Capital controls and the location of industry (Preliminary version)

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Abstract

This paper studies capital controls on the outflow of capital in a two-region new economic geography model. Capital controls are set in a non-cooperative or cooperative manner by social planners. Capital controls are relatively higher in the North in the non-cooperative equilibrium. This leads to relatively more firms located in the region where more consumers reside under the non-cooperative equilibrium. The locational bias towards the North in the non-cooperative equilibrium becomes larger as trade barriers are reduced. That is, firms locate to the North at a relatively higher rate in the non-cooperative equilibrium as trade is liberalized. Contrary to previous findings, it follows that global welfare is relatively higher in the non-cooperative equilibrium, although the social planner sets capital controls by maximizing joint regional welfare in the cooperative equilibrium.

Keywords: Capital Controls; Economic Geography; Welfare

JEL Classification: D70; F12; R12

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1 Introduction and related literature

World outward foreign direct investments (FDI) have increased dramatically since the 1990s. The stock of outward world FDI as a percentage of world GDP increased from 10 percent in 1990 to about 34 percent in 2014, or more than two times faster than the increase in world merchandise trade as a share of world GDP during the same period (UNCTAD, 2015; World Bank, 2015).[1] Clearly, FDI outflows of such magnitude have effects on real and financial outcomes in both FDI source countries and host countries as well as internationally. An important challenge for policymakers is to develop a coherent approach to the policies that affect the outflows.

The leading policy response to capital flows is the use of capital controls. Developed countries liberalized capital-account transactions during the 1970s and 1980s. Developing countries and economies in transition have also moved in the direction of liberalizing the capital account since the late 1980s, but many still retain various controls (UNCTAD, 2006). Specifically, restrictions on outward FDI have been maintained. Of the 155 developing economies surveyed by the IMF in 2005, 78 economies (40 in Africa, 23 in Asia and 15 in Latin America and the Caribbean) had restrictions on FDI outflows (IMF, 2005).

The use of capital controls on outward FDI may have various objectives. Policymakers view the hollowing out of the manufacturing industry as unfavourable. One objective therefore relates to the possible relocation and deindustrialization of the domestic production base. Indeed, research has confirmed that outward FDI undermines manufacturing production. For example, Stopford and Turner (1985) showed that outward FDI of British firms contributed to the loss of manufacturing jobs and production during the 1980s in the United Kingdom. Alderson (1999) concludes that outward FDI has played an important role in the deindustrialization of several

[1] Merchandise trade as a share of GDP is the sum of merchandise exports and imports divided by the value of GDP.

advanced industrial countries. Rowthorn and Ramaswamy (1998) find that North-South trade, historically characterized by outward FDI from developed economies, may explain around one-fifth of the deindustrialization in advanced economies 1970-1994. Simeon and Ikeda (2011) show that the decline of the manufacturing sector in Japan 1990-1999 coincided with a significant jump in outward FDI.

For a long time the so-called Washington Consensus held the view that capital account liberalizations are conducive to higher welfare. However, more recent studies by the IMF have provided the basis for the notion that the use of capital controls can calm volatile cross-border capital flows; while the free movement of capital is generally beneficial, it could destabilise economies whose financial systems are insufficiently developed.[2]

Academic research supports this conclusion, but has distinguished between non-cooperative and cooperative policy outcomes. For example, De Paoli and Lipińska (2013) argue that after a shock to productivity, a subsidy to international borrowing can help domestic households to share the burden of the shock with foreign households. Yet, individual countries find it optimal to tax rather than subsidize borrowing. With the goal of limiting fluctuations in domestic output and terms of trade, a country therefore imposes restrictions on capital flows that augment, rather than mitigate, the adverse effect of the shock. Their findings suggest that if capital controls are set in an uncoordinated fashion, they can have damaging implications for welfare. When countries simultaneously and independently engage in uncoordinated interventions in the international flow of capital, not only global but individual welfare is adversely affected. The results point to costly capital control wars and important gains from international coordination in the use of capital controls.

In a related paper, Costinot et al. (2014) consider two countries that set capital controls optimally, taking as given the capital controls chosen by the other country;

[2]See Arora et al. (2012) and Chamon et al. (2010).

a case referred to as capital control wars. Compared to the benchmark with no capital controls, the distortion imposed by a capital flow tax on the borrowing and lending decisions of consumers is larger when both countries set capital controls simultaneously and optimally; i.e., lack of international cooperation makes it more likely that both countries will lose from capital controls.

De Paoli and Lipińska (2013) and Costinot et al. (2014) do not study the interaction of capital controls and the location decisions of firms, but bring focus to a relationship between capital controls, welfare and international cooperation. In the current paper this relationship is analyzed in a setting where capital controls on outward FDI are determined in a standard model of industrial location (Martin and Rogers, 1995). Contrary to the previous studies, the location of industry is not taken as given, and firms face a decision between exporting and FDI which affects domestic and foreign prices. As to be seen, in such a set-up, policy coordination leads to lower total (i.e. global) welfare. This result differs from the view in the trade policy literature that international policy institutions, as represented by for example the World Trade Organization, are able to enforce cooperative solutions and in doing so achieve a higher global welfare (see for example Finus, 2001).

