Department of Economics

Behind the Scenes of Globalization: Strategic Trade Policy, Firm Decisions and Worker Expectations

Itai Agur

Thesis submitted for assessment with a view to obtaining the degree of
Doctor of Economics of the European University Institute

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Introduction to the thesis

Globalization is a dragon with one head but many bodies. The word globalization conjures up an image. But behind that image lie distinct processes that take place at the same time. Governments decide to what extent and in what way to open up their economy to global influences. They interact and negotiate with other governments. Firms decide if and how they want to enter foreign markets. Or how best to respond to foreign entrants on their domestic market. Consumers change their choice of products. Workers flow from declining to growing sectors.

This thesis aims at analyzing a few of the dragon's bodies, one at a time. The first chapter considers government negotiations. It tries to understand what is behind the observed change in the way that trade liberalization is negotiated. In the run-up to the Second World War governments around the world implemented highly protectionary trade policies. Tariffs and quotas on imported goods soared. World trade flows fell sharply, deepening the Great Depression. After the War the governments of the United States and several European countries were resolved to unravel the protectionist net. The General Agreement on Tariffs and Trade (GATT) was born: a forum for reducing international barriers to trade through multilateral negotiation rounds. The GATT proved to be a highly successful institution, shlashing tariffs and quotas during decades, while its membership kept on growing.

The US government played a key role in the multilateral process, continuously devoting its efforts and influence to avert its stagnation. One of the most successful rounds in the history of the multilateral process was even named after the US president who pushed for its inception: the Kennedy Round. To underline its commitment to multilateralism, the US government steered clear of signing any trade agreements outside of GATT. Until the 1980s. During the Reagan and Bush sr. Administrations a shift in thinking about trade policy took place. Suddenly, the US government began to actively seek selective bilateral trade partnerships outside of the multilateral system. This trend continued in the 1990s. But not only did the US government look for bilateral trade partners, all around the globe so-called Regional

Trade Agreements sprang up. The number of such trade agreements tripled between 1980 and 1995, and since 1995 has more than tripled again, approaching 200. This phenomenon has been dubbed "regionalism". Meanwhile, the multilateral process still managed to conclude the Uruguay Round in 1992, after a decade of negotiations. GATT subsequently transformed into the World Trade Organization (WTO). But the WTO has failed to produce a completed round ever since.

Why the shift? Why move away from a successful multilateral process towards regionalism? Why in the 1980s? Chapter I suggests a culprit: the rise of global trade imbalances. In particular, the 1980s witnessed an unprecedented growth of the US trade deficit, especially towards Japan. Such a development can make a government more selective about who to cooperate with. In a bilateral relationship the deficit country has relatively little to gain from lower tariffs on its exports, and relatively much to lose from lowering tariffs on its imports. The reason is its large market power over imported goods, with which it can lower world demand and world prices of its imported goods when applying tariffs. Multilateralism leaves no choice whom to cooperate with. But if the US opts for a regional route, it can choose trade partners towards which its deficit is relatively small, such as the NAFTA partners in the 1980s. As multilateralism slows down, other countries, in turn, step onto the regionalist path themselves.

This simple intuition is formalized using a game and an underlying model. The main result is that when global imbalances pass certain thresholds, multilateralism grinds to a halt and regionalism emerges. Moreover, the modelling allows us to go a step beyond the simple intuition, and analyze the welfare implications of regionalism. In fact, some academics have argued that the WTO should make it harder for countries to sign Regional Trade Agreements. This, they believe, may boost the multilateral process and help achieve world trade liberalization at a faster pace. The model in Chapter I shows, however, that the argument is not so simple. Consider an extreme case in which a law is passed forbidding Regional Trade Agreements. A country that first would have opted for regionalism is now faced with a choice between multilateralism or not cooperating with anyone. When trade imbalances are small enough, the policy prohibiting regionalism can push all countries to cooperate multilaterally. But for sufficiently large trade imbalances, the opposite may come about: partial cooperation is replaced by non-cooperation. As long as trade imbalances are around, therefore, allowing bilateral trade cooperation can be best for world welfare.

But what happens when large trade imbalances are not around anymore? After all, the dollar has fallen sharply in recent times. This makes US exports cheaper, decreasing the trade deficit. China has made first moves towards a more flexible exchange rate policy. If it allows its currency to appreciate against the dollar, then its exports would become more expensive, again helping to reduce the US trade deficit. If indeed we are moving towards a world with smaller trade imbalances, should we consequently also expect to see a world with more multilateralism? The modelling in Chapter I can be adjusted to tackle this question. In particular, one can construct a dynamic game, in which there is more than one period. Such a dynamic game yields an interesting result: even temporary trade imbalances can have a lasting effect on the structure of trade agreements. The intuition is simple. During times of large imbalances some countries sign Regional Trade Agreements. These agreements have the potential to generate rents for the insiders of an agreement over the outsiders (because by cutting tariffs on each other the insiders raise the world prices of their own export goods, at outsiders' expense). Temporary imbalances then trigger lasting regionalism.

Chapter II considers another body of the dragon: firm decisions. In particular, it asks how firms' decisions about entering and exiting markets can explain two empirical regularities. Firstly, empirical work using firm-level data reports that trade liberalization leads to so-called firm selection. That is, when a country cuts its tariffs relatively efficient foreign exporters enter the domestic market. At the same time, the least efficient domestic firms are forced to exit. Overall, the average productivity of firms selling to domestic consumers then rises. Secondly, trade brings a greater variety of products to consumers. Say that initially domestic producers offer a few types of sports shoes to domestic consumers. When barriers to trade are reduced, big producers like Nike, Reebok and Adidas come in and consumers have a wider choice among sports shoes.

Separately, for each of these empirical regularities there exists a seminal theory. But, taken together, they constitute a puzzle. In the main model for firm selection each firm produces only one variety. That is, Nike may be more cost-efficient than a small domestic shoe producer, but both offer only one type of sports shoe. Now, the model predicts that when trade barriers are reduced the total number of firms remaining on the domestic market decreases. Some efficient foreign firms come in, but even more inefficient domestic firms are pushed out. Since each firm produces only one variety, this means that total variety available to domestic consumers drops, contrary to what is observed empirically.

But what if firms can produce more than one variety? Nike produces not only one Nike sports shoe, but many different types: Nike Air, Nike Jordan, etcetera. Chapter II presents a model in which this is the case. Firms differ in productivity *and* choose how many varieties they wish to offer. They choose the number of varieties on the basis of a cost-benefit analysis. On the one hand, each additional variety takes away part of consumers' demand for the firms previous varieties. If Nike markets a new type of sports shoe, its existing types will be bought less. On the other hand, maintaining a brand is costly. For instance, Nike makes advertisements that benefit sales on all of its shoes. Thus, adding more varieties allows the firm to spread its cost.

The model in Chapter II provides an intuitive mechanism to understand how firm selection and rising product variety can take place together. Again, like in the standard model, when barriers to trade are reduced relatively efficient foreign exporters enter the domestic market, and the least efficient domestic firms are pushed out. Again, fewer firms remain in the market in total. However, contrary to the standard model, total variety nonetheless always rises. The reason is that efficient exporters offer more variety than the domestic firms that exit. Thinking about the sports shoes example once more: Nike, Reebok and Adidas enter a market and push out more than three small domestic firms. But Nike, Reebok and Adidas each offer more different varieties of sports shoes than the small domestic firms. As it turns out, the model predicts that this dominates the decrease in the number of firms. Thus, total variety available to domestic consumers increases.

However, does that mean that domestic consumers are always better off with lower trade barriers? They like having more varieties to choose from. But they also like having more different brands to choose from. Overall, the destruction of local brands can sometimes make consumers worse off, despite the increase in variety. Yet, consumers also benefit through an additional channel. The entering foreign firms are more cost-efficient, and therefore have lower prices than the small domestic firms. On the whole, the model predicts that even when consumers loose out through the variety channel, they are more than compensated through the price channel.

Chapter III considers the dragon's body formed by workers. In particular, workers' expectations about wages. The chapter is motivated by survey studies conducted among college and university students in several countries. In these studies students are asked what they expect to earn after graduation, or what they expect the average student in their field earns after graduation. The studies then perform empirical regressions that control for a host of variables, such as gender, educational performance, etcetera. They find that even when controlling for such factors there is a very wide dispersion of wage expectations among students. In fact, even when students are asked about the average wage earned by graduates in their field, they give a wide variety of answers. For instance, take a group of US students. Pick from them the student whose expectation about the average wage is higher than 90% of his fellow students. Also pick the student whose expectation is higher than only 10% of his fellow students. According to the survey studies the wage expectation of the first student will be about twice as high as that of the second.

But not only do wage expectations differ greatly among students within a country. The degree of dispersion differs strongly between countries. Survey studies in several European countries indicate that the dispersion of wage expectations among students in Europe is considerably *larger* than in the US. This is all the more surprising if you consider that the dispersion of actual wages earned is smaller than in the US. Generally, the greater dispersion of wage expectations in Europe is thought to be due to the fact that students there have less acurate information about wages. US students are better informed, through better counselling for example.

But what is the effect of such dispersion in wage expectations on the job market? Can cross-country differences in this dispersion perhaps tell us something about cross-country patterns in unemployment? Could it be a reason to plead for investments to improve the dissemination of information about wages, such as through student counselling? Chapter III develops a model to analyze such questions. Standard models of unemployment assume that everybody who is looking for a job has the same wage expectation. Instead, the model in Chapter III allows for different wage expectations among unemployed searchers.

The main result that the model yields is that the wider the dispersion of wage expectations is, the higher we should expect the overall unemployment to be. That is, if in Europe wage expectations among students are more widely dispersed than in the US, we should expect to observe more unemployed graduates in Europe. Why? The reason is quite intuitive. Imagine you are looking for a job. Every morning when you wake up you receive a phone call from an interested employer. He offers you a wage. If you expect to earn a lot, you are likely to decline an employer who does not offer much. Conversely, if you expect to earn little, even a pretty low wage offer would make you happy, and you accept. So optimists spend a longer time looking for jobs than pessimists. However, for an optimist there is no upper bound on how long he may decide to wait for the offer that he accepts. An extremely pessimistic person, instead, would accept the very next offer made to him. There is a lower bound on the duration of his search. So there is an asymmetry between overestimating wages and underestimating them. This assymetry drives the result that when wage expectations become more dispersed the average time it takes people to find a job increases.

Finally, Chapter III performs a numerical exercise to get an idea about the size of the effect that dispersed wage expectations may have. Using numbers from survey studies conducted among US and German students an upper bound on potential unemployment reduction can be computed. That is, how much can US and German unemployment at most be reduced by better wage information. At most, because the exercise has to assume that everybody in the labor market knows as little about wages as the students that were surveyed. For the US about

1 in 10 unemployed would have a job if information about wages were perfect, the exercise predicts. For Germany with its wider dispersion of expectations this figure approaches 1 in 5. Thus, investing in better information about wages may well have a significant impact on unemployment, especially in Europe.

Part I

The US Trade Deficit, the Decline of the WTO and the Rise of Regionalism

Abstract:

This paper argues that the growing US trade deficit has caused the decline of the WTO and the rise of regional trade agreements. A country in deficit prefers to retain market power against countries with a large surplus. Multilateral cooperation restricts its choice. This notion is formalized in a three-country game in which countries negotiate multilaterally and, if that fails, bilaterally. The multilateral agreement only holds for sufficiently even trade balances. When one country's deficit grows too large, a regionalist equilibrium emerges. That regionalism can last, even when imbalances disappear, as RTA insiders earn rents over outsiders.

Keywords: Regionalism, RTA, Multilateralism, WTO, Trade balance, US trade deficit

JEL Classification: C72, C73, F13, F32

Introduction

Over the past two decades the way countries negotiate trade liberalization has changed remarkably. The multilateral process, responsible for the highly successful post-War liberalization effort, has slowed down, arguably reaching a standstill at the WTO's Doha Round. At the same time, trade agreements outside of the multilateral system have grown at an extraordinary pace. The solid line in Figure 1 depicts the number of Regional Trade Agreements (RTAs) according to WTO data.[1]

[1] This figure includes RTAs on trade in goods (www.wto.org). Note that RTAs are not always regional in nature (i.e: US-Singapore).

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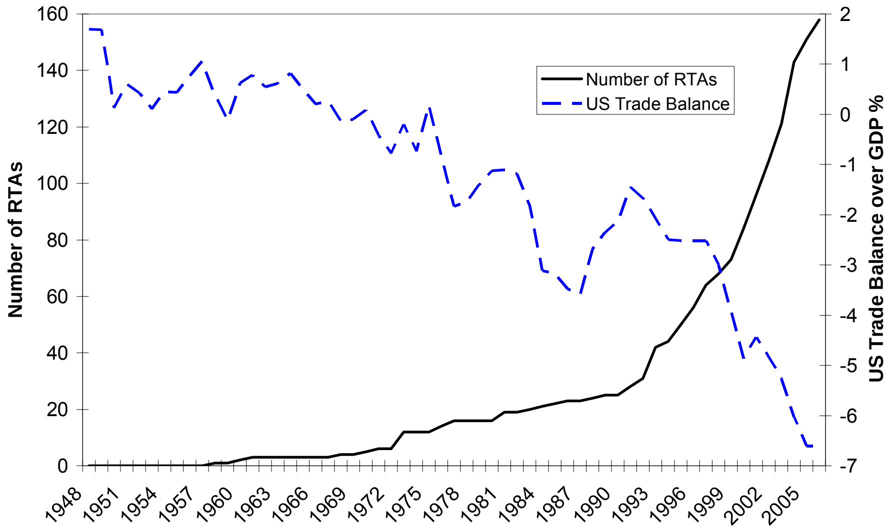
Figure 1: The number of RTAs and the US trade balance



What has made countries opt for this regional route? In what has become known as the Bhagwati-hypothesis, Bhagwati (1993, p.29) famously argued that:

> "The main driving force for regionalism today is the conversion of the United States, hitherto an abstaining party [...] The conversion of the United States is of major significance. As the key defender of multilateralism through the postwar years, its decision now to travel the regional route [...] tilts the balance of forces at the margin away from multilateralism to regionalism."

But what is it that made the US government suddenly change policy? Why did this happen in the 1980s and why has regionalism persisted ever since? In sum: what is the economic rationale for the hypothesis proposed by Bhagwati? This paper presents a theory capable of providing that rationale. Its explanation is based on the rise of trade imbalances. From the 1980s onwards, we argue, the growing US trade deficit has made selective trade partnerships more attractive for the US government. This has stalled multilateralism and has made countries around the world pursue the regionalist alternative. The broken line in Figure 1 displays the evolution of the US trade balance.

The basic mechanism is intuitive. When a bilateral trade imbalance is large enough, the deficit country can be better off under non-cooperation than under bilateral free trade. The reason is that a country in deficit loses much by giving up independent tariff setting. It has large market power over its import goods, and hence a strong incentive to depress their prices using import tariffs. At the same time, because a deficit country exports relatively little, it gains less from lower tariffs on its exports abroad. Empirical work by Broda et al. (2006) and Bagwell and Staiger (2006) provides support for the theory that countries set higher tariffs on goods that they have more market power over. Using probit regressions, moreover, both Magee (2003) and Holmes (2005) find that a larger bilateral trade imbalance implies a significantly smaller probability that two countries form a RTA. For instance, Magee (2003) estimates the effect of increasing a country's bilateral trade surplus with another country from zero to ten percent of total bilateral trade in 1980. He finds that this reduces the probability that the two countries sign a RTA before 1998 by 3.4%.

Now consider a multi-country setting. If a deficit country wants to cooperate at all, it will prefer to choose a partner towards which its deficit is small. It becomes selective. Instead of proceeding multilaterally, which restricts its choice, it opts for a regional route. We formalize this intuition in a negotiation game with three countries. One country, X, has a trade deficit against both others, Y and Z, but a larger deficit towards Z. One can think of X as the US, Z as Japan in the 1980s or China nowadays, and Y as the rest of the world. In an appendix we provide a microfounding model for the game's setting, where trade imbalances come about through optimal consumption smoothing in response to country-specific income shocks.

Negotiations in the game consist of two stages: multilateral and bilateral. In each stage, those agreements are signed for which all parties state that they consent. The game is solved using three properties, which we show can be derived from our microfounding goods market model: firstly, a country's benefit of a RTA increases in the trade surplus towards its partner; secondly, there is a threshold bilateral trade deficit beyond which a country is better off without a RTA; finally, a RTA between two countries reduces the welfare of the third country.

