INTERMEDIATED TRADE*

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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 to sell these goods in centralized (Walrasian) markets, they need to be matched with a trader, and this entails 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. We find that intermediation always magnifies the gains from trade under the former type of integration, but leads to more nuanced welfare results under the latter, including the possibility of aggregate losses. *JEL* Codes: F10, F15, D2, D3, O1.

I. INTRODUCTION

Intermediaries are the grease that allows the wheels of commerce to spin.[1] 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. Yet these intermediaries are rarely viewed as the unsung heroes of globalization. Instead, they are sometimes portrayed as villains that exploit producers in less

*We are grateful to Daron Acemoglu, Robert Barro, Federico Díez, Dave Donaldson, Gene Grossman, Elhanan Helpman, Oleg Itskhoki, James Mirlees, Jim Rauch, and Jonathan Vogel for very useful conversations, and to three anonoymous referees as as well as seminar participants at Toronto, Nottingham, Boston Fed, MIT, Paris School of Economics, Zurich, Autònoma-Barcelona, ITAM, Colorado-Boulder, Harvard Business School, the NBER Summer Institute, Oregon and Boston University for useful comments. Frank Schilbach provided excellent research assistance. Costinot thanks the Alfred P. Sloan foundation for financial support.

1. Though it is not straightforward to quantify the importance of intermediaries in market economies, 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." In an internationcal context, Feenstra, Hanson, and Lin (2004) estimate that during the 1990s, Hong Kong intermediated over 50% of the volume of China's exports to the rest of the world.

The Quarterly Journal of Economics (2011) 126, 1319–1374. doi:10.1093/qje/qjr019.

developed countries and siphon all gains from trade away from these economies and toward developed countries (see, for instance, 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 use this model to shed light on the role of intermediaries in materializing the gains from international trade as well as in affecting the 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 (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 because 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 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 in 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. We provide microfoundations for this assumption in a later section. For simplicity, we also 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. Throughout 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*. Broadly speaking, W-integration aims to shed light on the consequences of convergence in goods prices across countries in the presence of intermediaries, whereas M-integration, which is more closely related to foreign direct investment, seeks to capture the consequences of the entry of foreign intermediaries in local markets, regardless of whether such intermediaries are trading companies, banks, or multinational companies in practice.

The first type of 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, for example, Bhagwati (1971). Our first result demonstrates 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 toward 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.

By contrast, our analysis of the effects of M-integration produces much more nuanced results. The relatively higher profitability of Northern traders (due to their lower intermediation costs and higher bargaining power) allows them to penetrate the Southern island and intermediate trade there. Such process of entry naturally leads to an increase in the level of intermediation and output growth 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, despite its positive effect on output. When the (primitive) bargaining strength of traders is similar across islands 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 traders is disproportionately large in the North and the costs of intermediation are similar across islands, then M-integration may decrease social welfare in South. The reduction in Southern welfare occurs when the primitive bargaining power of traders is large relative to certain parameters governing search frictions. In those situations, 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 popular concerns regarding intermediaries. 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 in order. First, and most obvious, 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 benefiting 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 (rather than Northern) traders before and after M-integration.

Our model of intermediation is admittedly stylized and does not aspire to capture the precise workings of any particular

2. It is worth pointing out that this observation crucially relies on the fact that we are comparing convergent paths rather than steady states (see Diamond 1980). In Section V, we also briefly discuss the case where South is no longer small compared with North. In this situation, M-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, M-integration increases the relative supply of Southern goods, and in turn worsens its terms of trade.

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, incomplete information about quality or prices, or working-capital needs. Nonetheless, readers insisting on a literal interpretation of our framework may find our simple model particularly useful in analyzing the role of itinerant traders in certain agricultural markets in Africa. In Uganda, for instance, where coffee represents close to one quarter of total exports, 85% of Robusta coffee farmers sell to itinerant traders despite the existence of nearby centralized markets; see Fafchamps and Hill (2005). This phenomenon has been deemed important for understanding how the welfare gains associated with terms-of-trade improvements are distributed between farmers and intermediaries (see Fafchamps and Hill 2008). Furthermore, there is evidence that trading externalities of the type formalized by our model may be key in the determination of the welfare implications of these terms-of-trade movements (see Fafchamps and Hill 2008). In this context, one can also think of the significant presence of foreign firms in coffee production in Uganda as a real-world counterpart to M-integration in our model.[3]

We believe, however, that our approach of using dynamic bargaining and matching techniques to model international transactions has wider applicability and can be used more generally to shed light on other empirically relevant forms of intermediation, particularly in manufacturing processes. To illustrate that point, our final section presents a series of extensions that incorporate more realistic features of intermediation. Our first extension allows Northern trading companies to be larger than Southern ones and, in particular, to transact with more than one producer. This extension provides a simple microfoundation for our assumption that Northern traders have a higher bargaining power than Southern ones and also illustrates that welfare losses may be associated with the entry of inefficiently large Northern trading companies. Our second extension considers a variant of our framework in which traders are in fixed supply, perhaps because of government regulations, and thus earn rents, whereas the number of producers is endogenously determined by their choices between

3. For example, the Kaweri coffee plantation, which is Uganda's largest coffee farm, is owned by the Neumann Kaffee Gruppe based in Hamburg, Germany.

"market" and "nonmarket" activities. Though some predictions regarding the effect of integration on margins are sensitive to this modification, our main welfare results are robust to this alternative formulation. Our third extension allows the number of producers and traders to be endogenously determined via occupational choice decisions. Quite naturally, some of the distributional consequences of W- and M-integration are affected by this modification of our original model. Interestingly, however, we continue to find that W-integration makes all agents (weakly) better off, whereas M-integration can still create winners and losers and may well decrease aggregate welfare. We conclude this section by briefly describing three further variants of our model that highlight the implications of intersectoral mobility and producer heterogeneity.

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 sizable literature on search-theoretic approaches to the analysis of labor markets, which builds on the seminal papers by Diamond (1982) and Mortensen and Pissarides (1994).[5] In that respect, the inefficiency underlying our nonstandard welfare results bears a close relationship to Hosios's (1990a) analysis of the efficiency of labor market equilibria. Search-theoretic models have been applied to the study of international trade issues before, but with very different goals in mind. For instance, Davidson, Martin, and Matusz (1988, 1999) and Hosios (1990b) study the workings of two-sector, general equilibrium models featuring asymmetric search frictions in the two sectors, and revisit

4. This aspect of our analysis also is related to the work of Duffie, Gârleanu, and Pedersen (2005) who study how the bid and ask prices charged by market-makers in over-the-counter markets are shaped by search frictions.

