International Trade and Retailing: Diversity versus Accessibility and the Creation of "Retail Deserts"

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November 30, 2006

Abstract

The retail sectors in many industrialized countries have experienced a large increase in concentration and the appearance of so-called "retail deserts", areas of low retail provision. This study addresses the role of international trade in this process. The analysis shows that by raising product diversity, international trade also raises the costs of provision in retailing and leads to a consolidation in this industry. As a consequence, surviving retailers have larger catchment areas and consumers have to travel longer distances for their errands. These adjustments in retailing create a trade-off between diversity and accessibility, and international trade is not unambiguously welfare improving.

Keywords: International Trade, Retailing, Diversity, Accessibility, Retail Deserts.

JEL Classification: F12, L11, L81

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1   Introduction

The modern theory of international trade identifies an expansion in the choices for consumers as an important gain from trade (Krugman, 1979, 1980, for the seminal theoretical contributions; Broda and Weinstein, 2006, for an empirical investigation). The emphasis of this argument is on adjustments in the manufacturing industries. International trade enlarges the markets for manufacturers and makes their operations more profitable, so that the equilibrium number of firms in an integrated global economy is larger than the number of firms in any national economy under autarky. Thus, product diversity rises and consumers can choose from a larger menu of differentiated varieties.

Changes in the market structure of manufacturing industries are important for the choices available to consumers, but they are certainly not the only determinants of consumer choice. Adjustments in the retailing industry play a major role as well (Clarke et al., 2004). Typically, consumers do not buy their products directly from manufacturers but travel to the nearest retail outlet to run daily errands or purchase less frequent acquisitions. Hence, changes in the retail provision are also important for consumer choice. Surprisingly, the retail sector has received virtually no attention in the theory of international trade. This is particularly striking since the retailing industry has gone through immens structural changes over the past decades that have had an equally immens impact on the local availability of manufactured products.

In many industrialized countries, the retail sectors have experienced very similar developments. There is overwhelming evidence that the level of concentration has increased significantly (Dawson, 2001; Dobson et al., 2001; Weiss and Wittkopp, 2005) and that the overall number of retail outlets has declined (Dobson and Waterson, 1999; Clarke, 2000; U.S. Department of Commerce, 2006). At the same time, the average number of products stocked in supermarkets has risen significantly (Richards and Hamilton, 2006) and the number of gigantic supermarkets, so-called superstores, has even increased in absolute terms despite the overall decline in retail outlets (Dobson et al., 2001; Dobson et al., 2003). Today, the retail sectors in most countries are characterized by larger but fewer retail outlets than 20 or 30 years ago.

The increase in the number of products carried by retail outlets mirrows the increase in

the number of varieties traded on the world markets. However, the decline in the number of retail outlets draws a different picture than the increase in choices proposed by the "New Trade Theory". Urban economists and city planners are getting increasingly worried about the creation of so-called "retail deserts", areas with a low retail provision. A recent column in the Philadelphia Inquirer puts it this way:

> "One of the first things any visitor to the city notices is the dearth of places to shop. I'm not just talking about classy boutiques and gourmet shoppes; vast stretches lack basic grocery stores or pharmacies. (...) The problem isn't limited to the city's poorest areas, moreover. Stretches of Spring Garden Street and Baltimore and Germantown Avenues are practically retail deserts (...)." (Cassel, 2006)

Similar concerns are reported for the United Kingdom where the focus of attention is on grocery retailing and "food deserts". For Cardiff, Guy et al. (2004) find a polarization effect where the gap in accessibility to retail outlets has widened across electoral divisions. These authors illustrate that

> "'Food deserts' in British cities are partly the result of the expansion of multiple food retailing. New large stores force smaller stores to close down, thus depriving local residents of food shopping opportunities." (Guy et al., 2004, p. 72).

Wrigley et al. (2002, 2004) provide evidence for the existence of "retail deserts" in Leeds. Among other criteria, they use a definition set out by the former UK Department for Transport, Local Government and the Regions as "areas that lack retail services within say a 500-metre radius" (DTLR, 2000). Fitch (2004) complements the picture for Scotland and Furey et al. (2001) for Northern Ireland.

For the United States, Blanchard and Lyson (2002, 2003) show how the placement of "supercenter" retail grocery stores, like Wal-Mart, contributes to a retail desertification of rural populations. Their study indicates that accessibility to large supermarkets and supercenters varies considerably across space and that many rural areas are clearly "retail deserts". Kaufman (1998) reports that rural counties in the Lower Mississippi Delta average one super-

market per 190.5 square miles. This area corresponds to a radius of roughly 7.8 miles which exceeds by far the 500-metre criterion applied in the UK.

This paper addresses the role of international trade in the creation of "retail deserts". I will argue that "retail deserts" are partly driven by international trade, in particular by the trade-induced increase in the number of varieties. For retailing firms, the provision of an assortment of products is costly. Therefore, when international trade leads to an increase in the number of products traded, it also raises the costs of provision for local retailers. With costs rising, retailing becomes less profitable, and some retailers exit. This consolidation in the retail sector enables the remaining retailers to expand their catchment areas, so that they can cover the increase in the costs of provision. For consumers, larger catchment areas imply longer travels, both at the margin as well as on average. Thus, a major finding of this study is that adjustments in retailing create a trade-off between diversity and accessibility.

The framework is based on a standard model of intra-industry trade in differentiated products (Krugman, 1980). The spatial structure needed to measure distance combines elements of the monocentric city model à la Alonso (1964) and the spatial model by Salop (1979) used in industrial organization. Consumers live in a circle around a central business district and travel to the nearest local retailer for their purchases. The modeling of retailing, in particular the modeling of a retailer's cost function builds on recent contributions in industrial organization and agricultural economics, in particular on Sullivan (1997), Smith (2004), Ellickson (2004, 2005), and Richards and Hamilton (2006), as well as on an industry study by the Competition Commission (2000).

The model is described in great detail in the next section. The actual analysis is conducted in three parts. First, the impact of international trade on the retail sector and the feedback effects of retailing on international trade are studied extensively in section 3. This section illustrates how international trade can contribute to the creation of "retail deserts" and how adjustments in retailing can lead to a trade-off between diversity and accessibility. Secondly, section 4 addresses the isomorphism of international trade and economic growth. This isomorphism is often found in models of the "New Trade Theory" but does not survive when adjustments in retailing are taken into account. Finally, section 5 discusses alternative specifications of the costs of retailing.

