Limited Consumer Attention in International Trade*

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August 19, 2011

Abstract

This paper introduces a model of limited consumer attention into an otherwise standard new trade theory model with love-of-variety preferences and heterogeneous firms. In this setting, we show that trade liberalization needs not be welfare enhancing if the consumers' mental capacity to gather and process information is exhausted. Rather, it intensifies competition for scarce consumer attention, thereby triggering over-investment into advertising and diverting purchases to imported goods. The over-investment problem provides scope for policy intervention in the form of an advertising tax. However, the tax instrument is of no help for relaxing the consumers' perception constraint. Therefore, even under an optimal advertising tax, neither a fall in transport costs nor advancements in the global distribution of information need generate gains from trade in this framework.

JEL classification: D11, F12, F15, L10, M37.

Key words: New trade theory; Heterogeneous firms; Gains from trade; Love-of-variety preferences; Limited attention; Advertising.

*We thank ...

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1 Introduction

Since Krugman's path-breaking work more than three decades ago (Krugman, 1979; 1980), the idea that access to a greater mass of foreign varieties is the main engine for trade between industrialized countries and at the same time an important source for consumer welfare features prominently in the literature. Being initially seen as a simple shortcut for a preference-based channel through which gains from trade can materialize, the love-of-variety effect in the Krugman model has meanwhile become a doctrine of modern trade theory, which seems to be well in line with the data. For instance, Broda and Weinstein (2004, 2006) show that access to foreign varieties has contributed significantly to observed welfare gains in the US and other open economies over the last three decades of the 20th century.

But should we really believe that availability of more varieties *per se* renders consumers better off? There is strong evidence that the magnitude of available consumer goods is far beyond the mass of varieties that is perceived by individual agents, and this is not due to the lack of producer efforts to inform consumers. Rather, excessive advertising that aims at bringing specific products to the perception of potential buyers renders consumer attention a scarce resource in modern societies (Simon, 1971). For instance, Love and Lattimore (2009, p. 155) point out that "the average consumer in an OECD country is exposed to 3000 ads a day and will ignore most of them." From this we can conclude that, if the consumers' mental capacity to gather and process information about products is limited, access to new imported varieties needs no longer provide a welfare stimulus but instead may generate losses due to over-investment into combative advertising.[1]

It is the aim of this paper to shed light on the role of limitations in consumer attention in an international trade context. For this purpose, we enrich an otherwise standard trade

[1]Camerer (2003) lists limited consumer attention among the key challenges for future behavioral economic research, and recent years have indeed seen a surge in research dealing with this problem. Prominent examples include Sims (2003), Gabaix, Laibson, Moloche, and Weinberg (2006), Reis (2006a, 2006b), and Falkinger (2007, 2008). However, despite its prominent role in many fields of the economics discipline, limited consumer attention has so far not been at the research agenda of trade economists.

framework with a simple, analytically tractable model of limited consumer attention that has been proposed by Falkinger (2008). In this model, firms have to send a sufficiently strong signal relative to their competitors in order to bring their product to the attention of consumers. Sending the signal can be interpreted as an advertising investment.[2] We model this investment as a fixed cost whose size depends on market conditions, i.e. on the mass of available consumer goods. For the trade part, we use a new trade theory model, in which consumers have love-of-variety preferences. Instead of relying on a textbook Krugman (1980) model, we choose a more elaborated framework with heterogenous firms along the lines of Melitz (2003). This allows us to distinguish between gains from trade that materialize due to access to new varieties and selection effects that impact the distribution of active firms and thus the composition of consumer goods.

There are two possible regimes. In the first one, the mass of available consumer goods is small so that the total volume of information on products lies within the consumers' mental capacity to gather and process information. In this case, all products advertised with a minimum level of strength are perceived by consumers and the model degenerates to a standard Melitz framework. We call this scenario the information-poor (IP) regime. In the second regime, the consumers' mental capacity is exhausted and, in their endeavor to reach consumer attention, firms mutually overbid their advertising expenditures until firm exit has brought the mass of available products in accordance with the perception constraint of consumers. We refer to this scenario as the information-rich (IR) regime.

We use this framework to study the welfare implications of trade liberalization, which is modeled as a reduction in iceberg transport costs between two symmetric countries.

[2]The literature distinguishes three views of advertising; the first one emphasizes the persuasive character of advertising, which influences consumer preferences, increases brand loyalty, and reduces demand elasticity with detrimental effects on efficiency; the second view points to the informative role of advertising and thus emphasizes its efficiency-enhancing effect; the third view states that advertising is complementary to a product and thus raises utility of consuming it (see Bagwell, 2007, for a literature review). In our model, advertising is informative as it brings products to the consumers' attention. At the same time, it plays a combative role as it aims at diverting consumers' attention from competitors to the own output, which may be socially wasteful (see Marshall, 1919).

Thereby, the IP-regime serves as a benchmark of our analysis as it reproduces the standard result of gains from trade in the Melitz framework: access to a lager number of product varieties and a positive compositional effect triggered by exit of the least productive firms and exporting of the most productive ones. Things are different in an IR-regime. If consumer attention is a scarce resource, access to additional foreign varieties after the fall in transport costs raises advertising expenditures at the firm level.[3] Of course, this needs not necessarily be detrimental for welfare, as more intensive advertising induces exit of the least productive producers and thus gives way for newly imported varieties in consumer perception that are produced with higher labor productivity than the displaced domestic ones. This generates an attention-based selection effect which impacts the composition of consumer goods in a similar way as the selection effect in an IP-regime. However, with the mass of perceived and consumed varieties being limited by the consumers' mental capacity to gather and process information, the compositional effect is amplified and thus consumption diverted to imports relative to an IP-regime. If transport costs are significant, this diversion is wasteful and can generate welfare losses from economic integration in an IR-regime.[4]

In an IR-regime trade triggers an over-investment into advertising plus an attention-based diversion of consumer purchases to imports. This is an important source for potential welfare losses in our setting, but at the same time leaves scope for policy intervention.

[3]The link between iceberg transport costs and advertising expenditure in an information-rich environment relates our model to Arkolakis (2010), who considers a heterogeneous firms model of trade, in which marketing expenditures determine a firm's penetration of a market (i.e. the share of consumers, this firm can reach with its output). However, aside from the link between transport costs and advertising expenditure, the two models differ significantly in both their focus and their modeling strategy. In particular, Arkolakis does neither consider limited consumer attention, nor does he look at the role of firm-level adjustments in advertising spending for the welfare implications of trade.

[4]Egger and Kreickemeier (2009) distinguish two counteracting welfare effects that arise from importing. On the one hand, there is a negative *lost-in-transit* effect caused by goods melting away when being shipped to a foreign country and, on the other hand, there is a positive *export-selection* effect since it is the most productive foreign firms who export, so that in a symmetric world the average imported good is produced with a better technology than the average domestic product. If transport costs are high, the former effect dominates and importing is associated with a waste of resources.