Surprisingly little research has been devoted to how capital controls affect the location of industry; most earlier studies have taken an international finance approach, e.g., they focus on capital controls and currency crises (Chiu and Willett, 2011).[3] An exception can be found in Baldwin et al. (2003), who introduce a cost on capital mobility across regions in a model of industrial location (Martin and Rogers, 1995). However, this cost is not determined endogenously and thus does not reflect welfare considerations governments take account of.

The present paper combines the welfare focus of De Paoli and Lipińska (2013) and Costinot et al. (2014) with the economic geography approach of Baldwin et al.

[3]See for example Magud and Reinhart (2006) for an overview.

(2003). Specifically, it is assumed that social planners set capital controls, defined as a relocation cost on the outflow of firms (or capital), in a non-cooperative or cooperative manner. In the non-cooperative equilibrium, capital controls are determined simultaneously and unilaterally by regional social planners in the North (the economically larger region) and the South (the economically smaller region), taking the relocation cost of the other region as given. In the cooperative equilibrium, capital controls are set by a global social planner who maximizes the sum of welfare in the North and the South.

Firms serve its domestic market through domestic production. While still producing for the domestic market, they may also serve a foreign market, i.e., the other region. If so, they will choose to access the other region via FDI or exports. If a firm undertakes FDI it has to pay the relocation cost which is one-time; if a firm exports it has to pay a recurrent iceberg transportation cost which marks up export prices above local prices.

It is shown that the non-cooperative equilibrium is consistent with relatively higher capital controls on the FDI outflow from the North compared to what follows from the cooperative equilibrium. Intuitively, in the cooperative equilibrium, the global planner internalizes that the agents in the South benefit from lower capital controls on the FDI outflow from the North to the South. Lower capital controls on the outflow from the North lead to lower consumer prices in the South when more firms relocate from the North to the South. This welfare gain is not internalized by the regional planner of the North in the non-cooperative equilibrium, leading to relatively higher capital controls on the outflow from the North compared to the cooperative equilibrium. As a result, fewer firms locate from the North to the South in the non-cooperative equilibrium and, thus, there are relatively more firms located in the North in the non-cooperative equilibrium. As to be seen, this locational bias towards the North in the non-cooperative equilibrium becomes larger as trade barri-

ers are reduced. That is, firms locate to the North at a relatively higher rate in the non-cooperative equilibrium as trade is liberalized.

Since the non-cooperative equilibrium results in relatively more firms in the region with more consumers, the overall cost of imports is relatively lower under the non-cooperative solution. The reason is that fewer industrial varieties need to be imported to this region, and trade costs have to be paid on a lower number of goods when more firms are located there. Correspondingly, since the cooperative equilibrium implies relatively fewer firms in the region with more consumers, the total cost of imports is relatively higher in this equilibrium. It follows that the sum of the welfare in the North and the South is relatively higher under the non-cooperative solution, although the global planner sets capital controls by maximizing joint regional welfare in the cooperative setting. As a result, capital controls determined in a non-cooperative manner welfare-dominate the location equilibrium following from the cooperative solution.

The rest of the paper is organized as follows. The next section presents the general assumptions of the model. Section 3 solves for the equilibrium location of industry when capital controls are taken as exogenous. Section 4 solves for capital controls set in a non-cooperative and cooperative manner. The implied location equilibria and welfare consequences are then discussed in Section 5, while Section 6 concludes.

2 General assumptions

The economic model is based on the framework of Martin and Rogers (1995), extended with relocation costs on the outflow of capital. As opposed to the original model, firms face a decision between exporting and FDI.

There are two regions, two sectors and two factors. The two regions, North (N) and South (S), can be seen as either separate regions within a country, separate

countries, or separate federations of countries. The regions are endowed with two factors, labor (L) and capital (K), and are symmetric in terms of tastes, technology and openness to trade, but differ in their factor endowments: the North is a scaled-up version of the South. In particular, the North's endowment of both capital and labor is $\lambda > 1$ times the South's endowment. For this reason, λ can be interpreted as the relative economic size of the North.

The two sectors are referred to as agriculture (A) and industry or manufacturing (M). The agricultural sector is assumed to produce a homogeneous good under constant returns to scale and perfect competition with labor as the only input. The manufacturing sector uses both labor and capital to produce a differentiated good under increasing returns to scale and Dixit-Stiglitz monopolistic competition. The production of each differentiated good requires a one-time fixed cost consisting of one unit of capital, while labor is a variable input.

Physical capital can move between the regions, while labor can move freely between the sectors but is immobile between the regions. Since each firm supplies one industrial variety that requires one unit of capital, the share of the total capital stock employed in a region equals the region's share of the total manufacturing sector. Consequently, the North's share of industry can be used to represent the share of capital employed in the North and the share of all varieties made in the North. Thus, North's share of industry, capital or varieties can be written as $s_N \equiv n_N/(n_N + n_S)$, where n_N and n_S denote the number of industrial firms (or varieties or the amount of capital) in the North and the South, respectively.

Output in the agricultural sector is traded at no cost, while inter-regional trade in the differentiated output is subject to an iceberg transportation cost. Hence, in order to sell one unit of the differentiated good in the other region, $\tau > 1$ units need to be shipped.

The representative consumer in each region maximizes the following quasi-linear

utility function:[4]

$$U = C_A + \ln C_M, \tag{2.1}$$

where C_A is consumption of the homogeneous good. Consumption of manufactures enters the utility function through the index C_M, which is defined by:

$$C_M \equiv \left(\int_{i=0}^{n_W} c_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{2.2}$$

where $n_W = n_N + n_S$ denotes the total number of industrial varieties consumed, fixed by the total supply of capital; c_i is the amount of variety i consumed; and $\sigma > 1$ is the constant elasticity of substitution between any two varieties.