The game has three equilibria: multilateralism, regionalism and complete non-cooperation. On the basis of the three properties, we identify a set of restrictions on the size of the bilateral trade imbalances, which relate to the equilibrium outcome. When all restrictions hold, we say that imbalances are small. When some are violated, imbalances are large. And when none hold, imbalances are extreme. For extreme imbalances there is complete non-cooperation. For large imbalances, instead, a regionalist equilibrium emerges with bilateral cooperation between $X - Y$ or $Y - Z$ or both. Multilateralism only comes about for small imbalances. Thus, rising trade imbalances can trigger the move from multilateralism to regionalism. This is the central result of the paper.

Moreover, the shift to regionalism can be lasting, even if large trade imbalances are not. We extend the game to a dynamic setting and show that regionalism can have a lock-in effect. The reason is that once RTAs have been formed, insiders to the agreements gain rents over outsiders. These insiders may then not have sufficient incentive to proceed multilaterally, even if trade imbalances disappear over time. Thus, temporary imbalances can trigger a lasting change in the structure of trade agreements. Translating to current economic conditions, the large depreciation of the US dollar or a future revaluation of the Chinese renminbi would not necessarily induce a return to multilateralism.

Nonetheless, the existence of the regionalist option can be valuable to the global economy. Without it, countries are left with a choice between multilateralism and complete non-cooperation. We show that for sufficiently large trade imbalances, regionalism safeguards partial cooperation over complete non-cooperation. For more moderate imbalances, on the other hand, a restricted choice can force the deficit country into multilateral cooperation, raising world welfare.

The next section reviews the related literature. Section 3 presents our one-shot game. Section 4 derives its welfare implications. Subsequently, section 5 considers the game's dynamic extension. Finally, section 6 discusses the policy implications of our theory.

Literature review

There exist several alternatives to our explanation of the decline of multilateralism and the rise of regionalism.[2] Krugman (1993) has argued that, firstly, regionalism can go deeper than multilateralism on non-tariff issues and that, secondly, growing GATT/WTO membership has aggravated free-rider problems. Both arguments are often heard in policy debates on regionalism and the WTO (Collier (2006)). Baldwin (1997) has pointed out, however, that the regionalism of the 80s and 90s was actually primarily concerned with tariff liberalization, while Ludema (1991) has formally shown that free riding need not undermine multilateralism when conducted under the Most Favored Nation principle.

Baldwin (1995) offers a different perspective. In his model governments only join a RTA if the lobbying support of exporters exceeds that of importers. When, exogenously, a single RTA is signed among two countries, lobbying efforts in other countries tilt favorably towards supporting RTA. Thus, a single event of regionalism can lead to a domino effect, which can explain why existing blocs expand. But the model does not provide a rationale for the initial choice for regionalism, nor for the slowing of the multilateral process.

Freund (2000a) does model the choice for regionalism. She shows that RTAs become more attractive when multilateral tariffs are low. For high multilateral tariffs overall efficiency incentives dominate, and non-discriminatory liberalization is best. But for low tariffs, incentives to divert trade through exclusionary RTAs gain importance. Therefore, gradual multilateral liberalization can lead to growing regionalism. Multilateralism itself remains exogenous, however.

Our paper also relates to Bagwell and Staiger (1990) and Horn et al. (2006). They show, in different settings, that when two countries cooperate on trade policy, times of trade imbalances should be paired with higher cooperative tariffs. This compensates the deficit country for the inability to make use of its market power against the other country.

[2] Most of the literature on RTAs takes regionalism as given and considers its welfare implications. This literature is too extensive to review here. We refer to Winters (1996), Bhagwati et al. (1998), Panagariya (2000) and Baldwin (2005) for surveys.

One-shot game

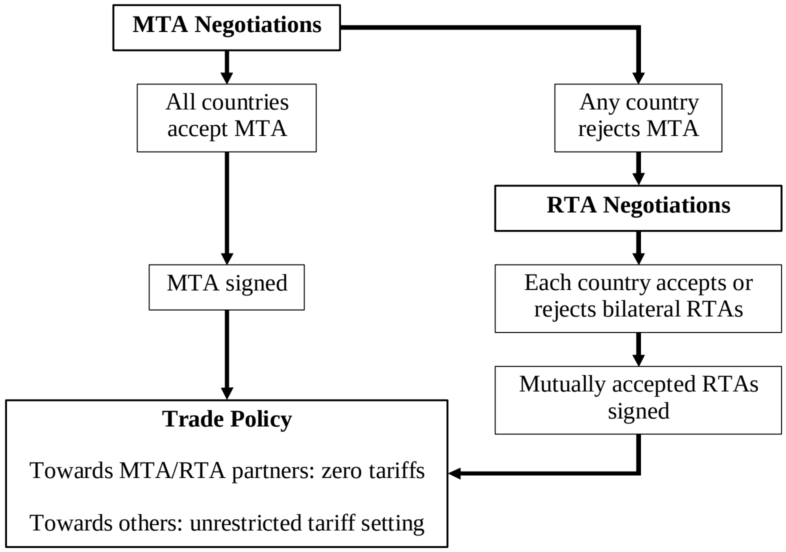
The way trade imbalances affect regionalism is best understood in a simple one-shot game. There are three players, namely countries X, Y and Z. These countries differ in their bilateral trade balances towards each other. We let $TB_{ij}(\Omega)$ denote the bilateral trade balance of country i with country j when the set of agreements Ω is in force (specified below). Here, clearly, one country's bilateral surplus is the other's bilateral deficit, $TB_{ij}(\Omega) = -TB_{ji}(\Omega)$, and world trade is always balanced, $\sum_i \sum_j TB_{ij}(\Omega) = 0$.

We obtain a simple analytical setting by ranking countries on the basis of their initial trade balances. That is, their trade balances in the absence of any agreements, $\Omega = \{\emptyset\}$. In particular, we let X be the deficit country, Y the middle country and Z the surplus country. Country X is in deficit against both others, but with a larger deficit against Z: $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} < 0$. And country Z in surplus against both others, with a larger surplus against X: $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{YZ}(\Omega)|_{\Omega=\{\emptyset\}} < 0$. In Appendix B we present a goods market model that provides microfoundations for the setting we assume here. This microfounding model is based on two periods. In it, the game described below takes place in the second period, against given trade imbalances, which are generated through first-period income shocks.

Countries X, Y and Z play the trade negotiation game depicted in Figure 2. Thus, negotiations take the form of a statement game. First, each country announces whether it accepts or rejects the Multilateral Trade Agreement (MTA). When all accept it, the MTA is signed. But if any country rejects it, the MTA fails and RTA negotiations begin. Regionalism is thus modelled as the outside option to multilateralism. Likewise, during RTA negotiations only those agreements are signed on which there is mutual consent. As a tie-breaking assumption, countries accept an agreement towards which they are indifferent. We denote the RTA between countries i and j by RTA_{ij}. Overall, at the end of negotiations the set of agreement, Ω, can include either the MTA, or any of RTA_{XY}, RTA_{XZ}, RTA_{YZ}, or it can remain the empty set

$\Omega = \{\emptyset\}$.[3]

Figure 2: Structure of the Game



After negotiations have been completed, tariffs are set. Countries implement zero tariffs against their MTA/RTA partners. We assume that countries commit themselves to the agreements that they sign during negotiations, and cannot subsequently defect from them.[4] However, an agreement between two countries imposes no constraints on their policies towards the third country.[5]

Thus, we have defined the game's players and their actions. Finally, we assume that governments are social welfare maximizers, and define three properties concerning the way that trade agreements and trade balances affect a country's welfare. Our microfounding model in Appendix B shows that these properties can be formally derived from a general specification

[3] Saggi and Yildiz (2006) and Zissimos (forthcoming) also model RTA negotiations as a statement game. For an alternative approach, in which a lead country decides whom to offer an agreement to, see Aghion et al. (2007).

[4] In the literature on RTAs there are two strands regarding commitment. One which, like us, assumes the ability to commit (see Krishna (1998) and Bagwell and Staiger (1999)), and another which requires agreements to be self-enforcing mechanisms (see Riezman (1991)). The commitment strand considers that, in reality, deviation from trade agreements can give only a very short-lived benefit to the defector, if any. Generally, trade measures are quickly observable to other countries. In fact, in our game one period equals one multilateral negotiation round. Such rounds can be more than a decade apart. Deviation profit would constitute only a fraction of the "period" income, therefore.

[5] That is, say, $X - Y$ RTA does not impose any constraints on either X or Y's indepedent tariff setting against Z. In our game RTAs are Free Trade Areas (FTAs), therefore, as opposed to Customs Unions. In the latter members set a common external tariff. In reality 84% of all RTAs are FTAs (Crawford and Fiorentino (2005)).

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with maximizing agents. Below we briefly explain the intuition behind each property.

P1 A country's net benefit of having a bilateral agreement with another country is increasing in the trade surplus towards it:

$$\frac{\partial}{\partial\, TB_{ij}\left(\Omega\right)|_{RTA_{ij}\notin\Omega}}\left[W_i|_{RTA_{ij}\in\Omega} - W_i|_{RTA_{ij}\notin\Omega}\right] > 0$$

where W_i is country i's sum of producer surplus, consumer surplus and tariff revenues.

P2 For a given set of agreements (Ω) that does not include RTA_{ij} ($RTA_{ij} \notin \Omega$) there exists a threshold bilateral trade deficit, $\overline{TB}_{ij} < 0$, below which country i is better off not signing RTA_{ij}. That is, country i's net benefit of the RTA is zero at the threshold:

$$W_i|_{RTA_{ij}\in\Omega} - W_i|_{RTA_{ij}\notin\Omega} = 0 \Longleftrightarrow TB_{ij}\left(\Omega\right)|_{RTA_{ij}\notin\Omega} = \overline{TB}_{ij}$$

P3 Two insiders to a RTA impose a negative externality on the outsider's welfare:

$$W_i|_{RTA_{j\neq i}\in\Omega} - W_i|_{RTA_{j\neq i}\notin\Omega} < 0$$

and worsen the outsider's trade balance:

$$TB_{ij}|_{RTA_{j\neq i}\in\Omega} - TB_{ij}|_{RTA_{j\neq i}\notin\Omega} < 0$$

Intuitively, the deficit country has more market power over its imports from the surplus country than vice versa. Thus, giving up the ability to influence the prices of import goods is more costly for the deficit country, which is the first property. This gives rise to a trade-off between the efficiency gains of mutual tax elimination and the cost of yielding unrestricted tariff setting. Under balanced trade the bilateral trade agreement is always mutually beneficial. But beyond a threshold bilateral imbalance, the deficit country is better off without

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an agreement.[6] This is the intuition behind the second property. Finally, the third property stems from the fact that the two insiders to a RTA raise the demand for, and thereby the prices of, each other's export goods. Hence, the outsider country pays more for its imports from them, which lowers its welfare and reduces its bilateral trade balances.[7]

Taken together, properties P1-P3 are sufficient to solve the game depicted in Figure 2 (proof in Appendix A):

Proposition I.1 *There are three types of Nash Equilibria: multilateralism ($\Omega = \{MTA\}$), regionalism ($\Omega = \{RTA_{XY}\}$, $\Omega = \{RTA_{YZ}\}$ or $\Omega = \{RTA_{XY}, RTA_{YZ}\}$), and complete non-cooperation ($\Omega = \{\emptyset\}$).*

1. *Multilateralism obtains when trade imbalances are small enough that $TB_{XY}(\Omega)|_{\Omega=\{RTA_{YZ}\}} \geq \overline{TB}_{XY}$ and $TB_{XZ}(\Omega)|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} \geq \overline{TB}_{XZ}$ hold.*

2. *Regionalism comes about when trade imbalances are sufficiently large that at least one of the above conditions is violated, but not so large that for all i with $TB_{ij} < 0$ it holds that $TB_{ij}(\Omega) < \overline{TB}_{ij} \forall \Omega$.*

3. *When for all i with $TB_{ij} < 0$ it holds that $TB_{ij}(\Omega) < \overline{TB}_{ij} \forall \Omega$, then there is complete non-cooperation.*

This is the central result of the paper. When trade imbalances are small enough, multilateral cooperation is feasible. But when they become too large, the deficit country prefers to choose its partner selectively. This country's decision to opt out of multilateralism subsequently gives rise to worldwide regionalism.

[6] This resembles Kennan and Riezman's (1988) result that a big country can win a trade war against a small country.

[7] The price effect of a RTA on outsiders is empirically documented by Chang and Winters (2002) for the case of MERCOSUR.

Welfare implications

But does this mean that world welfare is reduced by the existence of the regionalist option? Would our theory plead for rules that make it harder for countries to form Regional Trade Agreements? Suggestions to strengthen GATT Article XXIV, which formulates the conditions allowing WTO members to join RTAs, have been heard in academic policy debates (see the discussion in section 6).

Assume, as is standard in international trade theory, that world welfare is largest under world free trade. The welfare effect of regionalism then depends on the size of trade imbalances. For moderate imbalances regionalism is damaging. Consider the case where X loses a little from cooperating with Z, but gains much from a RTA with Y. Then, if X has the regionalist alternative, it rejects world free trade. But given the large gains from RTA_{XY}, X prefers the MTA to complete non-cooperation. That is: restricting X's choice to multilateralism or complete non-cooperation, it opts for multilateralism.

Now consider the opposite: X has a large trade deficit towards Z and gains much from retaining independent tariff setting against it, while X is indifferent towards a RTA with Y. When X is faced with the choice between multilateralism and non-cooperation only, it chooses non-cooperation. In this case, regionalism safeguards partial free trade.[8] Formally (proof in Appendix A):

Proposition I.2 *Consider a No-Regionalism Game, in which rejection of the MTA implies complete non-cooperation,* $\Omega = \{\emptyset\}$.

1. *Whenever* $W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} > W_X|_{\Omega=\{MTA\}} \geq W_X|_{\Omega=\{\emptyset\}}$ *multilateralism holds in the No-Regionalism Game but not in the standard Game.*

2. *Whenever* $W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} \geq W_X|_{\Omega=\{\emptyset\}} > W_X|_{\Omega=\{MTA\}}$ *complete non-cooperation comes about in the No-Regionalism Game but not in the standard Game.*

[8] Absent trade diversion (as in our microfoundations), partial cooperation is certainly better for world welfare than non-cooperation.

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Trade imbalances are a distortion. They create harmful asymmetries between countries. The first best solution would be the elimination of imbalances, or the establishment of a system of international transfers. When this is impossible, regionalism can sometimes be a second best solution.

Dynamic extension

So far we have considered only a one-shot game. But trade balances are constantly changing. In 2007 and throughout the first quarter of 2008 the dollar depreciated sharply against the euro. At the same time, the Chinese government has allowed a first modest appreciation of its currency. The US trade deficit has begun to decrease. If global trade imbalances continue to decline, should we also expect to observe a rekindling of multilateralism and a decline of regionalism? That is, do the predictions of the static model carry through to a dynamic setting without modification?

To analyze this question we extend last section's game to a dynamic setting. Each period is a precise repetition of the one-shot game in Figure 2, except that negotiations only take place about agreements that have not previously been signed. Moreover, if a MTA is signed, it supplants any existing RTAs. Governments discount future periods at a rate $\delta \in [0, 1]$.

The evolution of trade imbalances is as follows. In the first period of the game trade imbalances are as in the basic game. Afterwards, there is balanced trade forever. This is a simple dynamic setting, but will already allow us to derive quite rich results. Note that the assumption of infinite periods is of importance. We come back to this below. Furthermore, the dynamic game can be microfounded using precisely the same model as the basic game. One need only add the requirement that all period 0 debt (the pre-game period, see Appendix B) is repaid in period 1.

We solve the game by considering first the decisions taken in the limit for different structures of previously signed agreements. The decisions in the first period can then be derived by backward induction. The outcome is as follows (proof in Appendix A):

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Proposition I.3 *There are three equilibrium paths to the dynamic game: multilateralism forever; permanent regionalism (one RTA forever); temporary regionalism (one or two RTAs in the first period and multilateralism from the second period onwards). We call these the Good, the Bad and the Ugly Paths, respectively:*

1. *If for* $t > 1$, $\left[W_i^t|_{\Omega=\{RTA_{ij}\}} - W_i^t|_{\Omega=\{MTA\}} \right] \leq 0$ *then for small first period imbalances (as in point 1 of Proposition 1) the Good Path obtains, and otherwise the Ugly Path.*

2. *If* $t > 1$, $\left[W_i^t|_{\Omega=\{RTA_{ij}\}} - W_i^t|_{\Omega=\{MTA\}} \right] > 0$ *then there exists a value* $\overline{\delta}$ *of the discount rate such that for* $\delta \geq \overline{\delta}$ *all three paths are possible, and for* $\delta < \overline{\delta}$ *paths are as in (1).*

Here, $W_i^t|_{\Omega=\{RTA_{ij}\}} > W_i^t|_{\Omega=\{MTA\}}$ means that even under balanced trade ($t > 1$) a country is better off being the insider to the only RTA than being in a MTA. Notice that properties P1-P3 do not exclude this possibility. Intuitively, RTA insiders can gain rents by improving each other's terms-of-trade at the outsider's expense. The MTA destroys such rents.