To shed light on whether a policy that targets the over-investment problem can secure gains from trade, we investigate advertising taxation. Being interested in the ability of policy makers to render trade liberalization a success story in an IR-regime, we abstract from any imperfections that may arise due to unilateral tax setting in a non-cooperative policy game and focus on coordinated (symmetric) forms of policy intervention. Furthermore, in line with GATT rules we only consider non-discriminatory taxation that treats domestic and foreign firms identically. In this case, an optimal tax on advertising expenditure can indeed eliminate the over-investment problem, while it is of no help for relaxing the consumers' perception constraint in an IR-regime and cannot eliminate the attention-based selection bias in favor of imported goods. Thus, it needs not be successful in rendering consumers better off after trade liberalization. Put differently, since the mass of perceived and consumed varieties is fixed in an IR-regime, trade liberalization may reduce welfare, even if taxation eliminates excessive social costs of combative advertising.[5]

In a final step of our analysis we investigate advancements in information and communication technology (ICT) that reduce the costs of advertising. We conduct two comparative-static exercises. In the first one, we consider a general improvement in ICT that lowers domestic and foreign advertising costs symmetrically, and in the second one, we consider an advancement in ICT that extends the range of advertising and thus reduces the extra costs of reaching foreign consumers with a given domestic investment into advertising. In this case, the ICT advancement is export biased. We show that both types of technology improvement are efficiency-enhancing and thus welfare-improving in an IP-regime. Things are different in an IR-regime. If the consumers' mental capacity to gather and process in-

[5]The finding that trade may lower welfare in a setting with market distortions is not new (see Markusen, 1981; and Newberry and Stiglitz, 1984; for two prominent early examples). Shy (1988) summarizes the general mechanism behind such welfare losses of trade in the following way. If there is "a distortion in autarky, for example an over-production of some goods [...] and if the production of these goods increases even further with free trade (domestic distortion becomes larger with free trade), then the welfare loss resulting from an increase in domestic distortion outweighs the welfare gains from trade" (p. 152). What is new in our model relative to this literature are the two sources of welfare losses: over-investment into advertising and the diversion of consumer purchases to imports if the mental capacity of consumers to gather and process information is limited.

formation is exhausted, a general advancement in ICT raises advertising expenditures and thus aggravates the over-investment problem. This eats up the cost reduction per unit of advertising investment, so that welfare remains unaffected by the technology improvement. The outcome is even less encouraging in the case of an export-biased advancement in ICT, as a relative decline in the fixed costs of exporting reinforces the problem of consumer purchases being diverted to imports with negative welfare consequences.

The paper is organized as follows. Section 2 briefly summarizes the main ingredients of the Melitz (2003) model. Section 3 introduces limited attention and characterizes the trade equilibrium in the IP-regime and the IR-regime. Also, the impact of a reduction in the iceberg transport cost parameter on welfare is analyzed in this section. In Section 4, we study the role of advertising taxation. Section 5 deals with advancements in the information and communication technology, and Section 6 concludes with a summary of the most important results.

2 A model of trade and heterogeneous firms

We conduct our analysis in a Melitz (2003)-type framework in which consumers have Dixit and Stiglitz (1977) love-of-variety preferences for horizontally differentiated goods. Maximization of $U = \left[\int_{\omega\in\Omega} x(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$ – subject to a binding budget constraint – gives an isoelastic demand function for each variety ω:

$$x(\omega) = \frac{I}{P}\left(\frac{p(\omega)}{P}\right)^{-\sigma}, \tag{1}$$

where $\sigma > 1$ denotes the constant elasticity of substitution between the different varieties in consumers' utility, which equals the price elasticity of demand in this model. I is aggregate income, $p(\omega)$ is the consumer price for variety ω, and P is a true cost-of-living price index: $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$, with Ω being the set of differentiated consumer goods.

The economy is populated by L workers, each supplying one unit of labor in a perfectly competitive market. Labor is the only factor of production and serves as a numéraire in the subsequent analysis, implying that the wage rate is normalized to one. Labor input

in each firm is an affine linear function of output q: $l = f_t + q/\phi$, where ϕ is firm-specific labor productivity and f_t denotes the fixed labor requirement for overhead services, with $f_t = f$ if a firm is only active domestically and $f_t = f + f_x$ if a firm additionally exports. Each active firm produces a single variety and is a monopolist in the market for this variety. Facing demand (1), firms maximize their profits by charging a constant markup, $\sigma/(\sigma - 1)$, over their marginal costs, which are $1/\phi$ in the home market and τ/ϕ in the foreign market, with $\tau > 1$ capturing iceberg transport costs.[6]

The mass of available varieties depends on firm entry, which is modeled as in Melitz (2003). In particular, we consider an unbounded pool of potential entrants who decide upon an initial investment f_e (in units of labor). This investment provides access to a productivity lottery, in which firms draw their ϕ-level from the common distribution $G(\phi) = 1 - \phi^{-k}$, with $k > \sigma - 1$.[7] Each firm has only one draw and f_e is immediately sunk. After the lottery, firms decide upon production. If they start production, they make domestic profits $\pi(\phi) = r(\phi)/\sigma - f$ in each period in which they are active, with revenues from local sales, $r(\phi)$ being an increasing function of ϕ.[8] In addition, firms can export to a *symmetric* trading partner, which generates profits $\pi_x(\phi) = \tau^{1-\sigma} r(\phi)/\sigma - f_x$. With profits depending positively on a firm's productivity, we can characterize a productivity cutoff that separates active from inactive producers. This productivity cutoff is determined by the *zero cutoff profit condition* $\pi_t(\phi^*) = 0$, where $\pi_t(\phi)$ denotes total (domestic plus foreign) per-period profits of a firm with productivity ϕ.

[6]Goods market clearing requires $q = x$ in a firm's domestic market and $q = \tau x$ in this firm's export market. Hence, a firm's cost of serving foreign consumers with one unit of its output are τ-times higher than serving domestic consumers with one unit of its output.

[7]Assuming that the productivity distribution is Pareto has evolved as industry standard in the literature on heterogeneous firms. This assumption is attractive from the perspective of analytical tractability and has considerable empirical support (Del Gatto, Mion, and Ottaviano, 2006). Condition $k > \sigma - 1$ is needed to ensure an interior equilibrium with finite values of all endogenous variables (see Baldwin, 2005).

[8]In view of (1) and constant markup pricing, we have

$$r(\phi) = p(\phi)x(\phi) = \frac{I}{P^{1-\sigma}} \left(\frac{1}{\phi} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma}.$$

Furthermore, with a constant share $(\sigma - 1)/\sigma$ of revenues used for financing variable labor input, operating profits are given by $r(\phi)/\sigma$.

Firms have an infinite horizon and face an exogenous destruction probability which forces a share δ of producers to exit in each time period. Then, abstracting from time discounting and focusing on steady state equilibria, new firms will enter the productivity lottery in each period until the expected present value of profits, $\bar{\pi}_t/\delta$, multiplied by the probability of a successful draw, $1 - G(\phi^*)$, equals the lottery participation cost, f_e. This gives the *free entry condition*

$$\bar{\pi}_t = \frac{\delta f_e}{(\phi^*)^{-k}}, \tag{2}$$

which establishes a relationship between average (per-period) profits $\bar{\pi}_t$ and cutoff productivity ϕ^*.

The zero-cutoff profit condition provides a further link between average profits and the cutoff productivity, with the specific form of this link depending on how many firms self-select into export status. Provided that the beachhead costs for entering the foreign market are sufficiently high relative to domestic ones, i.e. $f_x/f > \tau^{1-\sigma}$, the model leads to partitioning of firms by their export status, with only the most productive firms serving both domestic and foreign consumers. In this case, productivity of the marginal exporter, ϕ_x^*, is larger than the productivity cutoff in the domestic market, ϕ^*, and the proportion of firms that export is given by $\chi \equiv (\phi_x^*/\phi^*)^{-k} = [(f_x/f)\tau^{\sigma-1}]^{-k/(\sigma-1)} < 1$.[9] This is the parameter domain, we are focusing on in the subsequent analysis. Adding up profits over all active producers and taking into account that firms differ in their export status, we get for average (per-period) profits in the open economy:

$$\bar{\pi}_t = \left(1 + \chi \frac{f_x}{f}\right) \frac{(\sigma - 1)f}{k - \sigma + 1}. \tag{3}$$

The latter equation is based on producers with $\phi \geq \phi^*$ and thus directly related to $\pi_t(\phi^*) = 0$. Hence, it represents a *modified* zero-cutoff profit condition.