A firm from region $j = N, S$ serves its domestic market through domestic production. It may also serve the foreign market, i.e., the other region. If so, it will choose to access the other region via FDI or exports. A fraction $\gamma_j \in [0, 1]$ of the firms in region j undertakes FDI and a fraction $1 - \gamma_j$ exports. If a firm in region N (S) undertakes FDI to region S (N), it has to pay a one-time relocation cost, α_N (α_S), which is proportional to the reward to capital in S (N), π_S (π_N).[5]

As to be seen, relocation costs are either set simultaneously and non-cooperatively by regional social planners in the North and the South (the non-cooperative equilibrium); or by a global planner who chooses relocation costs for both the North and the South (the cooperative equilibrium). In the non-cooperative equilibrium, the revenues raised from the relocation cost are rebated back by the regional planner of

[4]The choice of a quasi-linear specification, which is fairly standard in the literature on public goods provision (e.g., see Persson and Tabellini, 2000), does not change the qualitative results of the paper: all results carry over if a Cobb-Douglas functional form is chosen (calculations are available from the author). However, the quasi-linear specification simplifies the algebra.

[5]Capital controls can be direct or market-based (i.e. price-based). Direct controls limit the size of the capital flows through quotas, licensing requirements or outright prohibitions. Market-based controls work through price signals, discouraging capital flows by increasing their cost (UNCTAD, 2006). Hence, α_j is a market-based measure since the relocation cost relates to the profit the firm earns in the foreign market.

region j to the consumers residing in region j in a lump-sum fashion. In the cooperative equilibrium, the revenues raised from the relocation costs at the global level are rebated back by the global planner to the consumers in the whole economy in a lump-sum fashion. In both equilibria, wages are not affected by capital controls and since each individual receives lump-sum transfers and owns capital and labor, on net, the representative agent's income is unaffected by the relocation cost.

A firm from the North that incurs the relocation cost and serves the South via FDI earns a rate of return equal to:

$$R_N = \pi_S - \pi_S \alpha_N, \tag{2.3}$$

where $\alpha_N \in [0, 1)$. α_N close to one corresponds to outright bans on outward investments from the North to the South, while $\alpha_N = 0$ implies no capital controls.

A corresponding condition holds for firms in the South that incur the relocation cost and serve the North via FDI:

$$R_S = \pi_N - \pi_N \alpha_S, \tag{2.4}$$

where $\alpha_S \in [0, 1)$.

In equilibrium, (2.3) equals (2.4); i.e., the rate of return on FDI in the South equals the rate of return on FDI in the North: $\pi_S - \pi_S \alpha_N = \pi_N - \pi_N \alpha_S$.[6] This gives $\pi_N \beta = \pi_S$, where $\beta = (1 - \alpha_S)/(1 - \alpha_N)$ measures the relocation cost in the South relative to the relocation cost in the North. $\beta > 1$ when $\alpha_N > \alpha_S$, that is, when the cost of relocating from the North to the South is higher than the cost of

[6]To see that this condition holds, assume that the rate of return on FDI in the South is higher than the rate of return on FDI in the North: $\pi_S - \pi_S \alpha_N > \pi_N - \pi_N \alpha_S$. Then a firm from the South will not establish local production in the North, earning a rate of return of $\pi_S > \pi_N - \pi_N \alpha_S$. Assume instead that the rate of return on FDI in the North is higher than the rate of return on FDI in the South: $\pi_S - \pi_S \alpha_N < \pi_N - \pi_N \alpha_S$. Then a firm from the North will not establish local production in the South, earning a rate of return of $\pi_N > \pi_S - \pi_S \alpha_N$. That is, no firm in the North or the South will choose to access the other region via FDI. Hence, $\pi_S - \pi_S \alpha_N = \pi_N - \pi_N \alpha_S$ must hold in an FDI equilibrium.

relocating from the South to the North. $\beta \in (0,1)$ when $\alpha_N < \alpha_S$, i.e., when the cost of relocating from the South to the North is higher than the cost of relocating from the North to the South. $\beta = 1$ when the relocation costs are equal across the regions and there are no location incentives from the capital controls. β increases (decreases) as the cost of relocating from the North (South) to the South (North) increases.

By assuming equalized costs of undertaking FDI and exporting, γ_j can be derived. Market entry costs for firms in the North that choose to access the South via FDI or exports are equalized when the following condition is satisfied:

$$\gamma_N s_N \beta = \frac{(1-\gamma_N)s_N}{\phi}, \tag{2.5}$$

where $\tau^{1-\sigma} \equiv \phi \in [0,1]$. ϕ is thus a measure of the freeness of inter-regional trade, where 0 corresponds to infinite trade barriers and 1 represents free trade. The left-hand side of (2.5) represents the cost of FDI, while the right-hand side denotes the cost of exporting. Hence, the left-hand side increases as the relocation cost in the North increases (as β increases), while the right-hand side increases as trade costs increase (as ϕ decreases). A corresponding condition holds for firms in the South:

$$\frac{\gamma_S(1-s_N)}{\beta} = \frac{(1-\gamma_S)(1-s_N)}{\phi}. \tag{2.6}$$

(2.5) and (2.6) produces:

$$\gamma_N = \frac{1}{1+\beta\phi}, \tag{2.7}$$

and

$$\gamma_S = \frac{\beta}{\beta+\phi}. \tag{2.8}$$

Consequently, for a given β, the fraction of firms undertaking FDI increases when

trade protection increases. This is consistent with the empirically documented phenomenon in the trade literature that trade protection makes firms more likely to substitute FDI for exports to avoid the costs of trade production; a phenomenon commonly referred to as tariff-jumping FDI (see for example Blonigen, 2002; or Blonigen, 2005).

