mu_T\left[\theta(t)\right]+(1-\beta)\mu_F\left[\theta(t)\right]} + \frac{\left[r+(1-\beta)\mu_F\left[\theta(t)\right]\right]\left[N_F - u_F(t)\right]}{r+\lambda+(1-\beta)\mu_F\left[\theta(t)\right]+\beta\mu_T\left[\theta(t)\right]}.$$

As explained above, W-integration raises the surplus from trading, as captured by the utility term $v[p(t)]$. This is the standard welfare gain highlighted by neoclassical models of trade. Notice, however, that $\Omega(t)$ is increasing in the level of intermediation $\theta(t)$ and hence it also increases following W-integration. We can then conclude that, compared to a situation with an exogenous level of intermediation, the integration of Walrasian markets leads to a higher (percentage) increase in social welfare. We refer to this result as the "magnification effect" of intermediation. This is, of course, the welfare counterpart of the growth effect discussed in the previous section.[17]

Proposition 2 summarizes our findings about the effects of W-integration.

Proposition 2 *W-integration:* (i) *induces growth along the transition path and, if the matching elasticity ε is nonincreasing in the level of intermediation, leads to convergence across countries;* (ii) *improves the farmers' terms of trade and worsens the traders' terms of trade; and* (iii) *makes all agents (weakly) better off.*

In the case where the Southern island is not small relative to the Northern island, one can still show, in spite of the more complex terms-of-trade dynamics, that: (i) the values of θ^W and $\left(\theta^W\right)^*$ at any point in time are greater than their autarky levels, θ and θ^*; and: (ii) the value functions of all agents at any point in time are also greater than their autarky levels. We can thus conclude that W-integration increases output and makes all agents (weakly) better off at all points in time (see Appendix for details).

[17] Note that, following the lead of Diamond (1980), we are computing the effect of W-integration taking into account the convergent path from one steady state to another, rather than simply comparing steady-state welfare levels with and without W-integration. This distinction is immaterial for the qualitative results derived in this section, but it turns out to be more important when analyzing optimal policy within our framework in section 4.

5 Integration of Matching Markets

5.1 Assumptions

So far we have assumed that traders can only meet farmers from their own island. We now turn to a situation in which traders are (unexpectedly) allowed to search for farmers in both islands (though they can only search for farmers in one of these two islands at any point in time). We refer to this process as matching market integration, or simply *M-integration*, and we show below that the welfare implications of this type of integration are much more nuanced. In order to better illustrate our results, we assume that W-integration has already happened and that Northern and Southern traders have access to a common (integrated) Walrasian market where coffee is exchanged at a relative price $p^W = a_C^*/a_S^*$.[18]

As before, we continue to assume that countries differ in their intermediation costs and in the primitive bargaining power of traders. In order to avoid a taxonomic exercise, we assume throughout that Northern traders have a better intermediation technology, that is $\tau > \tau^*$, and that Northern agents, regardless of whether they are farmers or traders, tend to have high primitive bargaining power relative to Southern agents. In particular, when Northern traders bargain with Southern farmers, they obtain a share $\bar{\beta}$ of the ex-post gains from trade that is higher than that obtained by Southern traders bargaining with these same Southern farmers, that is $\bar{\beta} > \beta$.[19]

Throughout this paper, we do not take a stance on the precise source of asymmetry of bargaining power. The large literature emanating from the seminal work of Rubinstein (1982), has uncovered several potential determinants of primitive bargaining power. It is well-known, for instance, that relatively impatient or risk averse agents will tend to have relatively low bargaining power, and the same will be true about agents for which a bargaining delay might be particularly costly for reasons other than impatience, such as credit constraints.[20] For these reasons, we find it natural to focus on the case in which, if cross-country bargaining power asymmetries exist, they are associated with Northern agents being relatively more powerful negotiators.

Before proceeding to our analysis of the consequences of M-integration, we also need to specify how matching between agents from different islands takes place. Consistently with our closed-economy setup, we assume that if Northern and Southern traders both operate in the same island, then they have the same probability of being matched with farmers from that island. In other words, matching remains random. Farmers cannot direct their search towards one particular type of traders. This assumption aims to capture a situation in which farmers have no information about where traders are located in the island. Thus they simply stay in their farms and wait for traders to show up (or not). We will come back to this assumption in more details in section 6.

Finally, note that the heterogeneity between traders from the two islands forces us to consider

[18] The fact that the relative price p^W is common across countries is not important for the results below.

[19] Similarly, Southern traders that bargain with Northern farmers obtain a share $\underline{\beta}$ of the ex-post gains from trade that is lower than that obtained by Northern traders bargaining with these same Northern farmers, that is $\underline{\beta} < \beta^*$. We shall briefly show, however, that Southern traders will never intermediate trade in the North in equilibrium.

[20] See, for instance, Rubinstein (1982), Roth (1985), and Roth and Rothblum (1982). Muthoo (1999)'s textbook provides a useful survey of bargaining theory.

the endogenous destruction of matches. For instance, if Northern traders are much more efficient than Southern traders, it is possible for the joint surplus of a matched pair consisting of a Southern trader and a Southern farmer to be lower than the new (post M-integration) outside opportunity of the matched farmer (which is his or her value when being unmatched). In those circumstances, "all-Southern" partnerships would (efficiently) dissolve. In order to introduce this possibility formally, we assume that after matches are created, but before bargaining takes place, farmers choose the probability $\delta^i \in [0,1]$ with which they break their matches with traders from island i.

5.2 Equilibrium Conditions

We first study how M-integration affects the mix of traders operating in each country. Relative to the Northern traders searching in a given island, Southern traders searching in the same island incur a higher intermediation cost period per period and, when finding a match, they have relatively lower bargaining power. Since the surplus being generated by a match with a Northern trader is higher, $v\left(p^W\right) - \tau^* > v\left(p^W\right) - \tau$, farmers are also more likely to stay in a match that involves a Northern trader than to keep searching for another type of trader, $\delta^N \leq \delta^S$. Putting all the pieces together, we have that random matching between farmers and traders implies that Northern traders will necessarily be more profitable (i.e., attain higher welfare levels) than Southern traders (see Appendix for details). Appealing to free entry, we can then conclude:

Lemma 1 *If M-integration occurs at some unexpected date t_0, then with probability one, new matches only involve Northern traders in both islands for all $t > t_0$.*

It is important to emphasize that the previous result does not necessarily imply that M-integration instantly wipes out all Southern traders from the world economy. In particular, at the time that M-integration occurs, there will be a positive measure of matched pairs composed of a Southern trader and a Souther farmer. As argued above, as long as the joint value of this pair exceeds the new value of an unmatched farmer, the pair will not dissolve. Whether this occurs or not depends on the features of the new equilibrium, which we now describe.

Since the relative price of coffee must remain fixed at the Northern autarky level, the joint consumption that a trader and a farmer can attain by forming a match in either of the two islands (i.e., $v(p^W)$ and $v^*(p^W)$) will not be affected by M-integration and will feature no dynamics. Furthermore, Lemma 1 immediately implies that M-integration will have no effect on the North, so we can again focus on the South.

Under M-integration, there are six types of agents potentially active in the Southern island at any point in time: (*i*) unmatched Southern farmers, (*ii*) Southern farmers matched with Southern traders, (*iii*) Southern farmers matched with Northern traders, (*iv*) unmatched Northern traders, (*v*) matched Northern traders, and (*vi*) matched Southern traders. We denote by V_F^U, V_{FS}^M, V_{FN}^M, $V_{T^N}^U$, $V_{T^N}^M$, and $V_{T^S}^M$ the expected lifetime utilities of these six types of agents. Using Lemma 1 and the fact that all Southern farmers specialize in coffee production, we can then express the Bellman equations of these agents as follows:

$$
\begin{aligned}
rV_F^U &= \mu_F\left(\theta^N\right)\left(V_{F^N}^M - V_F^U\right) + \dot{V}_F^U, & (30)\\
rV_{F^N}^M &= \left(1-\alpha^N\right)v(p^W) + \lambda\left(V_F^U - V_{F^N}^M\right) + \dot{V}_{F^N}^M, & (31)\\
rV_{T^N}^U &= -\tau^* + \mu_T\left(\theta^N\right)\left(V_{T^N}^M - V_{T^N}^U\right) + \dot{V}_{T^N}^U, & (32)\\
rV_{T^N}^M &= \alpha^N v(p^W) - \tau^* + \lambda\left(V_{T^N}^U - V_{T^N}^M\right) + \dot{V}_{T^N}^M, & (33)\\
rV_{F^S}^M &= \left(1-\alpha^S\right)v(p^W) + \lambda\left(V_F^U - V_{F^S}^M\right) + \dot{V}_{F^S}^M, & (34)\\
rV_{T^S}^M &= \alpha^S v(p^W) - \tau - \lambda V_{T^S}^M + \dot{V}_{T^S}^M, & (35)
\end{aligned}
$$

where θ^N denotes the level of intermediation in the Southern island after M-integration, and α^N and α^S denote the terms of trade (or margins) of Northern and Southern traders, respectively. In addition, at all points in time, free entry by Northern traders will necessarily imply that

$$V_{T^N}^U = \dot{V}_{T^N}^U = 0.$$

Combining the previous expression with equations (30)-(33) and our Nash bargaining conditions, it is easy to verify that the Northern traders' margins, α^N, and the level of intermediation after M-integration, θ^N, will immediately satisfy

$$
\begin{aligned}
\alpha^N &= \bar{\beta} - \frac{\left(1-\bar{\beta}\right)\left(\theta^N - 1\right)\tau^*}{v\left(p^W\right)} & (36)\\
\frac{v\left(p^W\right) - \tau^*}{\tau^*} &= \frac{r + \lambda + \left(1-\bar{\beta}\right)\mu_F\left(\theta^N\right)}{\bar{\beta}\mu_T\left(\theta^N\right)}. & (37)
\end{aligned}
$$

Compared to W-integration, the value of a matched farmer-trader pair, $v\left(p^W\right)$, remains the same, but the level of intermediation in the South is now determined by the characteristics of Northern traders: τ^* and $\overline{\beta}$. Because only Northern traders search for matches after M-integration, only their (Northern) parameters are relevant for the determination of θ^N. It may seem counterintuitive that the level of intermediation in South immediately jumps to its new steady-state level and that this level is completely independent of the intermediation cost or bargaining power of Southern traders. After all, some Southern traders may remain active after M-integration and their measure gradually declines through time. The logic is the same as in sections 3 and 4: the measure of unmatched Northern traders is a jump variable and it can always ensure that the level of intermediation is such that the expected lifetime utility of unmatched Northern traders in South is exactly equal to 0 (independently of the measure of Southern farmers searching for matches).