What is surprising in Proposition 3 is the presence of the Bad Path. Temporary trade imbalances can cause permanent regionalism. That is, trade imbalances can affect the structure of trade agreements in a persistent, hysteretic manner. The reason is that regionalism creates rents for insiders. Thus, with regionalism in place, insiders may not participate to a multilateral agreement that they would otherwise have joined.

More precisely, when there is only one RTA and trade is balanced, RTA insiders face a trade-off. On the one hand, an insider has the incentive to sign an agreement with the excluded country. In this manner, it would become the insider on two RTAs and gain instantaneous welfare. On the other hand, it knows that the next period, the outsiders to the two respective agreements will be better off signing the last RTA and achieving world free trade. Due to the size of RTA rents, world free trade is worse for the insider than one RTA. When patience is high enough, future losses outweigh instantaneous gains, and regionalism that was triggered by temporary imbalances may perpetuate.

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Policy implications

Our theory relates the policy debate on global trade imbalances to the policy debate on the WTO. Until now these have been largely separate. If anything, some policy makers have suggested a role for the WTO in helping to bring down global imbalances (Dodge (2005), De Rato (2005)). Our work indicates the possible importance of the opposite channel: limiting imbalances to garner incentives for faster trade liberalization. The dynamic game shows that reducing imbalances may, at times, strengthen multilateralism. But, as it shows as well, this will not work if vested interests in existing RTAs are too large.

Our theory also relates to the policy question whether GATT Article XXIV should be strengthened. This Article governs the exception to non-discriminatory (multilateral) liberalization granted to RTAs. Proponents of strengthening this Article (Bhagwati (1993)) argue that larger barriers to RTA formation could aid world trade liberalization through the multilateral process. The result derived in section 4 cautions against such a move. In a world of large trade imbalances tougher rules on regionalism can end up pushing countries towards less, not more, trade cooperation.

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Part II

Trade Liberalization, Firm Selection and Variety Growth

Abstract

Recent empirical findings indicate that when trade is liberalized both firm selection takes place and product variety increases. Each of these two stylized facts has its own seminal theory. But how can they arise together? This paper presents a model of heterogeneous, multi-variety firms that provides an intuitive explanation. When trade is liberalized efficient foreign exporters enter and push out the least efficient domestic firms. Fewer firms remain in total. But exporters endogenously offer more variety than domestic firms. The entry of variety-rich foreign firms unambiguously dominates the decrease in the number of firms. Thus, total variety increases.

Keywords: Trade, Heterogeneous firms, Variety, Firm selection, Market concentration.

JEL Classification: F12, F15, L11

Introduction

According to Feenstra (2006) firm selection and rising product variety are the two key empirical regularities that emerge from recent microeconometric work in international trade. Firstly, when barriers to trade are lowered, efficient foreign exporters enter the domestic market and push out the least efficient domestic firms (Tybout (2003), Greenaway and Kneller (2007)). This is known as firm selection. Firm selection raises the average productivity of the firms that are active on the domestic market. Secondly, opening up the domestic market broadens the available choice of product varieties, to the benefit of domestic consumers (Broda and Weinstein (2006)).

For each of these stylized facts there exists a seminal theory: Melitz (2003) for firm selection and Krugman (1980) for product variety. But how are the two connected? The purpose of this paper is to present an intuitive mechanism that links the two stylized facts. When trade is liberalized, firm selection leaves a market with fewer, larger firms. But exporters endogenously offer more variety than purely domestic firms. Upon liberalization, the efficient foreign exporters that enter the domestic market are more variety-rich than those domestic firms that are pushed out. This more than compensates for the fact that fewer firms remain. Thus, total variety increases.

The model is based on the contributions of Melitz (2003) and Allanson and Montagna (2005). In the Melitz-model firms produce a single horizontally differentiated variety and differ in their productivity. Exporting involves a sunk cost, which leads to a scale ranking: only the most productive firms export. Allanson and Montagna (2005), instead, present a closed-economy model of multi-variety firms. They work with a nested CES, in which the varieties of a single firm are closer substitutes than the varieties of different firms. This bounds a firm's optimal variety, because additional varieties cannibalize on the demand for the firm's existing line.

Bringing these together, we obtain a model of international trade with heterogeneous, multi-variety firms. We assume that a firm's efficiency parameter is applicable to all its varieties. That is, we abstract from efficiency differences within a firm. This allows us to parameterize the productivity distribution and obtain a closed-form solution. As is common in both the theoretical and the empirical literature on firm heterogeneity, we apply a Pareto distribution (Melitz and Ottaviano (2008), Baldwin and Forslid (2006), Helpman et al. (2004)).

As proven by Baldwin and Forslid (2006), applying a Pareto distribution in the standard Melitz-model leads it to predict that trade liberalization reduces the total number of firms that sell to domestic consumers. Market concentration rises. This property of the model not only

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seems fairly intuitive, but is also consistent with Mirza's (2006) empirical work.[9] However, given that it is a single-variety model, fewer firms necessarily imply less variety.

In our multi-variety setting, instead, trade liberalization always increases total variety available to domestic consumers. The mechanism comes about because more productive firms choose to offer more variety. The reason is the presence of a firm-wide fixed cost. This generates an economy of scope, which is stronger for firms that have a lower marginal cost per variety. As only the most productive firms self-select into export, exporters offer more variety than purely domestic firms. Firm selection still leaves a more concentrated market. But, quite remarkably, the variety gap between entering exporters and exiting domestic firms unambiguously dominates. Thus, firm heterogeneity in productivity is the driving force behind both firm selection and variety growth.

However, the welfare implications of our model are less straightforward than those in a model with single-variety firms. Consumers value more variety. But due to the difference between the intra-firm and inter-firm elasticities of substitution, they also value being able to buy from different firms. We prove that, on the whole, consumers sometimes prefer the variety offering they could choose from before trade was liberalized. Gains from lower prices always more than compensate in this case, though.

Our work also relates to that of Bernard et al. (2006), Eckel and Neary (2005) and Nocke and Yeaple (2007) on multi-product firms in trade. The latter develop a model with firms that differ in organizational capability, while overall productivity declines in the number of product categories that firms choose to be active in. The model explains why larger firms have lower market-to-book values. In Bernard et al. (2006) firms are heterogeneous in both managerial ability and expertise in each product category. Trade liberalization results in higher average productivity due to not only firm selection, but also product selection within firms. Eckel and Neary (2005) consider trade with homogeneous multi-product firms under oligopolistic competition. Optimal variety offering depends on both core competencies (increasing marginal

[9] It should be noted, however, that Mirza's (2006) study is based on an oligopolistic market structure, not a monopolistically competitive one.

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costs for additional products) and cannibalization (additional products decrease demand for the firm's existing line). These three models have richer structures than our own. For this reason, they cannot be parameterized with a single distribution to obtain a simple mechanism that matches the stylized facts described above.

The next section presents the model. Section 3 computes the equilibrium solution, from which section 4 derives the results. Finally, section 5 considers the welfare implications.

Model

In this section we present our model. We first describe demand and then the decision problem that firms face. At the end of the section we demonstrate how the presented model nests the models of Melitz (2003) and Allanson and Montagna (2005).

Demand

Preferences are given by a nested CES, in which the domestic representative consumer optimizes over three stages. In the first stage, the consumer optimally allocates expenditure, E, between the quantity index of a differentiated good q (defined below), and an outside composite good, z, which is used as a numeraire. We assume that the numeraire good is produced with identical constant returns to scale technology everywhere and is freely traded. This is a common assumption (Helpman et al. 2004), which brings about international wage equalization. First-stage utility is given by:

$$U = z^{\eta} q^{1-\eta} \tag{1}$$

with $\eta \in (0,1)$. By optimization, the consumer spends $y = (1-\eta) E$ on q, so that we can write the consumer's budget constraint for the differentiated good as

$$y = pq \tag{2}$$

where p is the price index associated with the differentiated good. Second and third stage utility are given by

$$q = \left(\int_{i=0}^{n} q_i^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{3}$$

and

$$q_i = \left(\int_{k=0}^{h_i} q_{ik}^{\frac{\sigma-1}{\sigma}} dk \right)^{\frac{\sigma}{\sigma-1}} \tag{4}$$

where q_{ik} is the demand for each variety k of a given firm i, which produces a number (=mass) h_i of varieties. Then, q_i is the quantity index associated with the sales of a given firm, while n is the number of firms. Importantly, σ is the elasticity of substitution between different varieties of a given firm and θ is the inter-firm elasticity of substitution. We assume that $\sigma > \theta > 1$.

It is well-known that minimizing expenditure subject to the CES aggregator gives the following solutions for the welfare-based price indices (see Allanson and Montagna (2005) and Obstfeld and Rogoff (1996, pp. 227-228)):

$$p = \left(\int_{i=0}^{n} p_i^{1-\theta} di \right)^{\frac{1}{1-\theta}} \tag{5}$$

and

$$p_i = \left(\int_{k=0}^{h_i} p_{ik}^{1-\sigma} dk \right)^{\frac{1}{1-\sigma}} \tag{6}$$

and that the final demand for varieties can then be expressed as

$$q_{ik} = \left(\frac{p_i}{p} \right)^{-\theta} \left(\frac{p_{ik}}{p_i} \right)^{-\sigma} q \tag{7}$$

Firms

The firm's problem consists of an entry stage and, subsequently, for as many periods as it stays active, sales decisions. To start operating firms have to pay a one-time cost F_e, which entails, among other things, plant setup, initial market research and setting up a distribution network. Only after incurring this cost, do firms discover their productivity. Firms draw their productivity, φ, from a time-invariant distribution, $g(\varphi)$. This is an essential building block of model of Melitz (2003), based on empirical evidence that firms differ widely in their productivities, even within narrowly defined industries.[10]

Once firms know their productivity, they must decide whether to produce or to exit. Those who stay set their prices and variety offering. However, each period active firms face an exogenous probability, δ, of being hit by a death shock. These industry dynamics of the Melitz-model are essentially a simplified version of Hopenhayn's (1992) work on endogenous entry, exit, and long-run stationary equilibria.

Being active on the domestic market brings about the following costs each period:

$$C_i(\varphi) = a + (b + f_h) h_i + \int_{k=0}^{h_i} \frac{w}{\varphi} q_{ik} dk \tag{8}$$

where a and b are firm-wide and variety-specific fixed costs, respectively. These represent, for instance, advertisement, management time and maintenance of the distribution network. They are the fixed costs required to maintain activity on the domestic market. Both are necessary elements of the model: a generates increasing returns to scale, while a positive b, in conjunction with $\sigma > \theta$, keeps optimal variety bounded. That is, the marginal benefit of variety is decreasing due to $\sigma > \theta$, while its marginal cost is constant and positive.

Distinct from these is f_h, which is the cost of creating a new variety. Once we introduce exports, it will be clear why these must be kept distinct. In fact, it costs F_h to set up a new variety. But firms are indifferent between paying this F_h up front, or paying the amortized fixed cost $\delta F_h = f_h$ each period.[11] The last term in the equation captures the variable costs of production. Here, marginal costs are inversely proportional to the productivity parameter, φ, and w is the wage. We normalize $w = 1$.

[10] See the surveys of Greenaway and Kneller (2007) and Tybout (2003).

[11] See the discussion in Melitz (2003, p.1708) on rewriting fixed costs to per-period notation.

Simultaneously with its domestic sales decision a firm also chooses whether to become an exporter, how many of its varieties to export, and which prices to charge abroad. Yet, in order to export, firms face an additional hurdle. As in Melitz (2003), they must pay a so-called beachhead cost, f_x, associated to setting up a new trade line.[12] For simplicity, we let the fixed costs of maintaining activity on a market, a and b, be the same in the domestic and foreign markets. To export a good, furthermore, a firm pays tariff and transport costs $\tau > 1$ per shipped unit. The firm's per period profit function becomes:

$$\pi_i(\varphi) = \int_{k=0}^{h_i} \left(p_{ik} - \frac{1}{\varphi} \right) q_{ik} dk - a - (b + f_h) h_i + \max \left\{ 0, \int_{k=0}^{h_i^X} \left(p_{ik}^X - \frac{\tau}{\varphi} \right) q_{ik}^X dk - (a + f_x) - b h_i^X \right\} \tag{9}$$

where the second term in the max operator represents the profits from exporting. If these are smaller than zero, the firm will not export. The terms h_i^X, p_{ik}^X and q_{ik}^X stand for, respectively, the number of varieties exported, the price of variety k charged in the foreign market and the quantity of variety k sold abroad. Countries are identical and the trading cost τ is the same to each destination.[13] In the above equation, it is implicit that firms do not develop new varieties only for export. That is, $h_i \geq h_i^X$, and firms export a subset of their domestic varieties. Equation (13) below states the required parameter restriction for this to hold. This condition is necessary for an interior solution.

The first stage decision of the firm can now be summarized by a free-entry condition:

$$E\left[\max\left\{\left[\pi_i(\varphi)\right], 0\right\}\right] \geq f_e \tag{10}$$

where we have rewritten $\delta F_e = f_e$. Firms will enter as long as the expected net present value of positive future profits covers the entry cost. After having drawn φ, moreover, firms have a cutoff productivity level, $\widehat{\varphi}$, for which they are indifferent between continuing and ceasing

[12] Tybout (2003) discusses the empirical relevance of these fixed costs to commence export.

[13] It then makes no difference whether the model is termed a 2-country or a multi-country model: if a firm exports to any destination, then it exports to all.

production:

$$\pi_i(\widehat{\varphi}) = 0 \tag{11}$$

Similarly, the model contains a cutoff productivity for exporting, $\widehat{\varphi}^X$, which is the productivity draw for which a firm is indifferent between exporting and not exporting.

$$\int_{k=0}^{h_i^X} \left(p_{ik}^X - \frac{\tau}{\widehat{\varphi}^X} \right) q_{ik}^X dk - (a + f_x) - b h_i^X = 0 \tag{12}$$

As in Melitz (2003), however, we require a condition that ensures $\widehat{\varphi}^X \geq \widehat{\varphi}$:

$$\frac{b\left(\tau^{\theta-1} - 1\right)}{f_h} \geq 1 \tag{13}$$

After all, the fact that only the most productive fraction of active firms become exporters is the driving force of firm selection. The above condition is also necessary and sufficient for $h_i \geq h_i^X$. This is verifiable in the next section.

Finally, if we set $\sigma = \theta$ and fix $h_i = h_i^X = 1$ we obtain a model with heterogeneous, single-variety firms that is equivalent to Melitz's. An alternative way to put it is that in the standard Melitz-model $f_h = 0$ for $h_i \in [0, 1]$ and $f_h \to \infty$ for $h_i > 1$: the R&D cost function is discontinuous at one variety. In addition, the model presented above nests the contribution of Allanson and Montagna (2005). Their closed-economy model of homogeneous, multi-variety firms is obtained by fixing $\varphi = \overline{\varphi}$ for all firms and taking away firms' possibility to export.

Equilibrium

In this section we compute a closed-form equilibrium solution for the Pareto distribution. As discussed in the introduction, this is a common parameterization, both in theoretical and quantitative work on firm heterogeneity.

To solve for the price setting of the firms, we replace q_{ik} from equation (7) into equation (9) and set $\frac{\partial \pi_i(\varphi)}{\partial p_{ik}} = 0$. Likewise, noting that $q_{ik}^X = \left(\frac{p_i^X}{p}\right)^{-\theta} \left(\frac{p_{ik}^X}{p_i^X}\right)^{-\sigma} q$ - where p_i^X is the price

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index of domestic consumers' purchases from a foreign firm - we set $\frac{\partial \pi_i(\varphi)}{\partial p_{ik}^X} = 0$ to obtain prices charged by exporters. Subsequently, $\frac{\partial \pi_i(\varphi)}{\partial h_i} = 0$ and $\frac{\partial \pi_i(\varphi)}{\partial h_i^X} = 0$ give us equations for h_i and h_i^X. It should be noted that in solving for firms' decisions on pricing and variety offering we have ruled out strategic interactions. This follows Allanson and Montagna's (2005) approach in extending the standard single-variety per firm Dixit-Stiglitz monopolistic competition model to the multi-variety case.