Now, define the following three-stage game. In the first stage, firms are either located in the North or the South. It is assumed that this location equilibrium is characterized by no relocation costs, which is equivalent to the case when relocation costs are equal across regions, i.e., $\beta = 1$. By (2.7) and (2.8), this is also equivalent to $\gamma_N = \gamma_S = \frac{1}{1+\phi}$, since the incentives to undertake FDI are the same across the regions when the relocation costs are equal. In the second stage, the planners set α_N and α_S, which determine β. In the third and final stage, firms decide whether to access the foreign market via FDI or exports, and they relocate between the regions in response to the level of the iceberg transportation cost and the relative relocation cost defined by β. A subgame perfect equilibrium outcome of this game is solved by backward induction.

3 The location equilibrium

In the final stage, β is already given by the outcome of the policy-making process in the second stage. To derive the distribution of industry in the third stage, (2.1) is maximized subject to (2.2) and the budget constraint. This results in the following demand function in region j for variety i of the differentiated good:

$$c_i = \frac{\mu p_i^{-\sigma}}{\int_{k=0}^{n_W} {p_{jk}}^{1-\sigma} dk}, \tag{3.1}$$

where p_i is the price of variety i. The demand for the homogenous good in the cooperative equilibrium is:

$$C_A = L_j + \rho_j K_j + TL_j - \int_{k=0}^{n_W} c_{jk} p_{jk} dk, \tag{3.2}$$

where the wage rate, w, is set to unity; ρ_j is the regional return to capital including the relocation cost; and T denotes the global tax rate. The demand for the homogenous good in the non-cooperative equilibrium is:

$$C_A = L_j + \rho_j K_j + T_j L_j - \int_{k=0}^{n_W} c_{jk} p_{jk} dk, \tag{3.3}$$

where T_j denotes the tax rate in region j. (3.2) and (3.3) imply that spending on the homogenous good is a residual equal to the disposable income not spent on industrial goods.

Profit maximization yields $p = wa_M\sigma/(\sigma - 1)$ for each differentiated commodity sold in the home market by domestic firms and in the foreign market by firms undertaking FDI; $p^* = \tau wa_M\sigma/(\sigma - 1)$ for each differentiated commodity sold in the foreign market by exporting firms. a_M denotes the unit labor requirement in the production of differentiated goods. Without loss of generality, let $a_M = (\sigma - 1)/\sigma$, then using $w = 1$ to obtain the pricing rules for firms in the manufacturing sector: $p = 1$ and $p^* = \tau > 1$.

Since capital is used only in the fixed cost component of industrial production, the reward to capital is the operating profit of a variety. Under Dixit-Stiglitz competition, the operating profit is the value of sales divided by σ; i.e., $\pi_j = x_j/\sigma$, where x_j is the scale of production of a representative industrial firm in region j. Combining the domestic and foreign demand functions for industry i products with the optimal prices then yields:

$$\pi_N = \frac{x_N}{\sigma} = a\left(\frac{1}{s_N + (1 - s_N)\phi} + \frac{\phi}{s_N\phi + (1 - s_N)}\right), \tag{3.4}$$

and

$$\pi_S = \frac{x_S}{\sigma} = a\left(\frac{\phi}{s_N + (1-s_N)\phi} + \frac{1}{s_N\phi + (1-s_N)}\right), \tag{3.5}$$

where $a \equiv \mu/\sigma$. Given (3.4) and (3.5), and for exogenous β, the distribution of industry solving the location condition, $\pi_N\beta = \pi_S$, is:

$$s_N = \frac{\beta(1+\phi^2) - 2\phi}{(1+\beta)(\phi-1)^2}. \tag{3.6}$$

Taking the derivative of (3.6) with respect to β produces:

$$\frac{\partial s_N}{\partial \beta} = \frac{(1+\phi)^2}{(1+\beta)^2(\phi-1)^2} > 0. \tag{3.7}$$

Hence, the number of firms in the North (South) is increasing in the relocation cost imposed on FDI from the North (South). By inspection of (3.7), this effect becomes stronger as trade barriers are reduced, i.e., $\frac{\partial^2 s_N}{\partial\phi\partial\beta} > 0$.

4 Optimal capital controls

Consider the second stage when the planners set β by either maximizing regional or global welfare. In doing so, and through backward induction, the planners must take the location equilibrium from the third stage, defined by (3.6), into account.

The welfare of a representative individual is a function of the disposable income and the price index in the region of residence. Given (2.1), the indirect utility functions are:[7]

$$V_N(\beta) = \ln(1+a) + \frac{\mu}{\sigma-1}\ln\left(s_N(\beta) + (1-s_N(\beta))\gamma_S + (1-s_N(\beta))(1-\gamma_S)\phi\right), \tag{4.1}$$

[7](4.1) and (4.2) are derived in the working paper version of this article.

and

$$V_S(\beta) = \ln(1+a) + \frac{\mu}{\sigma - 1}\ln\left(s_N(\beta)(1-\gamma_N)\phi + s_N(\beta)\gamma_N + (1 - s_N(\beta))\right), \quad (4.2)$$

for an agent in the North and the South, respectively. The first term of (4.1) and (4.2) is the disposable income of the individual and the second term is the price index of region j, which at this stage is a function of the firms' choice between FDI or exports.