Combining equations (34) and (35) with our Nash bargaining conditions, we can also show (see proof of Lemma 1 for details) that the terms of trade of Southern traders must also immediately jump to

$$\alpha^S = \beta - \frac{(1-\beta)\left[\xi\theta^N - 1\right]\tau}{v\left(p^W\right)}, \tag{38}$$

where $\xi \equiv \left[\beta\left(1-\bar{\beta}\right)\tau^{*}\right]/\left[\bar{\beta}\left(1-\beta\right)\tau\right] < 1$. Equipped with equations (36)-(38), all other equilibrium variables can then be computed by simple substitutions. In particular, it is easy to show that all value functions must directly jump to their new steady state values.[21] Using equations (30), (31), (34), and (35), we can thus write the expected lifetime utilities of Southern agents after M-integration as follows:

$$V_F^U = \frac{\mu_F\left(\theta^N\right)\left(1-\alpha^N\right)v\left(p^W\right)}{r\left[r+\lambda+\mu_F\left(\theta^N\right)\right]}, \tag{39}$$

$$V_{F^N}^M = \frac{\left(1-\alpha^N\right)v\left(p^W\right)+\lambda V_F^U}{r+\lambda}, \tag{40}$$

$$V_{F^S}^M = \frac{\left(1-\alpha^S\right)v\left(p^W\right)+\lambda V_F^U}{r+\lambda}, \tag{41}$$

$$V_{T^S}^M = \frac{\alpha^S v\left(p^W\right)-\tau}{r+\lambda}. \tag{42}$$

Finally, note that equations (41) and (42) imply that $v\left(p^W\right)-\tau \geq rV_F^U$ is a necessary and sufficient condition for existing Southern matches to survive after M-integration. Using equations (36), (20) and (39), we can simplify this condition to

$$v\left(p^W\right)-\tau \geq \frac{\left(1-\bar{\beta}\right)}{\bar{\beta}}\tau^{*}\theta^N,$$

where θ^N is implicitly determined by equation (37). For a given value of θ^N, the previous inequality states that existing Southern matches are more likely to survive if the surplus generated by a match is high, i.e., if $v\left(p^W\right)$ is high or τ is low.

5.3 Intermediation, Growth, and Distributional Consequences

Since $\tau > \tau^{*}$ and $\beta < \overline{\beta}$, equations (27) and (37) imply that M-integration necessarily increases the level of intermediation in South: $\theta^N > \theta^W$. Intuitively, though the entry of Northern traders wipes out all unmatched Southern traders, these Northern traders bring a better intermediation technology and have a higher bargaining power, so it is not surprising that their entry exceeds that of Southern traders prior to M-integration.[22] Like in section 4, this instantaneous increase in the level of intermediation will increase the number of matched farmers in the South, thereby generating growth along the transition path. Furthermore, for the same reasons as in section 4, if the matching elasticity $\varepsilon \equiv \frac{d\ln m(u_F,u_T)}{d\ln u_T}$ is nonincreasing in the level of intermediation, output in islands with lower levels of intermediation will tend to grow faster after M-integration.

[21] Like in section 4, the absence of dynamics in intermediation levels and traders' margins hinges on the fact that North is large compared to South, which pins down the relative price of coffee in the Walrasian markets.

[22] If both Northern and Southern farmers were completely specialized in the production of sugar and coffee, respectively, the same prediction would hold at any point in time (in spite of the dynamics in the relative price of coffee). In addition, changes in the level of intermediation in the South would lead to an improvement in the Northern terms of trade, i.e. a decrease in the relative price of coffee, which would also raise the level of intermediation in the North.

We can next study how M-integration affects the share of the surplus that farmers are able to capture when matched with a trader. Here we have to distinguish between the cases in which the farmer is matched with a Northern trader and in which it continues to be matched with the same Southern trader as before M-integration. Let us consider the former case first. Equation (36) suggests that the effect of M-integration on the share of surplus captured by (newly) matched Southern farmers is in general ambiguous. On the one hand, the higher level of intermediation θ^N under M-integration tends to improve the Southern farmers' terms of trade compared to W-integration, i.e., α^N tends to be lower than α^W on that account. On the other hand, the fact that $\bar{\beta} > \beta$ mechanically decreases the share of consumption accruing to Southern farmers matched with Northern traders. When Northern and Southern traders differ only in their cost of intermediation, τ and τ^*, the first effect implies that, as in the case of W-integration, M-integration improves the terms of trade of newly matched Southern farmers. Nevertheless, the converse is true for the case in which $\tau = \tau^*$ and $\bar{\beta} > \beta$ (see Appendix for details).

What happens to the terms of trade of Southern agents that were already matched before M-integration occurs? Comparing equations (26) and (38), we immediately see that the impact of M-integration on the share of consumption accruing to Southern traders is also ambiguous. The entry of Northern traders in the Southern island has two effects. By increasing the level of intermediation from θ^W to θ^N, M-integration improves the outside option of matched farmers in the Southern island, which tends to improve their terms of trade and worsen the Southern traders' terms of trade. But conditional on the level of intermediation, Northern traders tend to have more bargaining power than Southern traders, ξ is strictly less than one in equation (38), which tends to worsen Southern farmers' outside options and improve the Southern traders' terms of trade. As we demonstrate in the next section, whether α^S is higher or lower than α^W will be closely related to changes in social welfare and the so-called Hosios (1990a) condition in the search-theoretical literature.

Finally, it is worth pointing out that, in general, one cannot rank the relative magnitude of the bargaining shares of Northern and Southern traders, α^N and α^S. Given that the primitive bargaining power of Northern traders is higher than that of Southern traders, it would seem intuitive that $\alpha^N > \alpha^S$. Yet, the ranking of intermediation costs, $\tau^* < \tau$, implies that the ex-post gains from trade are lower in the "all-Southern" pairs. Thus conditional on the same outside option, V_F^U, Southern farmers tend to obtain a lower payoff when matched with Southern traders, which tends to make α^S greater than α^N. Which of the two effects dominates again depends on the relative magnitude of the variation in primitive bargaining power, β and $\bar{\beta}$, and intermediation costs, τ and τ^*. According to equations (36) and (38), if traders from both islands only differ in their primitive bargaining power, $\tau = \tau^*$, then we should observe that $\alpha^N > \alpha^S$. By contrast, if their differences only come from their intermediation technology, $\beta = \bar{\beta}$, then we should have $\alpha^N < \alpha^S$.

5.4 Welfare Consequences

Our previous discussion hints at the fact that the welfare implications of M-integration are likely to be distinct from those of W-integration. Our first result in that respect is that, unlike in the case of W-integration, M-integration always creates winners and losers, and thus distributional conflicts. In particular, the effect on Southern traders' welfare is always of the opposite sign to that on Southern farmers, no matter whether the latter are matched or not at the time of M-integration.