2 A General Equilibrium Model of Retailing

2.1 Consumers

Suppose that the economy of a country is populated by a mass of L consumers and that all of these consumers live in a circle with circumference Ω and radius $\Omega/2\pi$ around a single central business district (CBD). The mass of consumers is uniformly distributed across the circumference of this circle, so that the population density is identical at all points and given by L/Ω. One can think of this framework as the spatial depiction of a representative city in this economy.

Consumers maximizes a standard CES utility function:

$$U_i = \frac{1}{t_i} X_i, \tag{1}$$

where $X_i \equiv \left[\int_0^N x(j)^\rho \, dj \right]^{\frac{1}{\rho}}$, $0 < \rho < 1$, is a basket of N differentiated goods $x(i)$ and t_i denotes transportation costs for consumer i. These transportation costs arise because consumers have to travel to retail outlets to buy goods for consumption.[1] The size of these transportation costs depends on the distance δ_i between the location of a particular retail outlet and the location (home) of consumer i, so that

$$t_i = t(\delta_i) \tag{2}$$

and $t'(\delta_i) \equiv \partial t_i / \partial \delta_i > 0$. The retail outlets are located on various points on the circumference of the circle, so that the distance δ_i can be expressed as the shortest arcdistance between the home of the consumer and the location of the retail outlet.

Maximization of (1) subject to the budget constraint $\int_0^N p(i) x(i) \, di \leq I$ (I is individual income) yields demand for individual varieties of X:

$$x(i) = p(i)^{-\sigma} P^{\sigma-1} I. \tag{3}$$

Here, $P \equiv \left(\int_0^N p(i)^{-\frac{\rho}{1-\rho}} \, di \right)^{-\frac{1-\rho}{\rho}}$ is the price index. Consumers disregard the impact of

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[1] Throughout the analysis, we assume that direct marketing is not an option, so that manufacturing firms need to sell their products through retailing firms.

individual prices on the price index $[\partial P/\partial p\,(i) = 0]$ so that the price elasticity is given by $-\sigma$, where $\sigma \equiv 1/(1-\rho)$. Note that the transportation costs are of the iceberg type. Hence, consumers have to pay the same price in any retail outlet, but on the way home some of the goods purchased "melt away" and are not available for consumption any more.

2.2   Retailing

Retail outlets buy products from manufacturers at the wholesale price p_W and sell them with a mark-up to local residents. In addition, retailers have to incur costs for the provision of the goods. The profits of a particular retailer j, $\Pi_R\,(j)$, are given by

$$
\begin{aligned}
\Pi_R\,(j) \;=\; & \frac{L}{\Omega} \int_0^{\delta_j^l} \int_0^{N_j} \left[p\,(i_1, i_2) - p_W\,(i_1, i_2)\right] x\,(i_1, i_2)\, di_1 di_2 \\
& + \frac{L}{\Omega} \int_0^{\delta_j^r} \int_0^{N_j} \left[p\,(i_1, i_2) - p_W\,(i_1, i_2)\right] x\,(i_1, i_2)\, di_1 di_2 \\
& - w\Gamma_j\,(N_j)\,.
\end{aligned}
\tag{4}
$$

Here, δ_j^l and δ_j^r denote the catchment area of retailer j to the left of its location on the circle and to the right, respectively. Thus, retailer j's entire catchment area is given by $\delta_j^l + \delta_j^r$.

The last term, $w\Gamma_j\,(N_j)$ denotes the costs of provision, where Γ_j is the labor requirement necessary to provide N_j goods and w is the (economy-wide) wage rate. These costs are sunk in the sense that once a retailer has decided upon its product assortment, the costs of providing these goods do not depend on the actual sales. They do depend positively on the number of varieties in the assortment $[\Gamma_j'\,(N_j) \equiv \partial \Gamma_j/\partial N_j > 0]$ (Competition Commission, 2000, in particular chaper 10 and its appendix). One can think of these costs as expenditures for in-store service personnel or labor services in departments such as purchasing or storage (Sullivan, 1997). A detailed discussion of alternative specifications for Γ follows in section 5. Equation (4) does not exhibit any marginal costs of retailing. Their relevance is limited with respect to the mechanisms described here, so we can safely ignore them.

Given the utility of consumers and their "love of variety", the product assortment offered by a retailer can also be interpreted as an index for the quality of a retail outlet (Ellickson, 2004, 2005). A trip to a retail outlet with a larger assortment of products allows a consumer to purchase a larger variety of goods and to realize a higher utility. In this case, $w\Gamma_j\,(N_j)$

denotes the costs of achieving a certain quality, and the model can be interpreted as a model with both vertical (quality) and horizontal (location) differentiation.

Retailers charge a uniform mark-up over wholesale prices:

$$p\left(i\right) = \left(1 + m_j\right) p_W\left(i\right). \tag{5}$$

An important difference between retailing firms and (single-product) manufacturing firms is that retailing firms sell a basket of goods. While changes in individual prices are not perceived by consumers as affecting their price index of consumption $[\partial P/\partial p\left(i\right) = 0]$, changes in a retailer's mark-up on the entire assortment certainly have a non-negligible impact on this price index. Therefore, a retailer's attractiveness to consumers depends on the mark-up it charges on its products. At the same time, $\partial P/\partial p\left(i\right) = 0$ excludes all incentives for retailers to discriminate the mark-ups between products, because bargains for individual goods does not make an outlet more attractive.

Retailers cannot discriminate prices on the basis of the location of their customers, either. Because of differences in opportunity costs there is a clear economic incentive for retailers to charge higher prices for customers who live closer to a particular retail outlet. However, such a discrimination is virtually impossible to implement in practice and unlawful in most countries.

Given (1) and (5), the boundaries of a retailer's catchment area are given by

$$t\left(\delta_j^i\right)\left(1 + m_j\right)^{\sigma} = t\left(D - \delta_j^i\right)\left(1 + m^i\right)^{\sigma}, \tag{6}$$

where $i = l, r$ indicates the side of the catchment area. Equation (6) determines the location of a customer who is just indifferent between shopping at retail outlet j or at the adjacent outlets to the left or to the right. It pins down the catchment area of retailer j for a given distance between the two adjacent retailers (D) and for a given mark-up of these adjacent retailers $(m^i, i = l, r)$.

We limit our analysis to symmetric equilibria where all retailers charge the same mark-up and locate around the circle at an equal distance from each other. Then, all retailers have the same catchment areas. This is illustrated in figure 1.