Since β has an impact on industry location by (3.7), capital controls have an effect on prices and welfare by (4.1) and (4.2). Specifically, it can be established that $\partial V_N/\partial\beta > 0$ and $\partial V_S/\partial\beta < 0$. That is, when the number of firms in the North (South) increases as β increases (decreases), consumer prices of manufactures in the North (South) decrease, which increases the welfare of an agent in the North (South). This welfare effect becomes stronger as trade barriers are reduced by (3.7).

It can also be shown that $V_N > V_S$ if and only if $s_N/1-s_N > 1-\gamma_S/1-\gamma_N$, while $V_N < V_S$ if and only if $s_N/1-s_N < 1-\gamma_S/1-\gamma_N$. Hence, for a given location outcome, since firms are disproportionally represented in the economically larger region (i.e. $s_N/1 - s_N > 1$), $\gamma_N < \gamma_S$ is a necessary and sufficient condition for welfare in the North to be higher than welfare in the South. Correspondingly, $\gamma_N > \gamma_S$ is a necessary (but not sufficient) condition for welfare in the South to be higher than welfare in the North. Intuitively, consumers benefit more from inward FDI than from imports, because prices set by direct investing firms in the FDI host region are lower than the export prices prevailing in that region. The reason is that the relocation cost paid by firms undertaking FDI is one-time, while the iceberg transportation cost paid by exporters is recurrent and marks up export prices over local prices by a factor of $\tau > 1$. Hence, the region that receives a relatively higher inflow of FDI gains more in terms in welfare, since the inflow decreases consumer prices of manufactures relatively

more when fewer industrial varieties need to be imported from the other region and trade costs have to be paid on a lower number of goods.

4.1 The non-cooperative equilibrium

Consider the case where capital controls are set simultaneously and non-cooperatively by regional social planners in the North and the South. It can be shown that (4.1) and (4.2) are symmetric in the sense that the welfare functions change by the same amount but in opposite directions in response to changes in the location of industry. The reason is that the total number of firms in the economy is fixed by the total supply of capital. Thus, as the outflow of FDI from the North to the South increases, the welfare of the South increases by the same factor as the welfare of the North decreases and vice versa. This implies that the planner of the North will set the relocation cost by maximizing welfare of the North while minimizing welfare of the South; equivalently, this planner maximizes total welfare of the North net of total welfare of the South, taking α_S as given:[8]

$$W_N(\alpha_N) = \lambda V_N(\beta(\alpha_N)) - V_S(\beta(\alpha_N)). \tag{4.3}$$

Likewise, the planner of the South maximizes total welfare of the South net of total welfare of the North, taking α_N as given:

$$W_S(\alpha_S) = V_S(\beta(\alpha_S)) - \lambda V_N(\beta(\alpha_S)). \tag{4.4}$$

To solve for capital controls in the non-cooperative equilibrium, substitute (2.7), (2.8) and (3.6) in (4.1) and (4.2). At this stage, the regional planners take the

[8]The notion that a country sets policy with the goal of influencing welfare in other countries has for example been proposed by Antràs and Padró i Miquel (2011). In a two-country voting model of electoral competition, where the government in each country takes actions that affect the election outcome in the other country, they show that each country implements optimal tariffs which maximize a weighted sum of domestic and foreign welfare.

outcome of the first stage equilibrium as given; i.e., (2.7) and (2.8) will be defined by $\gamma_N = \gamma_S = \frac{1}{1+\phi}$. Through backward induction, the planners must also take the third stage location equilibrium into account when relocation costs are set, meaning that $s_N = f(\phi, \beta)$, as defined by (3.6), enters (4.1) and (4.2) which in turn are used in (4.3) and (4.4). Then taking the derivative of (4.3) and (4.4) with respect to α_j and solving for $\beta = (1-\alpha_S)/(1-\alpha_N)$ to obtain the capital controls in the non-cooperative (NC) equilibrium:[9]

$$\beta^{NC} = \frac{1 - \phi + (1+\phi^2)(\lambda - \phi^2)}{\sqrt{(\phi-1)^2(1+\phi(1+2\phi)+\lambda(1-\phi^2))^2}}. \tag{4.5}$$

It can be shown that $\beta^{NC} > 1 \forall \phi \in [0,1]$ and $\lambda > 1$, which holds by assumption since the North is the economically larger region with more consumers. It is also straightforward to show that β^{NC} is increasing in $\lambda \forall \phi \in [0,1]$ and $\lambda > 1$. That is, the planner of the North sets a relatively higher relocation cost on the outflow of FDI from the North. Moreover, the relative relocation cost in the North increases as the relative number of consumers in the North increases. Intuitively, the more consumers there are in the North, the greater the benefit to this region of more restrictive capital controls on the outflow. The reason is that higher capital controls in the North lead to lower prices in the North when fewer firms relocate to the South and fewer varieties need to be imported from the South. Therefore, as the relative number of consumers in the North increases (as λ increases), the total cost of imports from the South decreases when capital controls are higher in the North and, consequently, more firms are located in the North.

