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Trade Liberalization and Self-Control Problems*

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Abstract

This paper analyzes the welfare effects of trade liberalization when some individuals suffer from self-control problems and hence consume too much of goods which generate immediate benefits but entail future costs. Within a classic Ricardian model of trade, the welfare effects depend crucially on the direction of trade. In the importing country, individuals who are sufficiently price-sensitive and have a sufficiently strong self-control problem lose from trade. In the exporting country, all individuals unambiguously gain from trade. These findings are however not robust to changes in the assumptions on production technology and market structure. Within a new trade model with increasing returns to scale and monopolistic competition, individuals with self-control problems can lose in both countries. In contrast to the Ricardian setting, even individuals without self-control problems can lose if the average self-control problem is stronger in their country than in the country they start trading with.

Keywords: Globalization, welfare gains from trade, self-control problems, time-inconsistency

JEL Classification: F11, F12, D91

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1 Introduction

A central result in international trade theory and the most powerful argument of the proponents of globalization is that trade liberalization creates welfare gains. In classic trade theory, gains from trade arise from specialization in production and the exploitation of differences in preferences and endowments across countries. Real incomes rise and the average consumer in each country is better off, independently of the direction of trade. New trade theories focus on imperfect competition and increasing returns to scale as sources of gains from trade. When trade is liberalized, firms serve a larger market and average costs decline. Consumers benefit from lower prices and a larger variety of products.

However, in each case the gains from trade result hinges on several assumptions. One of them, which is common to all trade models, is that individuals behave fully rationally in the sense that they would never do anything that violates their own preferences. Yet, recent research in behavioral economics suggests that this is often an inappropriate abstraction. For instance, there is by now substantial experimental and econometric evidence that people suffer from self-control problems when making economic decisions which involve benefits and costs occurring at different points in time.[1] Striving for immediate gratification, they are tempted to consume more than optimal of goods which generate instantaneous benefits but entail future costs. Such goods are also called sin goods. Examples include cigarettes, alcohol, or fast food. Individuals plan to smoke, drink, or eat less in order to enjoy a healthier and happier life, but when the moment of the decision has arrived, they revise their plans and consume more cigarettes, alcohol, or unhealthy food than they initially intended to. If trade in such goods is liberalized and leads to an expanded choice set and lower prices, the problem of overconsumption may in fact get worse for some consumers, and gains from trade are no longer guaranteed. When consumers are heterogeneous in their degree of self-control, trade will also have distributional consequences, even if preferences are otherwise identical, and the advantageousness of trade depends on whether feasible redistribution mechanisms exist.

The aim of the present paper is to analyze the welfare effects of trade when consumers lack self-control. Which factors determine who gains and who loses from trade, and how much? Is the distribution of winners and losers within and across countries sensitive to changes in the assumptions on production technology and market structure of the sin good? And finally, can we find instruments that correct for the inefficiencies caused by

[1] Frederick et al. (2002) provide a comprehensive overview of the respective studies. Gruber and Köszegi (2004) also review different kinds of evidence on self-control problems, but with a focus on smoking behavior.

self-control problems and make trade a Pareto-improvement over autarky, thus saving the gains from trade argument?

To address these questions, self-control problems are first incorporated into a dynamic Ricardian model of inter-industry trade with two countries and two goods. Self-control problems are modeled as time-inconsistent preferences for immediate gratification which apply to only one of the two goods. Individuals within a country may differ in their degree of self-control. In this setting, the welfare consequences depend on the direction of trade and on the price-sensitivity of consumers. Provided that they react strongly enough to price changes, individuals in the country importing the sin good lose if their self-control problem is sufficiently large, and if the traditional gains due to specialization and exchange are only small. This is because the declining price induces individuals with a lack of willpower to consume even more of the sin good. The loss due to inefficient overconsumption rises and overcompensates the traditional gains from trade. However, if individuals with low self-control are hardly responsive to price changes, trade does not aggravate their problem of overconsumption, and all consumers in the importing country are better off compared to autarky. In case some individuals lose, the welfare gains from trade can be redistributed by imposing a tariff on the imported good such that the price under trade equals the price in autarky and distributing the proceeds in a lump sum fashion. This way, the gains due to specialization can be realized without worsening the problem of overconsumption. In the exporting country, where the relative price of the sin good increases after borders open up, all individuals unambiguously gain from trade. Here, the rising price serves a self-control function, mitigating the problem of overconsumption. The more price-sensitive consumers with low self-control are, the stronger is this beneficial effect, and thus the higher are their gains from trade compared to the gains of the fully self-controlled individuals.

While the results in the Ricardian setting are essentially driven by price movements and are rather intuitive, the integration of self-control problems into a trade model with increasing returns to scale in production and monopolistic competition leads to surprising conclusions. In this setting, it is no longer the case that individuals with self-control problems gain from trade in at least one country. In fact, trade can lead to a lower price and a larger variety of the sin good in both countries, and thus exacerbate the problem of overconsumption for individuals with a lack of willpower on both sides of the border. In addition, heterogeneity in the degree of self-control across countries opens up the possibility that in one country even the fully self-controlled individuals lose from trade. This will be the case if the average degree of self-control is larger in the open economy than in the closed economy. All else equal, a larger average degree of self-control reduces aggregate demand, which reduces the available product variety and thus counteracts the conventional, beneficial effect of trade liberalization for the fully self-controlled. Hence, production technology and market structure play a decisive role in determining who gains and who loses from trade and need to be carefully taken into account when deriving policy recommendations.