Figure 1 *The Symmetric Retailing Equilibrium*

Figure 1 illustrates nicely that in a symmetric equilibrium the catchment areas of all retailers must add up to the circumference of the circle. Let M denote the number of retail outlets, then it must hold that

$$2\delta M = \Omega. \tag{7}$$

In a symmetric equilibrium, profits of retailers can be simplified to

$$\Pi_R = 2\delta \frac{m}{1+m} \frac{LI}{\Omega} - w\Gamma(N). \tag{8}$$

Here, LI/Ω with $I = PX$ denotes revenues per location within a retailer's catchment area, 2δ measures the extent of the catchment area, and $m/(1+m)$ is the ratio of net revenues to gross revenues.

Given equations (6) and (8), the profit maximizing retail mark-up is given by[2]

$$m(\delta) = \frac{2\varepsilon_t(\delta)}{\sigma}, \tag{9}$$

where $\varepsilon_t(\delta) \equiv t'(\delta)\delta/t(\delta)$. We assume that $\varepsilon_t'(\delta) \geq 0$ to ensure that mark-ups do not rise when competition rises.[3]

Note that the mark-up is simply two times the ratio of the elasticity of transportation costs $\varepsilon_t(\delta)$ to the (value of the) price elasticity of demand σ. These two terms relate to the extensive and the intensive margin of a retailing firm. If $\varepsilon_t(\cdot)$ is high, so that consumers are very sensitive with respect to distance, an increase in the mark-up of an individual retail outlet reduces its catchment area by only a little (the extensive margin). Consequently, the profit maximizing mark-up is high. Similarly, if the price elasticity of demand (σ) is small, an increase in the mark-up reduces demand for all varieties by only a little (the intensive margin), so that, again, the profit maximizing mark-up is high.

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[2] The determination of the mark-up follows the approach set out in the appendix of Helpman (1981, pp. 338-40).

[3] The elasticity of retail mark-ups with respect to the competition in retailing follows from (7) and (9): $d\ln m/d\ln M = -\varepsilon_t'(\delta)\delta/\varepsilon_t(\delta)$. Thus, $\varepsilon_t'(\delta) \geq 0$ ensures that $d\ln m/d\ln M \leq 0$.

2.3 Manufacturing

Manufacturing firms employ labor and produce single varieties of the differentiated good. Their profits are given by

$$\Pi_M(i) = p_W(i) Q(i) - w[\alpha + \beta Q(i)]. \tag{10}$$

Here, α and β denote the fixed and variable labor requirements, and $Q(i)$ denotes world market demand for variety i.

All of these manufacturing firms are located in the central business district (CBD) in the center of the circle in figure 1. Because the distance between the CBD and any retail outlet is identical and constant $(\Omega/2\pi)$, we can think of any transport costs associated with getting manufactured products to the retailers as being implicitly included in the variable cost component β.

World market demand comes from consumers in k identical countries, each of which is populated by a mass of L consumers. Hence,

$$Q(i) = k \int_0^L x(j)\, dj. \tag{11}$$

Given equations (3), (5), (10) and (11), the symmetric profit maximizing wholesale price is

$$p_W = w\beta \frac{\sigma}{\sigma - 1} \tag{12}$$

and total output of a variety can be expressed as

$$Q = kLx = \frac{(\sigma - 1) kL}{[\sigma + 2\varepsilon_t(\delta)] \beta N}. \tag{13}$$

2.4 Free Entry General Equilibrium

There is free entry in all markets and industries. First of all, this implies that the only source of income is labor income. Let each consumer be endowed with one unit of labor, so that

$$I = w. \tag{14}$$

Second, free entry implies that profits are driven down to zero. Using equations (8), (9) and (14), the joint optimal mark-up and zero profit condition for the retail industry is

$$2\delta \frac{2\varepsilon_t(\delta)}{\sigma + 2\varepsilon_t(\delta)} \frac{L}{\Omega} = \Gamma(N). \tag{15}$$

Similarily, using equations (3), (5), (9), (10), (11), (12) and (14), the joint optimal pricing and zero profit condition for the manufacturing industry can be expressed as

$$\frac{kL}{\sigma + 2\varepsilon_t(\delta)} = \alpha N. \tag{16}$$

Note that (13) and (16) imply that the equilibrium size of manufacturing firms is determined entirely by exogenous parameters: $Q = \frac{\alpha}{\beta}(\sigma - 1)$.

Conditions (15) and (16) are only valid simultaneously if it is profitable for retailers to include all varieties available in their portfolio of products traded. This has been assumed implicitly so far, but needs to be expressed explicitly now. Retailers add new varieties to their product assortment as long as the net revenues are larger than the additional costs induced by their provision:

$$\frac{d\Pi_R}{dN} = 2\delta \frac{m}{1+m} \frac{L}{\Omega} px - w\Gamma'(N) > 0. \tag{17}$$

Using (14), $px = I/N$ [from (3)] and $\Pi_R = 0$, this simplifies to

$$\Gamma'(N) \frac{N}{\Gamma(N)} < 1. \tag{18}$$

If condition (18) holds, the costs of providing goods increase less than proportional with the number of varieties traded. This implies that there are economies of scope in retailing. In this case, all varieties offered by manufacturing firms on the world market are actually traded by local retailers and the number of varieties available to consumers is determined by the aggregate number of manufacturing firms. Let us assume that condition (18) holds for now and discuss its implications in chapter 5.

Given (18), equations (15) and (16) determine the equilibrium simultaneously. They provide testable propositions with respect to the determinants of the number of varieties traded N and the retail catchment areas δ.

Proposition 1 *(i) The free entry profit maximizing retail catchment area is determined by*

$$\delta = \delta \left\{ \underset{-}{\varepsilon_t\left(\cdot\right)}, \underset{+}{\sigma}, \underset{+}{N}, \underset{+}{\Gamma\left(\cdot\right)}, \underset{-}{\frac{L}{\Omega}} \right\}. \tag{19}$$

(ii) The free entry profit maximizing number of varieties is given by

$$N = N \left\{ \underset{-}{\alpha}, \underset{-}{\varepsilon_t\left(\cdot\right)}, \underset{-/0}{\delta}, \underset{-}{\sigma}, \underset{+}{kL} \right\}. \tag{20}$$

Proposition 1, particularly part (i), provides valuable insights into the determinants of the industrial structure in the retailing industry. It shows that the size of the free entry profit maximizing retail catchment area depends negatively on the elasticity of transportation costs (ε_t), positively on the value of the price elasticity of demand (σ), positively on the size of the sunk cost components in retailing [$\Gamma\left(N\right)$] and negatively on the population density (L/Ω).