Together, Eqs. (2) and (3) determine the productivity cutoff, ϕ^*, and average profits, $\bar{\pi}_t$. Noting further that the aggregate resource constraint tells us that total employment in

[9] Whereas the marginal producer is characterized by $r(\phi^*)/\sigma = f$, the marginal exporter is characterized by $\tau^{1-\sigma} r(\phi_x^*) = f_x$. Hence, $\phi_x^* > \phi^*$ and thus $\chi < 1$, if $f_x/f > t^{1-\sigma}$. On the contrary, if $f_x/f \leq \tau^{1-\sigma}$, then $\phi_x^* = \phi^*$ and $\chi = 1$, such that all firms export.

all firms,[10] $M\sigma(\bar{\pi}_t + f + \chi f_x)$, must equal total labor supply L, i.e. $L = M\sigma(\bar{\pi}_t + f + \chi f_x)$, where M denotes the mass of producers in a country, we can solve for the total mass of (domestic and foreign) varieties, which are available in the market: $M_t = M(1+\chi)$. In view of Eq. (3), this yields

$$M_t = \frac{1+\chi}{1+\chi f_x/f} \frac{L(k-\sigma+1)}{f\sigma k}. \tag{4}$$

In a model in which consumers have love-of-variety preferences, the mass of available consumer goods is a key determinant of utilitarian welfare, U, which in our framework equals the real wage, w/P, and, as formally shown in the appendix, is given by

$$U = \frac{\sigma-1}{\sigma}\left[\frac{L}{\sigma f}\right]^{\frac{1}{\sigma-1}}\left[\left(1+\chi\frac{f_x}{f}\right)\frac{(\sigma-1)f}{(k-\sigma+1)\delta f_e}\right]^{\frac{1}{k}}. \tag{5}$$

This completes the characterization of the trade equilibrium.

3 Limited attention in an open economy

We now extend the basic trade model of Section 2 to one with limited consumer attention. Following Falkinger (2008), we use a basic insight from psychological research on human information processing as the cornerstone of our attention model: "[C]apacity limits *and* perceptual gating both characterize human perceptual processing" (Pashler, 1998, p. 224). This implies a fundamental bottleneck for a firm that tries to reach consumer attention. One may think about the firm's problem to address consumers in terms of Kahneman's (1973) dual-task approach. Individuals have a certain amount of mental capacity and the way a specific signal from advertising is processed by a consumer depends on the mental capacity left by the other signals to which the consumer is exposed. If total signal exposure

[10] In view of constant markup pricing, a share $(\sigma-1)/\sigma$ of total revenues, R, is spent for labor as variable production input. Noting that $w = 1$ and $R = M\sigma[\bar{\pi}_t + f + \chi f_x]$, total variable labor input is given by $M(\sigma-1)[\bar{\pi}_t + f + \chi f_x]$. Furthermore, $M(f + \chi f_x)$ is fixed total per-period labor input for overhead services, while $M\delta f_e/(1-G(\phi^*))$ is total per-period labor requirement of new entrants for participating in the productivity lottery. Adding up the different elements of labor demand, accounting for (2), (3) and setting the resulting expression equal to exogenous labor supply, L, gives the resource constraint in the text.

lies below the consumer's capacity constraint, there is no competition for scarce mental resources and thus no interference between different signals. On the contrary, if the mass of signals to which the respective consumer is exposed is excessive, interference between the different signals materializes.

As in Falkinger (2008), we account for the consumers' mental capacity constraint by assuming that, irrespective of the mass of actually available varieties, consumers cannot process information of more than $\bar{M}$ goods and, hence, purchase $M_t \leq \bar{M}$ varieties in equilibrium. Firms, on the other hand, while taking the capacity constraint as given, can invest into advertising in order to bring their products to consumers' attention. Thereby, firms must advertise with a sufficient strength in order to pass the perceptual gate of consumers. The minimum strength of advertising that makes a product visible to consumers is identical for all firms and denoted by $\rho_{min} \geq 1$. There are no other benefits of advertising for firms in our model than passing the perceptual gate of consumers, and thus firms advertise at a strength of $\rho = \rho_{min}$ in equilibrium.[11] The equilibrium value of ρ_{min} (and thus ρ) depends on the scarcity of attention and is endogenously determined.

Limited consumer attention renders advertising an important fixed cost factor, and a tractable specification that integrates this into our trade model is

$$f = a\rho^{\alpha}, \qquad f_x = a_x\rho^{\alpha}, \qquad \alpha > 0. \tag{6}$$

Thereby, focusing on a parameter domain with $a \geq a_x$ is meaningful in our context. For instance, the borderline case of $a_x = 0$ can be associated with an information and communication technology (ICT) that provides world-wide dissemination of information, such that firms do not have to bear additional costs of bringing their product to the attention of foreign consumers. In this case, the beachhead costs of entering the foreign market are zero, implying that all firms engage in exporting and, hence, there is no selection of just

[11] This assumption simplifies our model enormously and helps us focusing on the role of limited consumer attention – instead of changes in consumer behavior in response to marketing. The assumption is akin to Bagwell's (2007) conclusion from reviewing the advertising literature that "advertising often entails diminishing returns beyond a threshold level, where the threshold level varies across circumstances and may be small" (p. 1734).

the best firms into export status. In the other limiting case of $a_x = a$, the range of ICT is confined to the local market and firms have to promote their products separately in the two economies. In the intermediate case of $a_x \in (0, a)$, on which we focus in the subsequent analysis, part of the advertising investment, as for instance the set up of a principle advertising strategy, has a global character, while the residual part is location-specific, for instance due to different languages in the two countries. For (6), the assumption that $\phi_x^* > \phi^*$ reduces to $a_x/a > \tau^{1-\sigma}$. Therefore, we focus on $a_x/a \in (\tau^{1-\sigma}, 1)$ in the subsequent analysis. Finally, by suppressing country indices of ρ, we take account of our symmetry assumption, which implies that exporters face the same mass of competitors at home and abroad and, hence, must advertise with the same strength in their domestic and their foreign market.

In order to shed light on the role of limited attention in interaction with trade, we substitute (6) into Eq. (4). This gives

$$M_t = \frac{1+\chi}{1+\chi a_x/a} \frac{L(k-\sigma+1)}{a\rho^\alpha \sigma k} \equiv RHS(\rho), \tag{4'}$$

with $dRHS/d\rho = -RHS\alpha/\rho < 0$. In view of $M_t \leq \bar{M}$, there are two possible scenarios (see Falkinger, 2008). The first scenario is one, in which the mental capacity of consumers to process information is not exhausted. In this case, which we associate with an *information-poor* (IP) regime, we have $M_t < \bar{M}$ and $\rho = 1$. The second scenario is one, in which the consumer's mental capacity constraint to process information is binding, implying that $M_t = \bar{M}$ and $\rho \geq 1$. We use the term *information-rich* (IR) regime to refer to this scenario in the subsequent analysis.

Figure 1 depicts the two scenarios graphically. For RHS, the economy is in an IP-regime with the equilibrium represented by point A. All firms that find it profitable to enter and start production at $\rho = 1$ are perceived by the consumers. As a consequence, no firm has an incentive to raise its advertising strength above $\rho = 1$, because this would just increase fixed costs without a positive effect on the firm's operating profits. On the contrary, for RHS', the economy is in an IR-regime with equilibrium point A', in which attention is scarce. In this case, more than $\bar{M}$ firms would find it profitable to enter the market and start production at $\rho = 1$. As a consequence, firms raise their strength of

advertising above $\rho = 1$ in order to attract consumers' attention. Mutual overbidding of advertising effort drives up fixed costs and establishes an equilibrium at A'.