To see this, note that equations (41) and (42), together with Nash bargaining, imply

$$V_{TS}^{M} = \beta \left[\frac{v\left(p^{W}\right) - \tau - rV_{F}^{U}}{r+\lambda} \right]. \tag{43}$$

Among existing matches, the intermediation technology, τ, the primitive bargaining power of the trader, β, and the utility level, $v\left(p^{W}\right)$ are unaffected by M-integration. Therefore, we can conclude that if unmatched Southern farmers win from M-integration, $\Delta V_{F}^{U} > 0$, matched Southern traders must lose, $\Delta V_{TS}^{M} < 0$. The converse is obviously true as well: if unmatched Southern farmers lose, Southern traders must win. By equation (42), this result implies that there is a negative relationship between movements in V_{F}^{U} and movements in α_{S}. Armed with this observation, inspection of equation (41) then reveals that the welfare effect on matched farmers is always of the same sign as that of unmatched farmers. For instance, when V_{F}^{U} goes up, α_{S} goes down, and V_{FS}^{M} in (41) must necessarily go up. The intuition is simple. Among existing matches, M-integration only affects the outside option of Southern farmers, with the latter being equal to the value of unmatched Southern farmers. When this outside option goes up (i.e., α^{S} goes down), existing pairs redistribute surplus from traders to farmers, while the converse is true when this outside option goes down. The likelihood of each of these two scenarios will be studied in more detail below.[23]

Up to this point, we have shown that there cannot be any Pareto gains or losses from M-integration.[24] This leaves open, however, the possibility of aggregate losses from trade in the Southern island. In order to investigate this question formally, let us come back to the social welfare function introduced in section 4.4. At any date t before M-integration and after W-integration, we know that

$$W(t) = V_{F}^{U}(t) \left[u_{F}(t) + \left(\frac{\lambda}{r+\lambda} \right) \left[N_{F} - u_{F}(t) \right] \right] + \left[N_{F} - u_{F}(t) \right] \left[\frac{v\left(p^{W}\right) - \tau}{r+\lambda} \right].$$

Since $v\left(p^{W}\right)$ is not affected by M-integration, the previous expression implies that changes in social welfare caused by M-integration, ΔW, must reflect changes in the expected lifetime utility

[23] In the previous discussion, we implicitly assumed that existing Southern matches were not destroyed after M-integration. If this were to happen, then we would have $V_{FS}^{M} + V_{TS}^{M} - V_{F}^{U} = \left[v\left(p^{W}\right) - \tau - rV_{F}^{U} \right] / \left(r+\lambda\right) < 0$, which requires V_{F}^{U} goes up. In this case, unmatched and matched Southern farmers are again better off, whereas Southern traders are worse off.

[24] Comparing convergent paths rather than steady states is important for deriving this result. If Southern traders win from M-integration, then in the new steady state, the only winners from M-integration have disappeared, and we would erroneously conclude that M-integration generates Pareto losses.

of unmatched farmers, ΔV_F^U.[25] Given our earlier discussion of the relationship between V_F^U, V_{TS}^M, and α^S, this further implies the Southern trader's terms of trade, α^S, is a sufficient statistic for welfare analysis in the South.[26] In particular, there will be aggregate losses from M-integration in the South, $\Delta W < 0$, if and only if $\alpha^S > \alpha^W$. This observation will play an important role in the design of optimal policy, which we discuss in the next section. In particular, it suggests that governments aiming to maximize social welfare can use the (observable) response of α^S as a useful guide to policy, with welfare attaining its maximum when α^S attains its minimum.

Using equations (37), (36), and (39), we can compute explicitly the change in the expected lifetime utility of unmatched farmers caused by M-integration as

$$\Delta V_F^U = \frac{\mu_F\left(\theta^N\right)(1-\bar{\beta})v\left(p^W\right)}{r+\lambda+\bar{\beta}\mu_T\left(\theta^N\right)+\left(1-\bar{\beta}\right)\mu_F\left(\theta^N\right)} - \frac{\mu_F\left(\theta^W\right)(1-\beta)v\left(p^W\right)}{r+\lambda+\beta\mu_T\left(\theta^W\right)+(1-\beta)\mu_F\left(\theta^W\right)}. \quad (44)$$

As our analysis of the distributional consequences of M-integration already anticipates, it will prove useful to separate the rest of our welfare analysis into two parts. First, we consider the case in which differences in intermediation costs are the only difference in market institutions across the two islands: $\tau < \tau^*$, but $\beta = \bar{\beta}$. Second, we turn to the polar case in which intermediation costs are constant, $\tau = \tau^*$, but bargaining powers are not, $\beta < \bar{\beta}$.

If Northern and Southern traders only differ in terms of their intermediation costs, equation (44) and $\theta^N > \theta^W$ immediately imply that $\Delta V_F^U > 0$ and M-integration necessarily increases social welfare in the Southern island. Intuitively, in this case M-integration essentially provides unmatched Southern farmers with access to a better intermediation technology, which increases the rate at which they meet traders and, in addition, improves their bargaining positions. By affecting the threat point in their negotiations, M-integration also makes matched Southern farmers better off and matched Southern traders worse off.

In the polar case in which Northern and Southern traders only differ in terms of their bargaining power, M-integration is equivalent to an increase in the bargaining power of unmatched traders from β to $\bar{\beta}$. As equation (44) indicates, its effect on aggregate welfare in the Southern island depends on two forces. On the one hand, a larger β implies more entry and thus a higher probability of being matched for Southern farmers. On the other hand, once matched, Southern farmers have weaker bargaining power. In the Appendix, we show that social welfare is increasing in β if and only if $\beta \leq \varepsilon \equiv \frac{d \ln m(u_F, u_T)}{d \ln u_T}$, which in the search-theoretic literature on labor markets is referred to as Hosios' (1990a) condition. Hence, if $\beta \geq \varepsilon$, the second force will dominate and by raising primitive traders' primitive bargaining power from β to $\bar{\beta}$, M-integration will *reduce* aggregate welfare in the South. Note that aggregate losses in the Southern island are possible in spite of the fact M-integration always induces output growth compared to W-integration.

What explains these results? The source of these potentially perverse welfare results is *not* rent-

[25] By free entry, unmatched traders obtain a value of 0 regardless of their country of origin, so the above expression for $W(t)$ continues to be valid at the instant when M-integration occurs.

[26] Formally, equations (42) and (43) imply $V_F^U = \left[\left(\beta - \alpha^S\right)v\left(p^W\right) + (1-\beta)\tau\right] / r\beta$.

shifting between the two islands.[27] If social welfare goes down in the South after M-integration, then social welfare goes down in the world as a whole. Instead, what is important here is that when $\beta \geq \varepsilon$, the equilibrium in the Southern island under W-integration is inefficient because it features a disproportionate entry of traders given the matching frictions. The key behind the inefficiency is the trading externality underlying the search friction in goods markets. More specifically, the terms of exchange between a trader and a farmer not only affect the division of surplus among these two agents, but also affect the entry of traders and thus the probabilities for unmatched farmers and traders of finding a match. Nevertheless, farmers and traders only bargain after they have found a match and thus their negotiations will fail to internalize this externality. M-integration only aggravates this problem because Northern traders have an even higher bargaining power, and thus social welfare is driven down. This result clearly echoes Bhagwati's (1971) celebrated results on trade and domestic distortions. Nevertheless, we shall see that the policy response to these potential welfare losses features some distinctive properties in our framework.

An obvious question at this point is: if unmatched Southern farmers are worse off under M-integration, why do they trade with Northern traders? The answer is that random matching—which we believe fittingly captures search frictions in an environment where traders are mobile, but farmers are not—leads to a simple prisoner's dilemma situation. Although all Southern farmers are worse off in the equilibrium in which only Northern traders are active, each Southern farmer individually has an incentive to trade with Northern traders. This is true both *ex ante* and *ex post*, i.e., both before and after matches occur. Even if Southern farmers had the choice to commit not to trade with Northern traders ex ante, each farmer would strictly prefer to trade with Northern traders, independently of what other traders are doing. The intuition is the following. Because of Nash bargaining, Northern traders always give Southern farmers more than what they would get if unmatched. Since farmers are all of measure zero, they do not internalize the impact of their own actions on the composition of traders in the island. As a result, farmers are always better off trading with Northern traders, thereby leading to the exit of all unmatched Southern traders. If the primitive bargaining power of Northern traders is high enough, this may lead to lower aggregate welfare in the Southern island (and the world as whole).

Our main results about the impact of M-integration are summarized in the next proposition.

Proposition 3 *M-integration:* (*i*) *always induces growth along the transition path and, if the matching elasticity ε is nonincreasing in the level of intermediation, leads to convergence across countries;* (*ii*) *always creates winners and losers; and* (*iii*) *may decrease aggregate welfare.*

[27] A welfare analysis based on the comparison of steady states would wrongly suggest otherwise. In the new steady state, it is true that matched Northern traders earn rents that used to accrue to Southern traders. But since there are no matched Northern traders at t_0, such considerations are irrelevant for computing welfare changes at that date.

6 Policy

In the previous two sections we studied the effects of Walrasian and M-integration and demonstrated the possibility of losses from trade for the South under the latter type of economic integration. In this section, we study alternative ways to circumvent these losses and bring the equilibrium closer to the efficiency frontier.

6.1 Price Controls

As explained above, the possibility of losses from trade is tightly related to the fact that the entry of Northern traders may aggravate the trading externality in the Southern island. In our basic model, there is a unique socially efficient division of surplus between traders and farmers and it is associated with the parameter configuration $\beta = \varepsilon \equiv \frac{d \ln m(u_F, u_T)}{d \ln u_T}$. When $\beta > \varepsilon$, the entry of Northern traders with a bargaining share $\bar{\beta} > \beta$ naturally pushes the equilibrium division of surplus further away from the socially efficient one.

To fix ideas, suppose for now that the Southern government (or a worldwide social planner) is convinced that $\bar{\beta} > \beta > \varepsilon$. A first possible policy intervention in response to this inefficiency is to directly regulate the terms of exchange between farmers and traders. For example, the Southern government may force Northern traders operating in South to buy coffee from farmers at a relative price no lower than

$$p_f = \frac{1 - \tilde{\alpha}}{1 + \tilde{\alpha} p^W \psi\left(p^W\right)} p^W,$$

where $\tilde{\alpha}$ is implicitly given by

$$\tilde{\alpha} = \varepsilon - \frac{(1 - \varepsilon)\left(\tilde{\theta} - 1\right)\tau^*}{v\left(p^W\right)},$$

with $\tilde{\theta}$ such that

$$\frac{v\left(p^W\right) - \tau^*}{\tau^*} = \frac{r + \lambda + (1 - \varepsilon)\,\mu_F\left(\tilde{\theta}\right)}{\varepsilon \mu_T\left(\tilde{\theta}\right)}.$$

This policy effectively puts a cap on the margin charged by Northern traders. It is straightforward to check that the imposition of a price floor p_f would lead to an efficient level entry of Northern traders and to a level of intermediation in South that is also socially efficient. Hence, M-integration accompanied by optimal price controls on foreign traders would necessarily increase aggregate welfare in the South whenever $\beta > \varepsilon$.