The first two components, the elasticity of transportation costs and the price elasticity of demand, affect the catchment areas through the mark-ups charged by retailers. According to (9), mark-ups in retailing are high if consumers are sensitive with respect to distance [high $\varepsilon_t\left(\cdot\right)$] or not very sensitive with respect to prices (low σ). In both cases, high mark-ups lead to smaller catchment areas.

The sunk cost components [N and $\Gamma\left(\cdot\right)$] and the population density (L/Ω) affect the catchment areas through entry. An increase in sunk costs or a fall in the population density lower the profits of retailing firms. Consequently, the number of retail outlets drops and, through (7), the size of individual catchment areas rises. The negative relation between the population density and the equilibrium catchment areas is in line with reports indicating that the retail provision is on average lower in rural areas than in urban areas (e.g., Blanchard and Lyson, 2002, 2003).

Proposition 1 (ii) describes the determinants of the number of varieties available to consumers. Because of (18), this number is determined by the free entry profit maximizing number of manufacturing firms. Many of these determinants are not different from the standard models of international trade and do not need to be explained in detail. However, the only exception worth mentioning is the negative influence of $\varepsilon_t\left(\delta\right)$. This term plays a role because it affects the retail mark-up (see discussion above), and thus influences final demand

by consumers.

Finally, in general equilibrium, the various national labor markets must be in equilibrium as well. In contrast to goods markets, we do not allow for labor movements across countries, so that labor markets must clear at a national level. Labor demand in an individual country consists of demand by local manufacturing firms[4] $[(\alpha + \beta Q) N/k]$ and demand by retailing firms $[\Gamma(N) M]$. Given (13), (15) and (16), the ensuing national labor market clearing condition

$$(\alpha + \beta Q) \frac{N}{k} + \Gamma(N) M = L \qquad (21)$$

reduces to $M2\delta = \Omega$, so that equation (7) ensures that the labor market is in equilibrium as well.

Equations (15) and (16) provide two equations that determine the number of varieties N and the retail catchment areas δ. Knowing δ, the number of retail outlets in a country M can then be determined via (7). Figure 2 illustrates the equilibrium graphically.[5]

Figure 2 *The General Equilibrium*

The RR locus in the right quadrant of figure 2 depicts the $\delta - N$ configurations where the retail industry is in equilibrium. It is based on equation (15). The MM locus is the equivalent curve for the manufacturing industry, based on equation (16). The slopes of these two curves follow immediately from the signs in (19) and (20). The LL locus in the left quadrant illustrates the labor market equilibrium and follows from (21) or directly from (7).

3 International Trade, "Retail Deserts" and the Trade-off between Diversity and Accessibility

Having established the general equilibrium, we can now conduct a comparative static analysis. International trade is modelled as an increase in the number of countries participating in the world market. This implies that k rises. A quick look at the underlying equations describing

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[4]Note that N denotes the choices available to consumers and is thus the sum of all firms in all k countries. In a perfectly symmetric environment, the share of local firms is just N/k.

[5]In the figures we assume that $\varepsilon'(\delta)$ is strictly positive. If $\varepsilon'(\delta) = 0$, then (16) is independent of δ and the MM curve is a straight vertical line. Linearity of the RR and the MM curve is assumed for simplicity.

the RR, MM and LL loci reveals that k appears only in equation (16). According to (20), an increase in k shifts the MM locus outwards.

Figure 3 *International Trade*

Figure 3 illustrates the impact of international trade on the retailing and manufacturing industries. It shows that an increase in the number of countries participating in the world market (k) leads to an unambiguous increase in the number of varieties available to consumers (N) and in the size of the retail catchment areas (δ). The number of retail outlets (M) clearly falls.

The increase in the number of varieties available to consumers is perfectly in line with the results of standard models of international trade. Equation (16) shows that for a given industrial organization in the retailing industry (in particular for a given δ), the number of varieties available (N) is proportional to the number of countries (k). As new countries are integrated in the world market, firms from these countries export their varieties to all consumers worldwide, so that the choices available to consumers grow.

The retailing industry is not directly affected by the international trade integration. Technically, there is no k in equation (15) and the RR curve is unaffected by changes in k. Intuitively, retailers are not directly affected by an expansion of the world market because they sell only to local residents. However, the increase in the number of varieties available raises the costs of provision for retail outlets, so that retailing firms are affected indirectly through changes in their cost structure.

The increase in N raises the costs of provision, but overall expenditures by local residents do not change. As a consequence, net revenues are too small to cover the costs of provision, so that retailing becomes less profitable and some retailers need to exit. This explains the fall in the number of retail outlets M. In a symmetric equilibrium, a smaller number of retailers goes hand in hand with an increase in the catchment areas of the remaining retailers, so that δ rises. The increase in the catchment areas itself raises net revenues for surviving firms, but it also allows them to raise their mark-ups [see (9)] All in all, surviving retailing firms gain both in catchment areas and mark-ups to cover the increase in the costs of provision.

The adjustment processes in the retailing industry trigger further adjustments in the manufacturing industry. The increase in the mark-ups of retailers raises the prices of consumer

goods and lowers the sales of manufacturing firms. As a consequence, there is also some consolidation within the global manufacturing industry, so that in the new equilibrium the number of varieties available worldwide has increased by less than the size of the market. In the end, N still rises, but N/k falls.

The mathematical results confirm our intuitions:

$$\frac{d\ln N}{d\ln k} = \frac{1}{\Delta}\left[1 + \frac{\sigma}{\sigma + 2\varepsilon_t(\delta)}\varepsilon_t'(\delta)\frac{\delta}{\varepsilon_t(\delta)}\right] > 0, \tag{22}$$

$$\frac{d\ln \delta}{d\ln k} = \frac{1}{\Delta}\Gamma'(N)\frac{N}{\Gamma(N)} > 0, \tag{23}$$

where $\Delta = 1 + \frac{1}{\sigma + 2\varepsilon_t(\delta)}\varepsilon_t'(\delta)\frac{\delta}{\varepsilon_t(\delta)}\left[\sigma + 2\varepsilon_t(\delta)\Gamma'(N)\frac{N}{\Gamma(N)}\right] \geq 1$.