5. See Pissarides (2000) for an overview of the early contributions to this literature and Rogerson, Shimer, and Wright (2005) for an account of more recent developments.

the determination of comparative advantage and the effects of trade integration on labor market outcomes (see also Costinot 2009, and Helpman, Itskhoki, and Redding 2009). Instead, search frictions are symmetric in the two sectors in our model.[6]

In terms of focus, our paper is more closely related to a recent burgeoning 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, Khandelwal, and Wei 2009; Blum, Claro, and Horstmann 2009; Akerman 2010, or Bernard et al. 2010). It has been documented, for instance, that relatively unproductive exporters are more likely to resort to intermediaries than relatively productive exporters. As we show in Section VI, a simple extension of our model that introduces producer heterogeneity delivers predictions consistent with these empirical studies.

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 rationale for intermediaries and the margins they charge stems from search frictions. 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. In that respect, our work is most closely related to the earlier work of Rauch and Watson (2004) and recent working papers by Bardhan,

6. More recently, Eaton et al. (2010) have used a dynamic model of search and learning to rationalize the observed export dynamics of Colombian firms.

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, Rodrik, and Welch (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, Lugovskyy, and Skiba (2009) offer evidence of price discrimination in the shipping industry. See Stahl (1988) for an early, simple model of market power in international trading, and Eckel (2009) and Raff and Schmitt (2009) for more recent contributions featuring market power in wholesaling or retailing.

Mookherjee, and Tsumagari (2009) and Chau, Goto, and Kanbur (2009), who develop complementary theories of intermediation. Our work is distinct in three key dimensions. First, our model is built as a strict generalization of a standard Ricardian model of trade: when intermediation costs go to 0, 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 II describes the basic environment. Section III characterizes the equilibrium under autarky. Sections IV and V analyze the consequences of W- and M-integration, respectively. Section VI discusses several extensions and variants of our model. Section VII offers some concluding remarks. All proofs can be found in the Appendix or in the Online Addendum.[9]

II. The Basic Environment

Consider an island inhabited by a continuum of infinitely lived agents consuming two goods, coffee (C) and sugar (S). An exogenous measure N_F of the island inhabitants are engaged in production.[10] 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. For notational convenience, we drop time indices from all our variables whenever there is no risk of confusion.

Our main point of departure from the classical Ricardian model is that farmers do not have direct access to Walrasian markets where their output can be exchanged for that of other farmers. To be able to sell part of their output and consume both goods,

8. Bardhan, Mookherjee, and Tsumagari (2009) also consider two types of economic integration (trade and offshoring) but their focus is on their effect on income inequality.

9. The Online Addendum is available on the authors' web pages or upon request.

10. Throughout this paper, we slightly abuse terminology and equivalently speak about the "measure" and the "number" of agents of a given type.

a farmer needs to find a *trader*, and doing so may take time as described shortly. Traders do not spend any time engaged in production but have access to Walrasian markets 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.[11]

The pool of potential traders on the island is large. At any point in time, potential traders can become active or inactive. To remain connected to Walrasian markets, 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, for example, laying in a hammock.[12] 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. Hence, in equilibrium, N_T will be endogenously pinned down by free entry.

All agents aim to maximize the expected value of their lifetime utility[13]

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

where $r > 0$ is the common discount factor; $\mathcal{I}_A(t) = 1$ if the agent is an active trader at date t and $\mathcal{I}_A(t) = 0$ otherwise; $C(t) \geq 0$ 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 1 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

11. With this stark assumption we seek to capture the basic notion that through their informational advantage, specialized traders can facilitate producers' access to potential buyers. One can think of the provision of quality guarantees or trade credit as alternative means by which intermediaries perform the same function in the real world.

12. Dick Cooper and Avinash Dixit have both suggested that the alternative expression "lying in a hammock" would be less prone to venereal connotations. Of course our model is robust to inactive traders laying in hammocks in pairs and enjoying a positive utility flow from doing so.

13. 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.

function v is homogeneous of degree 1 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.

The process through which farmers find traders involves search frictions and one-to-one matching. 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 1, 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 $\beta \in (0,1)$ 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.[14] Similarly, let $V_{T_i}^M$ de-

14. 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 thus simply write $V_{F_C}^U = V_{F_S}^U \equiv V_F^U$.

note 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

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

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 Walrasian markets, consumption takes place, new matches are formed among unmatched agents, and a fraction of existing matches is dissolved exogenously.

III. Autarky Equilibrium

III.A. 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 $i = C, S$; and (v) 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) Walrasian markets clear.

III.B. Equilibrium Conditions

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:

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

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

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

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

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 with a coffee farmer with probability $\gamma\mu_T(\theta)$ and with a sugar farmer with probability $(1-\gamma)\mu_T(\theta)$, whereas traders matched with a farmer carrying good $i = C, S$ get instantaneous utility $v(C_{T_i}, S_{T_i}) - \tau$ and become unmatched at rate λ.[15]

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 implies that at any point in time,

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

as well as

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

and

(7) $$p\bar{C}_i + \bar{S}_i = (p/a_C)\cdot\mathcal{I}_C + (1/a_S)(1-\mathcal{I}_C),$$

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. Equation 5 simply states that traders get a share β of the surplus of any match, whereas Equations 6

15. For expositional purposes, we have chosen to write our Bellman equations under the implicit assumption that matched farmers never switch from coffee to sugar production and vice versa. This is innocuous in the autarky equilibrium. Of course, at the (unexpected) time of W- and M-integration, matched farmers will be allowed to switch sectors, as assumed in Section II.

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

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

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

These two equations 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. Note that Walras' law still holds in this environment: because of Equation 7, one of the two market-clearing conditions is redundant.

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 to 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:

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

III.C. Characterization, Existence, and Uniqueness

We next briefly characterize some key features of the autarkic equilibrium and outline a proof of its existence and uniqueness, with most technical details 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, which is ensured by our Inada conditions. 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 they get matched with.