A few comments are in order. First, we have presupposed that the primitive bargaining power of farmers is inefficiently low, i.e., $\beta > \varepsilon$. If instead we had $\beta < \varepsilon$, perhaps because the number of matches is very responsive to the measure of unmatched traders in the island, then our price floors may be lower than the price that farmers would actually command in the absence of a price control. In such case, the price-floor constraint would not be binding and an upper bound on the price of coffee might actually be the right welfare-enhancing policy!

Second, the previous policy intervention assumes that the Southern government is able to discriminate between Northern and Southern traders, which may go against, for example, the WTO's national treatment principle. If the Southern government had to force Southern traders to buy coffee at the same price as Northern traders, then matched Southern traders may decide to exit right away after M-integration, which may well reduce welfare in the South on that account (see the Appendix).

Third, getting the price floor right may, of course, be very difficult in practice. For the previous scheme to work, the Southern government needs to know, among other things, the shape of the matching function (and, in particular, its elasticity ε), the world relative demand for coffee (ψ), and the intermediation costs of Northern traders, τ^*. This seems highly unrealistic. It is worth mentioning, however, that our model provides a fairly simple way to implement optimal price control. Since the terms of trade of Southern traders, α^S, is a sufficient statistic for welfare analysis, the rule of thumb for the Southern government should be to pick the minimum price p_f paid by Northern traders in a way that minimizes the value α^S. In other words, the only variable that the Southern government may need to observe in practice to engineer a welfare-enhancing price control is the Southern traders' margins. For this mechanism to work, however, it is again important that the Southern government is allowed to impose the price control *only on Northern traders*. This feature of our model constitutes an important point of departure from the standard policy recommendations implied by models of trade in the presence of domestic distortions (c.f., Bhagwati, 1971). In particular, the optimal tackling of the inefficiency causing the (potentially) perverse welfare effects from trade requires a policy that actively discriminates foreign economic agents.[28]

Finally, note that the previous policy does more than prevent welfare losses from M-integration, it maximizes social welfare in the South conditional on (Southern) production technologies and (Northern) intermediation technologies. If the only goal of price control is to rule out the possibility of welfare losses from trade for the South, then simpler policies are possible. In our model, the increase in the level of intermediation caused by M-integration, $\theta^N > \theta^W$, tends to make farmers mechanically better off. Thus, losses from M-integration can only happen if their terms of trade worsen, $\alpha^N > \alpha^W$; see equation (39). Accordingly, requiring the margins of Northern traders be lower than those of Southern traders under W-integration, $\alpha^N \leq \alpha^W$, is sufficient to circumvent losses from M-integration.[29]

[28] An informationally lighter alternative to governmental price control is fostering the creation of farmers' cooperatives which would bind all farmers to sell their coffee to traders at some pre-specified price (in analogy to Pissarides', 1986, model of unions in a search-theoretic model of the labor market). For efficiency to be achieved, however, one can show that the farmers' cooperative should also be able to discriminate between Northern and Southern traders by offering these traders different prices (details available upon request).

[29] To see this, consider the situation in which the restriction on Northern traders' margins is binding: $\alpha^N = \alpha^W$. By equations (32) and (33), we know that $(r + \lambda)\,\tau^* / \mu_T\,(\theta^c) = \alpha^W v\left(p^W\right) - \tau^*$, where θ^c is the level of intermediation under this constraint. This is the same expression as under W-integration except that the cost of intermediation is τ^* instead of τ. Since $\tau^* < \tau$, we can conclude that $\theta^c > \theta^W$, which is sufficient for unmatched Southern farmers to be better off than under W-integration.

6.2 Tax Instruments

In this environment, price controls are not the only way to achieve social efficiency or rule out the possibility of losses from trade integration. In particular, tax instruments may be used to achieve the same goal. Suppose, for example, that the Southern government were to impose a tax (or subsidy) η on all unmatched traders finding a match in a given period, with the amount η being transferred to the farmer involved in such a match. Under such a policy, the value functions of unmatched Northern traders and unmatched Southern farmers would now satisfy

$$\begin{aligned} rV_F^U &= \mu_F(\theta^\eta)\left[V_{FN}^M + \eta - V_F^U\right], \\ rV_{TN}^U &= -\tau^* + \mu_T(\theta^\eta)\left(V_{TN}^M - \eta - V_{TN}^U\right), \end{aligned}$$

where θ^η is the intermediation level under this tax regime. It is straightforward to verify that if the tax is set to a level such that

$$\eta = \frac{(\beta - \varepsilon)\left[v\left(p^W\right) + (\theta^\eta - 1)\,\tau^*\right]}{r + \lambda + \mu_F(\theta^\eta)},$$

then the economy will attain social efficiency, just as with the price control. Note that when $\beta > \varepsilon$, there is over entry and so the optimal policy requires taxing unmatched traders. The converse is true for $\beta < \varepsilon$.

Compared to a price control, taxing or subsidizing entry has one important advantage. It does not require the Southern government to discriminate between Northern and Southern traders since, after M-integration, all unmatched traders active in the Southern island will be from the North. This also implies this tax/subsidy scheme will never generate inefficient separations of Southern matches. In all other respects, optimal tax policy and optimal price control raise similar issues. In principle, setting the right optimal tax/subsidy level η requires detailed information about the several parameters of the model. Nevertheless, observing the effect on the margins charged by Southern traders may serve as a useful guide in choosing taxes, as the welfare-maximizing level of η also minimizes the value of the share α^S.

6.3 Market Design

In our model, farmers randomly meet traders from both islands. In this situation, we have shown that M-integration may lead to aggregate welfare losses. We now discuss how changes in the structure of matching markets (if feasible) may alleviate the risk of such losses.

Suppose that the government of the Southern island can create two segmented matching markets. Formally, it can force Southern and Northern traders to search for farmers in the Eastern and the Western part of the island, respectively. Suppose, in addition, that this information can be made common knowledge. In such an environment, if farmers could freely locate their farms in either part of the island, should we still expect aggregate losses from M-integration?

In order to answer this question, we need to be more precise about the timing of the game and our equilibrium concept. Consider, for example, the following game. At the time of M-integration, unmatched farmers simultaneously and individually choose (once and for all) on which side of the island they want to search. Then, after observing farmers' decisions, unmatched traders from both islands decide whether or not they want to search in the Southern island. It is clear that such a game has multiple Nash equilibria, depending on which side of the island Southern farmers coordinate. If all farmers coordinate on the Eastern part of the island, then only Southern traders will enter. But the converse would be true if farmers were to coordinate on the Western part of the island, thereby leaving open the possibility of aggregate losses from M-integration.

Of course, the previous multiplicity of equilibria comes from the fact that a trader who enters an empty part of the island does not expect any farmer to start searching for him, although it may be optimal for some of these farmers to do so. With this in mind, a natural way to deal with this multiplicity of equilibria is to adopt a "subgame perfect" refinement as in Acemoglu and Shimer (1999). Formally, suppose that at the time of M-integration, unmatched farmers and traders simultaneously decide where and whether to search, respectively. Now define an equilibrium with "directed search" as a situation in which: (*i*) unmatched farmers search in the part of the island that maximizes their expected lifetime utility; (*ii*) unmatched traders active in one part of the island make zero expected profits; (*iii*) inactive unmatched traders expect the rate at which they find farmers in an empty part of the island (if any) to be such that farmers are indifferent between searching in both parts of the island; and (*iv*) conditional on these expectations, inactive unmatched traders make non-positive expected profits. It is easy to check that an equilibrium with directed search may only feature the entry of Northern traders if they *increase* aggregate welfare in the Southern island. The basic argument is simple. If there was an equilibrium with aggregate losses from M-integration because of the entry of Northern traders, then Southern traders would expect to meet farmers on their part on the island at a rate higher than under W-integration (because V_F^U is decreasing in μ_T), which would contradict the fact that their expected profits are non-positive.

To summarize, introducing segmented matching markets (and providing information about these markets) is likely to circumvent aggregate losses from M-integration. In our first example, the possibility of aggregate losses from trade hinges on a coordination failure: unmatched farmers are coordinating on a Pareto-dominated Nash equilibrium. In our second example, our "subgame perfect" refinement guarantees that aggregate losses can no longer arise: Northern traders will enter the Southern island if and only if they increase aggregate welfare in the South.

Although the results in this section are admittedly quite stylized, we believe that they resonate well with some of the issues raised by activists who emphasize the fact that farmers in developing countries tend to be "marginalized" and that this fact is important in explaining the low prices received for their products. In this section, we have shown that providing farmers from the South with better trading opportunities and better information about these opportunities may be sufficient to help farmers escape from their prisoner's dilemma problem and help them avoid losses from deeper trade integration. More generally, one would expect any reform that allows farmers to *direct* their search towards particular traders, whether they are from the islands or not, to be welfare-enhancing.[30] Of course, in the context of a developing economy, if implementing such reforms requires building new roads and investing in other infrastructure, it is likely to be very costly as well.