Replacing terms, equations (11) and (12) provide solutions for the cutoff productivity levels for activity on the domestic and foreign markets, $\widehat{\varphi}$ and $\widehat{\varphi}^X$. To solve for the firms' free-entry condition in equation (10), we rewrite the max operators in the profit function to probabilistic terms. That is, with the probability that $\varphi \geq \widehat{\varphi}$ the firm will remain active in the domestic market after discovering its productivity. This probability is simply $\int_{\widehat{\varphi}}^{\infty} g(\varphi)\, d\varphi$. Similarly, before entering the market, the firm has a chance of $\int_{\widehat{\varphi}^X}^{\infty} g(\varphi)\, d\varphi$ of becoming an exporter. Finally, we rewrite the aggregate price level from equation (5) to

$$p = \frac{\sigma}{\sigma - 1} \left(n \int_{\widehat{\varphi}}^{\infty} \varphi^{\theta-1} (h_i)^{\frac{\theta-1}{\sigma-1}} g(\varphi \mid \varphi \geq \widehat{\varphi})\, d\varphi + n^X \int_{\widehat{\varphi}^X}^{\infty} \left(\frac{\varphi}{\tau}\right)^{\theta-1} \left(h_i^X\right)^{\frac{\theta-1}{\sigma-1}} g\left(\varphi \mid \varphi \geq \widehat{\varphi}^X\right) d\varphi \right)^{\frac{1}{1-\theta}} \tag{14}$$

where $g(\varphi \mid \varphi \geq \widehat{\varphi})$ is the conditional distribution of φ. That is, the distribution of productivities among only active firms. While $g\left(\varphi \mid \varphi \geq \widehat{\varphi}^X\right)$ is that distribution among exporters. Furthermore, n^X is the number of foreign firms from which domestic consumers purchase. By the symmetry of countries this is equal to the number of domestic exporters. Formally,

$$n^X = n \frac{\int_{\widehat{\varphi}^X}^{\infty} g(\varphi)\, d\varphi}{\int_{\widehat{\varphi}}^{\infty} g(\varphi)\, d\varphi} \tag{15}$$

This gives us enough to solve the free-entry condition and obtain an equation for n. For the Pareto distribution, the probability density function takes the form

$$g(\varphi) = c d^c \varphi^{-c-1} \tag{16}$$

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where $g(\varphi)$ has support on $[d, \infty)$, and c is the parameter that measures heterogeneity. A smaller c implies a wider distribution and, thus, a more heterogeneous population of firms. As is common in the literature, we normalize $d = 1$. Moreover, as in Helpman et al. (2004) and Chaney (forthcoming), we require a parameter restriction

$$c > \max\left\{2, \frac{(\sigma-1)(\theta-1)}{\sigma-\theta}\right\} \tag{17}$$

to ensure finite variance of the distribution of productivity draws $g(\varphi)$ and the conditional productivity distribution of active firms $g(\varphi \mid \varphi \geq \widehat{\varphi})$. If this condition is violated, productivity cutoffs are indeterminate. Implementing the Pareto distribution and solving algebraically, gives us the closed-form solution:

$$q = \frac{y}{p} \tag{18}$$

$$p = \frac{1}{\widehat{\varphi}}\frac{\sigma}{\sigma-1}\left[\frac{\sigma(\sigma-1)}{y}\right]^{\frac{1}{\theta-1}}\left[\frac{b+f_h}{\theta-1}\right]^{\frac{1}{\sigma-1}}\left[\frac{a}{\sigma-\theta}\right]^{\frac{\sigma-\theta}{(\theta-1)(\sigma-1)}} \tag{19}$$

$$\widehat{\varphi} = \left[\frac{a}{f_e}\frac{(\theta-1)(\sigma-1)}{(\sigma-\theta)c-(\sigma-1)(\theta-1)}\left(1+\frac{1+\frac{f_x}{a}}{\Psi(\tau)}\right)\right]^{\frac{1}{c}} \tag{20}$$

$$\widehat{\varphi}^X = \left[\frac{a}{f_e}\frac{(\theta-1)(\sigma-1)}{(\sigma-\theta)c-(\sigma-1)(\theta-1)}\left(1+\frac{f_x}{a}+\Psi(\tau)\right)\right]^{\frac{1}{c}} \tag{21}$$

$$n = \frac{y}{a}\frac{(\sigma-\theta)c-(\sigma-1)(\theta-1)}{\sigma(\sigma-1)c}\frac{\Psi(\tau)}{1+\frac{f_x}{a}+\Psi(\tau)} \tag{22}$$

$$n^X = \frac{y}{a}\frac{(\sigma-\theta)c-(\sigma-1)(\theta-1)}{\sigma(\sigma-1)c}\frac{1}{1+\frac{f_x}{a}+\Psi(\tau)} \tag{23}$$

where we have defined

$$\Psi(\tau) = \left(\tau\left[\frac{b}{b+f_h}\right]^{\frac{1}{\sigma-1}}\left[\frac{a+f_x}{a}\right]^{\frac{\sigma-\theta}{(\theta-1)(\sigma-1)}}\right)^{c} \tag{24}$$

to make things visually easier to absorb. Moreover, for a given firm with productivity draw φ we also have the following equations governing price setting and the optimal scope at home

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and abroad:

$$p_{ik} = \frac{\sigma}{\sigma - 1}\frac{1}{\varphi} \tag{25}$$

$$p_{ik}^X = \frac{\sigma}{\sigma - 1}\frac{\tau}{\varphi} \tag{26}$$

$$h_i = \frac{\theta - 1}{\sigma - \theta}\frac{a}{b + f_h}\left(\frac{\varphi}{\widehat{\varphi}}\right)^{\frac{(\sigma-1)(\theta-1)}{\sigma-\theta}} \tag{27}$$

$$h_i^X = \left[\frac{b + f_h}{b}\right]^{\frac{\sigma-1}{\sigma-\theta}} \frac{\theta - 1}{\sigma - \theta}\frac{a}{b + f_h}\left(\frac{1}{\tau}\frac{\varphi}{\widehat{\varphi}}\right)^{\frac{(\sigma-1)(\theta-1)}{\sigma-\theta}} \tag{28}$$

It is interesting to observe here that the inter-firm elasticity of substitution, θ, does not affect price setting. Rather, firms set markups purely according to their intra-firm elasticity, σ, and adjust for θ completely along the variety margin.

Results

As discussed in the introduction, the purpose of our model is to explain how trade liberalization simultaneously leads to an increase in the average industry productivity and variety growth. With our closed-form solution in hand, we can now show that the model indeed matches these stylized facts, and observe the mechanism through which it does so.

The way that trade liberalization raises the average productivity of the firms that are active in an industry, is identical to the Melitz-model: firm selection. The least efficient firms are pushed out of the market. Formally, we have that $\frac{\partial \widehat{\varphi}}{\partial \tau} = \frac{\partial \widehat{\varphi}}{\partial \Psi(\tau)}\frac{\partial \Psi(\tau)}{\partial \tau} = (-)(+) < 0$. Hence, a tariff reduction raises the productivity cutoff, $\widehat{\varphi}$, and the average remaining firm is more productive.

Moreover, our equilibrium solution allows us to derive a closed-form expression for the number of firms that are active on the domestic market:

$$N = n + n^X = \frac{y}{\sigma}\frac{(\sigma - \theta)c - (\sigma - 1)(\theta - 1)}{(\sigma - 1)c}\frac{1}{a}\left[\frac{1 + \Psi(\tau)}{1 + \frac{f_x}{a} + \Psi(\tau)}\right] \tag{29}$$

Taking the derivative of this expression towards tariffs and replacing $\frac{\partial\Psi(\tau)}{\partial\tau} = \frac{c}{\tau}\Psi(\tau)$ yields

$$\frac{\partial N}{\partial \tau} = \frac{f_x}{\tau}\frac{y}{\sigma}\frac{(\sigma-\theta)c-(\sigma-1)(\theta-1)}{(\sigma-1)}\frac{1}{a^2}\frac{\Psi(\tau)}{\left[1+\frac{f_x}{a}+\Psi(\tau)\right]^2} > 0 \tag{30}$$

from which:

Proposition II.1 *The number of firms that sell to consumers on the domestic market unambiguously decreases when trade is liberalized:* $\frac{\partial N}{\partial \tau} > 0$.

Finally, we can obtain a similar expression for the total variety available to domestic consumers. In general form:

$$H = n\int_{\widehat{\varphi}}^{\infty} h_i g(\varphi \mid \varphi \geq \widehat{\varphi})\, d\varphi + n^X \int_{\widehat{\varphi}^X}^{\infty} h_i^X g\left(\varphi \mid \varphi \geq \widehat{\varphi}^X\right) d\varphi \tag{31}$$

That is, total variety is the sum of the variety offered by domestic firms and the variety offered by foreign firms. The former equals the number of domestic firms times the average amount of variety per domestic firm. Likewise, the latter equals the number of foreign firms on the domestic market times the average amount of variety that such firms offer to domestic consumers.

Solving in closed form gives:

$$H = \frac{y}{\sigma}\frac{(\theta-1)}{(\sigma-1)}\frac{1}{b}\frac{1+\frac{f_x}{a}+\left[\frac{b}{b+f_h}\right]\Psi(\tau)}{1+\frac{f_x}{a}+\Psi(\tau)} \tag{32}$$

And taking the derivative towards tariffs:

$$\frac{\partial H}{\partial \tau} = -\frac{c}{\tau}\frac{y}{\sigma}\frac{1}{b+f_h}\frac{(\theta-1)}{(\sigma-1)}\frac{a+f_x}{a}\frac{f_h}{b}\frac{\Psi(\tau)}{\left[1+\frac{f_x}{a}+\Psi(\tau)\right]^2} < 0 \tag{33}$$

so that:

Proposition II.2 *Total variety available to domestic consumers unambiguously rises when trade is liberalized:* $\frac{\partial H}{\partial \tau} < 0$.

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Thus, on the one hand, each foreign entrant pushes out more than one local firm when trade is liberalized. But, on the other hand, foreign entrants offer more variety than the firms that exit: $\left[h_i^X \mid \varphi = \widehat{\varphi}^X\right] > [h_i \mid \varphi = \widehat{\varphi}]$ by equations (27) and (28). This unambiguously dominates the decrease in the number of firms. In this manner, both market concentration and total variety increase.

The result on variety growth is quite surprising when one considers that, due to trade costs, firms export only a part of their domestic varieties ($h_i^X < h_i$). Hence, the productivity gap between the marginal foreign entrant and the marginal exiting domestic firm ($\widehat{\varphi}^X - \widehat{\varphi}$) is large enough to overcome the effect of the trade costs: the foreign entrant always offers more variety to domestic consumers than the exiting domestic firm $\left(\left[h_i^X \mid \varphi = \widehat{\varphi}^X\right] > [h_i \mid \varphi = \widehat{\varphi}]\right)$. And, in turn, this difference is large enough to more than compensate for variety lost from the decrease in the number of firms.

Welfare implications

On the whole, consumers always gain from trade liberalization in our model. From our closed-form solution it is apparent that $\frac{\partial q}{\partial \tau} = \frac{\partial q}{\partial p} \frac{\partial p}{\partial \widehat{\varphi}} \frac{\partial \widehat{\varphi}}{\partial \tau} = (-)(-)(-) < 0$ and total welfare unambiguously increases in liberalization.

However, these welfare gains come about through both prices and variety. We have seen that trade liberalization gives consumers the choice between more varieties, but from fewer firms. Thus, the question remains whether consumers prefer the available choice after liberalization to that before. After all, by $\sigma > \theta$ consumers care about how many firms they can buy from. We ask, therefore, whether the variety effect of trade liberalization is positive in welfare terms.

Proposition II.3 *There exist parameterizations for which the variety effect of trade liberalization is positive in welfare terms. There also exist parameterizations for which it is negative.*

Proof. It suffices to consider the cases $f_x \to 0$ and $f_h \to 0$ (neither of which violates the condition in equation (13)). When entry costs to export vanish, $f_x \to 0$, all firms export at least some varieties and liberalization ceases to affect the number of firms: $N \to \frac{y}{\sigma}\frac{(\sigma-\theta)c-(\sigma-1)(\theta-1)}{(\sigma-1)c}\frac{1}{a}$ and $\frac{\partial N}{\partial \tau} \to 0$ from equations (29) and (30). But by equation (33) $\frac{\partial H}{\partial \tau}$, does not go to zero, since exporters expand their variety offering when tariffs are lower, $\frac{\partial h_i^X}{\partial \tau} < 0$ (equation (28)). More variety with the same number of firms implies an unambiguous welfare gain. Conversely, for $f_h \to 0$ economies of scope from exporting domestically developed varieties vanish, and $H \to \frac{y}{\sigma}\frac{(\theta-1)}{(\sigma-1)}\frac{1}{b}$ so that $\frac{\partial H}{\partial \tau} \to 0$. At the same time, $\frac{\partial N}{\partial \tau}$ does not go to zero. The same amount of variety from fewer firms implies an unambiguous welfare loss. ■

Overall, therefore, the outcomes of our model are straightforward in the nominal sense (i.e., fewer firms, more variety), but more intricate when it comes to consumers' welfare. Yet, even when the variety effect of trade liberalization is negative in welfare terms, lower prices more than compensate the consumer.

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Part III

How Do Heterogeneous Wage Expectations Affect Unemployment?

Abstract

Models of unemployment assume that searchers have identical wage expectations. But a strand of survey studies finds that wage expectations are widely dispersed. This paper presents the first model of search with heterogeneous expectations. The model is calibrated on US and German data. For relevant parameter values, unemployment rises in the dispersion of wage expectations. Intuitively, there is an underlying convexity: pessimists have a lower bound on their search duration (one period), whereas optimists do not. For conservative parameter values, 1 in 10 US unemployed is jobless because of the dispersion of wage expectations. Better wage information can thus help reduce unemployment.

Keywords: Search, Wage expectations, Heterogeneous expectations, Unemployment

JEL Classification: D83, D84, J30, J64

Introduction

Unemployment theory is grounded upon models in which searchers have identical wage expectations. Yet, empirical evidence from an expanding body of survey studies questions this assumption. These surveys, mostly conducted among college students, find that wage expectations are very heterogeneous. Betts (1996), for instance, compares college students' estimates of national average salaries in their own fields with the actual salaries. The median student has roughly zero error, but, ranked by their estimate of the national average salary, the 90^{th} percentile of respondents foresees wages *twice* as high as the 10^{th} percentile. Dominitz and

Manski (1996) have almost the same result as Betts for national averages, but also ask students about their own wage expectations, controlling for factors such as age, gender and education. They find a close correspondence between overestimating national average wages and high personal wage expectations. In a similar survey, Brunello et al. (2001) find that for most European countries wage expectations are even more widely dispersed than in the US.[14]

This paper considers how such heterogeneity in wage expectations affects the labour market. In particular, we investigate the effect of dispersion in wage expectations on unemployment. We start from a basic job search model, in which searchers receive a wage offer each period and follow an optimal reservation wage strategy. Those who have a job, face an exogenous probability of job termination. We then introduce heterogeneous wage expectations. Based on the findings of the survey studies, we assume that the median searcher has the correct expectation, and other searchers' expectations are distributed symmetrically around his. Each searcher now has his own reservation wage. Therefore, each individual has his own steady-state unemployment rate (the steady-state probability of unemployment for a given period). Computing the average individual unemployment rate, we obtain an expression for the aggregate unemployment rate under heterogeneous wage expectations.

Subsequently, we investigate the relationship between the aggregate unemployment rate and the dispersion of wage expectations. Intuitively, one might think that when expectations become more dispersed, overall unemployment rises. After all, a very pessimistic searcher has a very low reservation wage and is likely to accept the next job offer. Pessimists have a lower bound on their search duration: it asymptotes to one period. Optimists, on the other hand, do not face a similar upper bound. There is an asymmetry between underestimating and overestimating wages. This drives convexity from expected wages to individuals' unemployment rates. Such a convexity, in turn, implies that average unemployment rises in dispersion. In fact, mathematically we can identify one term that represents this convexity.