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. Because 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 $\psi(\cdot) \equiv \left[v_C(\cdot, 1) / v_S(\cdot, 1)\right]^{-1}$ 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 $v(\cdot)$ is homogeneous of degree 1, it is also necessarily the case that $v(\cdot)$ is proportional to the value of the 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 $v(p) \equiv v\left(\bar{C}, \bar{S}\right)$ the joint utility level (net of effort costs) of a matched farmer-trader 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 analysis. Throughout the paper, we 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 at all points in time in the autarky equilibrium, the share α is given by

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

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 can be interpreted as 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 this formally, note that the instantaneous utility function v is homogeneous of degree 1. Thus the farmer obtains an instantaneous utility level equal to $(1 - \alpha) v(p)$, and his or her consumption choices are as if the farmer's income—and thus the price at which the trader buys coffee—had been reduced by a factor $1 - \alpha$. We can hence conclude that the traders' (percentage) margin is equal to $\left(p - p^{bid}\right)/p = \alpha > 0$. So without risk of confusion, we will simply refer to α as 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 the free entry condition 10, which of course implies $\dot{V}_T^U = 0$, we can rearrange Equation 3 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, $\theta \equiv \hat{\theta}\left(V_T^M\right)$. 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 4 with the free entry condition 10 and the Nash bargaining outcome 17, we obtain

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

Since we know that $\hat{\theta}'\left(V_T^M\right) > 0$ by 18, we can conclude that the dynamics of V_T^M in Equation 19 are unstable. For the expected lifetime utility of a matched trader to remain finite we therefore need $\dot{V}_T^M = 0$, 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 a standard 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. Because 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

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

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

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

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

Once the dynamics of u_F are 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 to ensure that Equation 20 holds at any point in time. In the steady-state, we have

$$(24)\qquad u_T = \frac{\lambda\theta}{\lambda+\mu_F(\theta)}N_F,$$

$$(25)\qquad N_T = \frac{\lambda\theta+\mu_F(\theta)}{\lambda+\mu_F(\theta)}N_F.$$

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 N_T is higher in economies with better production technologies, lower intermediation costs τ, 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.

IV. Integration of Walrasian Markets

IV.A. Assumptions

In the rest of this paper, we assume that the island described in Section II, 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 islands 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 measure of Southern farmers, N_F, is (infinitely) small compared with the measure 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 II, 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.[16]

IV.B. Equilibrium Conditions

Because the Northern island is large compared with 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

16. 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.

farmers will immediately specialize in coffee production, which will raise the indirect utility of 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.[17]

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

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

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

Equations 26 and 27 are just the counterparts of 17 and 20 with $v\left(p^W\right) > v(p)$. 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.[18]

IV.C. 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.

17. 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.

18. It is worth pointing out that the simple dynamics after W-integration hinge heavily on the fact that the Northern island is large compared with 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, and θ^* would slowly (and interdependently) vary over time. As we later discuss, our main results about the welfare consequences of W-integration would, however, remain unchanged.

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 GDP growth along the transition path toward the new steady-state equilibrium.[19] 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 nonincreasing in the level of intermediation, then ceteris paribus, islands with lower levels of intermediation always grow faster after W-integration (see Appendix).[20] In this situation, trade integration tends to lead to convergence across countries.

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

IV.D. 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 a standard Ricardian model.

19. 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.

20. This condition is fairly weak. It is satisfied, for instance, for all CES matching functions: $m\left(u_F, u_T\right) \equiv \left[\left(A_F u_F\right)^{\frac{\sigma-1}{\sigma}} + \left(A_T u_T\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$, with $0 \leq \sigma \leq 1$, where the restriction, $0 \leq \sigma \leq 1$, is necessary for the Inada conditions to hold.

It is intuitively clear why the increased matching rate and lower traders' margins 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 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

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

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 the Bellman equations 2 and 4 and the free entry condition 10, we also know that

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

Thus we can rearrange the social welfare function as

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

Since $u_F(t)$ is predetermined at date t, Equation 29 implies that 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:

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

where

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

As explained above, W-integration raises the surplus from trading, as captured by the utility term $v\left[p(t)\right]$. 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 with a standard Ricardian model, in which $\tau = 0$ and so $\theta(t) = +\infty$, 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.[21]

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 islands; (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).

21. Note that in line with 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. While this distinction is immaterial for the qualitative results derived in this section, it turns out to be important when analyzing the consequences of M-integration. Note also that while our magnification effect implictly refers to changes in the social welfare function, a similar effect would arise if we were to consider compensating variations instead; details are available upon request.

V. Integration of Matching Markets

V.A. 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 that the welfare implications of this type of integration are much more nuanced. 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 $p^W = a^*_C/a^*_S$.[22]

As before, we continue to assume that islands differ in their intermediation costs and in the primitive bargaining power of traders. 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 $\bar{\beta} > \beta$.[23]

Throughout this section, we do not take a stance on the precise source of asymmetry of bargaining power. In the next section, we demonstrate that the difference between the size of Northern and Southern "trading companies" can provide a simple and natural micro-foundation for the difference in their primitive bargaining power. In this extension larger trading companies will be associated with higher primitive bargaining power. For this reason, we find it natural to focus on the case in which, if cross-country bargaining power asymmetries exist, they are

22. The fact that the relative price p^W is common across countries is not important for the results that follow.

23. 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 briefly show, however, that Southern traders will never intermediate trade in the North in equilibrium.

associated with Northern agents being relatively more powerful negotiators.[24]

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 toward 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).

Finally, note that the heterogeneity between traders from the two islands forces us to consider 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 should efficiently dissolve. To introduce this possibility formally, we assume that after matches are created, but before bargaining takes place, farmers can break their matches with traders from island i.

V.B. Equilibrium Conditions

We first study how M-integration affects the mix of traders operating in each island. Relative to the Northern traders searching in a given island, Southern traders searching in the same island incur a higher intermediation cost per period and, when finding a match, they have relatively lower bargaining

24. The large literature emanating from the seminal work of Rubinstein (1982), has uncovered other potential determinants of 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. See, for instance, Rubinstein (1982); Roth (1985), and Roth and Rothblum (1982). These alternative explanations also suggest that Northern agents are likely to be relatively more powerful negotiators.

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. Putting all the previous pieces together, we have that Northern traders will necessarily be more profitable (i.e., attain higher welfare levels) than Southern traders under random matching; see Appendix for details. Appealing to free entry, we then obtain the following lemma.

LEMMA 1. If M-integration occurs at some unexpected date t_0, then with probability 1, 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. When M-integration occurs, we know that there is a positive measure of matched pairs composed of a Southern trader and a Southern farmer. As argued above, as long as the joint value of this pair exceeds the new value of an unmatched farmer, these pairs will not dissolve. Whether this condition holds depends on the features of the new equilibrium, which we now describe.