Proposition 4 summarizes the main results of our analysis about policy interventions.

Proposition 4 *Losses from M-integration can be circumvented if:* (*i*) *price controls or entry taxes on Northern traders are chosen by the Southern government in a way that minimizes the margins charged by Southern traders; and* (*ii*) *Southern farmers are assisted in directing their search towards Northern or Southern traders.*

7 Concluding Remarks

We have developed a simple model to study the role of intermediaries in world trade. Our model illustrates the role of these economic agents in facilitating the realization of gains from trade across countries in the presence of search frictions. Our analysis raises two questions. First, how does economic integration interact with these frictions in shaping the overall gains from trade? And second, what do optimal policies look like in such an environment?

In this paper, we have provided answers to these questions. First, we have shown that different types of integration interact with goods market frictions in distinct ways. While intermediaries always magnify the gains from trade under the integration of Walrasian markets, their presence can also be associated with a country incurring aggregate losses under the integration of matching markets. Second, we have used our theoretical framework to illustrate, among things, that price controls and tax policy might be welfare-enhancing in some circumstances, especially when implemented in a way that minimizes the margins charged by local (rather than foreign) traders.

Our model of intermediation in trade is special along several dimensions, but our approach of using dynamic bargaining and matching techniques to model international transactions can be explored and pursued in several fruitful directions. For instance, we have focused on a situation in which only one intermediary separates farmers from centralized markets. It would be interesting to extend our framework to allow for multiple layers of intermediation, perhaps by introducing search frictions between local traders and foreign ones. If materializing the gains from Walrasian market integration requires the use of additional layers of intermediation, then it becomes less obvious that this type of integration will always produce magnified gains from trade. Our framework has also abstracted from issues of ex-ante market power by traders. In practice, world trade is intermediate by a relatively small number of trading companies each controlling a large market share. A natural way to introduce these considerations into our framework would be to allow traders to form coalitions among themselves.

Finally, throughout our paper we have assumed that farmers are risk neutral and homogeneous. As argued before, assuming that farmers are risk averse would help microfound our assumption on

[30] Acemoglu and Shimer (1999) provides a well-known model under which directed search restores efficiency.

the existence of cross-country variation in primitive bargaining power. Besides this, risk aversion could also complement some of our results in interesting ways. For instance, one could endogenize the specialization decision of an individual farmer (instead of simply assuming it, as we have done in our model) and study how the decision to grow coffee, sugar, or both interacts with search frictions and risk aversion. In that respect, our predicted increase in intermediation following trade integration could encourage farmers to specialize their crops according to comparative advantage, thereby producing additional gains from trade. As a final note, we could also introduce variation across farmers in their productivity, geographical location or wealth (if traders also provide credit) and use our framework to derive cross-sectional predictions regarding the use of intermediaries, the margins that they charge, and their consequences for inequality.

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A Proofs

Section 3.3. In the main text we have illustrated the existence and uniqueness of the equilibrium by construction, but we have omitted a few derivations, which we develop below.

Claim 1: *At any point in time, the solution of the Nash bargaining problem satisfies equations* (5)-(7).

Using equations (1)-(4), it is clear that the first-order conditions associated with Nash bargaining are:

$$\begin{aligned}
\beta \frac{\left(V_{T_i}^M - V_T^U\right)^{\beta} \left(V_{F_i}^M - V_F^U\right)^{1-\beta}}{V_{T_i}^M - V_T^U} v_C(C_{T_i}, S_{T_i}) &= \lambda \\
(1-\beta) \frac{\left(V_{T_i}^M - V_T^U\right)^{\beta} \left(V_{F_i}^M - V_F^U\right)^{1-\beta}}{V_{F_i}^M - V_F^U} v_C(C_{F_i}, S_{F_i}) &= \lambda \\
\beta \frac{\left(V_{T_i}^M - V_T^U\right)^{\beta} \left(V_{F_i}^M - V_F^U\right)^{1-\beta}}{V_{T_i}^M - V_T^U} v_S(C_{T_i}, S_{T_i}) &= \lambda p \\
(1-\beta) \frac{\left(V_{T_i}^M - V_T^U\right)^{\beta} \left(V_{F_i}^M - V_F^U\right)^{1-\beta}}{V_{F_i}^M - V_F^U} v_S(C_{F_i}, S_{F_i}) &= \lambda p,
\end{aligned}$$

as well as constraint (7). From these equations, we immediately obtain (6), which ensures by homogeneity of degree one that $C_{F_i}/S_{F_i} = C_{T_i}/S_{T_i}$ as well as $v_C(C_{F_i}, S_{F_i}) = v_C(C_{T_i}, S_{T_i})$ and $v_S(C_{F_i}, S_{F_i}) = v_S(C_{T_i}, S_{T_i})$. Plugging these equalities in the first-order conditions we finally obtain equation (5). **QED**.

Claim 2: *At any point in time, α satisfies equation* (17).

Since v is homogeneous of degree one, we know that

$$\begin{aligned}
v(C_F, S_F) &= (1-\alpha)\, v(p) \\
v(C_T, S_T) &= \alpha v(p)
\end{aligned}$$

Combining the two previous expressions with equations (1)-(4), we obtain

$$(r+\lambda)\left(V_F^M - V_F^U\right) = (1-\alpha)\, v(p) - \mu_F(\theta)\left(V_F^M - V_F^U\right) + \dot{V}_F^M - \dot{V}_F^U \tag{45}$$

$$\left[r+\lambda+\mu_T(\theta)\right]\left(V_T^M - V_{T^c}^U\right) = \alpha v(p) + \dot{V}_T^M - \dot{V}_T^U \tag{46}$$

Since equation (5) holds at all points in time, we also know that

$$\begin{aligned}
(1-\beta)\left(V_T^M - V_T^U\right) &= \beta\left(V_F^M - V_F^U\right) \\
(1-\beta)\left(\dot{V}_T^M - \dot{V}_T^U\right) &= \beta\left(\dot{V}_F^M - \dot{V}_F^U\right)
\end{aligned}$$

Multiplying equation (45) by β and equation (46) by $(1-\beta)$ and subtracting, we get

$$\alpha = \beta - \frac{(1-\beta)\left(V_T^M - V_T^U\right)\left[\mu_F(\theta) - \mu_T(\theta)\right]}{v(p)}$$

Equation (17) derives from the previous expression and equations (10) and (18). **QED**.

Claim 3: *At any point in time, θ is the unique solution of equation* (20), *i.e.,*

$$\frac{v(p)-\tau}{\tau} = \frac{r+\lambda+(1-\beta)\,\mu_F(\theta)}{\beta\mu_T(\theta)} \equiv \kappa(\theta).$$

It is immediate that $\kappa(\theta)$ is strictly increasing in θ. We next note that $\lim_{\theta\to 0}\mu_T(\theta)=+\infty$ and $\lim_{\theta\to+\infty}\mu_F(\theta)=+\infty$ imply $\lim_{\theta\to 0}\kappa(\theta)=0$ and $\lim_{\theta\to+\infty}\kappa(\theta)=+\infty$. By the intermediate value theorem, these two boundary conditions and $\kappa'(\theta)>0$ guarantee the existence of a unique θ satisfying equation (20). **QED**.

Claim 4: *In steady state, N_T is strictly increasing in θ.*

From equation (25), we have

$$N_T=\frac{\lambda\theta+\mu_F(\theta)}{\lambda+\mu_F(\theta)}\equiv\zeta(\theta)\,N_F, \tag{47}$$

We need to show that $\zeta'(\theta)>0$. Differentiating $\zeta(\cdot)$, we obtain

$$\zeta'(\theta)=\frac{\left[\lambda+\mu_F'(\theta)\right]\lambda+\lambda\mu_F(\theta)\left[1-\frac{\theta\mu_F'(\theta)}{\mu_F(\theta)}\right]}{\left[\lambda+\mu_F(\theta)\right]^2}>0,$$

where the inequality follows from $\mu_F'(\theta)>0$ and $\theta\mu_F'(\theta)/\mu_F(\theta)<1$ since $\mu_F(\theta)/\theta$ is decreasing in θ. **QED**. ■

Section 4.3. In the main text we have argued that if the elasticity $\varepsilon(\theta)\equiv d\ln m(u_F,u_T)/\,d\ln u_T$ is decreasing in the level of intermediation, θ, then, ceteris paribus, islands with lower levels of intermediation will grow faster after W-integration. We now establish this result formally.

Let us denote by N^A the steady state number of matched farmer-trader pairs in the South under autarky. Since the relative price of coffee is $p=a_C/a_S$, real GDP in the South under autarky, Y^A, is given by

$$Y^A=N^A/a_S$$

Similarly, if N^W denotes the steady state number of matched farmer-trader pairs in the South under W-integration, real GDP under W-integration, Y^W, is given by

$$Y^W=(a_C/a_S)\,N^W/a_C$$

The two previous equations imply that the growth rate in real GDP between the autarky and W-integration steady states, Y^W/Y^A, is proportional to the growth rate in the number of matches, N^W/N^A. In order to establish that W-integrations leads to convergence, we therefore need to show that N^W/N^A is decreasing in θ.