Two extreme cases can help to illustrate the economic mechanisms behind our results: The first case underlines the importance of the cost structure in the retailing industry. If $\Gamma'(N) = 0$, then $d\ln N/d\ln k = 1$ and $d\ln \delta/d\ln k = 0$. In this case, the increase in the number of varieties has no impact on the cost structure of retailing firms. As a consequence, the number of varieties rises proportionally to the size of the world market, while the industrial structure of the retailing industry remains unaffected. The second case addresses the role of changes in the retail mark-up. If $\Gamma'(N) > 0$ but $\varepsilon_t'(\delta) = 0$, then $d\ln N/d\ln k = 1$ and $d\ln \delta/d\ln k = \Gamma'(N)N/\Gamma(N) > 0$. This is the case where the costs of provision in retailing rise with the number of varieties provided, but where the mark-ups in retailing are independent of the catchment areas. Here, surviving retailers need to cover all additional costs through an increase in the size of their catchment areas. This is why the catchment areas rise proportionally to the costs of provision. In all other cases, where $\Gamma'(N) > 0$ and $\varepsilon_t'(\delta) > 0$, the increases in N and δ are less than proportional to the increase in the world market: $d\ln N/d\ln k, d\ln \delta/d\ln k \in (0,1)$. Note that $d\ln N/d\ln k < 1$ implies that $d(\ln N - \ln k)/d\ln k < 0$, so that the number of manufacturing firms per country (N/k) falls.

Proposition 2 *International trade integration leads to an increase in the choices available to consumers (N), but the number of manufacturing firms in individual countries falls (N/k). The number of retail outlets (M) also falls. The surviving retail outlets exhibit larger retail catchment areas (δ).*

According to proposition 2, international trade leads to larger but fewer retail outlets. Because their catchment areas grow, the maximum distance travelled by the marginal consumer, i.e. the consumer who is just indifferent between two retailers, as well as the average distance travelled by all consumers, defined as $\tilde{\delta}(\delta) = \delta/2$, clearly rise, too.

It is this increase in the maximum and the average distance that shows how international trade can contribute to the creation or the expansion of so called "retail deserts". "Retail deserts" are areas with a low accessibility to retail outlets. In order to capture this notion within this framework, let a "retail desert" be defined as an area where the shortest arc distance to the nearest retail outlet exceeds a critical distance of $\check{\delta}$. This definition can be seen as a generalization of the 500-metre criterion in the UK (DTLR, 2000). Then, the size of a "retail desert" ψ is given by its arc length

$$\psi = \max\left\{0, 2\left(\delta - \check{\delta}\right)\right\}. \tag{24}$$

Given this definition, an increase in δ as induced by international trade either contributes to the creation of "retail deserts" (as long as $\delta < \check{\delta}$) or leads to their expansion (if $\delta > \check{\delta}$).

Corollary 1 *International trade integration can contribute to the creation or the expansion of "retail deserts" by raising both the maximum and the average distance to the nearest retail outlet.*

From a utility perspective, consumers at various locations are affected quite differently by the adjustments in the retailing industry. Some consumers may benefit from having larger retail outlets nearby, whereas other consumers may find themselves in the middle of a "retail desert" and suffer from having to travel longer distances to the next retail outlet. The gap in utility between consumers living right next to a retailer [with transportation costs $t(0) = 1$] and consumers living right in between two retailers [with transportation costs $t(\delta)$] clearly rises as δ rises. Hence, international trade unambiguously widens the utility gap.

The average utility of consumers is given by

$$\tilde{U}\left(\underset{+}{N}, \underset{-}{\delta}\right) = \frac{(\sigma - 1)}{\beta\left[\sigma + 2\varepsilon_t(\delta)\right]} \frac{N^{\frac{1-\rho}{\rho}}}{\tilde{t}(\delta)} \tag{25}$$

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where $\tilde{t}(\delta) \equiv \left(\frac{1}{\delta}\int_0^\delta t_j^{-1} dj\right)^{-1}$ denotes average transportation costs for consumers.

Equation (25) illustrates that consumers value diversity (N), because - by assumption - they have a "love of variety". In addition, consumers also care about the size of retail catchment areas (δ) for two reasons. First, according to the mark-up rule in (9), a larger catchment area implies a higher mark-up by retailing firms $[p/w = \beta[\sigma + 2\varepsilon_t(\delta)]/(\sigma - 1)]$ and, thus, a lower real wage for consumers. Second, a larger catchment area leads to an increase in average transportation costs. Thus, larger retail catchment areas clearly lower average utility. In principle, consumers also profit from lower mark-ups by manufacturing firms $[p^w/w = \beta\sigma/(\sigma - 1)]$, but this mark-up is constant here and remains unaffected in our analysis.

According to proposition 2, international trade leads to an increase in diversity as well as to an increase in the retail catchment areas. While the increase in diversity clearly raises the utility of all consumers, the increase in the distance between retailers lowers utility on average. In contrast to the results of international trade models without retailing, our results suggest that the overall impact of international trade on welfare (as measured by average utility) can be negative once adjustments in the retailing industry are taken into account.

A mathematical analysis provides further insights. The relative change in $\tilde{U}$ is given by

$$
\begin{aligned}
\frac{d\ln\tilde{U}}{d\ln k} &= \frac{1}{\Delta}\left[1 + \frac{\sigma}{\sigma + 2\varepsilon_t(\delta)}\varepsilon_t'(\delta)\frac{\delta}{\varepsilon_t(\delta)}\right]\frac{1-\rho}{\rho} \\
&\quad - \frac{1}{\Delta}\left[\frac{2\varepsilon_t(\delta)}{\sigma + 2\varepsilon_t(\delta)}\varepsilon_t'(\delta)\frac{\delta}{\varepsilon_t(\delta)} + \tilde{t}'(\delta)\frac{\delta}{\tilde{t}(\delta)}\right]\Gamma'(N)\frac{N}{\Gamma(N)}
\end{aligned}
\tag{26}
$$

Equation (26) shows that the relative change in $\tilde{U}$ is ambiguous. The first term is clearly positive and the second term clearly negative.

Again, two extreme cases help to understand the underlying mechanisms. If $\Gamma'(N) = 0$, then $d\ln\tilde{U}/d\ln k = 1/\rho - 1 > 0$. In this case, the cost structure of the retailing industry is invariant to changes in the product diversity, so that international trade does not affect the retaling sector. Then, only the "love of variety" effect remains and average utility clearly rises. If $\Gamma'(N) > 0$, but $\varepsilon_t'(\delta) = 0$, equation (26) reduces to

$$
\left.\frac{d\ln\tilde{U}}{d\ln k}\right|_{\varepsilon_t'(\delta)=0} = \frac{1-\rho}{\rho} - \tilde{t}'(\delta)\frac{\delta}{\tilde{t}(\delta)}\Gamma'(N)\frac{N}{\Gamma(N)}.
\tag{27}
$$

15

In this case the impact on average utility depends solely on the interplay of the "love of variety" on the one side and the disutility of larger distances to retail outlets on the other side. Average utility falls if

$$\frac{1-\rho}{\rho} < \tilde{t}'(\delta)\frac{\delta}{\tilde{t}(\delta)}\Gamma'(N)\frac{N}{\Gamma(N)}. \tag{28}$$

Average utility can fall, if the "love of variety" is small (ρ is close to one), if average transportation costs are very sensitive to changes in distance [$\tilde{t}'(\delta)\delta/\tilde{t}(\delta)$ is large], and/or if sunk costs in retailing are very elastic with respect to changes in the number of varieties [$\Gamma'(N)N/\Gamma(N)$ is large].