Because 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 Northern traders, (iii) unmatched Northern traders, (iv) matched Northern traders, (v) Southern farmers matched with Southern traders, and (vi) matched Southern traders. We denote by V_F^U, $V_{F^N}^M$, $V_{T^N}^U$, $V_{T^N}^M$, $V_{F^S}^M$, 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:

$$rV_F^U = \mu_F\left(\theta^N\right)\left(V_{F^N}^M - V_F^U\right) + \dot{V}_F^U, \tag{30}$$

$$rV^M_{F^N} = \left(1 - \alpha^N\right) v(p^W) + \lambda \left(V^U_F - V^M_{F^N}\right) + \dot{V}^M_{F^N}, \tag{31}$$

$$rV^U_{T^N} = -\tau^* + \mu_T\left(\theta^N\right)\left(V^M_{T^N} - V^U_{T^N}\right) + \dot{V}^U_{T^N}, \tag{32}$$

$$rV^M_{T^N} = \alpha^N v(p^W) - \tau^* + \lambda \left(V^U_{T^N} - V^M_{T^N}\right) + \dot{V}^M_{T^N}, \tag{33}$$

$$rV^M_{F^S} = \left(1 - \alpha^S\right) v(p^W) + \lambda \left(V^U_F - V^M_{F^S}\right) + \dot{V}^M_{F^S}, \tag{34}$$

$$rV^M_{T^S} = \alpha^S v(p^W) - \tau - \lambda V^M_{T^S} + \dot{V}^M_{T^S}, \tag{35}$$

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

$$V^U_{T^N} = \dot{V}^U_{T^N} = 0.$$

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

$$\alpha^N = \bar{\beta} - \frac{\left(1 - \bar{\beta}\right)\left(\theta^N - 1\right)\tau^*}{v\left(p^W\right)}, \tag{36}$$

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

These two expressions are just the counterpart of Equations 26 and 27 with $\tau^* < \tau$ and $\overline{\beta} > \beta$. Compared with 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 III and IV: 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 margins 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.[25] 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, 37 and 39, we can simplify this condition to

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

25. Like in Section IV, the absence of dynamics in intermediation levels and traders' margins hinges on the fact that North is large compared with South, which pins down the relative price of coffee in the Walrasian markets.

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, that is, if $v\left(p^W\right)$ is high or τ is low.

V.C. *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.[26] Like in Section IV, 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 IV, 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, the lower is the level of intermediation in the South, the faster will output grow in that island after M-integration.

We 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 he or she 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 one hand, the higher level of intermediation θ^N under M-integration tends to improve the Southern farmers' terms of trade compared with W-integration, that is, 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

26. 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, that is, a decrease in the relative price of coffee, which would also raise the level of intermediation in the North.

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 $\tau \rightarrow \tau^*$ 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 Southern traders' margins 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 1 in Equation 38, which tends to worsen Southern farmers' outside option 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.[27]

V.D. 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

27. 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, $\tau \rightarrow \tau^*$, then we should observe that $\alpha^N > \alpha^S$. By contrast, if their differences only come from their intermediation technology, $\beta \rightarrow \bar{\beta}$, then we should have $\alpha^N < \alpha^S$.

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

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

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, $\Delta V_{T^S}^M < 0$. 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 $V_{F^S}^M$ in Equation 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, whereas the converse is true when this outside option goes down. The likelihood of each of these two scenarios will be studied in more detail shortly.[28]

Up to this point, we have shown that there cannot be any Pareto gains or losses from M-integration.[29] This leaves open, however, the possibility of aggregate losses from trade in the Southern island. To investigate this question formally, let us come back to the social welfare function introduced in Section IV.D. At

28. 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 $V_{F^S}^M + V_{T^S}^M - V_F^U = \left[v\left(p^W\right) - \tau - rV_F^U\right]/(r+\lambda) < 0$, which requires V_F^U going up. In this case, unmatched and matched Southern farmers are again better off, whereas Southern traders are worse off.

29. 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.

any date t before M-integration and after W-integration, we know that

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

Since $v\left(p^W\right)$ is not affected by M-integration and $u_F(t)$ is predetermined at date t, the previous expression implies that changes in social welfare caused by M-integration, ΔW, must reflect changes in the expected lifetime utility of unmatched farmers, ΔV_F^U. Given our earlier discussion of the relationship between V_F^U, $V_{T^S}^M$, and α^S, this further implies the Southern traders' terms of trade, α^S, is a sufficient statistic for welfare analysis in the South.[30] In particular, there will be aggregate losses from M-integration in the South, $\Delta W < 0$, if and only if $\alpha^S > \alpha^W$.[31]

Using Equations 36, 37, and 39 as well as their counterparts under W-integration, we can compute explicitly the change in the expected lifetime utility of unmatched farmers caused by M-integration as

$$\Delta V_F^U = \frac{\theta^N \tau^*(1-\bar{\beta})}{r\bar{\beta}} - \frac{\theta^W \tau(1-\beta)}{r\beta}. \tag{44}$$

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 $\beta \to \bar{\beta}$. Second, we turn to the polar case in which intermediation costs are similar across countries, $\tau \to \tau^*$, 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

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

31. This observation would play an important role in the design of optimal policy. 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.

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 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's (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 that M-integration always induces output growth compared with W-integration.

What explains these results? The source of these potentially perverse welfare results is *not* rent-shifting between the two islands.[32] 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

32. 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.

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.

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, that is, 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. Because farmers are all of measure 0, 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 a 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 islands; (ii) always creates winners and losers; and (iii) may decrease aggregate welfare.

VI. EXTENSIONS

Our model of intermediation in trade is special along several dimensions. A natural concern is the robustness of our main results to various modifications of some of our key assumptions. We tackle this issue in this section. To save on space, we focus on sketching alternative environments and summarizing their main implications. A detailed analysis of our three main extensions can be found in our Online Addendum.

VI.A. Large Northern Traders

So far, our analysis has abstracted from any issues related to the size of traders because we have treated both Southern and Northern traders as infinitesimally small. In practice, Northern intermediaries operating in developing countries often differ from their local counterparts by the scale of their operations. This is the case, for example, in the Ugandan coffee industry, in which intermediation is dominated by a few large European buyers. In this final extension, we introduce "large" Northern traders and investigate their implications for the consequences of M-integration.[33]

We formalize the notion of "large" Northern traders by assuming that there is an exogenously given number n of Northern trading companies operating in the South each consisting of an endogenous measure, $x > 0$, of traders.[34] Under M-integration, the matching between each individual member of the trading company and Southern farmers is as described in Section V. Bargaining, however, now proceeds under the common knowledge that if a farmer refuses to trade with a given member of a trading company, other members of that trading company will stop intermediating on her behalf until she has been matched with a Southern trader or another Northern trading company.[35] Hence, the Nash bargaining consumption levels of a Southern farmer–Northern trader match with good i, $(C_{F_i}, S_{F_i}, C_{T_i}, S_{T_i})$, now solves

$$\max_{C_{F_i}, S_{F_i}, C_{T_i}, S_{T_i}} \left(V^M_{T^N_i} - V^U_{T^N}\right)^{\overline{\beta}} \left(V^M_{F^N_i} - \underline{V}^U_F\right)^{1-\overline{\beta}}$$
$$\text{s.t.} \qquad pC_{F_i} + S_{F_i} + pC_{T_i} + S_{T_i} \leq (p/a_C)\cdot \mathcal{I}_C + (1/a_S)\left(1 - \mathcal{I}_C\right),$$