To do so, we denote by $N(v)$ the number of matches in equilibrium when the utility associated with a matched farmer trader pair is equal to v in the South. With these notations, we have $N^W/N^A=N(v^W)/N(v^A)$, where $v^W\equiv v\left(p^W\right)$ and $v^A\equiv v(p)$. Hence showing that N^W/N^A is decreasing in θ is equivalent to showing that $\partial\ln N/\,\partial\ln v$ is decreasing in θ, which we now demonstrate. In steady state, we know by equation (23) that $N(v)=(\mu_F(\theta)\,N_F)/\left[\lambda+\mu_F(\theta)\right]$. This implies

$$\frac{\partial\ln N}{\partial\ln v}=\left[\frac{\lambda}{\lambda+\mu_F(\theta)}\right]\left(\frac{\partial\ln\mu_F(\theta)}{\partial\ln v}\right), \tag{48}$$

which can be rearranged as

$$\frac{\partial\ln N}{\partial\ln v}=\left[\frac{\lambda\varepsilon(\theta)}{\lambda+\mu_F(\theta)}\right]\left(\frac{\partial\ln\theta}{\partial\ln v}\right).$$

Using equation (20), it is easy to check that

$$\frac{\partial \ln \theta}{\partial \ln v} = \frac{(r+\lambda) + (1-\beta)\,\mu_F(\theta)}{(r+\lambda)\,[1-\varepsilon(\theta)] + (1-\beta)\,\mu_F(\theta)} + \frac{\beta \mu_T(\theta)}{(r+\lambda)\,[1-\varepsilon(\theta)] + (1-\beta)\,\mu_F(\theta)}. \tag{49}$$

Since $\varepsilon(\theta)$ and $\mu_T(\theta)$ are decreasing in θ and $\mu_F(\theta)$ is increasing in θ, equation (49) implies that $\partial \ln \theta / \partial \ln v$ is decreasing in θ. Combining this observation with equation (48), we obtain that $\partial \ln N / \partial \ln v$ is decreasing in θ.

Finally, note that if the matching function is CES, $m(u_F, u_T) \equiv \left[(A_F u_F)^{\frac{\sigma-1}{\sigma}} + (A_T u_T)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ with $\sigma \in [0,1]$, then

$$\varepsilon(\theta) = \frac{(A_T\theta)^{\frac{\sigma-1}{\sigma}}}{1+(A_T\theta)^{\frac{\sigma-1}{\sigma}}},$$

which is decreasing in θ for $\sigma \in [0,1]$, as argued in the main text. **QED**. ■

Section 4.4. In the main text we have argued that if countries are completely specialized under W-integration, then: (*i*) the values of θ^W and $\left(\theta^W\right)^*$ are greater than their autarky levels, θ and θ^*, at any point in time; and: (*ii*) the value functions of all agents are also greater than their autarky levels at any point in time. We now demonstrate these two results formally.

Without loss of generality, we focus on the Southern island. We assume that W-integration occurs at some date t_0. For notational convenience, we still denote by p^W and θ^W the world price and the intermediation level, respectively, but it should be clear that they now are functions of t. Our proof proceeds in four steps.

Step 1: *For all $t \geq t_0$, the indirect utility of a matched farmer-trader pair in the South satisfies $v(p^W) \geq v(p)$.*

This directly derives from the fact that, like in a standard Ricardian model, a change in the relative price of coffee necessarily expands the "budget set" of a farmer-trader match.

Step 2: *For all $t \geq t_0$, the intermediation level in the South satisfies $\theta^W \geq \theta$.*

By the same argument as in Section 3.3, the value function of matched traders in the South under W-integration must satisfy

$$\begin{aligned} V_T^M &= \tau/\mu_T\left(\theta^W\right), \\ \dot{V}_T^M &= (r+\lambda)\,V_T^M + (1-\beta)\,\theta\left(V_T^M\right) - \beta\left[v\left(p^W\right) - \tau\right]. \end{aligned}$$

Combining the two previous expressions, we obtain

$$\dot{z}^W = f\left(z^W\right) + g\left(p^W\right), \tag{50}$$

where

$$\begin{aligned} z^W &\equiv 1/\mu_T\left(\theta^W\right); \\ f\left(z^W\right) &\equiv (1-\beta)\,\theta\left(\tau z^W\right) + (r+\lambda)\,z^W; \\ g\left(p^W\right) &\equiv 1 - \left[\beta v(p^W)/\tau + (1-\beta)\right]. \end{aligned}$$

Notice that, by definition of $\mu_T\left(\theta^W\right)$, z^W is a strictly increasing function of θ^W, and thus, f is a strictly increasing function of z^W. Notice also that $g\left(p^W\right) \leq g(p)$ by Step 1.

The rest of our proof proceeds by contradiction. Suppose that there exists $t_1 > t_0$ such that $\theta^W < \theta$. Thus there exists $t_1 > t_0$ such that $z^W(t_1) < z$ with z such that $0 = f(z) + g(p)$. Since f is increasing in z^W and $g\left(p^W\right) \leq g(p)$, we get $\dot{z}^W(t_1) = f\left[z^W(t_1)\right] + g\left[p^W(t_1)\right] \leq f\left[z^W(t_1)\right] + g(p) < 0$ at t_1. This implies $\dot{z}^W(t) < f\left[z^W(t_1)\right] + g(p) < 0$ for all $t > t_1$. (To see this note that if there was a date $t_2 > t_1$ such that $\dot{z}^W \geq f\left[z^W(t_1)\right] + g(p)$, then there would also exist, by continuity, a date $t_c \in (t_1, t_2)$ such that $\dot{z}^W(t_c) = f\left[z^W(t_1)\right] + g(p)$ and $\dot{z}(t) < 0$ for all $t \in (t_1, t_c)$. By equation (50), we would therefore have $f\left[z^W(t_c)\right] + g\left[p^W(t_c)\right] = f\left[z^W(t_1)\right] + g(p)$. Since f is increasing in z^W and $g\left[p^W(t_c)\right] \leq g(p)$, this implies $z^W(t_c) > z^W(t_1)$, which contradicts $\dot{z}(t) < 0$ for all $t \in (t_1, t_c)$.) This further implies $z^W(t) \to -\infty$, which cannot be an equilibrium.

Step 3: *All traders are necessarily better off under W-integration.*

For unmatched traders, this directly derives from free entry. For matched traders, this derives from equation (18) and the fact that $\mu_T\left(\theta^W\right) \leq \mu_T(\theta)$ by Step 2.

Step 4: *All farmers are necessarily better off under W-integration.*

The Bellman equations associated with the farmers' value functions are still given by equations (1) and (2). Using equation (17), they can be rearranged as

$$\begin{aligned} rV_F^U &= \mu_F\left(\theta^W\right)\left(V_F^M - V_F^U\right) + \dot{V}_F^U, \\ rV_F^M &= h\left(\theta^W\right) + \lambda\left(V_F^U - V_F^M\right) + \dot{V}_F^M, \end{aligned}$$

where $h\left(\theta^W\right) \equiv (1-\beta)\, v(p^W) + (1-\beta)\left(\theta^W - 1\right)\tau$. Combining the two previous expressions with equations (5) and (18), we obtain

$$\dot{V}_F^U = rV_F^U - \theta^W \tau \left(\frac{1-\beta}{\beta}\right), \tag{51}$$

$$\dot{V}_F^M = (r+\lambda)\, V_F^M - h\left(\theta^W\right) - \lambda V_F^U. \tag{52}$$

By Step 2, we know that $\theta^W \geq \theta$. Using equation (51) and the same logic as in Step 2, we can therefore conclude that $V_F^U \geq \left(V_F^U\right)^A$ for all $t \geq t_0$, where $\left(V_F^U\right)^A$ denotes the value function of an unmatched farmer under autarky. By Steps 1 and 2, we also know that $h\left(\theta^W\right) \geq h(\theta)$. Using this observation with the fact that $V_F^U \geq \left(V_F^U\right)^A$ for all $t \geq t_0$ and equation (52), the same logic as in Step 2 implies $V_F^M \geq \left(V_F^M\right)^A$ for all $t \geq t_0$, where $\left(V_F^M\right)^A$ denotes the value function of a matched farmer under autarky. ■

Proof of Lemma 1. Without loss of generality, we focus on the Southern island. For the same reasons as in section 3.3, we must have $V^M_{F^i_C} = V^M_{F^i_S} \equiv V^M_{F^i}$ and $V^M_{T^i_C} = V^M_{T^i_S} \equiv V^M_{T^i}$, where $V^M_{F^i}$ denotes the value function of a Southern farmer matched with a trader from island $i = N, S$ and $V^M_{T^i}$ denotes the value function of a trader from island i matched with a Southern farmer. Let u_{T^N} and u_{T^S} denote the measures of unmatched Northern and Southern traders, respectively, searching for matches in the South. If $\phi \equiv u_{T^N} / \left[u_{T^N} + u_{T^S}\right]$ denotes the fraction of unmatched Northern traders in the Southern island, the value functions of all agents can then be expressed as

$$rV_F^U = \mu_F\left(\theta^D\right)\left[\phi \max\left(V^M_{F^N} - V_F^U, 0\right) + (1-\phi)\max\left(V^M_{F^S} - V_F^U, 0\right)\right] + \dot{V}_F^U, \tag{53}$$

$$rV^M_{F^i} = \left(1-\alpha^i\right) v\left(p^W\right) + \lambda\left(V_F^U - V^M_{F^i}\right) + \dot{V}^M_{F^i}, \tag{54}$$

$$rV^U_{T^i} = \max\left[-\tau^i + \mu_T\left(\theta^D\right)\left(1-\delta^i\right)\left(V^M_{T^i} - V^U_{T^i}\right) + \dot{V}^U_{T^i}, 0\right], \tag{55}$$

$$rV^M_{T^i} = \alpha^i v\left(p^W\right) - \tau^i + \lambda\left(V^U_{T^i} - V^M_{T^i}\right) + \dot{V}^M_{T^i}, \tag{56}$$

where θ^D denotes the level of intermediation after M-integration; and α^i denotes the share of consumption accruing to traders from island i, $\tau^S \equiv \tau$, and $\tau^N \equiv \tau^*$. The max operator in equations (54) and (55) reflects the fact that, on the one hand, a farmer matched with a trader from island i may now prefer to keep searching for a trader from the other island, and on the other hand, traders from island i may at any point in time go back to their hammocks. In this environment, $\delta^i \in [0,1]$ corresponds to the probability that a Southern farmer will break a match with a trader from island i. It should be clear that all functions in equations (53)-(56), including θ^D, δ^i, ϕ, and $v\left(p^W\right)$, may a priori vary over time. Finally, note that free entry requires $V^U_{T^i} \leq 0$ for $i = N, S$. Combining this inequality with equation (55), we obtain

$$V^U_{T^i} = \dot{V}^U_{T^i} = 0, \tag{57}$$

at all points in time. The rest of our proof proceeds in three steps.