[14] Another recent empirical contribution applying survey data on wage expectations is Filippin and Ichino (2004). They use data gathered from University of Bocconi students to investigate the relationship between the expected and realized gender wage gap. We refer to Botelho and Pinto (2004) for a useful survey of the empirical literature on wage expectations.

Nonetheless, the theory result is not as straightforward as this intuition would suggest. There are several effects relating to the shape of the true wage-offer distribution that can go in the opposite direction. In two propositions we prove the existence of distributions for which aggregate unemployment unambiguously increases in the dispersion of expected wages, and distributions for which it unambiguously decreases.

To make further inroads, we turn to numerics. We calibrate the model on US and German unemployment. We work with a standard lognormal distribution and, specifying the discount rate and the job separation rate, we impute its shape parameter. We then introduce heterogeneous wage expectations. Moreover, the results of the survey studies allow us to define upper bounds on the degree of heterogeneity (upper bounds because students are likely the least informed labor market participants). As heterogeneity rises from zero to the upper bound, unemployment continuously increases. Thus, for relevant parameter values, aggregate unemployment unambiguously increases in the dispersion of wage expectations.

This leads to a policy implication: unemployment can be reduced through a better dissemination of wage information. Career counseling among students, for instance, which generally focusses on helping students in knowing what jobs to look for and where (reducing frictions), could also focus on improving students' knowledge of the wages they can expect.

We apply a different numerical exercise to assess the size of potential gains from better wage information. We match the current unemployment rate to the model with heterogeneous wage expectations, for different degrees of heterogeneity. We then compute how much unemployment decreases as wage expectations converge. For instance, for the US, if the 90th percentile of searchers overestimate the true expected wage by 10% and the 10th percentile underestimate it by 10%, better wage information could reduce unemployment by up to 0.5 percentage points. That is, for a degree of dispersion far below those in the survey studies, 1 out of 10 unemployed in the US are jobless because of the dispersion of expected wages. Hence, the model predicts that the effect of heterogeneous wage expectations on unemployment is sizeable.

Our paper relates to the literature on search when the true wage-offer distribution is unknown. This literature does not consider a heterogeneous population of searchers, but rather a representative searcher who learns about the distribution by observing wage offers. Rothschild (1974) was first to investigate whether the reservation wage property also holds under Bayesian learning. He proved that it does, but only under particular assumptions about the prior (Dirichlet distribution). Bikhchandani and Sharma (1996) generalize Rothschild's result.[15] Contrary to this literature, our paper abstracts from learning, in order to focus on the effect of aggregating over heterogeneous agents. Adam (2001) provides a discussion of several studies in search theory that abstract from learning in order to focus on a different aspect, such as distinguishable search alternatives.

Theoretical analysis

In this section we analytically investigate the relationship between unemployment and heterogeneous wage expectations. We start from a standard representative-agent search model, which includes job separation, and derive an expression for the equilibrium unemployment rate. Subsequently, we allow for heterogeneous searchers who differ in their wage expectations, and consider the implications.

The representative-agent model

Our exposition of the representative-agent search model follows that in Sargent and Ljungqvist (2004). An infinetely-lived, risk-neutral, unemployed worker gets a wage offer, w, each period, which is drawn from a time-invariant cumulative density function, $F(w)$, on the support $[0, \infty)$. The worker can reject the offer, in which case he is allowed to draw another offer, w', next period. Alternatively, he can accept the offer and work at wage w until he is fired. On every job he faces the same fixed probability, $\lambda \in (0, 1)$, each period of being fired.[16]

[15] Other contributions in this field include Burdett and Viswanath (1988) and Dubra (2004).

[16] We abstract from quitting as it makes no qualitative difference. As formally shown by Sargent and Ljungqvist (2004, pp. 140-141), a worker will never voluntarily quit a job that pays him more than his reservation wage. Moreover, we do not consider unemployment benefits or search costs, as they are not essential to our analysis.

The worker maximizes the expected present value of his income stream, where income at t, y_t, equals 0 if the worker is unemployed, and w if he is working. Define $V(w)$ as the expected value of $\sum_{t=0}^{\infty} \beta^t y_t$ if the worker has offer w in hand. Here, $\beta \in (0,1)$ is the discount factor. If the searcher rejects the current wage offer w, he gets the option to make a new draw next period, which has value $V(w) = \beta \int_0^{\infty} V(w')f(w')dw'$. But if he accepts the current offer he gets

$$V(w) = w + \beta \left[\lambda\beta \int_0^{\infty} V(w')f(w')dw' + (1-\lambda)V(w) \right] \iff V(w) = \frac{w + \beta \left[\lambda\beta \int_0^{\infty} V(w')f(w')dw' \right]}{1-\beta(1-\lambda)}$$

Hence, the searcher's maximization problem becomes:

$$V(w) = \max_{\{accept,reject\}} \left\{ \frac{w + \beta \left[\lambda\beta \int_0^{\infty} V(w')f(w')dw' \right]}{1-\beta(1-\lambda)}, \beta \int_0^{\infty} V(w')f(w')dw' \right\} \tag{34}$$

The reservation wage, $\overline{w}$, is the wage offer for which the searcher is indifferent between accepting and rejecting. Equating both sides in the max operator and solving gives:

$$\overline{w} = \frac{\beta}{1-\beta+\beta\lambda} \int_{\overline{w}}^{\infty} (w' - \overline{w}) f(w') dw' \tag{35}$$

When the distribution F is determined and λ and β are parameterized, this equation can be solved numerically for $\overline{w}$.

As is well-known (Pissarides (2000)), the equilibrium unemployment rate, $\overline{U}$, can be expressed as

$$\overline{U} = \frac{\lambda}{\lambda + q} \tag{36}$$

where q is the job creation rate. Here, the job creation rate equals the probability of accepting a job offer: $q = \int_{\overline{w}}^{\infty} f(w')dw'$.

Heterogeneous wage expectations

Instead of a representative agent who knows the true wage-offer distribution, $F(w)$, we now consider searchers with heterogeneous wage expectations. Each searcher has his own subjective distribution, $G_i(w)$, and associated expected wage, $E[w' \mid G_i]$. We make the following assumption:

Assumption 1 $E[w' \mid G_i]$ are distributed symmetrically around the true expected wage $E[w' \mid F]$.

This assumption is founded on the empirical results in the survey studies cited before. The median searcher is unbiased. What we are interested in is the relationship between the equilibrium unemployment rate, $\overline{U}$, and the dispersion of expected wages. Hence, we consider what happens to unemployment when the median wage expectation remains the same (at $E[w' \mid F]$), but the degree of heterogeneity of searchers' wage expectations rises. That is, when the dispersion of $E[w' \mid G_i]$ around $E[w' \mid F]$ increases. Let us define Ω as a measure of dispersion of $E[w' \mid G_i]$. For instance, $\Omega = VAR[E[w' \mid G_i]]$, or Ω is the ratio of the 90th to the 10th percentile of expected wages, as reported in the survey studies. Our aim is to understand $\frac{\partial \overline{U}}{\partial \Omega}$.

We require a new expression for $\overline{U}$, however. One that takes account of searchers' heterogeneity. Each searcher now has his own reservation wage, $\overline{w}_i$. This means that each searcher has an individual equilibrium unemployment rate, which we call $\overline{U}_i$. This unemployment rate is the steady-state probability that a worker is unemployed in a given period. After all, an individual is either employed or unemployed in a given period. Thus, with the transition probabilities into and out of work we can obtain an expression for the steady-state probability of unemployment in a given period:

$$\overline{U}_i = \frac{\lambda}{\lambda + \int_{\overline{w}_i}^{\infty} f(w')dw'} \tag{37}$$

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Aggregate unemployment is then simply the average individual unemployment rate:

$$\overline{U} = E\left[\overline{U}_i\right] \tag{38}$$

By the properties of an average, however, we can work directly with $\overline{U}_i$. If we find, for instance, that $\overline{U}_i$ is increasing and convex in $E[w' \mid G_i]$, then the average $\overline{U}_i$ will rise when $E[w' \mid G_i]$ become more dispersed: $\frac{\partial \overline{U}}{\partial \Omega} > 0$.

Understanding the relationship between aggregate unemployment and the dispersion of wage expectations thus becomes a matter of taking first and second derivatives.

$$\frac{d\overline{U}_i}{dE[w' \mid G_i]} = \frac{d\overline{U}_i}{d\overline{w}_i}\frac{d\overline{w}_i}{dE[w' \mid G_i]} = \lambda \frac{f(\overline{w}_i)}{\left[\lambda + \int_{\overline{w}_i}^{\infty} f(w')dw'\right]^2}\frac{d\overline{w}_i}{dE[w' \mid G_i]} \tag{39}$$

where we assume that:

Assumption 2 $\frac{d\overline{w}_i}{dE[w'|G_i]} > 0$.

That is, searchers with higher expected wages set higher reservation wages. This assumption involves implicit restrictions on the variance (and higher moments) of the distributions $G_i(w')$. The next example illustrates this point:

Example 1 *Imagine there are two searchers. Searcher 1 has subjective wage distribution* G_1 *which is uniform on* $[5, 15]$*, while searcher 2 has* G_2 *which is uniform on* $[8.1, 12.5]$*. Let us take parameter values,* $\beta = 0.95$ *and* $\lambda = 0.025$*. Then* $E[w \mid G_1] = 10 < E[w \mid G_2] = 10.3$ *but by equation (35),* $\overline{w}_1 = 10.9 > \overline{w}_2 = 9.9$*. This is due to the larger variance of* G_1*.*

Assumption 2 thus implies that if searcher i has a higher expected wage than searcher j, then the variance under $G_i(w')$ is either at least as large as that under $G_j(w')$ or, if not, it is not so much smaller that $\overline{w}_i > \overline{w}_j$ is violated. As an empirical matter, very little is known about the variance of subjective wage distributions. The only study we know of that investigates this is Dominitz and Manski (1997). They find that, on average, people with higher expected income, have a larger variance of income expectations. This would be in agreement with Assumption 2.

Naturally, by equation (39) and Assumption 2 we have that $\frac{d\overline{U}_i}{dE[w'|G_i]} > 0$. Hence, a searcher with a higher wage expectation has a higher individual unemployment rate. This says nothing yet about how the dispersion of wage expectations affects unemployment. For that, we need to analyze the second derivative.

$$\frac{d^2\overline{U}_i}{dE\left[w' \mid G_i\right]^2} = \frac{d\overline{U}_i}{dE\left[w' \mid G_i\right]}\left[2\frac{f\left(\overline{w}_i\right)}{\lambda + \int_{\overline{w}_i}^{\infty} f(w')dw'} + \frac{f'\left(\overline{w}_i\right)}{f\left(\overline{w}_i\right)} + \frac{\frac{d^2\overline{w}_i}{dE[w'|G_i]^2}}{\frac{d\overline{w}_i}{dE[w'|G_i]}}\right] \tag{40}$$

The first term in parentheses is very intuitive. Abstracting from the other terms, the first term implies that an individual's unemployment rate is strictly convex in his expected wage. Imagine a very pessimistic searcher. He will almost certainly accept the next job offer he receives. His search duration is bounded from below. Hence the unemployment duration of pessimists asymptotes towards one period. Optimists, on the other hand, face no such upper bound. Therefore, there is an asymmetry between underestimating wages and overestimating wages, which drives the convexity.

The second and third term inside the brackets are more subtle to interpret. The second term relates to the slope of the probability distribution function. Where the density function is downward sloping, this term works against the convexity implied by the first term. Though a higher expected wage implies a higher reservation wage, the extent to which this higher reservation wage translates into higher unemployment depends on $f(w')$. At a point where it slopes steeply downwards, a rise in the reservation wage implies only a small loss in the total area of the distribution above $\overline{w}_i$. And, therefore, a small increase in unemployment. The third term, moreover, relates to the convexity/concavity of the reservation wage in expected wages, about which we have made no assumptions. Overall, we cannot make a statement about the sign of $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2}$ that will hold true for all distributions. But, instead, we establish two benchmark results. Firstly:

Proposition III.1 *There exist distributions, $F(w')$, for which $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} > 0$ holds over the entire support. Hence, for some distributions the aggregate unemployment rate unambiguously increases in the dispersion of wage expectations: $\frac{\partial \overline{U}}{\partial \Omega} > 0$.*

And, secondly:

Proposition III.2 *There exist distributions, $F(w')$, for which $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} < 0$ over at least some subset $[a, b]$ of the support. Hence, cases can be constructed for which a marginal increase in the dispersion of expected wages leads to a decrease in the aggregate unemployment rate: $\frac{\partial \overline{U}}{\partial \Omega} < 0$.*

Proofs can be found in the appendix. These propositions establish that heterogeneity of wage expectations could, in principle, affect aggregate unemployment either way. In order to gain a deeper insight into the way the dispersion of wage expectations is likely to affect unemployment, we need to consider a realistic parameterization. This allows us to assess not only the sign, but also the size of the effect.

Calibration

In this section we calibrate the model. Specifically, we propose the following numerical exercise. First, we calibrate a completely standard homogeneous-expectations search model on the current unemployment rate in the United States and Germany. Subsequently, we introduce heterogeneous wage expectations. We then analyze the sign of the relationship between the dispersion of expected wages and unemployment, and estimate the quantitative impact of reducing the dispersion of wage expectations through better wage information.

Standard model

We want to calibrate equations (35) and (36) such that $\overline{U}_{US}$ equals the unemployment rate of the US: 5.0% in June 2005 according to OECD Statistics, while by the same source for Germany $\overline{U}_{DE} = 9.5\%$. We require parameter values for the discount rate, the job separation rate and a functional form for $f(w')$.

The discount rate

In a comprehensive survey on rates of time preference, Frederick et al. (2002) give an overview of the results of estimating discount rates from 42 different studies. Though the variation in results is very large, the median study finds an annual rate of time preference of around 0.90. However, we do not know how long a period is in calender time in our model. But using data from the US BLS and the German Statistisches Bundesamt we have an indication for job arrival rates. For instance, for the US we already have $\frac{\text{unemployed}}{\text{labour force}} = 0.05$. Next, the BLS reports the ratio $\frac{\text{new job openings}}{\text{employed}}$, which for the first half of 2005 stands at around 3.5% per month. Taking these two together, plus the equation that employed + unemployed = labour force, we compute $\frac{\text{new job openings}}{\text{unemployed}} = 0.665$. We call this the monthly probability of receiving a job offer. This is of course rather rough, since job-to-job transitions and structural unemployment are implicitly assumed away. This is consistent with our model, however. Finally, given the monthly probability of receiving an offer, p, we can compute the average number of months until a job offer is received as follows: $Average\,[N] = \sum_{N=1}^{\infty} Np\,[1-p]^{N-1}$. For the US, the average number of months till a job offer is 1.5. By similar computation it stands at 10 months for Germany. These are the periods that we have in the model: from one job offer to the next. If $\beta = 0.90$ is taken as the yearly discount rate, then $\beta_{DE} \approx 0.915$ and $\beta_{US} \approx 0.985$.

The job separation rate

Data from the German Institut fur Arbeitsmarkt- und Berufsforschung (see Bachmann (2005)) indicate that in Germany the job separation rate is around 0.63% per month. It should be noted though, that the German figures are for all types of job separation, not only layoffs which is what λ essentially stands for. The US BLS reports figures by cause of separation. The layoff rate stands at about 1.2% a month in 2005. For the period lengths found above, these figures translate into $\lambda_{DE} = (1.0063)^{10} - 1 = 0.065$ and $\lambda_{US} = (1.012)^{1.5} - 1 = 0.018$. Below we perform sensitivity tests for both λ and β.

The wage distribution

We choose to work with the lognormal distribution, as it is generally considered a good approximation of empirical wage distributions (see, for instance, Dominitz and Manski (1996, 1997)). In fact, we take the standard lognormal distribution, for which:

$$f(w) = \frac{1}{w\sigma\sqrt{2\pi}} \exp\left[-\frac{[\ln w]^2}{2\sigma^2}\right] \tag{41}$$

with $w > 0$ and $\sigma > 0$. Hence the standard lognormal distribution has only a shape parameter, σ. Equations (35) and (36) become:

$$\overline{w} = \frac{\beta}{1-\beta+\beta\lambda} \int_{\overline{w}}^{\infty} \frac{w' - \overline{w}}{w'\sigma\sqrt{2\pi}} \exp\left[-\frac{[\ln w']^2}{2\sigma^2}\right] dw' \tag{42}$$

and

$$\overline{U} = \lambda \left[\lambda + 1 - \int_{0}^{\overline{w}} \frac{1}{w'\sigma\sqrt{2\pi}} \exp\left[-\frac{[\ln w']^2}{2\sigma^2}\right] dw'\right]^{-1} \tag{43}$$

Given $\overline{U}$, λ and β we can impute σ using the two equations above. This is the advantage of using a *standard* lognormal distribution: since it is a one parameter distribution, we can impute a unique value for the free parameter. For the given parameters we impute $\sigma_{US} = 0.135$ and $\sigma_{DE} = 0.235$. It is not remarkable that the imputed σ's differ considerably for the US and Germany, because the periods are different: it is likely that the wage-offer distribution of an individual who receives an offer every 1.5 months is different from that of someone who receives an offer every 10 months.