33. The characteristics of Northern traders have, of course, no implications for the consequences of W-integration.

34. For simplicity, we focus on symmetric equilibria in which x is constant across all Northern trading companies.

35. We are thus assuming that matching has a "cleansing" effect on a farmer's past behavior. Thus once a punished farmer has been matched with another trader, either from the North or the South, he can no longer be recognized by the Northern trading company that had previously ostracized him. While this assumption is admittedly ad hoc, it considerably simplifies the analysis. Since newly matched farmers can no longer be punished, traders' margins are independent of farmers' history.

where $\underline{V}_F^U$ is the expected lifetime utility of an unmatched Southern farmer *if* she were to refuse to trade. Compared with Section V, the key difference lies in the fact that $\underline{V}_F^U$ is now different from the expected lifetime utility, V_F^U, of an unmatched farmer who has never refused to trade (or has since been matched with another trader). Formally, these two value functions satisfy the following Bellman equations:

$$rV_F^U = \mu_F\left(\theta^N\right)\left[\phi\left(V_{F^N}^M - V_F^U\right) + (1-\phi)\left(V_{F^S}^M - V_F^U\right)\right] + \dot{V}_F^U,$$

$$r\underline{V}_F^U = \mu_F\left(\theta^N\right)\left[\left(\frac{n-1}{n}\right)\phi\left(V_{F^N}^M - \underline{V}_F^U\right) + (1-\phi)\left(V_{F^S}^M - \underline{V}_F^U\right)\right] + \dot{\underline{V}}_F^U$$

where $\phi \equiv u_{T^N}/\left[u_{T^N} + u_{T^S}\right]$ is the share of unmatched Northern traders, and $V_{F^N}^M \equiv \max\left\{V_{F_C^N}^M, V_{F_S^N}^M\right\}$ and $V_{F^S}^M \equiv \max\left\{V_{F_C^S}^M, V_{F_S^S}^M\right\}$ still denote the expected lifetime utilities of Southern farmers matched with Northern and Southern traders, respectively. The rest of our model is as described in Section V, with x being endogenously determined through free entry.

In this environment, one can show the following proposition.

PROPOSITION 4. The equilibrium under M-integration with large Northern traders is isomorphic to an equilibrium under M-integration with infinitesimally small Northern traders with primitive bargaining power

$$\beta^L \equiv \overline{\beta}\frac{r + \mu_F\left(\theta^N\right)}{r + \mu_F\left(\theta^N\right)\left[\overline{\beta} + \left(\frac{n-1}{n}\right)\left(1-\overline{\beta}\right)\right]} > \overline{\beta}.$$

Proposition 4 indicates that the difference between the size of Northern and Southern trading companies provides a simple and natural micro-foundation for the difference in primitive bargaining power between Northern and Southern traders assumed in Section V. Quite naturally, when $n \to +\infty$, we have $x \to 0$ and $\beta^L \to \overline{\beta}$, so we revert back to our original model. Another interesting implication of Proposition 4 is that even in the absence of differences in primitive bargaining power between Northern and Southern traders, $\overline{\beta} = \beta$, M-integration may lead to aggregate welfare losses if Northern traders are large. In this situation, however, welfare losses are not associated with an inefficiently high entry of Northern traders, but rather with the fact that these trading companies are inefficiently large.

VI.B. Endogenous Number of Farmers, Exogenous Number of Traders

In previous sections we have focused on economies with an exogenous number of farmers and an endogenous number of traders. We now discuss the polar case, often emphasized in the early development economics literature (see for instance Bates 1984 and Bauer 2000), in which the number of traders is exogenously given by government regulations, whereas the number of farmers is endogenously determined by their choices between "market" and "nonmarket" activities.

Preferences, technology, matching, and bargaining are as described in Section II. Compared with Section II, we assume that an exogenous measure N_T of the island inhabitants are traders, and for simplicity, that these traders can be connected to Walrasian markets at zero cost, $\tau = 0$. Conversely, we assume that there is a large pool of potential farmers who can decide at any point in time to become active or inactive. As in Section II, active farmers get zero utility per period when unmatched, but stand to obtain some remuneration when matched with a trader. By contrast, inactive farmers are now involved in a nonmarket activity that generates a constant expected lifetime utility, $V_F^* > 0$, for example, subsistence agriculture. We assume that the pool of potential traders is large enough to ensure that the measure of farmers operating on the island, N_F, is not constrained by population size and that some agents are always involved in subsistence agriculture. Hence, in equilibrium, N_F is endogenously pinned down by the farmers' indifference condition.

In this new environment, the equilibrium conditions 1–9 and 11–12 are unchanged (but for the fact that $\tau = 0$). The only difference between our original model and the present one comes from the counterpart of Equation 10, which now applies to the expected lifetime utility of unmatched farmer rather than the expected lifetime utility of unmatched traders:

$$V_F^U = V_F^*.$$

Using the previous equilibrium conditions and the same strategy as in Sections IV and V, one can establish the following proposition.

PROPOSITION 5. Suppose that there is an endogenous number of farmers and an exogenous number of traders. Then W-integration worsens the farmers' terms of trade, improves the traders' terms of trade, and makes all agents (weakly) better off. By contrast, M-integration always creates winners and losers and may decrease aggregate welfare.

According to Proposition 5, the welfare impact of W- and M-integration in environments with an endogenous number of farmers and an exogenous number of traders is qualitatively similar to its impact in our original model. The main difference between the predictions of the two models comes from the distributional implications of W-integration. In this new model, W-integration triggers the entry of new farmers into "market activities," which reduces the level of intermediation, and in turn increases the traders' margins.

A more subtle difference between the two models concerns the welfare impact of M-integration. Although aggregate welfare losses under M-integration are possible in both models, these losses in our original model reflects the trade-off between higher levels of intermediation, which raise the expected lifetime utility of unmatched farmers and hence aggregate welfare, and lower farmers' margins, which decrease them. By contrast, in the present version of the model, the losses are associated with the dissipation of traders' rents by the entry of a set of traders, the Northern ones, with higher bargaining power.[36] As a result of this distinct intuitions, the condition $\bar{\beta} > \beta$ is sufficient to generate welfare losses in the South, regardless of the value of the matching function elasticity ε (see online Addendum for details).