By introducing time-inconsistent preferences into models of trade, the present piece of research bridges a gap between international trade theory and new insights from behavioral economics. Even though more realistic psychological foundations of economic behavior have by now found acceptance and applications in macroeconomics, labor economics, and, most notably, finance,[2] they have hardly found their way into international trade theory.[3] The theoretical work most closely related to the present paper deals with the issue of optimal taxation in case individuals have time-inconsistent preferences. O'Donoghue and Rabin (2006) also consider a model with two goods, one of which is associated with self-control problems, and analyze whether a small tax on the sin good improves social welfare.[4] In principle, trade liberalization has the same effect like a tax on the price of the sin good in the importing country, and thus has similar implications for individual and social welfare. Yet, the analysis in the present paper differs in several aspects from O'Donoghue and Rabin (2006). First, I will abstract from population heterogeneity in tastes to further simplify the analysis and concentrate on population heterogeneity in the degree of self-control. Second, unlike O'Donoghue and Rabin (2006), I cannot rest the welfare analysis on marginal arguments, since autarky and free trade are effectively two different states of the world. Yet another and maybe the most important difference is that the present paper adopts a general equilibrium perspective and explicitly models the production sector and the labor market of the economy, while O'Donoghue and Rabin (2006) assume that marginal costs and hence wages are fixed and that individuals are given an exogenously fixed income. Taking the supply side of the economy into account is essential to determine the gains from trade which arise from specialization in production and which can potentially compensate the losses due to inefficiencies on the consumption side.[5]

However, analyzing the welfare effects of trade liberalization in the presence of self-control problems is not only of theoretical interest. In the mid 1980's, the U.S. forced

[2]See Camerer et al. (2004), Frederick et al. (2002), and Khalil (2009) for a collection of the most important recent contributions.

[3]Two noteworthy exceptions are Freund and Özden (2008) and Tovar (2009), who analyze the implications of loss aversion for trade policy, both theoretically and empirically.

[4]Haavio and Kotakorpi (2011) extend the analysis to a political economy setting in which individuals with self-control problems vote on taxes on the consumption of harmful goods.

[5]To the extent that self-control problems are interpreted as a negative externality an individual imposes on its future selves, the present paper also relates to the broad literature on the theory of second-best in international trade, which started off with Lipsey and Lancaster (1956) and Bhagwati (1971).

four Asian countries to drastically cut their import tariffs on cigarettes by threatening them with retaliatory sanctions. As a consequence, per capita cigarette consumption in these four countries increased significantly (Chaloupka and Laixuthai, 1996). The positive relationship between trade liberalization in general and smoking has been identified for other low- and middle income countries as well (Bettcher et al., 2003; Taylor et al., 2000). The negative health effects of smoking are well documented and have induced the public to blame free trade in cigarettes for reducing the subjective well-being of consumers. Accepting that individuals have time-inconsistent preferences with respect to smoking would support such a claim and provide an economic rationale for government intervention that goes beyond negative externalities or incorrect information. In fact, I show for the example of Taiwan that losses from trade in cigarettes due to self-control problems are not only a theoretical possibility but do occur in practice. A similar case has been made for unhealthy food. Amongst other factors, the Food and Agriculture Organisation (2008) holds imports of foods from industrialized countries, which are rich in fat and sugar, responsible for changing nutrition patterns and growing obesity in developing countries. As Stutzer (2007) shows empirically, obesity reduces the subjective well-being of individuals who lack self-control. For them, the availability of Western style food does more harm than good. Another example is the consumption of cultural goods. Benesch et al. (2010) show that heavy TV viewers are worse off if a larger number of TV channels is available, a result which is incompatible with standard economic theory, but compatible with heavy TV viewers experiencing self-control problems. To the extent that globalization increases the choice of TV channels, it may actually decrease the happiness of TV viewers with time-inconsistent preferences.

In the following section, I will illustrate in more detail the case of trade in cigarettes as one example where self-control problems might influence the benefits of free trade. In section 3, I will present a simple way to model self-control problems as present-biased preferences. These preferences will then be incorporated into a Ricardian model to analyze the welfare consequences of trade under constant returns to scale and perfect competition in section 4. Section 5 deals with self-control problems and the welfare consequences of trade in a model with increasing returns to scale and monopolistic competition. Section 6 summarizes the results and concludes.

2 Self-control problems and the liberalization of trade in cigarettes

In the past thirty years, tariff and non-tariff barriers to trade have been reduced in many countries and for a variety of goods and services, including cigarettes. Tobacco companies such as Philip Morris or British American Tobacco, facing a declining demand in the United States and Western Europe, actively promoted the liberalization of trade in tobacco, and seized the opportunity to target the newly opened markets in Asia, Eastern Europe, the former Soviet Union, and Africa.[6] Consequently, world exports of cigarettes increased from 59 billion pieces in 1960 to 322 billion pieces in 1980. In 2004, world exports of cigarettes amounted to 749 billion pieces (Foreign Agricultural Service, 2007).