Model with heterogeneous wage expectations

Using the parameter values above, we now want to understand how unemployment is affected when job searchers have different wage expectations. We need a way, however, to translate individuals' expected wages into reservation wages. One possibility would be to make an assumption about the shape of all G_i. Instead, we prefer to keep the calibration's predictions

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more general, and use empirical estimates of the elasticity of reservation wages to expected wages.

Obtaining estimates of the elasticity

A few studies have estimated the elasticity of the reservation wage to the expected wage. There are two ways to do this. Jones (1989) estimates an OLS equation for the UK in which he regresses the log reservation wage on, among other variables, the log past wage of the unemployed searcher. He takes the past wage as a proxy for the mean of the individual-specific wage distribution. This may seem like a rather rough procedure, but in a recent study Hogan (2004) uses a different method and has very close results to those of Jones. Hogan uses data from the British Household Panel Survey to test for the determinants of reservation wages. One of his regressors is the mean of the individual-specific distribution of wage offers. He constructs this mean by an estimation on variables that reflect a person's characteristics in terms of human capital and household composition. In the second step, the log reservation wage is regressed on, among other variables, the log mean of the individual-specific wage distribution. Both Jones and Hogan find (highly significant) elasticities in the range $0.25 - 0.29$ for the UK.

Using Jones' method, Christensen (2001) estimates this elasticity for Germany at $\eta_{DE} = 0.46$. Another estimate by Addison et al. (2004) for the EU-15 minus Sweden and Luxemburg gives a fairly similar result, with an elasticity of 0.41. For the US we are aware of only one such estimate, again following Jones (1989), by Haurin and Sridhar (2003), $\eta_{US} = 0.64$.[17] We use the estimates by Christensen (2001) and Haurin and Sridhar (2003) for our calibration.

The distribution of wage expectations

Assumption 1 states that $E[w' \mid G_i]$ are distributed symmetrically around the true expected wage $E[w' \mid F]$. In fact, using the above elasticities we have a linear transformation of expected wages into reservation wages, so that we can directly write $\overline{w}_i = \overline{w} + \varepsilon_i$ where $\overline{w}$ is the

[17] From Jones (2002) we do have an estimate of this elasticity for Canada at 0.59.

reservation wage against the true distribution $F(w')$ and ε_i are distributed symmetrically with mean zero. Call $h(\varepsilon_i)$ the distribution of ε_i. This distribution requires a functional form in our calibration. We set $h(\varepsilon_i) \sim N(0, \sigma_\varepsilon^2)$. However, we need to determine a cutoff to avoid negative reservation wages. We set the cutoff at 3 standard deviations, $\varepsilon_i \in [-3\sigma_\varepsilon, 3\sigma_\varepsilon]$, which, as an empirical matter, is nearly equivalent to $\varepsilon_i \in [-\infty, \infty]$, as it includes 99.73% of the distribution. We now have the following expression for the aggregate unemployment rate, from equations (37) and (38):

$$\overline{U} = \frac{\lambda}{\sigma_\varepsilon\sqrt{2\pi}} \int_{-3\sigma_\varepsilon}^{3\sigma_\varepsilon} \left[1 + \lambda - \int_0^{\overline{w}+\varepsilon_i} \frac{1}{w'\sigma\sqrt{2\pi}} \exp\left[-\frac{[\ln w']^2}{2\sigma^2}\right] dw'\right]^{-1} \exp\left[-\frac{\varepsilon_i^2}{2\sigma_\varepsilon^2}\right] d\varepsilon_i \qquad (44)$$

Measuring the degree of dispersion

We have values for all parameters in the expression above, except for σ_ε. However, from the papers by Betts (1996), Dominitz and Manski (1996) and Brunello et al. (2001) we have point estimates for a measure of heterogeneity of wage expectations. This measure is the ratio of the 90th against the 10th percentile of respondents, ranked by expected wages. We let $\varepsilon_{..th}$ refer to the ..th percentile. Then, $\Omega = \frac{E\left[w|G_i=G_{\varepsilon_{90th}}\right]}{E\left[w|G_i=G_{\varepsilon_{10th}}\right]}$ denotes the ratio we have from the survey studies, which from both Betts (1996) and Dominitz and Manski (1996) is about $\Omega = 2$ for the US, while from Brunello et al. (2001) it is around $\Omega = 3.2$ for Germany. These estimates for Ω allow us to obtain an upper bound on σ_ε. The reason they constitute an upper bound is that the surveys were conducted among students, who are likely to possess less information than experienced labour market participants.

To derive this upper bound, we start from

$$\frac{\overline{w}(\varepsilon_{90th}) - \overline{w}(\varepsilon_{10th})}{\overline{w}(\varepsilon_{10th})} = \eta \frac{E\left[w \mid G_i = G_{\varepsilon_{90th}}\right] - E\left[w \mid G_i = G_{\varepsilon_{10th}}\right]}{E\left[w \mid G_i = G_{\varepsilon_{10th}}\right]} = \eta(\Omega - 1) \qquad (45)$$

where η is the elasticity of reservation wages to expected wages. By $\overline{w}(\varepsilon_i) = \overline{w} + \varepsilon_i$, moreover, we can rewrite to

$$\frac{\varepsilon_{90th} - \varepsilon_{10th}}{\overline{w} + \varepsilon_{10th}} = \eta\left(\Omega - 1\right) \tag{46}$$

Secondly, in our symmetric setup, where the 50th percentile is the median searcher for which $\varepsilon_{50th} = 0$,

$$\varepsilon_{90th} + \varepsilon_{10th} = 0 \tag{47}$$

And since $h\left(\varepsilon_i\right) \sim N\left(0, \sigma_{\varepsilon}^2\right)$ then by the tables of the normal distribution

$$\varepsilon_{90th} - \varepsilon_{10th} = 2\left(1.28\right)\sigma_{\varepsilon} \tag{48}$$

And the three preceding equations together yield

$$\sigma_{\varepsilon} = \frac{1}{1.28}\overline{w}\left[\frac{\eta\left(\Omega - 1\right)}{2 + \eta\left(\Omega - 1\right)}\right] \tag{49}$$

So for the US calibration, for instance, we consider σ_{ε} for $\Omega \in [1, 2]$, because $\Omega = 1$ is the minimum (implying homogeneous wage expectations) and $\Omega = 2$ is the upper bound on heterogeneity.

Calibration results

The numerical exercise we conduct is to compute for the relevant range of Ω, the difference between unemployment in equation (44) and unemployment in equation (43). That is, the difference between unemployment when searchers have heterogeneous wage expectations and the unemployment when they have homogeneous wage expectations. The latter we matched to the actual unemployment rate. Call this difference $\Delta\overline{U}$. Our results are reported in the tables below. In these tables $\Delta\overline{U}$ is expressed in terms of percentage points. So, for instance, for the United States if $\Omega = 1.2$ then the unemployment rate with heterogeneous wage expectations, is 5.47%, an increase of 0.47% over the actual US unemployment rate. Hence the entry 0.47 at $\boldsymbol{\Delta}\overline{U}_{\Omega=1.2}$ in the first row of Table I. The rows below give an indication of the sensitivity of the results to changes in the values of the exogenous parameters β and λ.

[Insert Tables I and II here]

The results consistently indicate that unemployment is rising in the dispersion of wage expectations. Hence, though Propositions 1 and 2 formally proved ambiguity in the general case, in the calibration the outcome is unambiguous.

The size of the effect

The above results do not tell us how much policy-makers could potentially reduce unemployment by improving information about wages in the economy. Instead, we can turn the exercise upside down and obtain a quantitative outcome. We match the expression in equation (44) to the actual unemployment rate, and compute how much unemployment falls as $\Omega \to 1$. That is, assuming we live in a world where people differ in their wage expectations, we can ask how much unemployment could be reduced if suddenly all expectations converged to the unbiased median. This provides an upper bound on unemployment reduction due to better wage information. As an example, say that in the US we set $\Omega = 1.2$, and find the σ that matches $Average\left[\overline{U}_i\right] = 5.0\%$. This turns out to be $\sigma = 0.133$. Then we can compute for $\Omega \to 1$ that the model predicts that unemployment goes to 4.47%. Hence, the maximum reduction in unemployment due to better wage information is 0.53% in this case. Table III reports the maximum unemployment reduction due to better wage information for different values of Ω, given the same β and λ as before.

[Insert Table III here]

Unfortunately, we cannot compute beyond $\Omega = 1.2$ for the US and $\Omega = 2$ for Germany. The reason is that for high values of Ω there no longer exists a σ that matches the current unemployment rate.[18] However, already for the relatively low values of Ω in Table III, the

[18] For instance, when $\Omega = 1.3$, $\beta = 0.985$ and $\lambda = 0.018$, then in equation (44) $\overline{U}_{US} > 5.0$ even as $\sigma \to 0$. This happens because for low values of σ, $\overline{U}_{US}$ becomes almost irresponsive to further reductions. The reservation wage then asymptotes towards a lower bound, in this case $\overline{w} \to 0.967$.

model predicts that a considerable part of current unemployment is due to heterogeneous wage expectations. For instance, $\Omega = 1.2$ means that the 90th percentile of searchers overestimate the true expected wage by 10% and the 10th percentile underestimate it by 10%. But already for this relatively small degree of heterogeneity, 1 out of 10 unemployed in the US is jobless because of the dispersion of expected wages. Hence, the calibrated model suggests that the potential for unemployment reduction due to a better dissemination of wage information is rather large.

Conclusions

Motivated by survey studies' findings that wage expectations are widely dispersed, we have considered the effects of heterogeneous expectations about wages on unemployment. We extended a standard search model to include heterogeneous wage expectations. Dispersed wage expectations have an ambiguous effect on unemployment. On the one hand, search duration of pessimists converges to a lower bound, whereas optimists face no upper bound on their search duration. There is an asymmetry between underestimating and overestimating wages. This would imply a higher unemployment rate for wider dispersion. On the other hand, there are subtle effects related to the shape of the wage-offer distribution, which can, in principle, overturn the positive relationship between the dispersion of wage expectations and unemployment.

In order to assess what the relationship looks like for relevant parameter values, we calibrated the model on US and German unemployment. Not only does greater dispersion of wage expectations now unambiguously increase unemployment, but the effect is sizeable. For dispersion levels far below those reported in survey studies, a considerable part of unemployment is due to dispersed wage expectations.

Our results advocate efforts to improve the dissemination of information about wages. Career counseling among students, for instance, which generally focusses on helping students in knowing what jobs to look for and where (reducing frictions), could also focus on improving

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students' knowledge of the wages they can expect. More generally, awareness of the importance of a culture that fosters greater openness about wages may be helpful, especially in Europe, where there tends to be a culture that does not promote the exchange of knowledge about wages.

This paper is the first to explore the relationship between heterogeneous wage expectations and unemployment. For this reason, it started from the most basic setting. Embedding expectations dispersion in a richer structure, including learning or an endogenous firm side, is left for future research.

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Part IV

Appendices

Appendix A. Microfoundations of Chapter I

This appendix presents a general model that matches properties P1-P3. To do so the following elements will prove sufficient:

1. There are trade imbalances.

2. There is full specialization in production.

3. Tariffs can affect the terms-of-trade.

4. There are gains from trade.

Before presenting the formal derivation, we explain intuitively how these elements lead to properties P1-P3. Trade imbalances in conjunction with the ability to affect terms-of-trade lead to P1: the larger a country's trade deficit is, the more it loses more from giving up the ability to influence its import prices. When, in addition, there are gains from trade, P2 obtains, because there is a trade-off between the gains from trade and the losses from yielding independent tariff setting. Beyond a threshold trade deficit, losses exceed gains. Finally, full specialization and the ability to affect terms-of trade together bring about P3. The reason is that when two countries sign an agreement to cut bilateral tariffs, they raise the price of each other's export goods. Given that the third country does not produce these goods itself, but imports them, the agreement makes it worse off.

Thus, we present a model that contains these four elements and microfounds our one-shot game. The model has two periods. In the first period there are country-specific income shocks and consumers smooth consumption through international borrowing and lending. When a country borrows from abroad, it purchases more than it sells, and is in trade deficit. Upon repayment of the debt it must generate a trade surplus. This is a standard approach to modelling imbalances (Obstfeld and Rogoff (1996)). Subsequently, in the second period, the trade negotiation game described in Figure 2 takes place.

Intertemporal preferences

As is common in the literature on trade imbalances, preferences over the intertemporal allocation of consumption expenditure and preferences over the intratemporal allocation of goods

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are separately defined (Obstfeld and Rogoff (1996)). Intertemporal utility in country i is given by $U\left(C_i^t\right)$ where C_i^t is country i's total consumption expenditure in period t. We do not need to specify a particular functional form. However, we assume that $\frac{dU\left(C_i^t\right)}{dC_i^t} > 0$ and $\frac{d^2U\left(C_i^t\right)}{d\left(C_i^t\right)^2} < 0$: intertemporal preferences are concave. This bring about the incentive to smooth consumption over time. Country i's representative consumer maximizes:

$$\max_{C_i^{t=1}, C_i^{t=2}} \left\{U\left(C_i^{t=1}\right) + \delta U\left(C_i^{t=2}\right)\right\} \tag{A.1}$$

where δ is the discount rate. Income in the periods is given by

$$Y_i^t = \overline{Y} + g\left(C_i^t, C_j^t\right) + \nu_i^t \tag{A.2}$$

where $\overline{Y}$ is an exogenous income component and $g\left(C_i^t, C_j^t\right)$ is an income component that depends on consumption decisions in country i and abroad. It includes producer profits and tariff revenues. Finally, ν_i^t is the country-specific income shock with $\nu_i^{t=1}$ being independently and identically distributed across countries, while $\nu_i^{t=2} = 0$ for all countries.

To smooth income shocks consumers are allowed to buy and sell an internationally traded bond, B, which pays interest rate r. Hence,

$$C_i^{t=1} = Y_i^{t=1} - B_i \tag{A.3}$$

and

$$C_i^{t=2} = Y_i^{t=2} + (1+r) B_i \tag{A.4}$$

The bond is the only internationally traded asset. Financial market clearing requires that r adjusts so as to obtain

$$\sum_i B_i = 0 \tag{A.5}$$

We can now rewrite the consumer's optimization problem to

$$\max_{B_i} \left\{U\left(\overline{Y} + g\left(C_i^{t=1}, C_j^{t=1}\right) + \nu_i^{t=1} - B_i\right) + \delta U\left(\overline{Y} + g\left(C_i^{t=2}, C_j^{t=2}\right) + (1+r) B_i\right)\right\}$$

where the outcome of trade negotiations in period 2 affects $g\left(C_i^{t=2}, C_j^{t=2}\right)$. In fact, we assume that governments play no role in the first period, and that first period tariffs are exogenously given. Governments only play the negotiation game in period 2. By separating consumer and government decisions over the two periods, much complexity is avoided. In the second period governments take consumers' first period decision as given. And in the first period consumers optimize taking into account the effect that their borrowing and lending has on second period negotiations. The first order condition to the consumer's problem yields:

$$\frac{dU\left(\overline{Y}+g\left(\cdot\right)^{t=1}+\nu_i^{t=1}-B_i\right)/dB_i}{dU\left(\overline{Y}+g\left(\cdot\right)^{t=2}+\left(1+r\right)B_i\right)/dB_i}=\frac{\delta\left[\left(1+r\right)+\frac{d}{dB_i}g\left(\cdot\right)^{t=2}\right]}{1-\frac{d}{dB_i}g\left(\cdot\right)^{t=1}} \tag{A.6}$$

where the effect of the consumer's first period decision on the outcome of the negotiation game in the second period is contained in $\frac{d}{dB_i}g\left(\cdot\right)^{t=2}$.