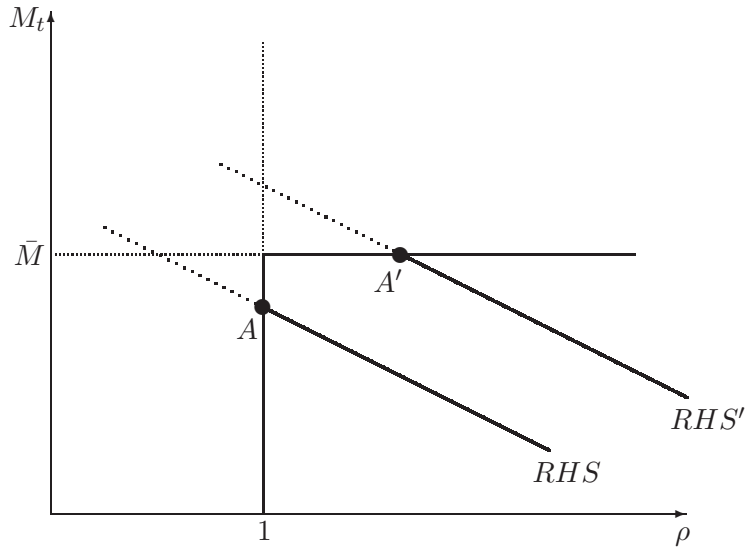

Figure 1: Advertising in an IP- and in an IR regime

From inspection of $(4')$ it is obvious that the position of the relevant RHS-locus depends on the share χ of exporting firms, which in turn is given by $\chi = (a_x/a)^{-k/(\sigma-1)}\tau^{-k}$. This renders the size of iceberg transport cost parameter τ a key determinant of the prevailing information regime. On the other hand, the impact of a change in the transport cost parameter τ on utilitarian welfare U depends on whether the economy is in an IP- or an IR-regime. A detailed discussion of these issues is at the agenda of the next two subsections. We start with a comparative-static analysis of transport cost changes in an IP-regime in Subsection 3.1 and discuss the IR-regime in Subsection 3.2.

3.1 Falling transport costs in an IP-regime

If the perception capacity of consumers is not exhausted, i.e. if $M_t < \bar{M}$, a marginal reduction in the iceberg transport cost parameter exerts similar effects as in the original

Melitz (2003) paper. In particular, differentiating (4′) and (5) with respect to τ yields

$$\frac{dM_t}{d\tau} = \frac{(1-a_x/a)M_t}{(1+\chi)(1+\chi a_x/a)}\frac{d\chi}{d\tau} < 0, \tag{7}$$

$$\frac{dU}{d\tau} = \frac{(a_x/a)U}{k(1+\chi a_x/a)}\frac{d\chi}{d\tau} < 0, \tag{8}$$

respectively. For a given mass of competitors in either market, M, a transport cost reduction triggers an expansion of exports at both the intensive margin (higher foreign sales of initial exporters) and, provided that $\chi < 1$, the extensive margin (self-selection of new firms into export status). This generates additional demand for labor and compels the least productive non-exporters to leave the market. Therefore, the productivity cutoff increases, which generates welfare gains, according to Eq. (8). At the same time, there are two counteracting effects on the mass of product varieties that are available for consumers. Access to newly exported foreign goods raises M_t, while exit of the least productive local producers lowers it. With $a > a_x$, it is the first effect that dominates, so that a fall in transport costs raises the mass of available product varieties (see Eq. (7)).

While these effects are well-known from existing work on heterogeneous firms in open economies, it is a novel feature of our analysis that a fall in the transport cost parameter brings the open economy closer to the IR-regime, which we analyze in detail in the next subsection.

3.2 Falling transport costs in an IR-regime

If the mental capacity of consumers to gather and process information is exhausted, the mass of perceived varieties is fixed by $\bar{M}$ and the strength of advertising is determined by Eq. (4′), when accounting for $M_t = \bar{M}$. Applying the implicit function theorem, yields

$$\left.\frac{d\rho}{d\tau}\right|_{M_t=\bar{M}} = \frac{\rho(1-a_x/a)}{\alpha(1+\chi)(1+\chi a_x/a)}\frac{d\chi}{d\tau} < 0. \tag{9}$$

A decline in the transport cost parameter renders exporting more attractive and, due to expansion of exports at the extensive margin, would raise the mass of available varieties in either economy *ceteris paribus*. However, with a binding perception constraint, consumers

cannot process information of additional product varieties. Hence, in order to attract consumers' attention firms raise their advertising strength, ρ, which induces higher fixed costs in both the domestic and the foreign market. The higher fixed costs reinforce firm exit at the bottom of the productivity distribution, implying that M falls stronger and ϕ^* rises by more than in an IP-regime. A new equilibrium is reached if sufficiently many non-exporters have left the market, such that the remaining firm population is consistent with the mental capacity constraint of consumers, $M_t = \bar{M}$, and the now higher proportion of exporters, χ. In the new equilibrium, all firms again advertise with the same strength, which, however, is higher than it was prior to the fall in transport costs. This can easily be seen by means of Figure 1, in which a decline in τ corresponds to an upward shift of RHS.

While in an IR-regime a fall in transport costs raises firm-level advertising expenditures, with a negative externality on competitors, this does not automatically mean that economy-wide advertising expenditures increase as well. The reason is that the least productive firms exit the market and stop advertising at all. Noting that total advertising expenditures are given by $Ma\rho^{\alpha}(1+\chi a_x/a)$ and accounting for $(4')$, we find that the two opposing effects exactly cancel out, so that total advertising expenditures remain unaffected by a fall in the iceberg transport cost parameter.[12] Still, there are efficiency effects from the increase in firm-level advertising. By reinforcing exit incentives of the least productive firms, higher firm-level advertising expenditures shift demand from local firms to imports, which are subject to transport costs. Hence, the productivity gain due to additional exit of low-productivity firms may be offset by an attention-based diversion of consumer expenditures to imports,[13] and we say that importing is excessive if the negative welfare implications of diverted consumption dominates the welfare benefits of better

[12] To be more specific, accounting for $M = M_t(1+\chi)^{-1}$ and substituting M_t from $(4')$, we get $Ma\rho^{\alpha}(1+\chi a_x/a) = L(k-\sigma+1)/(k\sigma)$, which is a constant.

[13] To be more specific, we can infer from setting $M_t = \bar{M}$ in Eq. $(4')$ that the share of exporters χ is too large to be consistent with advertising strength $\rho = 1$. Hence, the share of varieties imported, $\chi/(1+\chi)$, and the share of expenditures used for financing imports, $\chi(a_x/a)/(1+\chi a_x/a)$, are too high relative to an equilibrium with $M_t = \bar{M}$ and $\rho = 1$.

domestic firm composition.

For a detailed analysis of this trade-off, we can substitute (6) into (5) and differentiate the resulting expression with respect to τ. Accounting for (9), this gives

$$\left.\frac{dU}{d\tau}\right|_{M_t=\bar{M}} = \frac{U}{(1+\chi)k}\left[1-\frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\right]\frac{d\chi}{d\tau}, \tag{10}$$

with derivation details being deferred to the appendix. As illustrated in Figure 2, the welfare implications of trade liberalization crucially depend on the range of ICT. We assumed $a_x/a \in (\tau^{1-\sigma}, 1)$. If a_x/a is low, domestic advertising information can easily be spread also to foreign markets, and ICT has a (rather) global range. In this case, a fall in the transport cost parameter generates a strong incentive for initial non-exporters to start exporting, thereby providing a strong stimulus on firm-level advertising. Hence, many low-productivity firms are forced to exit, so that the efficiency loss from wasteful advertising and the attention-based diversion of consumption towards imports dominates the gains associated with a higher productivity cutoff and welfare deteriorates if τ shrinks. To put it formally, we call ICT global if $a_x/a < (k-\sigma+1)/(k+\sigma-1)$, so that $dU/d\tau > 0$, according to (10) and Figure 2.