Step 1: *For all $t \geq t_0$, we must have $\delta^N \leq \delta^S$.*

We proceed by contradiction. Suppose that there exists a date t such that $\delta^S < \delta^N$. Then, it must be the case that $\delta^S < 1$ and $\delta^N > 0$. This implies $V^M_{F^S} + V^M_{T^S} \geq V^U_F + V^U_{T^S}$ and $V^M_{F^N} + V^M_{T^N} \leq V^U_F + V^U_{T^N}$. By equation (57), we know that $V^U_{T^S} = V^U_{T^N} = 0$. Thus

$$V^M_{F^S} + V^M_{T^S} \geq V^M_{F^N} + V^M_{T^N}. \tag{58}$$

Using equations (54) and (56), it is easy to check that

$$\left(\dot{V}^M_{F^S} + \dot{V}^M_{T^S} - \dot{V}^M_{F^N} - \dot{V}^M_{T^N}\right) = \tau - \tau^* + (r+\lambda)\left(V^M_{F^S} + V^M_{T^S} - V^M_{F^N} - V^M_{T^N}\right)$$

which admits a unique stable solution

$$V^M_{F^S} + V^M_{T^S} - V^M_{F^N} - V^M_{T^N} = \frac{\tau^* - \tau}{r+\lambda} < 0,$$

which contradicts inequality (58).

Step 2: *For all $t > t_0$, the pay-off of matched Northern traders is higher than the pay-off of matched Southern traders: $\alpha^N v\left(p^W\right) - \tau^* > \alpha^S v\left(p^W\right) - \tau$.*

We consider three separate cases.

Case 1: $\phi(t) \in (0,1)$.

If $\phi(t) \in (0,1)$, then traders from both islands are actively searching for Southern farmers at date t. Hence (55) requires

$$rV^U_{T^i} = -\tau^i + \mu_T\left(\theta^D\right)\left(1-\delta^i\right)\left(V^M_{T^i} - V^U_{T^i}\right) + \dot{V}^U_{T^i}. \tag{59}$$

By equation (53), $\phi(t) \in (0,1)$ also requires that

$$rV^U_F = \mu_F\left(\theta^D\right)\left[\phi\left(V^M_{F^N} - V^U_F\right) + (1-\phi)\left(V^M_{F^S} - V^U_F\right)\right] + \dot{V}^U_F. \tag{60}$$

Otherwise, Southern farmers would never accept matches with (at least) one type of traders, say those from island i. This would imply $\delta^i = 0$, and so, that traders form island i would be better off staying in their hammocks by equations (55) and (57).

Combining equation (59) and (56), we obtain

$$\left[r+\lambda+\mu_T\left(\theta^D\right)\delta^i\right]\left(V_{T^i}^M-V_{T^i}^U\right)=\alpha^i v\left(p^W\right)+\dot{V}_{T^i}^M-\dot{V}_{T^i}^U. \tag{61}$$

Similarly, combining equations (54) and (60), we get

$$(r+\lambda)\left(V_{F^i}^M-V_F^U\right)=\left(1-\alpha^i\right)v\left(\bar{C},\bar{S}\right)-\mu_F\left(\theta^D\right)\left[\phi\left(V_{F^N}^M-V_F^U\right)+(1-\phi)\left(V_{F^S}^M-V_F^U\right)\right]+\dot{V}_{F^i}^M-\dot{V}_F^U. \tag{62}$$

At any date $t>t_0$, we know that Nash bargaining implies

$$\left(1-\beta^i\right)\left(V_{T^i}^M-V_{T^i}^U\right)=\beta^i\left(V_{F^i}^M-V_F^U\right),$$

as well as

$$\left(1-\beta^i\right)\left(\dot{V}_{T^i}^M-\dot{V}_{T^i}^U\right)=\beta^i\left(\dot{V}_{F^i}^M-\dot{V}_F^U\right),$$

where $\beta^S\equiv\beta$ and $\beta^N\equiv\bar{\beta}$. Multiplying equation (61) by $\left(1-\beta^i\right)$ and equation (62) by β^i and subtracting, we get

$$\alpha^i=\beta^i+\frac{\left(1-\beta^i\right)\left\{\mu_T\left(\theta^D\right)\left(1-\delta^i\right)\left(V_{T^i}^M-V_{T^i}^U\right)-\mu_F\left(\theta^D\right)\left[\phi\left(V_{T^N}^M-V_T^U\right)+(1-\phi)\left(V_{T^S}^M-V_T^U\right)\right]\right\}}{v\left(p^W\right)}.$$

Using the previous expression and equation (57), we obtain

$$\alpha^i=\beta^i+\frac{\left(1-\beta^i\right)\left[\mu_T\left(\theta^D\right)\left(1-\delta^i\right)V_{T^i}^M-\mu_F\left(\theta^D\right)\left[\phi V_{T^N}^M+(1-\phi)V_{T^S}^M\right]\right]}{v\left(p^W\right)}. \tag{63}$$

Equations (57) and (59) further imply

$$V_{T^i}^M=\frac{\tau^i}{\mu_T\left(\theta^D\right)\left(1-\delta^i\right)}. \tag{64}$$

Combining equations (63) and (64), we get

$$\alpha^i v\left(p^W\right)-\tau^i=\beta^i\left[v\left(p^W\right)-\tau^i\right]-\left(1-\beta^i\right)\theta\bar{\tau},$$

where $\bar{\tau}\equiv\phi\tau^*/\left(1-\delta^N\right)+(1-\phi)\tau/\left(1-\delta^S\right)$. Since $\bar{\beta}>\beta$, $\tau^*<\tau$, $v\left(p^W\right)-\tau^*>0$, and $v\left(\bar{C},\bar{S}\right)-\tau>0$, the previous expression implies $\left[\alpha^N v\left(p^W\right)-\tau^*\right]-\left[\alpha^S v\left(p^W\right)-\tau\right]>0$.

Case 2: $\phi(t)=0$.

If $\phi(t)=0$, then only Southern traders are searching for Southern farmers at date t. Following the exact same logic as in Case 2 for Southern traders only, we get

$$\alpha^S v\left(p^W\right)-\tau=\beta\left[v\left(p^W\right)-\tau\right]-(1-\beta)\theta\tau,$$

which can be rearranged as

$$\alpha^S v\left(p^W\right)-\tau=\beta\left[v\left(p^W\right)-\tau-\frac{(1-\beta)}{\beta}\theta\tau\right]. \tag{65}$$

What about matched Northern traders (if there are any)? Using our free entry condition, equation (57), we can rearrange equation (56) as

$$(r+\lambda)\left(V_{T^N}^M - V_{T^N}^U\right) = \alpha^N v\left(p^W\right) - \tau^* + \dot{V}_{T^N}^M - \dot{V}_{T^N}^U. \tag{66}$$

By equations (53) and (54), we also know that

$$(r+\lambda)\left(V_{F^N}^M - V_F^U\right) = \left(1-\alpha^N\right) v\left(p^W\right) - \mu_F\left(V_{F^S}^M - V_F^U\right) + \dot{V}_{F^N}^M - \dot{V}_F^U, \tag{67}$$

where we have used the fact that if Southern traders search at date t, we must have $\max\left(V_{F^S}^M - V_F^U, 0\right) = V_{F^S}^M - V_F^U$. Using our Nash bargaining conditions with equations (66) and (67), we obtain

$$\alpha^N v\left(p^W\right) - \tau^* = \bar{\beta}\left[v\left(p^W\right) - \tau^*\right] - \left(\frac{\bar{\beta}}{\beta}\right)(1-\beta)\,\mu_F\left(\theta^D\right)\left(V_{T^S}^M - V_T^U\right).$$

Because of free entry of the Southern traders, we know by equation (55) that $V_{T^S}^M = \tau/\mu_T\left(\theta^D\right)$. Thus we get

$$\alpha^N v\left(p^W\right) - \tau^* = \bar{\beta}\left[v\left(p^W\right) - \tau^*\right] - \left(\frac{\bar{\beta}}{\beta}\right)(1-\beta)\,\theta\tau,$$

which can be rearranged as

$$\alpha^N v\left(p^W\right) - \tau^* = \bar{\beta}\left[v\left(p^W\right) - \tau^* - \left(\frac{1-\beta}{\beta}\right)\theta\tau\right]. \tag{68}$$

Since Southern traders are searching for Northern farmers, we know that $v\left(p^W\right) - \tau - \frac{(1-\beta)}{\beta}\theta\tau > 0$. Combining this observation with equations (65) and (65) and the fact that $\bar{\beta} > \beta$ and $\tau^* < \tau$, we obtain $\left[\alpha^N v\left(p^W\right) - \tau^*\right] - \left[\alpha^S v\left(p^W\right) - \tau\right] > 0$.