Now, take $\nu_i^{t=1}<\nu_j^{t=1}\forall j$. That is, country i experiences a negative income shock relative to other countries. Then, by $\frac{dU\left(C_i^t\right)}{dC_i^t}>0$ and $\frac{d^2U\left(C_i^t\right)}{d\left(C_i^t\right)^2}<0$ we have that

$$\left.\frac{d}{dB_i}U\left(\overline{Y}+g\left(\cdot\right)^{t=1}+\nu_i^{t=1}-B_i\right)\right|_{B_i=0}<\left.\frac{d}{dB_j}U\left(\overline{Y}+g\left(\cdot\right)^{t=1}+\nu_j^{t=1}-B_j\right)\right|_{B_j=0}\forall j$$

and, therefore, $B_i<0$ is optimal. Consumers in country i borrow in period 1 and repay in period 2. Notice that it is the relative size of shocks that determines borrowing and lending ($\nu_i^{t=1}<\nu_j^{t=1}$), not the absolute size ($\nu_i^{t=1}\lesseqgtr 0$). When, say, $\nu_i^{t=1}=\nu_j^{t=1}\forall j$ with $\nu_i^{t=1}<0$, no borrowing and lending takes place, since all countries are in an identical position.

As trade negotiations occur in the second period, for $\nu_i^{t=1}<\nu_j^{t=1}\forall j$ country i would be in the position of country Z in our one-shot game. Likewise, when $\nu_i^{t=1}>\nu_j^{t=1}\forall j$ then country i is in the position of country X during trade negotiations.

Therefore, borrowing in the first period implies a weaker negotiation position in the second period (since country Z is the least favoured partner). Likewise, first period lending can bestow benefits beyond interest payment. This, of course, is factored into consumers' optimal borrowing and lending (through $\frac{d}{dB_i}g\left(\cdot\right)^{t=2}$) and hence into market clearing interest rates.

Intratemporal preferences

The intertemporal decision determines how much the domestic consumer spends on consumption each period. Intratemporal allocation within a given period faces the following budget constraint, therefore:

$$\sum_k p_{ik}^t c_{ik}^t=C_i^t \tag{A.7}$$

where c_{ik}^t is the consumption in country i of good k at time t, and p_{ik}^t is that good's price. Intratemporal utility over the consumption of the goods, $u\left(c_{ik}^t\right)$, does not require a particular functional form. We assume, however, that preferences generate downward sloping demand

$$\frac{\partial c_{ik}^t}{\partial p_{ik}^t}<0 \tag{A.8}$$

In addition, we assume that demand elasticities are the same for different goods, and across different countries:

$$\frac{\partial c_{ik}^{t}}{\partial p_{ik}^{t}} = \frac{\partial c}{\partial p} \forall i, k, t \tag{A.9}$$

This will ensure that countries' relative market power over different product markets can be expressed in terms of differences in consumption shares only.

Production

Producers in each country produce one good only, which is made nowhere else. Thus, each country exports one good and imports two, i.e., there is full specialization. We denote by c_{ij}^{t} and p_{ij}^{t} the consumption and price in country i of country j's export good. Likewise, c_{ii}^{t} and p_{ii}^{t} are the domestic consumption and domestic price of the locally produced good.

Production is subject to decreasing returns to scale and perfect competition. Denote by Q_{i}^{t} the total quantity supplied of country i's export good by local producers. Modelling in reduced form:

$$Q_{i}^{t} = h\left(p_{ii}^{t}\right) \tag{A.10}$$

with $h'\left(p_{ii}^{t}\right) > 0$, while market clearing implies

$$c_{ii}^{t} + \sum_{j} c_{ji}^{t} = Q_{i}^{t} \tag{A.11}$$

Tariffs

The difference between the local price of an import good and the price in its country of origin, $p_{ij}^{t} - p_{jj}^{t}$, comes about through import tariffs. In particular,

$$p_{ij}^{t} = f\left(p_{jj}^{t}, \tau_{ij}^{t}\right) \tag{A.12}$$

where τ_{ij}^{t} is country i's import tariff on country j's good, and $\frac{\partial p_{ij}^{t}}{\partial \tau_{ij}^{t}} > 0$. We can show, furthermore, that part of the tariff is absorbed by a lower world price of the good, $\frac{\partial p_{jj}^{t}}{\partial \tau_{ij}^{t}} < 0$. This follows from equations (A.8), (A.10), (A.11) and (A.12):

$$\frac{\partial p_{jj}^{t}}{\partial \tau_{ij}^{t}} = \frac{dp_{jj}^{t}}{dQ_{j}^{t}} \frac{\partial Q_{j}^{t}}{\partial c_{ij}^{t}} \frac{\partial c_{ij}^{t}}{\partial p_{ij}^{t}} \frac{\partial p_{ij}^{t}}{\partial \tau_{ij}^{t}} = + + - + < 0 \tag{A.13}$$

which means that tariffs affect the terms-of-trade. Terms-of-trade can be written as the number of goods country i can import with the proceeds from one of its goods being exported, p_{ii}^{t}/p_{jj}^{t} (ex-tariff price of exports over ex-tariff price of imports). Thus, a higher tariff of i on

j implies that country j's exports become cheaper, and its terms-of-trade worsen, while those of country i improve.

Finally, we assume that the ability to affect terms-of-trade strengthens in the market power over a good:

$$\frac{\partial^2 p_{jj}^t}{\partial \tau_{ij}^t \partial \left[c_{ij}^t / Q_j^t\right]} < 0 \tag{A.14}$$

The greater the fraction a country consumes of a foreign good, c_{ij}^t/Q_j^t, the greater the ability to depress its price with import tariffs.

We assume, moreover, that governments make optimal use of this market power when they set tariffs (which only happens when negotiations conclude without an agreement in the second period). Standard optimum tariff theory arguments (Johnson (1953-1954)) then imply that

$$\frac{c_{ij}^t}{Q_j^t} > \frac{c_{ji}^t}{Q_i^t} \Longleftrightarrow \left.\frac{p_{ii}^t}{p_{jj}^t}\right|_{RTA_{ij}\in\Omega^t} < \left.\frac{p_{ii}^t}{p_{jj}^t}\right|_{RTA_{ij}\notin\Omega^t} \tag{A.15}$$

When one country has greater influence over terms-of-trade than another country, it has lower terms-of-trade under bilateral free trade than under non-cooperation.

Results

Properties P1-P3 are written in terms of welfare. To link statements about terms-of-trade to statements about welfare, we first specify that:

$$\frac{\partial W_i^t}{\partial \left[p_{ii}^t / p_{jj}^t\right]} > 0 \tag{A.16}$$

That is, a country's welfare is increasing in its terms-of-trade.

Moreover, by downward sloping demand and upward sloping supply from equations (A.8) and (A.10), standard deadweight losses from taxation imply that

$$\left[W_i^t + W_j^t\right]\Big|_{RTA_{ij}\in\Omega^t} > \left[W_i^t + W_j^t\right]\Big|_{RTA_{ij}\notin\Omega^t} \tag{A.17}$$

and tariff elimination raises joint welfare.

To match P1-P3, welfare statements, in turn, need to be related to the trade balance:

$$TB_{ij}^t = p_{ii}^t c_{ji}^t - p_{jj}^t c_{ij}^t \tag{A.18}$$

where $TB_{ij}^t < 0 \Longleftrightarrow C_i^t > C_j^t$. And, by equation (A.9), $C_i^t > C_j^t \Longleftrightarrow \frac{c_{ij}^t}{Q_j^t} > \frac{c_{ji}^t}{Q_i^t}$. Hence, by equation (A.15), deficit country i suffers a terms-of-trade loss from signing an agreement. It follows that

$$\frac{\partial}{\partial TB_{ij}^t}\left[\left.\frac{p_{ii}^t}{p_{jj}^t}\right|_{RTA_{ij}\in\Omega^t}-\left.\frac{p_{ii}^t}{p_{jj}^t}\right|_{RTA_{ij}\notin\Omega^t}\right]<0 \tag{A.19}$$

That is, the size of the loss increases in the bilateral trade deficit, from which:

$$\frac{\partial}{\partial TB_{ij}^t}\left[W_i^t\big|_{RTA_{ij}\in\Omega^t}-W_i^t\big|_{RTA_{ij}\notin\Omega^t}\right]>0 \tag{A.20}$$

which is P1. Thus, a country faces a trade-off between the efficiency gains from an agreement (A.17) and losing its ability to affect terms-of-trade (A.20). In particular, by equation (A.17):

$$\left.\left[W_i^t\big|_{RTA_{ij}\in\Omega^t}-W_i^t\big|_{RTA_{ij}\notin\Omega^t}\right]\right|_{TB_{ij}^t=0}>0 \tag{A.21}$$

so that by equation (A.20) there exists some $\overline{TB}_{ij}^t<0$ at which

$$\left.\left[W_i^t\big|_{RTA_{ij}\in\Omega^t}-W_i^t\big|_{RTA_{ij}\notin\Omega^t}\right]\right|_{TB_{ij}^t=\overline{TB}_{ij}^t}=0 \tag{A.22}$$

This is P2. Finally, $RTA_{j\neq i}$ implies that countries $j\neq i$ cut tariffs on each other's goods, which raises mutual consumption of each other's goods and p_{jj}^t increases for both $j\neq i$. Therefore, $\frac{p_{ii}^t}{p_{jj}^t}$ decreases, so that

$$W_i^t\big|_{RTA_{j\neq i}\in\Omega^t}-W_i^t\big|_{RTA_{j\neq i}\notin\Omega^t}<0 \tag{A.23}$$

and

$$TB_{ij}\big|_{RTA_{j\neq i}\in\Omega^t}-TB_{ij}\big|_{RTA_{j\neq i}\notin\Omega^t}<0 \tag{A.24}$$

which matches P3.

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Appendix B. Proofs of Chapter I

Proof of Proposition 1. Applying backward induction, we consider first the outcome of RTA negotiations and then that of MTA negotiations. Below is country X's payoff matrix during RTA negotiations:

X's actions:	Other players' actions:	
	$RTA_{YZ} \in \Omega$	$RTA_{YZ} \notin \Omega$
Reject both	$W_X\|_{\Omega=\{RTA_{YZ}\}}$	$W_X\|_{\Omega=\{\emptyset\}}$
Accept only RTA_{XY}	$W_X\|_{\Omega=\{RTA_{XY},RTA_{YZ}\}}$	$W_X\|_{\Omega=\{RTA_{XY}\}}$
Accept only RTA_{XZ}	$W_X\|_{\Omega=\{RTA_{XZ},RTA_{YZ}\}}$	$W_X\|_{\Omega=\{RTA_{XZ}\}}$
Accept both	$W_X\|_{\Omega=\left\{RTA_{XY},RTA_{XZ},RTA_{YZ}\right\}}$	$W_X\|_{\Omega=\{RTA_{XY},RTA_{XZ}\}}$

where it is implicit that whenever X accepts RTA_{XY} or RTA_{XZ}, Y or Z accept it too. This follows from P1 and P2: $TB_{ij}(\Omega) > 0 > \overline{TB}_{ij}$. While by initial imbalances, $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} < 0$ and from P3, $TB_{XY}|_{RTA_{YZ}\in\Omega} - TB_{XY}|_{RTA_{YZ}\notin\Omega} < 0$ and $TB_{XZ}|_{RTA_{YZ}\in\Omega} - TB_{XZ}|_{RTA_{YZ}\notin\Omega} < 0$ country X is in bilateral deficit against Y and Z regardless of the actions of Y and Z against each other. Thus, irrespective of whether $RTA_{YZ} \in \Omega$ or $RTA_{YZ} \notin \Omega$, the RTAs that country X accepts are always signed.

Now, consider the case when $TB_{XZ}(\Omega)|_{\Omega=\left\{RTA_{XY},RTA_{YZ}\right\}} \geq \overline{TB}_{XZ}$ and $TB_{XY}(\Omega)|_{\Omega=\{RTA_{YZ}\}} \geq \overline{TB}_{XY}$ hold (point 1 in Proposition 1). P2 in conjunction with $TB_{XZ}(\Omega)|_{\Omega=\left\{RTA_{XY},RTA_{YZ}\right\}} \geq \overline{TB}_{XZ}$ gives

$$W_X|_{\Omega=\left\{RTA_{XY},RTA_{XZ},RTA_{YZ}\right\}} > W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}}$$

which, in turn, implies that

$$W_X|_{\Omega=\left\{RTA_{XY},RTA_{XZ},RTA_{YZ}\right\}} > W_X|_{\Omega=\{RTA_{XZ},RTA_{YZ}\}}$$

Likewise, P2 together with $TB_{XY}(\Omega)|_{\Omega=\{RTA_{YZ}\}} \geq \overline{TB}_{XY}$ gives

$$W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} > W_X|_{\Omega=\{RTA_{YZ}\}}$$

Hence, when Y and Z accept RTA_{YZ}, then $\Omega = \{RTA_{XY}, RTA_{XZ}, RTA_{YZ}\}$ achieves maximum welfare for country X and the action "Accept both" is optimal. However, by P3, the above welfare rankings directly imply

$$W_X|_{\Omega=\left\{RTA_{XY},RTA_{XZ}\right\}} > W_X|_{\Omega=\{RTA_{XY}\}}$$

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$$W_X|_{\Omega=\{RTA_{XY,}RTA_{XZ}\}} > W_X|_{\Omega=\{RTA_{XZ}\}}$$

$$W_X|_{\Omega=\{RTA_{XY}\}} > W_X|_{\Omega=\{\emptyset\}}$$

Therefore, "Accept both" is X's dominant strategy (i.e. optimal regardless of whether Y and Z accept RTA_{YZ}).

Moreover, whenever X is willing to accept RTA_{XZ} then, by $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{YZ}(\Omega)|_{\Omega=\{\emptyset\}} < 0$, Y is also willing to accept RTA_{YZ} (as is Z, by P2). Hence, during RTA negotiations all RTAs are accepted. Then, during the preceding MTA negotiations, countries face the choice between $\Omega = \{MTA\}$ if all accept the MTA and $\Omega = \{RTA_{XY,}RTA_{XZ}, RTA_{YZ}\}$ if the MTA is rejected. Since both imply world free trade $W_i|_{\Omega=\{RTA_{XY,}RTA_{XZ},RTA_{YZ}\}} = W_i|_{\Omega=\{MTA\}}\,\forall i$ and by the tie-breaking assumption the MTA is accepted by all. This proves point 1 in Proposition 1.

Next, consider the case that for all i with $TB_{ij} < 0$ it holds that $TB_{ij}(\Omega) < \overline{TB}_{ij}\forall\Omega$ (point 3 in Proposition 1). During RTA negotiations for each country pair there is one country (i with $TB_{ij} < 0$) that rejects the RTA, regardless of other countries' actions ($\forall\Omega$). Hence, RTA negotiations have $\Omega = \{\emptyset\}$ as the outcome. At the preceding MTA negotiations, countries thus choose between $\Omega = \{MTA\}$ and $\Omega = \{\emptyset\}$. Here, country X certainly rejects MTA. This follows from the fact that $TB_{Xj}(\Omega) < \overline{TB}_{Xj}\forall\Omega$ implies

$$W_X|_{\Omega=\{\emptyset\}} > W_X|_{\Omega=\{RTA_{XY},RTA_{XZ}\}}$$

and, by P3,

$$W_X|_{\Omega=\{RTA_{XY},RTA_{XZ}\}} > W_X|_{\Omega=\{RTA_{XY},RTA_{XZ},RTA_{YZ}\}}$$

so that by $W_X|_{\Omega=\{RTA_{XY,}RTA_{XZ},RTA_{YZ}\}} = W_X|_{\Omega=\{MTA\}}$ we have

$$W_X|_{\Omega=\{\emptyset\}} > W_X|_{\Omega=\{MTA\}}$$

and country X rejects the MTA. Thus, the outcome of trade negotiations is $\Omega = \{\emptyset\}$ which proves point 3 in Proposition 1.

Finally, when trade balances do not satisfy the conditions in either point 1 or point 3 of Proposition 1, then not all RTAs are accepted, nor are all RTAs rejected. The outcome is either $\Omega = \{RTA_{XY}\}$ or $\Omega = \{RTA_{YZ}\}$ or $\Omega = \{RTA_{XY}, RTA_{YZ}\}$. By $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} < 0$ and $TB_{XZ}(\Omega)|_{\Omega=\{\emptyset\}} < TB_{YZ}(\Omega)|_{\Omega=\{\emptyset\}} < 0$, if any RTA is rejected, then RTA_{XZ} is rejected by country X. When RTA_{XZ} is rejected, it holds that

$$W_X|_{\Omega=\{MTA\}} = W_X|_{\Omega=\{RTA_{XY,}RTA_{XZ},RTA_{YZ}\}} < W_X|_{\Omega=\{RTA_{XY,}RTA_{YZ}\}}$$

and, by P3,

$$W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} < W_X|_{\Omega=\{RTA_{XY}\}}$$

so that, regardless of whether Y and Z sign RTA_{YZ}, X achieves higher welfare without the MTA. Thus, when X rejects any RTA it also rejects the MTA.