If a_x/a is high, the opposite holds. To be more specific, if $a_x/a > (k-\sigma+1)/k$, we speak of a (rather) local ICT range. In this case, $dU/d\tau < 0$, according to (10) and Figure 2. A given reduction in the iceberg transport cost parameter exerts a minor impact on the extensive margin of exporting (χ), and firms will respond to the fall in transport costs with just a small increase in their advertising strength. Hence, the efficiency loss from higher individual advertising expenditures is small and gains from trade materialize due to an increase in the cutoff productivity level, similar to the IP-regime. Finally, if ICT has an intermediate range, i.e. if $(k-\sigma+1)/k > a_x/a > (k-\sigma+1)/(k+\sigma-1)$, we can identify a critical transport cost level[14]

$$\bar{\tau} \equiv \left(\frac{a}{a_x}\right)^{\frac{1}{\sigma-1}}\left[\frac{1}{(a/a_x)\left[k/(\sigma-1)-1\right]-k/(\sigma-1)}\right]^{\frac{1}{k}}, \tag{11}$$

[14]Setting the bracket term on the right-hand side of (10) equal to zero and solving the respective expression for χ yields $\chi = (a/a_x)[k/(\sigma-1)-1]-k/(\sigma-1)$. Substituting $\chi = [(a_x/a)\tau^{\sigma-1}]^{-k/(\sigma-1)}$, then establishes Eq. (11), with $\tau > (a/a_x)^{1/(\sigma-1)}$ being necessary for $\chi < 1$.

such that $dU/d\tau >, =, < 0$ if $\tau >, =, < \bar{\tau}$. Put differently, a decline in the iceberg transport cost parameter exerts a negative (positive) welfare effect if transport costs have been high (low) initially (see Figure 2 for an illustration).

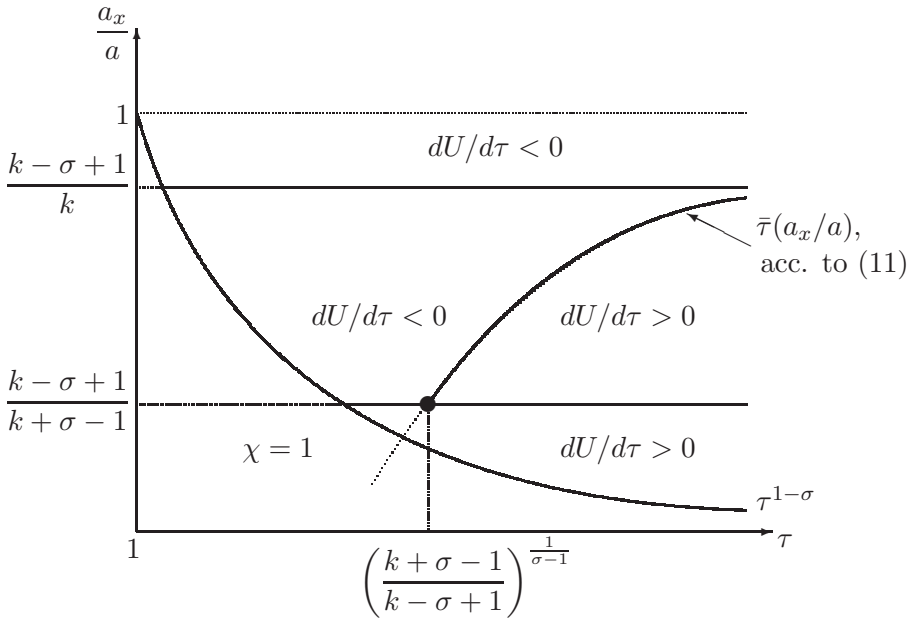

Figure 2: Welfare effects of changes in the iceberg transport cost parameter

The following proposition rounds off the formal discussion in this and the former subsection by summarizing the main insights in a non-technical way.

Proposition 1. *In an information-rich scenario, a fall in iceberg transport costs may exert negative welfare effects, as firms in an endeavor to attract consumers' attention raise their advertising expenditures, which enforces (additional) exit of low-productivity firms and diverts demand to imported goods. This is in contrast to an information-poor regime, in which a decline in transport costs always generates welfare gains.*

4 Trade liberalization and advertising taxation

An immediate question arising from our analysis above is how policy intervention can be designed to reestablish positive welfare effects of trade liberalization in an IR-regime.

Restricting our attention to non-discriminatory policy measures and noting that the negative welfare effects are triggered by over-investment into advertising at the firm level, we consider a *uniform* advertising tax as a natural instrument for policy intervention (see Falkinger, 2008).[15] We do not allow for negative tax rates,[16] and we assume that the two symmetric countries coordinate their policies and implement the same advertising tax. Focusing on coordinated policies is attractive for two reasons. On the one hand, it avoids complications arising from non-cooperative taxation in a trade model with heterogeneous producers (see Davies and Eckel, 2010). On the other hand, coordination generates the largest potential for welfare gains from trade liberalization under endogenous policy adjustments and thus provides an optimistic view upon the role of governments in the process of economic integration.

For a proportional tax, with tax rate $t \geq 0$, the effective advertising costs for the firm are

$$f = (1+t)a\rho^{\alpha}, \qquad f_x = (1+t)a_x\rho^{\alpha}. \tag{12}$$

Since total advertising expenditures of firms net of tax are given by $Ma\rho^{\alpha}(1+\chi a_x/a)$, the total tax revenue amounts to $T = tMa\rho^{\alpha}(1+\chi a_x/a)$. It is assumed that this tax is redistributed to the consumers via a lump-sum transfer. Thus, their total disposable

[15] In principle, the government could also increase political barriers to trade in order to reproduce the outcome prior to the fall in the transport cost parameter. However, such policy measures would be difficult to implement under current GATT rules and are clearly against the goal of the World Trade Organization to dispel barriers to international goods and services transactions. Thus, we do not account for discriminatory policy instruments in our analysis.

[16] It is well-established in the literature that the combination of product market imperfection and external scale economies leads to inefficiently low firm entry. This generates a welfare loss that can be reduced by subsidizing firm entry. However, since subsidizing periodical fixed costs is a relevant policy option only in an IP-regime, our model cannot contribute novel insights on that matter to the existing literature. For this reason, we have decided to focus on positive tax rates that are imposed in order to cure the over-investment problem and refer readers who are interested in the role of subsidies for firm entry in a Melitz-type model to Pflüger and Südekum (2009), who provide an extensive discussion on this issue.

income is $L+T$. With these assumptions at hand, we can rewrite Eq. (4′) as follows:

$$M_t = \frac{1+\chi}{1+\chi a_x/a}\frac{k-\sigma+1}{\sigma k}\frac{L+T}{a\rho^{\alpha}(1+t)}. \tag{4''}$$

Furthermore, utility is given by

$$U = \frac{\sigma-1}{\sigma}\left(\frac{L+T}{\sigma a\rho^{\alpha}(1+t)}\right)^{\frac{1}{\sigma-1}}\left[\left(1+\chi\frac{a_x}{a}\right)\frac{\sigma-1}{k-\sigma+1}\frac{a\rho^{\alpha}(1+t)}{\delta f_e}\right]^{\frac{1}{k}}, \tag{5′}$$

where the last bracket term represents the cutoff productivity, ϕ^*, as a function of the tax rate (see Eqs. (2) and (3)).