[9]The solution has two roots. It is straightforward to show that one of them implies negative relocation costs; i.e., this root gives rise to a solution outside the admissible parameter space, $\beta \in \mathbb{R}_{++}$.

4.2 The cooperative equilibrium

Consider again the second stage, but where the policy decisions are delegated to a global planner who chooses relocation costs for both the North and the South. This planner chooses β to maximize the sum of total welfare in the North and the South:

$$W(\beta) = \lambda V_N(\beta) + V_S(\beta). \tag{4.6}$$

(4.6) implies that β is a weighted mean of the optimal policy choices in the North and the South, where the weights correspond to the regions' marginal utilities of capital controls. Using $\gamma_N = \gamma_S = \frac{1}{1+\phi}$ and $s_N = f(\phi, \beta)$ in (4.1) and (4.2) which in turn are substituted in (4.6), then taking the derivative with respect to β to obtain the capital controls in the cooperative (C) equilibrium:

$$\beta^C = \frac{\lambda - 1 + \phi(1+\phi^2) + \phi^2(\lambda+1)}{1 - \lambda + \phi\lambda(1+\phi^2) + \phi^2(\lambda+1)}. \tag{4.7}$$

It is straightforward to show that $\beta^C > 1 \forall \phi \in [0,1]$ and $\lambda > 1$, which holds by assumption since the North is the economically larger region. Hence, the global planner sets a relatively higher relocation cost on the outflow of FDI from the North if there are more consumers in the North than in the South, since this implies a relatively higher marginal utility of capital controls in the North. It can also be verified that β^C is increasing in λ. That is, the global planner increases the relative relocation cost on the outflow from the North as the number of consumers in the North increases. The global benefit of more restrictive capital controls on the outflow of firms from the North increases as the number of consumers in the North increases. The reason is that such a policy decreases prices and the total cost of imports in the economically larger region, which benefit more consumers at the global level.

4.3 Comparative analysis

By using (4.5), (4.7), $\phi \in [0,1]$ and $\lambda > 1$ it is straightforward to show that $\beta^{NC} > \beta^{C} \forall \phi \in [0,1]$; i.e., the non-cooperative equilibrium is consistent with relatively higher capital controls in the North. Intuitively, and by (4.6), in the cooperative equilibrium, the global planner internalizes that the agents in the South benefit from lower capital controls on the FDI outflow from the North. This leads to lower consumer prices in the South when more firms find it profitable to relocate from the North to the South. By (4.3), this welfare gain is not internalized by the regional planner in the North in the non-cooperative equilibrium, leading to relatively higher capital controls on the outflow from the North compared to what follows from the cooperative equilibrium.

5 The distribution of industry and welfare

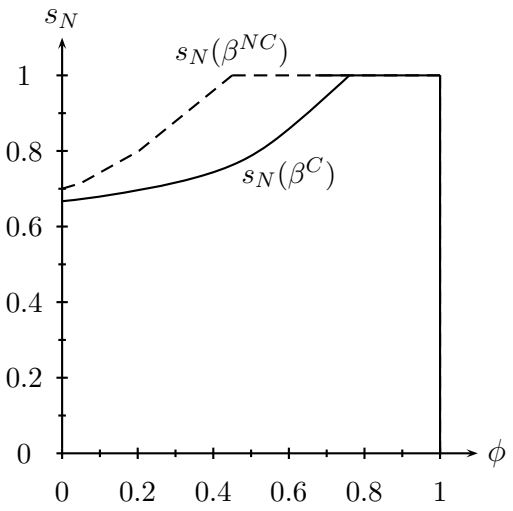
To gauge the effect of capital controls on the distribution of industry and welfare, consider again the third stage. At this stage, firms locate between the regions in the response to the level of the transportation cost and the relative relocation cost. By combining (3.6), (4.1), (4.2), (4.5) and (4.7), it follows that the optimal capital controls have welfare implications that differ depending on if they are determined in a non-cooperative or cooperative manner.

5.1 The distribution of industry

Recall that the number of firms in the North (South) is increasing in the relocation cost imposed on FDI from the North (South) by (3.7). Consequently, $s_N(\beta^{NC}) > s_N(\beta^{C}) \forall \phi \in [0,1]$ since $\beta^{NC} > \beta^{C} \forall \phi \in [0,1]$. That is, there are more firms located in the North in the non-cooperative equilibrium than in the cooperative equilibrium. Intuitively, when capital controls are relatively higher in the North, the relative return to capital increases in this region by the location condition ($\pi_N \beta = \pi_S$). As a result,

and since the relative relocation cost is higher in the North in the non-cooperative equilibrium than in the cooperative equilibrium, the North's share of the manufacturing industry is relatively higher in the non-cooperative equilibrium. By (3.7), this locational bias towards the North in the non-cooperative equilibrium becomes larger as trade barriers are reduced since $\frac{\partial^2 s_N}{\partial \phi \partial \beta} > 0$. This result is illustrated in Figure 1, which shows how the share of industry in the North changes as trade barriers are reduced, setting $\lambda = 2$.