VI.C. Occupational Choices

Both our original model and the previous two extensions rule out the possibility of agents endogenously choosing to become traders or farmers. This assumption describes fairly well, for instance, situations in which trading activities are only undertaken by a particular ethnic group. Such situations are frequent in the context of developing countries; see Landa (1981) or Rauch (2001). From a theoretical standpoint, however, one may be concerned that the lack of occupational choices in our model is crucial for many of our results. With that in mind, we turn to a variation of our original model that allows for endogenous occupational decisions.

36. A related treatment of the rent-shifting effects of M-integration can be found in Antràs and Costinot (2010b).

Compared with Section II, we now assume that the island is inhabited by a measure L of agents who, at any point in time, can either become farmers or traders. For simplicity, we also assume that traders can be connected to Walrasian markets at zero cost, $\tau = 0$, as in our previous extension. The rest of our model is unchanged. In terms of equilibrium conditions, the key difference between the model described in Section II and the present one is that the expected lifetime utility of unmatched farmers and traders must now satisfy:

$$V_T^U \geq V_F^U, \text{ if } N_T > 0,$$

$$V_F^U \geq V_T^U, \text{ if } N_F > 0.$$

This is the counterpart of the free entry condition, Equation (10), in our original model. In any non-degenerate equilibrium with both types of agents being active, the previous conditions, of course, imply that agents must be indifferent between becoming a farmer or a trader: $V_T^U = V_F^U$.

In such an economy, the impact of W- and M-integration can be summarized as follows.

PROPOSITION 6. Suppose that all agents can become farmers or traders at any point in time. Then W-integration does not affect the farmers' and traders' terms of trade and makes all agents (weakly) better off. By contrast, M-integration may create winners and losers and decrease aggregate welfare.

Not surprisingly, the introduction of endogenous occupational decisions does affect the distributional consequences of W-integration. In this new model, W-integration no longer affects the level intermediation, which is entirely pinned down by the primitive bargaining power β of traders. Because agents must be indifferent between farming and trading activities both before and after the W-integration, their share of the surplus must remain unchanged.[37] Perhaps more interestingly, Proposition 6 demonstrates that allowing agents to switch freely between occupations does not rule out the possibility of aggregate welfare losses under

37. It is also worth pointing out that since the intermediation level is not affected by W-integration, there is no "magnification effect." In our original model, W-integration leads more traders to leave their hammocks, which leads to positive growth and welfare effects. Here no additional resources are being pulled into coffee and sugar production, hence the lack of magnification effect.

M-integration. Like in Section V, such losses may still occur if the primitive bargaining power of Southern traders, β, the primitive bargaining power of Northern traders, $\overline{\beta}$, and the matching elasticity, ε, are such that $\overline{\beta} > \beta > \varepsilon$. The basic idea is the following. If $\overline{\beta}$ is close enough to ε, M-integration must reduce the expected lifetime utility of unmatched Southern traders *by more* than it reduces the expected lifetime utility of unmatched Southern farmers because the negative effect of the increase in the level of intermediation (or negative congestion externality) associated with the entry of Northern traders necessarily outweighs the positive effect of the decrease in the expected lifetime utility of unmatched Southern farmers. Accordingly, even when Southern agents can freely choose their occupation, there exist circumstances such that M-integration: (i) leads all agents to become farmers (and thus Lemma 1 continues to apply); and (ii) lowers both the expected lifetime utility of unmatched farmers and aggregate welfare. An important difference relative to our benchmark model in Section II is that the condition $\overline{\beta} > \beta > \varepsilon$ is no longer sufficient to ensure aggregate losses from M-integration in South.

VI.D. Other Extensions

In this final subsection, we briefly outline three alternative variants of our model. The first two extensions attempt to capture the fact that the relocation of resources to the comparative advantage sector may be slower than in our original Ricardian-style framework. The final extension illustrates how introducing heterogeneity in farmer productivity generates positive predictions from our model that seem in line with available empirical evidence.

In our original model we have assumed that farmers can costlessly switch from producing sugar in one period (or instant) to producing coffee in the next. This facilitates the comparison between our original model and a standard Ricardian one, but it raises the issue of whether our results are sensitive to this assumption. A particularly simple way to address this concern is to consider the extreme case in which farmers decide at some initial date which good to grow and, after that, are unable to switch to a different crop. Although this is obviously as unrealistic as the situation considered in our benchmark model, it will allow us to illustrate the sensitivity of our results to farmers' switching costs in the most straightforward manner. It is easy to check that the steady state of this alternative economy is identical to that of our original model and that the effects of M-integration are also identical (provided again that M-integration does not alter the Walrasian relative price). Less trivially, one can also verify that W-integration continues to generate aggregate welfare gains that are magnified relative to an analogous economy with zero intermediation costs. Such an analogous economy, however, is no longer Ricardian, but rather resembles an endowment economy. Accordingly, W-integration generates richer distributional effects and may no longer make all the agents in the economy (weakly) better off.

Another way to capture the imperfect reallocation of resources to the comparative advantage sector is to assume that traders, because of sector-specific skills or knowledge, can intermediate trade for only one type of farmers in the economy. While the steady state of this alternative economy is again identical to that in our original model, the transitional dynamics are quite distinct. In particular, matched Southern farmers growing sugar prior to W-integration, now need to wait for a match with a coffee trader to start growing and selling coffee, and as a result, they may be worse off under W-integration. Despite these differences, W-integration continues to generate aggregate welfare gains, whereas the effects of M-integration are identical to those described in Section V.

Finally, our original model may also accommodate productivity heterogeneity across farmers. Consider, for instance, an environment with two types of farmers: an exogenous share η of farmers has access to the same technologies as in our original model, while the remaining share $1 - \eta$ has access to technologies that are ω times higher. Furthermore, suppose that farmers may now access Walrasian markets, though only after incurring a cost $\tau^F > \tau$. It can be shown that whenever ω and τ^F are large, there exists an equilibrium in which more productive farmers bypass intermediaries and directly market their own goods, and less productive farmers continue to wait for traders at their farms. This simple sorting pattern is consistent with available empirical evidence on the use of intermediaries (see Ahn, Khandelwal, and Wei 2009; Blum, Claro, and Horstmann 2009; Akerman 2010; or Bernard et al. 2010). In this variant of our model W-integration again generates magnified gains from trade, while M-integration reduces Southern welfare under the same conditions as in Section V. Interestingly, this extension of our original framework also predicts that within-farmer lifetime expected income inequality is reduced by W-integration, but increased by M-integration whenever the latter is welfare reducing.