If the economy is in an IP-regime without taxation, the consumers' mental capacity to gather and process information is not a limiting factor and, hence, firms already advertise with the minimum possible strength $\rho = 1$ prior to taxation. In this case, there is no need for correcting the decentralized advertising decision through taxation, so that, when abstracting from subsidies, $t = 0$ is the preferred tax rate of a welfare-maximizing government that takes the competitive environment in the goods market as given. In an IR-regime, the mass of available varieties is determined by the consumers' perception constraint, and an increase in t influences the advertising effort of firms. To be more specific, substituting $T = tMa\rho^{\alpha}(1+\chi a_x/a)$ into (4″), accounting for $M = M_t(1+\chi)^{-1}$, and setting $M_t = \bar{M}$, we can explicitly solve for the strength of advertising in an IR-regime:

$$\rho = \left[\frac{1+\chi}{1+\chi a_x/a}\frac{k-\sigma+1}{k\sigma+t(k+1)(\sigma-1)}\frac{L}{a\bar{M}}\right]^{\frac{1}{\alpha}}. \tag{13}$$

Differentiating the latter with respect to t gives

$$\left.\frac{d\rho}{dt}\right|_{M_t=\bar{M}} = -\frac{\rho}{\alpha}\frac{(k+1)(\sigma-1)}{k\sigma+t(k+1)(\sigma-1)}, \tag{14}$$

which is negative, implying that a higher tax lowers the strength of advertising. However, regarding the impact of higher taxes on the fixed costs of domestic production, the indirect effect through a reduction in the strength of advertising does not compensate the direct effect of a higher tax rate and, hence, firms face higher fixed costs when t increases.[17]

[17] Substituting (13) into $f = a\rho^{\alpha}(1+t)$ and differentiating the resulting expression with respect to t gives $df/dt > 0$, since $k > \sigma - 1$ holds by assumption.

Therefore, advertising taxation generates two counteracting effects on the entry decision of firms. On the one hand, the higher fixed cost renders production of the least productive producers unattractive and *ceteris paribus* reduces firm entry. On the other hand, higher disposable income renders participation in the productivity lottery more attractive. As long as the economy remains in an IR-regime, the two effects exactly cancel out so that the mass of local producers, M, remains unaffected by an increase in t. This follows immediately from $M = \bar{M}(1+\chi)^{-1}$ and the fact that χ is invariant to introduction of and adjustments in a uniform advertising tax. Finally, setting $M_t = \bar{M}$ in $(4')$ and substituting the resulting expression in $(5')$, we can conclude that

$$\text{sign}\left[\left.\frac{dU}{dt}\right|_{M_t=\bar{M}}\right] = \text{sign}\left[\frac{\alpha}{\rho}\left.\frac{d\rho}{dt}\right|_{M_t=\bar{M}} + \frac{1}{1+t}\right], \tag{15}$$

which, in view of (14), is positive, since $k > \sigma - 1$ holds by assumption. Hence, in an IR-regime the considered tax instrument is a remedy for the problem of over-investment into advertising at the firm level and, thereby, generates positive welfare effects.

Putting together our insights from the positive policy analysis, we can conclude that the welfare-maximizing (non-negative) advertising tax is zero if an IP-regime was realized in the pre-tax equilibrium, and it is given by[18]

$$\hat{t} = \frac{L(k-\sigma+1) - \sigma k\bar{M}a(1+\chi a_x/a)/(1+\chi)}{(k+1)(\sigma-1)\bar{M}a(1+\chi a_x/a)/(1+\chi)}, \tag{16}$$

otherwise. We can differentiate $\hat{t}$ with respect to τ in order to shed light on how governments should adjust their tax policy in an IR-regime, when transport costs decline. Straightforward calculations give $d\hat{t}/d\tau < 0$, implying that in an IR-regime governments should raise advertising taxes in response to economic integration. This points to a new channel through which gains from trade can materialize in an IR-regime: higher revenues from advertising taxation. All other things equal, the advertising tax renders positive welfare effects of a transport cost reduction more likely. However, as shown in the appendix,

[18]The optimal tax in an IR-regime is characterized by the conditions $M_t = \bar{M}$ and $\rho = 1$, and it follows from solving (13) for t. Using $(4'')$, Eq. (16) can be rewritten as $\hat{t} = \sigma k(L\hat{t} - T)/[(k+1)(\sigma-1)(L+T)]$, which is positive, as the revenue of taxing fixed labor input in advertising, T, is smaller than taxing all labor, $\hat{t}L$.

the optimal tax response to a given change in τ needs not be sufficient for generating positive welfare effects of economic integration, in particular if $\bar{M}$ is relatively low and τ high initially. The reason is that, while the tax is a suitable instrument for correcting the over-investment problem, it does not relax the consumers' perception constraint, which closes one important channel through which gains from trade typically materialize in models of the new trade theory: access to additional varieties of the consumer good. Also under a tax that eliminates over-investment in advertising, declining transport costs lead to a selection bias in consumption in favor of foreign products. As a consequence, limited attention may lead to excessive importing and thus waste due to goods melting away, when being shipped internationally.

The following proposition summarizes the main insights from the policy analysis.

Proposition 2. *Applying a non-discriminatory and internationally coordinated tax on advertising is a useful instrument to overcome the over-investment problem at the firm level. However, the instrument is of no help for relaxing the consumers' mental capacity constraint to gather and process information and, hence, welfare gains from a marginal transport cost reduction are not guaranteed even if governments adjust the advertising tax optimally.*

5 Advancements in information and communication technology

In the previous two sections, we have studied the consequences of trade liberalization for optimal taxation and consumer welfare. Thereby, we have shown that the available ICT for the distribution of advertisements is a key determinant of the welfare effects of international integration under limited consumer attention. In the last two decades, ICT itself has been subject to significant changes, with the respective changes being interpreted in the literature as an important stimulus for economic growth (Jorgenson and Vu, 2005; Venturini, 2009) and international trade (Freund and Weinhold, 2004; Fink, Mattoo, and Neagu, 2005). It is therefore worthwhile to look at the impact that changes in ICT exert

on welfare in our model with limited consumer attention. To shed light on this issue, we distinguish between general ICT advancements, which affect domestic and foreign costs of advertising symmetrically, and advancements that reduce in particular the extra costs of targeting foreign consumers. In our model, the former means that a and a_x decline *pari passu*, while the latter is associated with a decline in a_x for a given a.

We start with a discussion of general advancements in ICT. A proportional reduction in the fixed cost parameters a and a_x leaves the decision of firms upon exporting (χ) unaffected. However, it lowers the fixed costs of production. Hence, additional firms enter at the bottom of the productivity distribution, and cutoff productivity ϕ^* falls. In an IP-regime, the consumers' mental capacity is not a scarce resource, so that the additional market entry at the bottom of the productivity distribution raises the amount of perceived and consumed product varieties, and firms have no reason to adjust their advertising strength in response to the technology improvement. This leads to a welfare increase, despite the fall in the cutoff productivity level. On the contrary, if the economy is in an IR-regime, the perception capacity of consumers is exhausted and firms raise their advertising effort in response to the technology advancement, as competition for scarce consumer attention is reinforced by additional entry of firms at the bottom of the productivity distribution. With the total mass of perceived product varieties being limited by $\bar{M}$, the increase in advertising eats up all the benefits from the *pari passu* decline in a and a_x, implying that firm-level fixed costs and thus welfare remain unaffected by such general advancements in ICT (see the appendix for formal details).

We now turn to the analysis of biased ICT change that reduces the extra costs of targeting foreign consumers (export-biased ICT change, in short). The "Internet revolution" in the early 1990s is a good example for such a change. It has opened a new medium for advertising, with a much more global range than its offline alternatives. Empirical evidence shows that due to its wider range of information dissemination, the internet has attracted a substantial share of total advertising expenditures since the beginning of its commercial use in 1994.[19] In our model, these changes can be captured by a decline in

[19]Evans (2009) presents empirical evidence that the revenue share for online advertising in total adver-

parameter a_x for a given level of a. This interpretation is akin to the conclusion by Freund and Weinhold (2004) that "the Internet reduces market-specific fixed costs of trade" (p. 171).