Figure 1: The share of industry in the North for different degrees of openness



Starting from autarky in Figure 1, the North's share of industry is increasing as trade is liberalized. This holds in both the non-cooperative and the cooperative equilibrium. The reason is that $\beta^{NC} > 1$ and $\beta^C > 1 \forall \phi$, which makes it relatively less beneficial for firms to relocate from the North to the South under both equilibria. However, since $\beta^{NC} > \beta^C \forall \phi$ and $\frac{\partial^2 s_N}{\partial \phi \partial \beta} > 0$, firms shift production to the North at a relatively higher rate in the non-cooperative equilibrium as trade is liberalized.[10]

[10]Note that $s_N(\beta^{NC}) > s_N(\beta^C)$ at autarky, since $\beta^{NC} > \beta^C \forall \phi$.

5.2 Welfare

Total welfare is the sum of the individual welfare in the North and the South and defined by the general functions: $V^{NC} = \lambda\varepsilon V_N(s_N(\beta^{NC})) + V_S(s_N(\beta^{NC}))$ and $V^C = \lambda\varepsilon V_N(s_N(\beta^C)) + V_S(s_N(\beta^C))$, where $\varepsilon \in \mathbb{R}_+$ is the weight assigned to the welfare of an individual in the North relative to the weight assigned to an agent in the South.[11] Using (4.1) and (4.2) to obtain:

$$V^{NC} = \ln(1+a)(1+\lambda\varepsilon) + \frac{\mu\lambda\varepsilon}{\sigma-1}\ln\left(s_N(\beta^{NC}) + (1-s_N(\beta^{NC}))\gamma_S + (1-s_N(\beta^{NC}))(1-\gamma_S)\phi\right)$$
$$+ \frac{\mu}{\sigma-1}\ln\left(s_N(\beta^{NC})(1-\gamma_N)\phi + s_N(\beta^{NC})\gamma_N + (1-s_N(\beta^{NC}))\right), \tag{5.1}$$

and

$$V^{C} = \ln(1+a)(1+\lambda\varepsilon) + \frac{\mu\lambda\varepsilon}{\sigma-1}\ln\left(s_N(\beta^{C}) + (1-s_N(\beta^{C}))\gamma_S + (1-s_N(\beta^{C}))(1-\gamma_S)\phi\right)$$
$$+ \frac{\mu}{\sigma-1}\ln\left(s_N(\beta^{C})(1-\gamma_N)\phi + s_N(\beta^{C})\gamma_N + (1-s_N(\beta^{C}))\right). \tag{5.2}$$

It is shown in the Appendix that total welfare is relatively higher in the non-cooperative equilibrium, that is, $V^{NC} > V^C$, if: $\lambda > 1$, which holds by assumption since the North is the economically larger region; $\varepsilon \geq 1$; and there are relatively more firms located in the North in the non-cooperative equilibrium, i.e., if $s_N(\beta^{NC}) > s_N(\beta^C)$, which is satisfied since $\beta^{NC} > \beta^C$. $s_N(\beta^{NC}) > s_N(\beta^C)$ is consistent with a non-cooperative equilibrium defined by relatively more firms located in the region with more consumers. Consequently, total cost of imports is relatively lower in this equilibrium, since trade costs on imports from the South have to be paid on a lower number of goods when more firms are located in the North. As a result, total welfare

[11] When $\varepsilon = 1$ the welfare functions are identical to the utilitarian welfare function, where the same weights are assigned to individuals in the North and the South.

is relatively higher in the non-cooperative equilibrium.

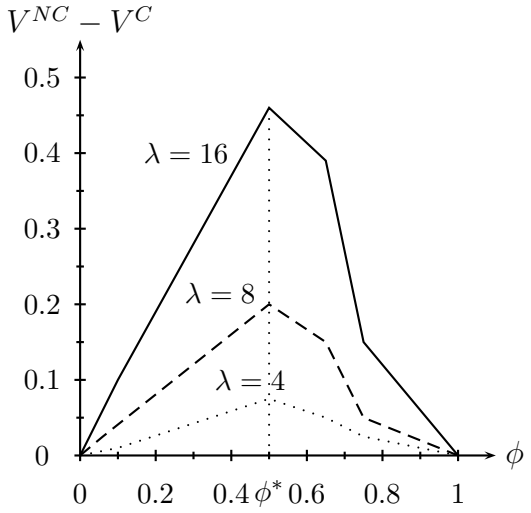
Figure 2 shows the welfare level in the non-cooperative equilibrium compared to the welfare level under the cooperative equilibrium on the vertical axis for different λ and as trade barriers are reduced, setting $\varepsilon = 1$, $\mu = 0.7$ and $\sigma = 2.1$.[12] First, note from the figure that $V^{NC} - V^C > 0 \forall \phi \in (0, 1)$. Second, note that $V^{NC} - V^C$ is monotonically increasing in $\phi \; \forall \phi \in (0, \phi^*]$ and reaches a maximum at ϕ^*. When trade costs are sufficiently low, that is, when firms are increasingly indifferent to location, $V^{NC} - V^C = 0$. Recall that firms shift production to the North at a relatively higher rate in the non-cooperative equilibrium compared to the cooperative equilibrium as trade is liberalized. Therefore, the total cost of imports becomes relatively lower and total welfare relatively higher in the non-cooperative equilibrium as trade costs are lowered. Hence, the distance between $s_N(\beta^{NC})$ and $s_N(\beta^C)$ in Figure 1 captures total welfare in the non-cooperative equilibrium relative to total welfare in the cooperative equilibrium. As a result, at $\phi = 0.5$ in Figure 1, that is, when all firms are located in the North in the non-cooperative equilibrium, $V^{NC} - V^C$ reaches a maximum, denoted by ϕ^* in Figure 2.