VII. 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. The main lesson from our analysis is that different types of economic integration interact with the entry of intermediaries in distinct ways. When economic integration leads to the convergence of goods prices across countries, as is the case under W-integration, intermediaries always magnify the standard gains from trade. By contrast, when economic integration leads to the entry of foreign intermediaries in local markets, as is the case under M-integration, their presence can be associated with a country—and the world as a whole—incurring welfare losses under further economic integration.[38]

As mentioned in the introduction, although our model is admittedly stylized, we believe that the general idea of using dynamic bargaining and matching techniques to model international transactions could be pursued in several fruitful directions. The previous section has explored some of them. There are many others. 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. Throughout this paper we have also assumed that farmers are risk neutral. Assuming that farmers are risk averse could

38. In the working paper version of this paper, Antràs and Costinot (2010a), we have further shown how these losses can be circumvented through price controls, tax instruments, and market design. More precisely, 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 of Southern traders; and (ii) Southern farmers are assisted in directing their search toward Northern or Southern traders.

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. Last but not least, one could investigate the implication of directed search in this environment. As discussed in Antràs and Costinot (2010a), allowing farmers to direct their search toward particular traders can alleviate the welfare loss associated with the integration of matching markets. These are exciting avenues for future research, some of them already under way; see Dasgupta and Mondria (2010) and Fernández-Blanco (2010).

APPENDIX

A. Section III.C.

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 here.

CLAIM 1. At any point in time, the solution of the Nash bargaining problem satisfies Equations 5–7.

Let λ^N denote the Lagrange multiplier associated with the Nash bargaining problem. Using Equations 1–4, it is clear that the first-order conditions associated with Nash bargaining are:

$$\beta\left(V_{T_i}^M - V_T^U\right)^{\beta-1}\left(V_{F_i}^M - V_F^U\right)^{1-\beta} v_C(C_{T_i}, S_{T_i}) = \lambda^N p,$$

$$(1-\beta)\left(V_{T_i}^M - V_T^U\right)^{\beta}\left(V_{F_i}^M - V_F^U\right)^{-\beta} v_C(C_{F_i}, S_{F_i}) = \lambda^N p,$$

$$\beta\left(V_{T_i}^M - V_T^U\right)^{\beta-1}\left(V_{F_i}^M - V_F^U\right)^{1-\beta} v_S(C_{T_i}, S_{T_i}) = \lambda^N,$$

$$(1-\beta)\left(V_{T_i}^M - V_T^U\right)^{\beta}\left(V_{F_i}^M - V_F^U\right)^{-\beta} v_S(C_{F_i}, S_{F_i}) = \lambda^N,$$

as well as constraint 7. From these equations, we immediately obtain (6), which ensures by concavity and homogeneity of degree 1 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. ■

CLAIM 2. At any point in time, α satisfies Equation 17.

Because v is homogeneous of degree 1, we know that

$$v(C_F, S_F) = (1-\alpha)\, v(p),$$
$$v(C_T, S_T) = \alpha v(p).$$

Combining the two previous expressions with Equations 1–4, we obtain

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

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

Since Equation 5 holds at all points in time, we also know that

$$(1-\beta)\left(V_T^M - V_T^U\right) = \beta\left(V_F^M - V_F^U\right),$$
$$(1-\beta)\left(\dot{V}_T^M - \dot{V}_T^U\right) = \beta\left(\dot{V}_F^M - \dot{V}_F^U\right).$$

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

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

Equation 17 derives from the previous expression and Equations 10 and 18. ■

CLAIM 3. At any point in time, θ is the unique solution of Equation 20, that is,

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

It is immediate that $\kappa(\theta)$ is continuous and 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. ■

CLAIM 4. In steady state, N_T is strictly increasing in θ.

From Equation 25, we have

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

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

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

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 ■

B. Section IV.C

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 non-increasing 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. Because 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. To establish that W-integration 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 $d\ln N/d\ln v$ is decreasing in θ, which we now demonstrate. In steady state, we know by Equation 23 that $N(v) = (\mu_F(\theta)N_F)/[\lambda + \mu_F(\theta)]$. This implies

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

which can be rearranged as

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

Using Equation 20, it is easy to check that

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

Because $\varepsilon(\theta)$ and $\mu_T(\theta)$ are nonincreasing 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

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

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

C. Section IV.D

In the main text we have argued that if islands are completely specialized under W-integration, then: (i) the values of θ^W and $(\theta^W)^*$ 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 III.C., the value function of matched traders in the South under W-integration must satisfy

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

Combining the two previous expressions, we obtain

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

where

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

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 $g\left(p^W\right) \leq g\left(p\right)$ by Step 1.

The rest of our proof proceeds by contradiction. Suppose that there exists $t_1 \geq t_0$ such that $\theta^W < \theta$. Thus there exists $t_1 \geq t_0$ such that $z^W\left(t_1\right) < z$ with z such that $0 = f\left(z\right) + g\left(p\right)$. Since f is increasing in z^W and $g\left(p^W\right) \leq g\left(p\right)$, we get $\dot{z}^W\left(t_1\right) = f\left[z^W\left(t_1\right)\right] + g\left[p^W\left(t_1\right)\right] \leq f\left[z^W\left(t_1\right)\right] + g\left(p\right) < 0$ at t_1. This implies $\dot{z}^W\left(t\right) < f\left[z^W\left(t_1\right)\right] + g\left(p\right) < 0$ for all $t > t_1$. (To see this note that if there was a date $t_2 > t_1$ such that $\dot{z}^W \geq f\left[z^W\left(t_1\right)\right] + g\left(p\right)$, then there would also exist, by continuity, a date $t_c \in \left(t_1, t_2\right)$ such that $\dot{z}^W\left(t_c\right) = f\left[z^W\left(t_1\right)\right] + g\left(p\right)$ and $\dot{z}\left(t\right) < 0$ for all $t \in \left(t_1, t_c\right)$. By Equation 50, we would therefore have $f\left[z^W(t_c)\right] + g\left[p^W\left(t_c\right)\right] = f\left[z^W\left(t_1\right)\right] + g\left(p\right)$. Since f is increasing in z^W and $g\left[p^W\left(t_c\right)\right] \leq g\left(p\right)$, this implies $z^W\left(t_c\right) > z^W\left(t_1\right)$, which contradicts $\dot{z}\left(t\right) < 0$ for all $t \in \left(t_1, t_c\right)$.) This further implies $z^W\left(t\right) \to -\infty$, 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 $\mu_T\left(\theta^W\right) \leq \mu_T\left(\theta\right)$ 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

$$rV_F^U = \mu_F\left(\theta^W\right)\left(V_F^M - V_F^U\right) + \dot{V}_F^U,$$

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

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, 10 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 III.C., 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

$$\begin{aligned} rV_F^U = \mu_F\left(\theta^N\right)\Bigg\{&\phi \max_{\delta^N \in \{0,1\}} \left[\left(1-\delta^N\right)\left(V^M_{F^N} - V_F^U\right)\right] \\ &+ (1-\phi) \max_{\delta^S \in \{0,1\}} \left[\left(1-\delta^S\right)\left(V^M_{F^S} - V_F^U\right)\right]\Bigg\} + \dot{V}_F^U, \end{aligned} \tag{53}$$