In an IP-regime, a fall in cost parameter a_x renders exporting more attractive and thus intensifies competition for labor. This enforces exit of the least productive non-exporters, so that the cutoff productivity, ϕ^*, unambiguously increases when the fixed costs of exporting fall (see Melitz, 2003). Regarding the mass of available varieties, their are two counteracting effects. While the increase in the proportion of exporters, χ, provides access to additional foreign varieties, there is a fall in the mass of domestic producers, M. Differentiating $(4')$, we can show that the former effect dominates if $a_x < a$ so that the mass of varieties available to consumers increases. This together with the stimulus on the productivity cutoff leads to an increase in welfare (see Eq. (5)).

In an IR-regime, the strength of advertising, ρ, is determined by (13), with $t = 0$ in the absence of taxation. Differentiation with respect to a_x yields

$$\left.\frac{d\rho}{da_x}\right|_{M_t=\bar{M}} = -\frac{\rho}{\alpha}\frac{\chi}{a_x(1+\chi a_x/a)}\left[\frac{1-a_x/a}{1+\chi}\frac{k}{\sigma-1}+\frac{a_x}{a}\right], \tag{17}$$

which, in view of $a_x < a$, is negative, so that each firm advertises at a higher intensity, ρ, when the extra costs of targeting foreign consumers' attention, a_x, shrink. Compared to the IP-regime, additional advertising at the individual firm level generates a further pressure on the least-productive firms to exit, thereby reinforcing the positive effect on cutoff productivity ϕ^*. The now stronger selection at the bottom of the productivity distribution gives an additional welfare stimulus, which, however, is counteracted by an efficiency loss stemming from over-investment in advertising and a perception bias in favor of foreign goods, which diverts consumer expenditures to imports and thus induces additional transport cost expenditures. As shown in the appendix, it is the second effect that dominates in our model, so that an export-biased advancement in ICT leads to a welfare loss in an IR-regime.[20]

tising has significantly increased between 2000 and 2008, from 3.2 to 8.8 percent.

[20]The negative picture about the welfare implications of advancements in ICT when the perception capacity of consumers is exhausted could at least partly be softened by giving an active role to policy makers.

The following proposition summarizes the main insights from our analysis in this section.

Proposition 3. *A general advancement in ICT raises welfare in an IP-regime and leaves welfare unaffected in an IR-regime. An ICT advancement that is biased towards international trade, lowers the fixed costs of exporting and thus generates welfare gains in an IP-regime. In an IR-regime, it intensifies competition for scarce consumer attention, which induces an over-investment in advertising at the firm level and to the detriment of welfare diverts demand to imported goods.*

6 Concluding remarks

This paper has introduced the idea of limited consumer attention into a new trade theory model with love-of-variety preferences and heterogeneous firms. In this setting, we have shown that access to new foreign varieties need not provide gains from trade. The existence of a positive welfare effect from trade liberalization crucially depends on whether an economy is in an information-poor or in an information-rich regime. In the former case, a decline in transport costs raises both the mass of consumed varieties and the cutoff productivity level, thereby triggering positive welfare effects as in other new trade theory models with heterogeneous producers. In the latter case, firms raise their advertising expenditures in response to lower transport costs in order to reach consumers in the then fiercer competition for their limited attention. With a binding capacity constraint to perceive information about available products, higher advertising expenditures exert a negative externality on a firm's competitors. This reinforces the selection effect at the bottom of the productivity distribution and diverts consumer demand to imports with possibly negative effects on welfare.

As seen in the previous section, there is scope for policy intervention by means of a non-discriminatory and internationally coordinated advertising tax. Such a tax, if optimally adjusted by the government, unambiguously generates welfare gains in the case of a general advancement in ICT. However, it needs not be successful in making an export-biased advancement in ICT a success story, because it is not suited to directly target the bias in consumer perception in favor of imported goods.

Aside from a positive analysis of the role that limited consumer attention plays for the welfare effects of trade, we have also studied the scope for policy intervention that aims at reducing the over-investment problem in an information-rich environment. In this respect, we have shown that setting a welfare-maximizing internationally coordinated and non-discriminatory advertising tax is indeed a remedy for the over-investment problem, but it does not relax the consumers' perception constraint. Hence, an optimal adjustment of the advertising tax to changes in transport costs need not be sufficient to ensure gains from trade.

In a final step of our analysis, we have looked at the consequences of advancements in information and communication technologies which ease the distribution of advertisement information. We have shown that the welfare implications of such an advancement depend on two things: the scarcity of consumer attention and the export bias in the technology improvement. If the economy is in an information-poor regime, both a general and an export-biased advancement in ICT – despite exerting different effects on the cut-off productivity level – lead to an increase in the mass of available product variants and thus enhance welfare. On the contrary, in an information-rich regime, firms raise their advertising strength in response to an advancement in ICT. In the case of a general advancement, the firm-level adjustment in the advertising strength exactly offsets the direct positive effect of falling advertising costs, thereby leaving the productivity cutoff, the mass of available varieties, and welfare at their initial levels. If the advancement is export biased, its implications are even less encouraging. By reinforcing selection at the bottom of the productivity distribution and diverting demand to imports, the ICT-induced increase in firm-level advertising unambiguously lowers welfare.

Of course, without conclusive empirical evidence the findings in our analysis regarding the possible welfare implications of falling trade costs and advancements in the information and communication technology remain somewhat speculative. However, since the average consumer in the OECD is exposed to 3000 ads a day (Love and Lattimore, 2009), it is important to take the limitations in the consumers' mental capacity to gather and process information seriously in order to obtain a more realistic picture about the conse-

quences of macroeconomic changes – as, for instance, trade liberalization or technology improvements – and their challenges for economic policy in the 21st century. While more research is needed before definite conclusions upon these issues can be derived, we hope that our analysis provides a useful first step for modeling limited consumer attention in an international trade context.

Appendix

Derivation details for Eq. (5)

The cost-of-living (CES) price index is given by

$$\begin{aligned} P &= \left[M \int_{\phi^*}^{\infty} p(\phi)^{1-\sigma} \frac{dG(\phi)}{1-G(\phi^*)} + \chi M \int_{\phi_x^*}^{\infty} (\tau p(\phi))^{1-\sigma} \frac{dG(\phi)}{1-G(\phi_x^*)} \right]^{\frac{1}{1-\sigma}} \\ &= \left[\frac{Mk\left(1+\chi\tau^{1-\sigma}(\phi_x^*/\phi^*)^{\sigma-1}\right)}{k-\sigma+1} \right]^{\frac{1}{1-\sigma}} p(\phi^*). \end{aligned} \tag{18}$$

Substituting $(\phi_x^*/\phi^*)^{\sigma-1} = (f_x/f)\tau^{\sigma-1}$, $M = M_t/(1+\chi)$ and noting that $U = P^{-1}$, further gives

$$U = \left[\frac{M_t k}{k-\sigma+1} \frac{1+\chi f_x/f}{1+\chi} \right]^{\frac{1}{\sigma-1}} p(\phi^*)^{-1}, \tag{19}$$

which, in view of (4), can be simplified to

$$U = \left[\frac{L}{\sigma f} \right]^{\frac{1}{\sigma-1}} p(\phi^*)^{-1}. \tag{20}$$

Solving (2) and (3) for ϕ^* and substituting the resulting expression into $p(\phi^*) = [\sigma/(\sigma-1)](\phi^*)^{-1}$, we obtain

$$p(\phi^*) = \frac{\sigma}{\sigma-1} \left[\left(1+\chi\frac{f_x}{f}\right) \frac{(\sigma-1)f}{(k-\sigma+1)\delta f_e} \right]^{-\frac{1}{k}}. \tag{21}$$

Using the latter in (20), we finally gives (5).