Case 3: $\phi(t) = 1$.

The exact same logic as in case 2 implies

$$\alpha^N v\left(p^W\right) - \tau^* = \bar{\beta}\left[v\left(p^W\right) - \tau^*\right] - \left(1-\bar{\beta}\right)\theta\tau^*$$

and

$$\alpha^S v\left(p^W\right) - \tau = \beta\left[v\left(p^W\right) - \tau\right] - \left(\frac{\beta}{\bar{\beta}}\right)\left(1-\bar{\beta}\right)\theta\tau^*$$

Step 2 directly follows.

Step 3: *For almost all $t > t_0$, we must have $\phi(t) = 1$.*

We proceed by contradiction. Suppose that there exist $t_1 < t_2$ such that an arbitrary trader from the Southern island is active in the Southern island for all $t \in (t_1, t_2)$. By definition, we know that

$$V_{T^S}^U(t) = E\left[\int_t^{+\infty} e^{-rt'} v\left[C_{T^S}(t'), S_{T^S}(t')\right] dt'\right].$$

Let $\mathcal{I}_A(t)$ denote indicator variable which is equal to one if this trader is active at a given date t and zero otherwise. With this notation, we can be rearrange the previous expression as

$$V_{T^S}^U(t) = \int_t^{+\infty} e^{-rt'} E\left\{\mathcal{I}_A(t')\left\{\mathcal{I}_{M^S}(t')\left[\alpha^S v\left(p^W\right) M(t') - \tau\right] + \left[1-\mathcal{I}_{M^S}(t')\right](-\tau)\right\}\right\} dt' \tag{69}$$

where $\mathcal{I}_{M^S}(t')$ is an indicator variable equal to one if the trader from the Southern island is matched at date t' and zero otherwise.

Now consider an arbitrary trader from the Northern island. Suppose that this trader follows the exact same strategy as the trader from the Southern island, i.e. he would choose to be active or inactive at the exact same dates (conditional on the same history). Let $\mathcal{I}_{M^N}(t')$ denote the indicator variable which is equal to one if the trader from the Northern island is matched at date t' and zero otherwise By Step 1, we know that $\delta^N \leq \delta^S$, which implies $\Pr\{\mathcal{I}_{M^N}(t') = 1\} \geq \Pr\{\mathcal{I}_{M^S}(t') = 1\}$ for all t'. By Step 2, we also know that $\alpha^N v(p^W) - \tau^* > \alpha^S v(p^W) - \tau$. Thus, if we denote by $Z^i(t') \equiv \mathcal{I}_{M^i}(t')\left[\alpha^i v(\bar{C}, \bar{S}) M(t') - \tau^i\right] + [1 - \mathcal{I}_{M^i}(t')](-\tau^i)$, $Z^N(t')$ strictly first-order stochastically dominates $Z^S(t')$ for all t'. Since $\mathcal{I}_A(t') = 1$ for all $t \in (t_1, t_2)$, this implies that $\mathcal{I}_{A^S}(t') Z^N(t')$ strictly first-order stochastically dominates $\mathcal{I}_{A^S}(t') Z^S(t')$, and therefore, that $E\left[\mathcal{I}_{A^S}(t') Z^N(t')\right] > E\left[\mathcal{I}_{A^S}(t') Z^S(t')\right]$. Combining this observation with equation (69), we obtain $V^U_{T^N}(t) > V^U_{T^S}(t)$, where $V^U_{T^N}(t)$ is the expected lifetime utility of the Northern trader. By equation (57), we know that $V^U_{T^S}(t) = V^U_{T^N}(t) = 0$, a contradiction. **QED**. ■

Section 5.3. In the main text, we have argued that: (i) if $\tau > \tau^*$ and $\overline{\beta} = \beta$, then $\alpha^N < \alpha^W$; and (ii) if $\tau = \tau^*$ and $\overline{\beta} > \beta$, then $\alpha^N > \alpha^W$. To verify these claims, note that we can combine equations (36) and (37) to express α^N in the following two ways:

$$\alpha^N = \overline{\beta} \cdot \left[\frac{r + \lambda + \mu_T\left(\theta^N\right)}{r + \lambda + \left(1 - \overline{\beta}\right)\mu_F\left(\theta^N\right) + \overline{\beta}\mu_T\left(\theta^N\right)}\right];$$

$$\alpha^N = \frac{\tau^*}{v(p^W)}\left[\frac{r + \lambda + \mu_T\left(\theta^N\right)}{\mu_T\left(\theta^N\right)}\right].$$

Because the right-hand-side of the first equation is decreasing in θ^N, we can conclude that, for $\beta = \overline{\beta}$, we must have $\alpha^N < \alpha^W$, where α^W is defined in (28). On the other hand, the right-hand-side of the second equation is increasing in θ^N. Inspection of the equation indicates that, for $\tau = \tau^*$, the larger level of θ^N induced by $\overline{\beta} > \beta$ necessarily translates into a value of α^N that is larger than in the absence of M-integration (that is, $\alpha^N > \alpha^W$). **QED**. ■

Section 5.4. In the next main text, we have argued that social welfare is increasing in β if and only if $\beta \leq \varepsilon \equiv d\ln m(u_F, u_T)/\,d\ln u_T$. We now establish this result formally. For expositional purposes, we focus on the autarky case. The other cases are similar.

By equation (29), we know that social welfare is given by

$$W(t) = V^U_F(t)\left[u_F(t) + \left(\frac{\lambda}{r+\lambda}\right)[N_F - u_F(t)]\right] + [N_F - u_F(t)]\left[\frac{v(p^W) - \tau}{r + \lambda}\right].$$

Since $u_F(t)$ is predetermined at date t and $v(p^W)$ is independent of β, this implies

$$\frac{dW(t)}{d\beta} = Z(t) \cdot \frac{dV^U_F(t)}{d\beta}, \tag{70}$$

where $Z(t) \equiv u_F(t) + \frac{\lambda[N_F - u_F(t)]}{r+\lambda} > 0$. By equations (20), and (21), we know that

$$V^U_F = \frac{\tau\theta(1-\beta)}{r\beta}$$

Differentiating the previous expression, we obtain

$$\frac{\partial V_F^U(t)}{\partial \beta} = \frac{\tau\theta}{r\beta^2}\left[(1-\beta)\frac{d\ln\theta}{d\ln\beta} - 1\right] \tag{71}$$

By directly differentiating equation (20), it is easy to check that

$$\frac{d\ln\theta}{d\ln\beta} = \frac{r+\lambda+\mu_F(\theta)}{(r+\lambda)(1-\varepsilon)+(1-\beta)\mu_F(\theta)} \tag{72}$$

Combining equations (71) and (72) we obtain

$$\frac{\partial V_F^U(t)}{\partial \beta} = \frac{\tau\theta}{r\beta^2}\left[\frac{(r+\lambda)(\varepsilon-\beta)}{(r+\lambda)(1-\varepsilon)+(1-\beta)\mu_F(\theta)}\right] \tag{73}$$

Equations (70) and (73) imply that $W(t)$ is increasing in β if and only if $\beta \leq \varepsilon$. **QED** ■

Section 6.1. In the main text, we have argued that price control may lead to inefficient separations in the Southern island. We now demonstrate this result formally. Under price control, we know that $\tilde{\alpha}$ and $\tilde{\theta}$ satisfy

$$\tilde{\alpha} = \varepsilon - \frac{(1-\varepsilon)\left(\tilde{\theta}-1\right)\tau^*}{v\left(p^W\right)}, \tag{74}$$

and

$$\frac{v\left(p^W\right)-\tau^*}{\tau^*} = \frac{r+\lambda+(1-\varepsilon)\mu_F\left(\tilde{\theta}\right)}{\varepsilon\mu_T\left(\tilde{\theta}\right)}. \tag{75}$$

A nondiscriminatory price control would immediately set $\alpha^S = \tilde{\alpha}$ and would push Southern traders to want to separate from their matched farmers whenever $\tilde{\alpha}v\left(p^W\right) < \tau$, which using (74) requires

$$(1-\varepsilon)\left[v\left(p^W\right)+\left(\tilde{\theta}-1\right)\tau^*\right] > v\left(p^W\right)-\tau.$$

Such separation will be inefficient if

$$v\left(p^W\right)-\tau > rV_F^U = \frac{(1-\varepsilon)}{\varepsilon}\tau^*\tilde{\theta}.$$

Using equation (75), it is easy to check that $(1-\varepsilon)\left[v\left(p^W\right)+\left(\tilde{\theta}-1\right)\tau^*\right] > \frac{(1-\varepsilon)}{\varepsilon}\tau^*\tilde{\theta}$. Hence price control may lead to inefficient separations in the Southern island. **QED**. ■