As further seen in Figure 2, holding the level of the trade cost constant, $V^{NC} - V^C$ increases as λ increases. Intuitively, since there are relatively more firms located in the North in the non-cooperative equilibrium, total welfare increases relatively more in this equilibrium when the number of consumers residing in the North increases, i.e., when λ increases. The reason is that this saves more on the total cost of imports compared to the cooperative equilibrium.

To conclude, the cooperative equilibrium produces too little agglomeration from a welfare point of view, due to relatively lower capital controls on outward FDI from the economically larger region. As a result, capital controls determined in a non-cooperative manner lead to relatively higher global welfare compared to the capital

[12] $\mu = 0.7$ and $\sigma = 2.1$ are the averages of the implied values estimated across U.S. counties 1970–1980 and 1980–1990 by Hanson (2005).

Figure 2: The relative welfare level ($V^{NC} - V^{C}$) for different degrees of openness



controls that follow from a cooperative equilibrium.

6 Conclusions

The institutional structure of the World Trade Organization and other international policy institutions is based on the premise that cooperative policy outcomes provide the basis for global welfare improvements (Finus, 2001). Consistent with this view, recent research has argued that capital controls set in an uncoordinated fashion can have damaging implications for global and individual welfare (De Paoli and Lipińska, 2013; Costinot et al., 2014). As shown in the current paper, this conclusion does not hold when capital controls on outward FDI are introduced in a two-region new economic geography model.

It was assumed that social planners set capital controls in a non-cooperative or cooperative manner. It was shown that the non-cooperative equilibrium produced relatively higher capital controls in the North. In the cooperative equilibrium, the global planner internalizes that the agents in the South benefit from lower capital controls on the FDI outflow from the North. Lower capital controls on the outflow from

the North lead to lower consumer prices in the South when more firms relocate from the North to the South. This welfare gain is not internalized by the regional planner in the North in the non-cooperative equilibrium, leading to relatively higher capital controls on the outflow from the North compared to the cooperative equilibrium. It was further shown that firms shift production to the North at a relatively higher rate in the non-cooperative equilibrium compared to the cooperative equilibrium as trade costs are lowered.

Since the non-cooperative equilibrium results in relatively more firms located in the region with more consumers, the overall cost of imports is relatively lower in this equilibrium. Therefore, capital controls determined in a non-cooperative manner welfare-dominate capital controls set in a cooperative fashion.

As Costinot et al. (2014) note, in the trade literature, optimal tariff arguments have paved the way for a rich positive theory of international trade agreements. Based on the results presented in the current paper, it is worth considering to what extent this theory extends to international agreements on capital controls.

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A Appendix

When is $V^{NC} > V^{C}$ satisfied?

By using (5.1) and (5.2) it can be shown that $V^{NC} > V^{C}$ if:

$$\lambda\varepsilon \ln\left(\frac{s_N(\beta^{NC}) + (1 - s_N(\beta^{NC}))\gamma_S + (1 - s_N(\beta^{NC}))(1 - \gamma_S)\phi}{s_N(\beta^{C}) + (1 - s_N(\beta^{C}))\gamma_S + (1 - s_N(\beta^{C}))(1 - \gamma_S)\phi}\right) > \ln\left(\frac{s_N(\beta^{C})(1 - \gamma_N)\phi + s_N(\beta^{C})\gamma_N + (1 - s_N(\beta^{C}))}{s_N(\beta^{NC})(1 - \gamma_N)\phi + s_N(\beta^{NC})\gamma_N + (1 - s_N(\beta^{NC}))}\right). \tag{A.1}$$

The term on the left-hand side is the welfare that a representative individual residing in the North achieves in the non-cooperative equilibrium, relative to what the individual obtains in the cooperative equilibrium, weighed by the relative number of individuals residing in the North, λ, and the relative weight assigned to the welfare of an individual in the North, ε. It is straightforward to show that this term is positive if $s_N(\beta^{NC}) > s_N(\beta^{C})$, which is satisfied if $\beta^{NC} > \beta^{C}$. Hence, the welfare of an individual residing in the North is relatively higher in the non-cooperative equilibrium. The reason is that higher capital controls in the North under the non-cooperative equilibrium translate into relatively more firms located in the North compared to the cooperative equilibrium.

The term on the right-hand side is the welfare that a representative individual residing in the South achieves in the cooperative equilibrium relative to what the individual obtains in the non-cooperative equilibrium. This term is also positive if $s_N(\beta^{NC}) > s_N(\beta^{C})$, since the higher capital controls in the North in the non-cooperative equilibrium lead to relatively more firms located in the North.

Recall that when more firms locate to the North, welfare of the North increases by the same factor as welfare of the South decreases. Consider then the following assumptions. First, assume that $\varepsilon \geq 1$, that is, consider a set of welfare functions

which encompasses the utilitarian case. Second, let $\lambda > 1$, i.e., assume that there are more individuals residing in the North than in the South. Then the total welfare gain of the North net of the total welfare loss of the South is positive when more firms locate to the North, since there are more consumers in the North who will benefit from the lower prices that follow when fewer industrial varieties need to be imported from the South. Since there are more firms located in the North in the non-cooperative equilibrium than in the cooperative equilibrium, i.e., $s_N(\beta^{NC}) > s_N(\beta^C)$, total welfare is therefore relatively higher in the non-cooperative equilibrium.