It remains to show that all three regionalist equilibria, $\Omega = \{RTA_{XY}\}$, $\Omega = \{RTA_{YZ}\}$ and $\Omega = \{RTA_{XY}, RTA_{YZ}\}$, exist. Three examples suffice. Take $TB_{XZ}(\Omega)|_{\Omega=\{RTA_{XY}\}} < \overline{TB}_{XZ}$, $TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} \geq \overline{TB}_{XY}$ and $TB_{YZ}(\Omega)|_{\Omega=\{RTA_{XY}\}} < \overline{TB}_{YZ}$. By P3,

$$TB_{YZ}(\Omega)|_{\Omega=\{RTA_{XY}\}} = \max_{\Omega}\{TB_{YZ}(\Omega)\}$$

Hence, Y's dominant strategy is "Accept only RTA_{XY}". Similarly, X is always best off rejecting RTA_{XZ}. Thus, by $TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} \geq \overline{TB}_{XY}$ we have that $\Omega = \{RTA_{XY}\}$ results.

When, instead, $TB_{XY}(\Omega)|_{\Omega=\{\emptyset\}} < \overline{TB}_{XY}$, $TB_{XZ}(\Omega)|_{\Omega=\{RTA_{XY}\}} < \overline{TB}_{XZ}$ and $TB_{YZ}(\Omega)|_{\Omega=\{\emptyset\}} \geq \overline{TB}_{YZ}$ then X's dominant strategy is "Reject both", and, given X's response, Y accepts RTA_{YZ} (as does Z). Therefore, $\Omega = \{RTA_{YZ}\}$ results.

When $TB_{XY}(\Omega)|_{\Omega=\{RTA_{YZ}\}} \geq \overline{TB}_{XY}$, $TB_{XZ}(\Omega)|_{\Omega=\{RTA_{YZ}\}} < \overline{TB}_{XZ}$ and $TB_{YZ}(\Omega)|_{\Omega=\{RTA_{XZ}\}} \geq \overline{TB}_{YZ}$ then by P3

$$TB_{YZ}(\Omega)|_{\Omega=\{RTA_{YZ}\}} = \min_{\Omega}\{TB_{YZ}(\Omega)\}$$

and Y's dominant strategy is "Accept both". Given this action, X's best response is "Accept only RTA_{XY}", leading to $\Omega = \{RTA_{XY}, RTA_{YZ}\}$. ■

Proof of Proposition 2. By the Proof of Proposition 1, whenever country X accepts an agreement, then so do other countries. Furthermore, by P3, when $W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} > W_X|_{\Omega=\{MTA\}} \geq W_X|_{\Omega=\{\emptyset\}}$ then

$$W_X|_{\Omega=\{RTA_{XY}\}} > W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} > W_X|_{\Omega=\{MTA\}} \geq W_X|_{\Omega=\{\emptyset\}}$$

and, therefore, in the standard Game it is the dominant strategy for X to reject the MTA during multilateral negotiations. But in the No-Regionalism Game X is left with $W_X|_{\Omega=\{MTA\}} \geq W_X|_{\Omega=\{\emptyset\}}$ and accepts the MTA. This proves point 1.

Similarly, by P3

$$W_X|_{\Omega=\{RTA_{XY}\}} > W_X|_{\Omega=\{RTA_{XY},RTA_{YZ}\}} \geq W_X|_{\Omega=\{\emptyset\}} > W_X|_{\Omega=\{MTA\}}$$

holds for the setting in point 2. Hence, in the No-Regionalism Game X rejects the MTA, leading to $\Omega = \{\emptyset\}$. But in the standard Game X rejects the MTA, while playing dominant strategy "Accept RTA_{XY}" during RTA negotiations. Hence, in the standard Game $\Omega = \{\emptyset\}$

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does not come about. This proves point 2. ■

Proof of Proposition 3. We first prove the statement in point 1 and, subsequently, the statement in point 2. Given points 1 and 2, any initial conditions (δ, $TB_{ij}^{t=1}\left(\Omega^{t=1}\right)\big|_{\Omega^{t=1}=\{\emptyset\}}$, $\left[W_i^t|_{\Omega^t=\{RTA_{ij}\}} - W_i^t|_{\Omega^t=\{MTA\}}\right] \forall t > 1$) lead to one of the three equilibrium paths described in the statement of Proposition 3. Therefore, these equilibrium paths are the only ones that exist, and Proposition 3 is proven.

As described in the text, in the first period initial trade balances are as in the one-shot game: $TB_{XZ}^{t=1}\left(\Omega^{t=1}\right)|_{\Omega^{t=1}=\{\emptyset\}} < TB_{XY}^{t=1}\left(\Omega^{t=1}\right)|_{\Omega^{t=1}=\{\emptyset\}} < 0$ and $TB_{XZ}^{t=1}\left(\Omega^{t=1}\right)|_{\Omega^{t=1}=\{\emptyset\}} < TB_{YZ}^{t=1}\left(\Omega^{t=1}\right)|_{\Omega^{t=1}=\{\emptyset\}} < 0$. However, balanced trade is restored afterwards: $TB_{ij}^{t}\left(\Omega^{t}\right) = 0 \forall i, j, \Omega, t > 1$.

We prove point 1 by showing that when $\left[W_i^t|_{\Omega^t=\{RTA_{ij}\}} - W_i^t|_{\Omega^t=\{MTA\}}\right] \leq 0 \forall t > 1$ then: a) for $t > 1$ world free trade (MTA) always obtains; b) in period 1 the MTA is signed only when imbalances are as in point 1 of Proposition 1. Given a) and b), for small enough first period imbalances the MTA holds from period 1 onwards (Good Path), and if imbalances are larger, then there is temporary regionalism (Ugly Path).

Consider a). By assumption: $TB_{ij}^{t}\left(\Omega^{t}\right) = 0 \forall i, j, \Omega, t > 1$ and hence balanced trade obtains for $t > 1$. Given P3 and $\left[W_i^t|_{\Omega^t=\{RTA_{ij}\}} - W_i^t|_{\Omega^t=\{MTA\}}\right] \leq 0 \forall t > 1$ country i has the following welfare ranking over Ω^t after period 1:

$$W_i^t\Big|_{\Omega^t=\left\{\{MTA\}-\left\{RTA_{j\neq i}\right\}\right\}} > W_i^t\Big|_{\Omega^t=\{MTA\}} \geq W_i^t\Big|_{\Omega^t=\{RTA_{ij}\}} > W_i^t\Big|_{\Omega^t=\left\{RTA_{ij},RTA_{j\neq i}\right\}} > W_i^t\Big|_{\Omega^t=\left\{RTA_{j\neq i}\right\}}$$

where $\Omega^t = \{\{MTA\} - \{RTA_{j\neq i}\}\}$ stands for the structure that includes the two RTAs to which country i can be part, but excludes $RTA_{j\neq i}$. Moreover, by P1 and P2

$$W_i^t\Big|_{\Omega^t=\{RTA_{ij}\}} > W_i^t\Big|_{\Omega^t=\{\emptyset\}}$$

Given this ranking, during RTA negotiations country i accepts any RTA that it had not previously signed, regardless of whether $RTA_{j\neq i}$ is in force. As this holds true for all countries, world free trade always obtains for $t > 1$. That is, in period $t = 2$, $\Omega^t = \{RTA_{XY}, RTA_{XZ}, RTA_{YZ}\}$ is known to be the outcome of RTA negotiations, and the MTA is accepted at the preceding MTA negotiations (by the tie-breaking assumption).

Now, consider b). When first period imbalances satisfy the conditions in point 1 of Proposition 1 then, by the Proof of Proposition 1, accepting the MTA is the best response viewed from instantaneous welfare. Moreover, the period 1 decision has no effect on Ω from period 2 onwards, which, by the above, is always MTA. Thus, the instantaneous-welfare maximizing choice (MTA) is accepted by all in period 1.

When, instead, first period imbalances do not satisfy these conditions, country X is best

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off rejecting at least RTA_{XZ} (Proof of Proposition 1). Moreover, X loses no future welfare by doing so: regardless of first period structure, future structure is MTA. Gaining instantaneously, but losing no welfare in the future, country X rejects the MTA in period 1. This completes the proof of point b).

Next, we prove point 2. By P3 and $\left[W_i^t|_{\Omega^t=\{RTA_{ij}\}} - W_i^t|_{\Omega^t=\{MTA\}}\right] > 0 \forall t > 1$ we again obtain country i's welfare ranking over Ω^t for $t > 1$:

$$W_i^t\big|_{\Omega^t=\left\{\{MTA\}-\left\{RTA_{j\neq i}\right\}\right\}} > W_i^t\big|_{\Omega^t=\{RTA_{ij}\}} > W_i^t\big|_{\Omega^t=\{MTA\}} > W_i^t\big|_{\Omega^t=\left\{RTA_{ij},RTA_{j\neq i}\right\}} > W_i^t\big|_{\Omega^t=\left\{RTA_{j\neq i}\right\}}$$

Consider the case that there is only one RTA, $\Omega^t = \{RTA_{ij}\}$. For instance, take $\Omega^t = \{RTA_{XY}\}$. Viewed from instantaneous welfare, "Accept RTA_{XZ}" and "Accept RTA_{YZ}" are the dominant strategies for X and Y, respectively: $W_X^t|_{\Omega^t=\{RTA_{XY},RTA_{XZ}\}} > W_X^t|_{\Omega^t=\{RTA_{XY}\}}$ and $W_X^t|_{\Omega^t=\{RTA_{XY},RTA_{XZ},RTA_{YZ}\}} > W_X^t|_{\Omega^t=\{RTA_{XY},RTA_{YZ}\}}$, and likewise for Y. Thus, accepting all RTAs (and, therefore, MTA at the preceding MTA negotiations) is a one-shot Nash Equilibrium.

However, both X and Y are worse off under $\Omega^t = \{MTA\}$ than under $\Omega^t = \{RTA_{XY}\}$. Therefore, they could play a Tit-for-Tat strategy whereby neither signs the RTA with Z as long as the other does not do so either. If one country signs the RTA with Z, then the next period the other country signs it too. Hence, $\Omega^t = \{RTA_{XY}\}$ is sustainable as long as the instantaneous gains from signing the RTA with Z, given that the other does not, are smaller than the subsequent losses from moving to world free trade. That is, given that all periods from $t = 2$ onwards are identical, the Bad Path can be sustained forever if:

$$W_i^{t=2}\big|_{\Omega^{t=2}=\left\{\{MTA\}-\left\{RTA_{j\neq i}\right\}\right\}} - W_i^{t=2}\big|_{\Omega^{t=2}=\{RTA_{ij}\}} < \sum_{s=2}^{\infty} \delta^s \left(W_i^{t=2}\big|_{\Omega^{t=2}=\{MTA\}} - W_i^{t=2}\big|_{\Omega^{t=2}=\{RTA_{ij}\}}\right)$$

Thus, there is some $\overline{\delta} \in (0,1)$ such that for $\delta \geq \overline{\delta}$ the Bad Path is sustainable. Of course, even for $\delta \geq \overline{\delta}$ this is not the only equilibrium. If one or both players do not follow a Tit-for-Tat strategy, the MTA is signed. This proves point 2. ■

Appendix C. Proofs of Chapter III

Proof of Proposition 1. Suppose not. Then there would not exist a distribution for which $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} > 0$ holds over the entire support. A counterexample suffices to show that this cannot be true. Let $F(w')$ be the cumulative density function of a uniform distribution on $[E[w' \mid F] - s, E[w' \mid F] + s]$: $F(w') = \frac{w' - (E[w'|F]-s)}{(E[w'|F]+s)-(E[w'|F]-s)} = \frac{w'-E[w'|F]+s}{2s}$ and $f(w') = \frac{1}{2s}$. Now, by equation (40) and $f'(w') = 0$ we can state that $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} > 0$ holds whenever it is true that $\frac{d^2\overline{w}_i}{dE[w'|G_i]^2} > 0$.

Putting $f(w') = \frac{1}{2s}$ into equation (35) and solving, gives us

$$\overline{w}_i = E[w' \mid G_i] + s\left(\frac{2}{\beta} + 2\lambda - 1\right) - \frac{2}{\beta}\sqrt{s(1-\beta+\beta\lambda)(s\beta\lambda + \beta E[w' \mid G_i] + s)}$$

and hence

$$\frac{\partial \overline{w}_i}{\partial E[w' \mid G_i]} = 1 - \sqrt{\frac{s(1+\beta\lambda) - s\beta}{s(1+\beta\lambda) + \beta E[w' \mid G_i]}} > 0$$

from which

$$\frac{\partial^2 \overline{w}_i}{\partial E[w' \mid G_i]^2} = \frac{\beta}{2(s(1+\beta\lambda) + \beta E[w' \mid G_i])}\sqrt{\frac{s(1+\beta\lambda) - s\beta}{s(1+\beta\lambda) + \beta E[w' \mid G_i]}} > 0$$

Thus, $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} > 0$ holds. ■

Proof of Proposition 2. It is possible to construct distributions which are arbitrarily strongly downward sloping over a part of the support. In particular, one can have $f'(\overline{w}_i) \to -\infty$ when part of a distribution approaches a vertical line. For $f'(\overline{w}_i) \to -\infty$ other terms in $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2}$ do not go to extreme values. That is, neither $\frac{d\overline{w}_i}{dE[w'|G_i]}$ nor $\frac{d^2\overline{w}_i}{dE[w'|G_i]^2}$ depend on the actual shape of $F(w')$ at all, while $\frac{d\overline{U}_i}{dE[w'|G_i]} = \lambda \frac{f(\overline{w}_i)}{\left[\lambda + \int_{\overline{w}_i}^{\infty} f(w')dw'\right]^2} \frac{d\overline{w}_i}{dE[w'|G_i]}$ does not go to zero for $f'(\overline{w}_i) \to -\infty$. Therefore, it is possible to obtain a distribution for which $\frac{d^2\overline{U}_i}{dE[w'|G_i]^2} < 0$ over at least part of the support of $F(w')$. ■

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Appendix D. Tables of Chapter III

Table I: US, calibration results

$\boldsymbol{\beta}$	$\boldsymbol{\lambda}$	**imputed** σ	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.1}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.2}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.3}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.5}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=2}$
0.985	**0.018**	**0.135**	**0.12**	**0.47**	**1.08**	**3.03**	**9.58**
Sensitivity to β							
0.98	0.018	0.155	0.08	0.34	0.77	2.14	7.25
0.99	0.018	0.117	0.15	0.66	1.54	4.34	12.42
Sensitivity to λ							
0.985	0.016	0.15	0.09	0.41	0.93	2.59	8.40
0.985	0.020	0.125	0.12	0.51	1.18	3.37	10.47

Table II: Germany, calibration results

$\boldsymbol{\beta}$	$\boldsymbol{\lambda}$	**imputed** σ	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.1}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.2}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.3}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=1.5}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=2}$	$\boldsymbol{\Delta}\overline{U}_{\Omega=3.2}$
0.915	**0.065**	**0.235**	**0.00**	**0.04**	**0.11**	**0.34**	**1.23**	**4.19**
Sensitivity to β								
0.905	0.065	0.250	0.00	0.03	0.10	0.29	1.05	3.61
0.925	0.065	0.220	0.00	0.05	0.14	0.40	1.44	4.89
Sensitivity to λ								
0.915	0.06	0.256	0.00	0.03	0.10	0.31	1.11	3.76
0.915	0.07	0.213	0.00	0.05	0.13	0.38	1.37	4.71

Table III: Maximum unemployment reduction due to better wage information

US	$\Omega = 1.1$	$\Omega = 1.2$
maximum unemployment reduction	0.11%	0.53%
imputed σ	0.133	0.118

Germany	$\Omega = 1.1$	$\Omega = 1.2$	$\Omega = 1.3$	$\Omega = 1.5$	$\Omega = 2$
maximum unemployment reduction	0.00%	0.04%	0.11%	0.37%	1.82%
imputed σ	0.235	0.234	0.233	0.218	0.155