The impact of $\varepsilon'_t(\delta)\delta/\varepsilon_t(\delta)$, which provides the responsiveness of the retail mark-up, is ambiguous because of two counteracting effects. On the one hand, a larger $\varepsilon'_t(\delta)\delta/\varepsilon_t(\delta)$ implies that the retail mark-up rises more, which tends to reduce utility. On the other hand, a larger $\varepsilon'_t(\delta)\delta/\varepsilon_t(\delta)$ reduces the consolidation in the retail industry, so that the distance between retailers rises by less [see equation (23)].

The ambiguity in the impact on average utility can be described as a trade-off between diversity and (retail) accessibility. Consumers value both, but adjustments in the retailing industry create this trade-off. The RR curve in figure 2 visualizes this trade-off. It illustrates that an equilibrium in the retailing industry requires a positive relation between N and δ, and thus a negative relation between diversity (N) and accessibility ($1/\delta$).

Proposition 3 *The increase in diversity raises welfare, but the increase in the distance between retailers raises transportation costs and lowers welfare. Thus, adjustments in the retailing industry create a trade-off between diversity and accessibility, and the aggregate impact of international trade on welfare is ambiguous.*

4 International Trade versus Economic Growth

Since Krugman's (1979) seminal analysis it is common knowledge, and a popular modeling technique, that in standard models of the "New Trade Theory" a switch from autarky to free international trade is isomorphic in its impact on the world economy to the impact of an internal expansion, such as an increase in the population, on an individual country. This

is because both shocks expand the size of the relevant markets for manufacturers and the induced increase in sales is the driving force behind the adjustments.

With retailing, this isomorphism does not survive. In our framework, the results with respect to an increase in L are:

$$\frac{d \ln N}{d \ln L} = \frac{1}{\Delta} \left[1 + \varepsilon_t'(\delta) \frac{\delta}{\varepsilon_t(\delta)} \right] > 0, \tag{29}$$

$$\frac{d \ln \delta}{d \ln L} = -\frac{1}{\Delta} \left[1 - \Gamma'(N) \frac{N}{\Gamma(N)} \right] < 0. \tag{30}$$

Equation (29) shows that the impact of an increase in the population on diversity is indeed very similar because the adjustment processes in the manufacturing industry are similar. But the adjustments in the retailing industry are fundamentally different. While the catchment areas in retailing rise and the number of retailers falls when new countries are integrated in the global economy, an increase in the size of national economies lowers the catchment areas and raises the number of retailers.

These differences in the adjustment processes arise because international trade integration affects the retailing industry only indirectly through changes in the number of varieties, whereas an internal expansion has a direct impact on retailers through the population density [see the impact of L/Ω on δ in (19)]. When the population density rises, retailing becomes more profitable and new retailers enter (M goes up). The new retailing firms squeeze into the market and lower the catchment areas of all retailers.

Graphically, an increase in L shifts both curves (MM and RR) outwards in the right hand quadrant of figure 2. But since $\Gamma'(N) N/\Gamma(N) < 1$, the shift of the RR curve is even larger then the shift of the MM curve [see equations (15) and (16)], so that in the new equilibrium N has risen by more than in the case of international trade, but δ has fallen. This is illustrated in figure 4.

Figure 4 *Economic Growth*

5　The Costs of Provision and Optimal Assortment Size

In the previous sections we have relied heavily on our specification of the costs of provision, in particular on the assumption that Γ depends exclusively on N, and on our assumption that condition (18) holds, i.e. that $\Gamma'(N) N/\Gamma(N) < 1$. In this section we want to take a closer look at the role of these assumptions, both for the determination of the equilibrium as well as for the impact of international trade and internal growth.

Some studies suggest that the costs of provision do not only depend on the number of varieties (N), but also on the aggregate quantity of units sold (Nx) (Sullivan, 1997; Competition Commission, 2000; Weiss and Wittkopp, 2005). We can address this issue by assuming that the costs of provision are given by the weighted geometric mean of N and Nx:

$$\Gamma(N, Nx) = N^\eta (Nx)^{1-\eta} = Nx^{1-\eta}, \tag{31}$$

where $0 \leq \eta \leq 1$.[6] If $\eta = 1$, equation (31) reduces to a simple linear version of our original cost function $\Gamma(N)$. If $\eta = 0$, the costs of provision depend exclusively on the aggregate quantity of products stocked, irrespective of the diversity in the assortment. If $0 < \eta < 1$, equation (31) implies that the costs of provision are not only increasing in the diversity of products offered, but also in the aggregate quantity of goods. Lemma 1 addresses the role of this change in the cost function:

Lemma 1 *Including aggregate quantities in the cost function does not change the results qualitatively, as long as diversity affects the costs of provision independently ($\eta > 0$). In particular, the trade-off between diversity and accessibility remains.*

Proof. Using equation (13), the costs of provision can be written as $\Gamma(N, \delta) = N^\eta[\sigma + 2\varepsilon_t(\delta)]^{\eta-1}[(\sigma-1)/\beta]^{1-\eta}$. In this case, the elasticity of the RR locus is given by

$$\left. \frac{d\ln\delta}{d\ln N} \right|_{RR} = \eta \left\{ 1 + \left[1 - \eta \frac{2\varepsilon_t(\delta)}{(\sigma + 2\varepsilon_t(\delta))} \right] \varepsilon_t'(\delta) \frac{\delta}{\varepsilon_t(\delta)} \right\}^{-1} \geq 0. \tag{32}$$

Clearly $d\left(d\ln\delta/d\ln N|_{RR} \right)/d\eta > 0$. Thus, a reduction in η dampens the positive slope of the RR locus, but the slope cannot become negative. It can, however, become zero if $\eta = 0$ so

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[6] Note that with (31), condition (18) holds with equality, so that any assortment size is optimal.

that the RR locus becomes a vertical line. In this case, the equilibrium catchment areas are fully determined by exogenous parameters and the trade-off between diversity and accessibility ceases to exist. ∎

Lemma 1 indicates that our simplification is admissable as long as $\eta > 0$, i.e. as long as product diversity enters the cost function independently. Since this condition appears to be well established (Sullivan, 1997; Competition Commission, 2000), our simplification may overstate the extent of the trade-off between diversity and accessibility, but it does not affect our results qualitatively.