Derivation details for Eq. (10)

Substituting (6) into (5), setting $M_t = \bar{M}$, and differentiating the resulting expression with respect to τ yields

$$\left.\frac{dU}{d\tau}\right|_{M_t=\bar{M}} = \frac{\partial U}{\partial \rho} \times \left.\frac{d\rho}{d\tau}\right|_{M_t=\bar{M}} + \frac{\partial U}{\partial \chi} \times \frac{d\chi}{d\tau}. \tag{22}$$

Accounting for (9) and

$$\frac{\partial U}{\partial \rho} = -\frac{\alpha U}{\rho k}\frac{k-\sigma+1}{\sigma-1}, \tag{23}$$

we obtain

$$\frac{\partial U}{\partial \rho} \times \left.\frac{d\rho}{d\tau}\right|_{M_t=\bar{M}} = -\frac{U(1-a_x/a)}{k(1+\chi)(1+\chi a_x/a)}\frac{k-\sigma+1}{\sigma-1}\frac{d\chi}{d\tau}. \tag{24}$$

Substituting the latter together with

$$\frac{\partial U}{\partial \chi} = \frac{(a_x/a)U}{k(1+\chi a_x/a)}, \tag{25}$$

into (22) and rearranging terms, establishes Eq. (10).

Welfare effects of trade liberalization under optimal advertising taxation

In the subsequent, we analyze how a decline in the transport cost parameter affects welfare in an IR-regime if the government adjusts its tax policy optimally. For this purpose, we set $M_t = \bar{M}$ in (4″), solve the resulting expression for $(L+T)/[\sigma a \rho^{\alpha}(1+t)]$ and substitute the latter together with $\rho = 1$ and $t = \hat{t}$ from (16) into (5′). This gives[21]

$$U = \frac{\sigma-1}{\sigma}\left[\frac{k\bar{M}}{k-\sigma+1}\frac{1+\chi a_x/a}{1+\chi}\right]^{\frac{1}{\sigma-1}}\left[\frac{L(1+\chi)-\bar{M}a(1+\chi a_x/a)}{(k+1)\delta f_e \bar{M}}\right]^{\frac{1}{k}} \tag{26}$$

Differentiating the latter with respect to τ, we obtain

$$\left.\frac{dU}{d\tau}\right|_{t=\hat{t}} = A(\chi)\left[\left(1-\frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\right)\left(L-\bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right) + \frac{\bar{M}a\,(1-a_x/a)}{1+\chi}\right]\frac{d\chi}{d\tau}, \tag{27}$$

[21] By definition, an economy is in an IR-regime if the right-hand side of Eq. (4) exceeds $\bar{M}$ at $\rho = 1, t = 0$. Rearranging terms, we thus obtain $L(1+\chi)(k-\sigma+1)/(\sigma k) > \bar{M}a(1+\chi a_x/a)$ and, in view of $k-\sigma+1 < k\sigma$, $L(1+\chi) > \bar{M}a(1+\chi a_x/a)$.

with

$$A(\chi) \equiv \frac{U}{k\left[L(1+\chi) - \bar{M}a(1+\chi a_x/a)\right]} > 0.$$

Comparing (27) with (10), we can conclude that in an IR-regime $\tau \leq \bar{\tau}$ is sufficient (not necessary) for a positive welfare effect of a marginal decline in transport cost parameter τ if the government adjusts its tax rate according to (16). However, positive welfare effects of trade liberalization are not guaranteed if $\tau > \bar{\tau}$. In this case, the first component in the square bracket is negative, according to (10). So, if $\bar{M}$ is sufficiently small, a marginal decline in τ lowers welfare.

The implications of ICT advancements

General ICT-advancement

Let us first consider the case of a *pari passu* decline in both a and a_x. Accounting for $\rho = 1$ and differentiating (4′) with respect to a (holding a_x/a constant), we find that $dM_t/da < 0$ holds in an IP-regime. On the contrary, setting $M_t = \bar{M}$, it follows from (4′) that, for a given a_x/a, $d\rho/da < 0$, while $a\rho^\alpha = const.$ in an IR-regime. In order to determine the welfare effects of a general advancement in ICT, we can rewrite (5) as

$$U = \frac{\sigma - 1}{\sigma}\left(\frac{L}{\sigma a \rho^\alpha}\right)^{\frac{1}{\sigma-1}}\left[(1+\chi)\frac{\sigma-1}{k-\sigma+1}\frac{a\rho^\alpha}{\delta f_e}\right]^{\frac{1}{k}} \tag{28}$$

Then, substituting $\rho = 1$ and differentiating (28) with respect to a (holding a_x/a constant), we find that $dU/da < 0$ holds in an IP-regime. In an IR-regime, in which $M_t = \bar{M}$ and $\rho > 1$, we have $a\rho^\alpha = const.$, so that a *pari passu* change in a and a_x does not affect welfare.

Export-biased ICT-advancement

The impact of an export-biased ICT change on M_t in an IP-regime can be determined by setting $\rho = 1$ and differentiating $(4')$ with respect to a_x. This gives

$$\begin{aligned}\frac{dM_t}{da_x} &= \frac{\partial M_t}{\partial \chi}\frac{d\chi}{da_x} + \frac{\partial M_t}{\partial a_x} \\ &= -\frac{M_t}{1+\chi a_x/a}\frac{\chi}{a_x}\left[\frac{k}{\sigma-1}\frac{1-a_x/a}{1+\chi} + \frac{a_x}{a}\right] \end{aligned} \tag{29}$$

and, hence, $dM_t/da_x < 0$ in an IP-regime. In an IR-regime, we have $M_t = \bar{M}$ and ρ responds to changes in a_x according to (17).

The welfare implications of an export-biased ICT change in an IP-regime can be determined by substituting (6) and $\rho = 1$ into (5) and differentiating the resulting expression by a_x. This gives

$$\frac{dU}{da_x} = \frac{\partial U}{\partial \chi} \times \frac{d\chi}{da_x} + \frac{\partial U}{\partial a_x}, \tag{30}$$

which – by using (25) and $d\chi/da_x = -k\chi/[(\sigma-1)a_x]$ for $\partial U/\partial\chi \times d\chi/da_x$, and (5) for $\partial U/\partial a_x = U\chi/[ak(1+\chi a_x/a)]$ – can be rewritten as

$$\frac{dU}{da_x} = -\frac{U\chi/a}{k(1+\chi a_x/a)}\frac{k-\sigma+1}{\sigma-1} < 0. \tag{31}$$

Hence, an export-biased advancement in ICT generates welfare gains in an IP-regime.

In an IR-regime, the impact of a change in technology parameter a_x is determined by

$$\left.\frac{dU}{da_x}\right|_{M_t=\bar{M}} = \frac{\partial U}{\partial \rho} \times \left.\frac{d\rho}{da_x}\right|_{M_t=\bar{M}} + \frac{\partial U}{\partial \chi} \times \frac{d\chi}{da_x} + \frac{\partial U}{\partial a_x}, \tag{32}$$

which – by using (17) and (23) for $\partial U/\partial\rho \times d\rho/da_x|_{M_t=\bar{M}}$, (25) and $d\chi/da_x = -k\chi/[(\sigma-1)a_x]$ for $\partial U/\partial\chi \times d\chi/da_x$, and (5) for $\partial U/\partial a_x = U\chi/[ak(1+\chi a_x/a)]$ – can be reformulated to

$$\left.\frac{dU}{da_x}\right|_{M_t=\bar{M}} = \frac{U\chi/a_x}{(\sigma-1)(1+\chi a_x/a)}\frac{k-\sigma+1}{\sigma-1}\ \frac{1-a_x/a}{1+\chi} > 0, \tag{33}$$

implying that an export-biased advancement in ICT lowers welfare in an IR-regime. This completes the formal discussion upon the consequences of advancements in information and communication technologies.

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