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

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

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

where θ^N 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 53 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, $\delta^i = 1$ if Southern farmers break their matches with traders from island i and $\delta^i = 0$ if they don't. It should be clear that all functions in Equations 53–56, including θ^N, 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

$$(57)\qquad V^U_{T^i} = \dot{V}^U_{T^i} = 0,$$

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 $\delta^S = 0$ and $\delta^N = 1$. By Equation 53, we must therefore have $V^M_{F^S} - V^U_F \geq 0$ and $V^M_{F^N} - V^U_F \leq 0$. Combining this observation with Nash Bargaining, we further get $V^M_{F^S} + V^M_{T^S} \geq V^U_F + V^U_{T^S}$ 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

$$(58)\qquad V^M_{F^S} + V^M_{T^S} \geq V^M_{F^N} + V^M_{T^N}.$$

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. Thus we must have $\delta^i = 0$ for $i = N, S$. Otherwise traders form island i would be better off staying in their hammocks by Equations 55. Accordingly, we can rearrange Equations 53 and 55 as

$$(59)\qquad rV_F^U = \mu_F\left(\theta^N\right)\left[\phi\left(V_{F^N}^M - V_F^U\right) + (1-\phi)\left(V_{F^S}^M - V_F^U\right)\right] + \dot V_F^U.$$

and

$$(60)\qquad rV_{T^i}^U = -\tau^i + \mu_T\left(\theta^N\right)\left(V_{T^i}^M - V_{T^i}^U\right) + \dot V_{T^i}^U.$$

Combining Equations 56 and 60, we obtain

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

Similarly, combining Equations 54 and 59, we get

$$\begin{aligned}(r+\lambda)\left(V_{F^i}^M - V_F^U\right) = &\left(1-\alpha^i\right) v\left(p^W\right) - \mu_F\left(\theta^N\right)\left[\phi\left(V_{F^N}^M - V_F^U\right)\right.\\ (62)\qquad &\left. + (1-\phi)\left(V_{F^S}^M - V_F^U\right)\right] + \dot V_{F^i}^M - \dot V_F^U.\end{aligned}$$

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

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

Using the previous expression and Equation 57, we obtain

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

Equations 57 and 60 further imply

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

Combining Equations 63 and 64, we get

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

where $\bar{\tau} \equiv \phi\tau^* + (1-\phi)\,\tau$. Since $\bar{\beta} > \beta$, $\tau^* < \tau$, $v\left(p^W\right) - \tau^* > 0$, and $v\left(p^W\right) - \tau > 0$, 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. Thus we must have $\delta^S = 0$. Following the same logic as in Case 1 for Southern traders only, we get

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

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

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

Using our Nash bargaining conditions with Equations 66 and 67, we obtain

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

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

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

Since Southern traders are searching for Northern farmers, we know that $v\left(p^W\right) - \tau - \frac{(1-\beta)}{\beta}\theta^N\tau > 0$. Combining this observation with Equations 65 and 68 and the fact that $\bar{\beta} > \beta$ and $\tau^* < \tau$, with at least one strict inequality, 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 same logic as in case 2 implies

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

and

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

which again implies $\left[\alpha^N v\left(p^W\right) - \tau^*\right] - \left[\alpha^S v\left(p^W\right) - \tau\right] > 0$. This completes the proof of Step 2.

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

$$V^U_{T^S}(t) = \boldsymbol{E}\left[\int_t^{+\infty} e^{-rt'}\left[v\left[C_{T^S}(t'), S_{T^S}(t')\right] - \mathcal{I}_{A^S}(t')\,\tau\right] dt'\right].$$

Let $\mathcal{I}_{M^S}(t')$ denote the indicator variable that is equal to 1 if the trader from the Southern island is matched at date t' and 0 otherwise. With this notation, we can rearrange the previous expression as

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

Now consider an arbitrary trader from the Northern island. Suppose that this trader follows the same strategy as the trader from the Southern island, that is, he would choose to be active or inactive at the same dates (conditional on the same history). Let $\mathcal{I}_{M^N}(t')$ denote the indicator variable that is equal to 1 if the trader from the Northern island is matched at date t' and 0 otherwise. By Step 1, we know that $\delta^N \le \delta^S$, which implies $\Pr\{\mathcal{I}_{M^N}(t') = 1\} \ge \Pr\{\mathcal{I}_{M^S}(t') = 1\}$ for all t'. By Step 2, we also know that $\alpha^N v\left(p^W\right) - \tau^* > \alpha^S v\left(p^W\right) - \tau$. Thus, if we denote by $\boldsymbol{Z}^i(t') \equiv \mathcal{I}_{M^i}(t')\,\alpha^i v\left(p^W\right) - \tau^i$, $\boldsymbol{Z}^N(t')$ strictly first-order stochastically dominates $\boldsymbol{Z}^S(t')$ 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 $E[\mathcal{I}_{A^S}(t') Z^N(t')] > E[\mathcal{I}_{A^S}(t') Z^S(t')]$. 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. ■

D. Section V.C

In the main text, we have argued that: (i) if $\tau > \tau^*$ and $\bar{\beta} = \beta$, then $\alpha^N < \alpha^W$; and (ii) if $\tau = \tau^*$ and $\bar{\beta} > \beta$, 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:

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

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

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, $\alpha^N > \alpha^W$). ■

E. Section V.D

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

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

Because $u_F(t)$ 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

$$V_F^U = \frac{\tau\theta(1-\beta)}{r\beta}.$$

Differentiating the previous expression, we obtain

$$\text{(71)} \qquad \frac{dV_F^U(t)}{d\beta} = \frac{\tau\theta}{r\beta^2}\left[(1-\beta)\frac{d\ln\theta}{d\ln\beta} - 1\right].$$

By directly differentiating Equation 20, it is easy to check that

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

where $(r+\lambda)(1-\varepsilon)+(1-\beta)\mu_F(\theta) > 0$ since θ is increasing in β. Combining Equations 71 and 72, we obtain

$$\text{(73)} \qquad \frac{dV_F^U(t)}{d\beta} = \frac{\tau\theta}{r\beta^2}\left[\frac{(r+\lambda)(\varepsilon-\beta)}{(r+\lambda)(1-\varepsilon)+(1-\beta)\mu_F(\theta)}\right].$$

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

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