Next, we address the role of economies of scope in retailing and whether condition (18) holds. For this purpose we assume that $\Gamma(N)$ takes on a quadratic form where its elasticity changes with N:[7]

$$\Gamma(N) = \gamma_1 + \gamma_2 N + \frac{1}{2}\gamma_3 N^2, \tag{33}$$

where $\gamma_i > 0 \ \forall \ i$. Given (33), the elasticity of $\Gamma(N)$ is endogenous and increasing in N:

$$\Gamma'(N)\frac{N}{\Gamma(N)} = \frac{2(\gamma_2 + \gamma_3 N)N}{2\gamma_1 + 2\gamma_2 N + \gamma_3 N^2}. \tag{34}$$

Clearly, whether condition (18) holds, i.e. whether $\Gamma'(N)N/\Gamma(N) < 1$, depends on whether $N < \sqrt{2\gamma_1/\gamma_3}$. Let us simplify further by assuming that the elasticity of transport costs is constant $[\varepsilon_t(\delta) = \varepsilon]$ so that mark-ups in retailing are also constant. This allows us to derive explicit solutions. Then, using (16), condition (18) requires that

$$kL < \alpha(\sigma + 2\varepsilon)\sqrt{\frac{2\gamma_1}{\gamma_3}}. \tag{35}$$

If (35) holds, the free entry number of manufacturing firms is small enough to ensure that $\Gamma'(N)N/\Gamma(N) < 1$. Because both external and internal growth lead to an increase in N, condition (35) requires that the size of the world market is below a certain threshold. As long as condition (35) holds, the analysis can be conducted along the lines laid out in the previous sections.

But what happens if condition (35) is not satisfied? Ceteris paribus, this can be the case if either the size of the world market (kL) is large, if economies of scope in retailing (γ_1) are

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[7]See Richards and Hamilton (2006, p. 717) and Draganska and Jain (2005) for similar specifications.

small or if diseconomies of scope in retailing (γ_3) are significant. If $kL > \alpha \left(\sigma + 2\varepsilon\right) \sqrt{2\gamma_1/\gamma_3}$, then the number of varieties traded by retailing firms is no longer determined by the free entry number of manufacturing firms, but by the optimal product assortment of retailing firms. This is given by $\Gamma'\left(N\right) N/\Gamma\left(N\right) = 1$:

$$N = \sqrt{\frac{2\gamma_1}{\gamma_3}}. \tag{36}$$

With N being fixed below the free entry number of firms, the profit maximizing price of manufacturing firms (12) exceeds average costs. However, the profit maximizing price as determined by (12) is not a Nash equilibrium any more. The ceiling on the number of products traded imposed by retailers changes the nature of competition in the manufacturing industry. The main focus of competition in this industry switches from capturing a profit maximizing market share to capturing a slot on the limited retailing shelves. Because consumers have no preferences for particular varieties, they are perfectly indifferent between already existing specifications and new specifications offered by potential competitors. The ensuing strategic game among manufacturers is then isomorphic to a Bertrand competition in homogeneous products. As a consequence, manufacturing firms cannot raise their prices above average costs. If they did, a potential competitor would undercut their price and take their place in the retailers' assortments. Hence, even though the number of manufacturing products - and thereby the number of manufacturing firms in the market - is limited by the optimal product assortment of retailing firms, manufacturing firms cannot raise their prices above average costs. This insight is summarized in lemma 2.

Lemma 2 *If diseconomies of scope in the retail provision limit the number of varieties traded by retailing firms, manufacturing firms compete in a Bertrand fashion for a place on the retailing shelves. Consequently, in equilibrium all varieties are priced at average costs.*

With average cost pricing and N determined by (36), the size of manufacturing firms is given by

$$Q = \frac{1}{\beta} \left(\frac{\sigma kL}{\sigma + 2\varepsilon} \sqrt{\frac{\gamma_3}{2\gamma_1}} - \alpha \right). \tag{37}$$

The limitation of the product assortments in retailing has no impact on the nature of competition in retailing itself. Hence, equation (15) continues to describe the retailing equi-

librium. In the case of $\varepsilon_t (\delta) = \varepsilon$ and (33), the equilibrium catchment area of retailing firms is

$$2\delta = \left(2\gamma_1 + \gamma_2 \sqrt{\frac{2\gamma_1}{\gamma_3}} \right) \left(\frac{\sigma}{2\varepsilon} + 1 \right) \frac{\Omega}{L}. \tag{38}$$

Equations (36) to (38) uniquely determine N, Q, and δ. First of all, equation (36) clearly shows that the number of varieties available to consumers is fixed by the condition for the optimal product assortment in retailing. Therefore, neither international trade nor internal growth has any impact on product diversity. International trade (an increase in k) raises solely the size of manufacturing firms and has no impact on the retailing industry. Internal growth (an increase in L) raises the size of manufacturing firms, too, but in addition it also reduces the catchment areas of retailing firms. The economic intuition behind these adjustments is basically identical to the intuition behind the results in the previous sections, except that now product diversity is unaffected by an increase in the size of the market.

As a consequence to the absence of any adverse market structure effects in the retailing industry, international trade is now clearly welfare increasing. Because the output of manufacturing firms rises and average production costs fall, international trade raises the real wages of consumers despite the constancy of retail mark-ups. International trade does not increase the choices available to consumers, so that the traditional gain from a larger product diversity is missing. But at the same time it does not increase the distance between retailers, either, so that the counteracting negative welfare effect is also missing. Hence, average utility clearly rises.

The results of this section are summarized in proposition 4.

Proposition 4 *If diseconomies of scope in the retail provision limits the number of varieties traded by retailing firms, neither international trade nor internal growth have an impact on product diversity. Both continue to raise real wages, and internal growth also increases the number of retail outlets. Consequently, even though there are no gains from an increase in diversity, both international trade and internal growth are clearly welfare enhancing.*

Poposition 4 points out an important fact. The choices available to consumers are ultimately determined in the retailing industry, and not in the manufacturing industry. Even if international trade makes manufacturing more profitable, this will only lead to an increase in

the choices for consumers if new manufactured goods are actually added to the assortments of retailing firms. This underlines the importance of addressing retailing explicitly when discussing the impact of international trade on consumers.

6　Conclusions

Consumer choice has two faces, diversity and accessibility. The first face, diversity, describes the extent to which consumers can choose between different products. The second face, accessibility, describes the extent to which they can choose between different places to shop. Our analysis reveals that in a general equilibrium framework, the retail sector creates a trade-off between diversity and accessibility.

The trade-off between diversity and accessibility is important when it comes to the impact of international trade on consumer choice. International trade raises product diversity, but the flip side of this medal is an increase in concentration in the retail sector. Reduced access to retail outlets and the creation of so-called "retail deserts" are the result. As a consequence, consumers need to travel longer distances on average and the improvement in utility due to the larger menu of consumer goods is at least partly offset by the reduced access to these goods.

This paper provides a first link between the adjustments in the retail sector and international trade. It presents a coherent framework and an intuitive explanation for the dramatic adjustments in the retailing industry. But this framework can also be pushed further to explore questions that have not been addressed here. One example is the flight of retailing firms from inner cities and the role of land prices in this process. A second issue is the role of national retail institutions, such as zoning regulations, for international trade flows. Further research along these lines can deepen our understanding of the interdependencies between international trade and retailing and, ultimately, of the impact of globalization on consumers.

Acknowledgments

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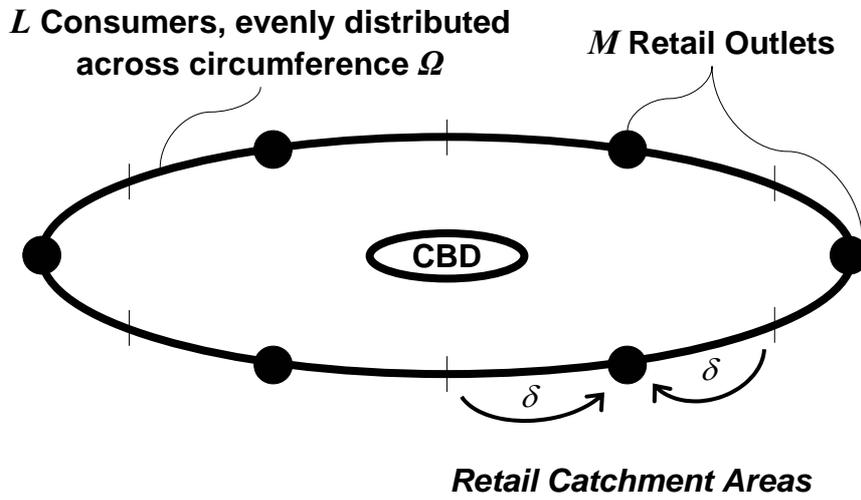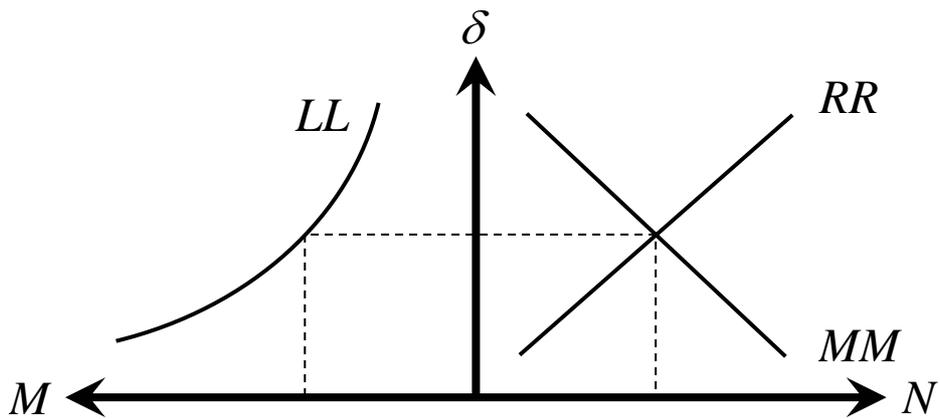
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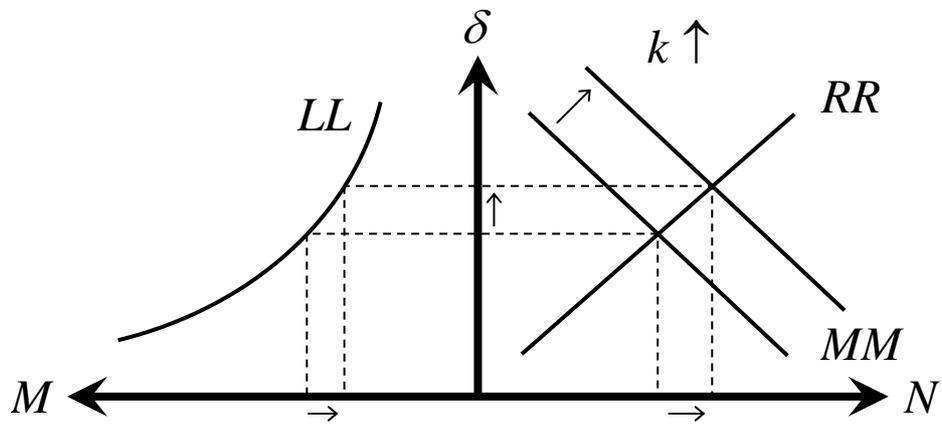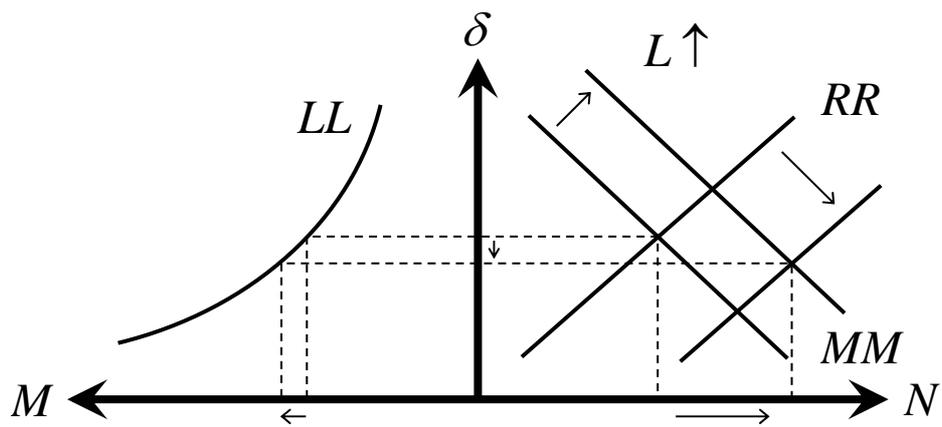

Figure 2: The General Equilibrium

Figure 3: International Trade

Figure 4: Economic Growth