After having opened their borders to foreign cigarette imports, many countries experienced a sharp increase in per capita consumption of cigarettes. In fact, several empirical studies have confirmed a causal relationship running from trade liberalization to cigarette consumption. For instance, Chaloupka and Laixuthai (1996) analyze annual time series data from 1970 to 1991 for ten Asian countries, four of which were forced to open their markets to U.S. cigarette imports in the mid-1980's under the threat of retaliatory sanctions, namely Japan, South Korea, Taiwan, and Thailand. Their results suggest that per capita consumption in the liberalized countries was on average ten percent higher than it would have been if imports had remained restricted. Hsieh et al. (1999) estimate the demand for domestic and imported cigarettes in Taiwan using 1966-1995 annual time series data. They conclude that opening the borders to U.S. cigarette imports has had two effects. First, consumers have switched from domestic to imported brands and second, overall consumption of cigarettes has increased. These results are in line with Hsu et al. (2005), who compare actual with projected trends for smoking rates in Taiwan for the period after market opening in 1986. Based on data from consumer surveys of the Monopoly Bureau and the National Health Interview Survey they show that in 2001, the actual smoking rates were significantly higher than the projected ones, both for males and females. In addition, the data reveal that per capita consumption of cigarettes in Taiwan increased by 30% from 1986 to 2001. Taylor et al. (2000) use a data set including 42 countries from 1970 to 1995. Estimating fixed-effects models separately for low-income, middle-income, and high-income countries with per capita cigarette consumption as the dependent variable, they find that trade openness has had a significantly positive effect on smoking in lower- and middle-income countries. Bettcher et al. (2003) proceed in

[6]Details on the companies' business strategies were revealed in 1998, when once secret tobacco industry documents were made publicly available as a result of legal action. See World Health Organization (2004) and Bettcher et al. (2003) for an overview.

a similar fashion, but with a larger data set covering 80 countries from 1970 to 1997. Their results are consistent with Taylor et al. (2000), indicating that trade openness has contributed to an increase in per capita cigarette consumption in low- and middle-income countries.

There is also more indirect evidence of the positive relationship between trade liberalization and cigarette consumption. In many countries, including Japan, Taiwan, South Korea, and Thailand, the tobacco industry was controlled by a government run monopoly before trade in tobacco was liberalized. As pointed out by Chaloupka and Laixuthai (1996), opening borders has led to increased competition and lower prices. The inverse relationship between prices and tobacco consumption is in turn well documented, with most estimates of the overall price elasticity ranging from -0.25 to -0.5 for high-income countries. Low- and middle-income countries are generally more price sensitive, with most estimates ranging from -0.5 to -1.0. Lower prices both increase smoking prevalence and boost conditional cigarette demand. For the United States, estimates indicate that at least half of the overall price elasticity can be attributed to smoking prevalence (see Chaloupka and Warner (2000) and Chaloupka et al. (2000) for a survey of the respective studies). A recent study on youth smoking behavior in low- and middle-income countries by Kostova et al. (2010) suggests a price elasticity of smoking participation of -0.63, and a price elasticity of conditional cigarette demand of -1.2.

Unlike other consumer goods, however, cigarettes entail enormous health costs. Numerous epidemiologic studies have shown that smoking is causal for a variety of cancers as well as for several cardiovascular and respiratory diseases.[7] As pointed out by Peto and Lopez (2001), half of lifetime smokers die prematurely. Viscusi and Hersch (2008) estimate that the discounted expected mortality costs of smoking, measured in terms of foregone income due to premature death, amount to 222 $ per pack for a male consumer and 94 $ for a female consumer, assuming a 3% discount rate.

To sum up, there is strong evidence that trade liberalization has led to increased cigarette consumption in the importing countries, and it is an established fact that such an increase has devastating health consequences, although these occur with a delay of several years or even decades.[8] Correspondingly, Mathers and Loncar (2006) predict that the total number of premature, tobacco-related deaths will rise from 5.4 million in 2005 to 8.3 million in 2030. Regional aggregates are not available, but Mathers and Loncar (2006) suggest that it will decline in high-income countries, while it will double in low- and middle income countries. Ezzati and Lopez (2004) estimate that the fraction of adult

[7] The U.S. Department of Health and Human Services (2004) and the World Health Organization (2005) provide a comprehensive overview of the scientific evidence on the health consequences of smoking.

[8] On the delay between the onset of smoking and the occurrence of smoking-related diseases, see Gajalakshmi et al. (2000) and the literature cited therein.

deaths that can be attributed to smoking was 12% in 2000, with large variations across regions, age, and gender. Males in the industrialized countries had the highest smoking mortality rates, which is not surprising given the long latency and the only recent cutbacks in smoking. However, the developing countries are catching up. Wen et al. (2005) provide estimates for Taiwan, indicating that smoking attributable male mortality will increase from 16% in 2001 to 20% in 2020 if current smoking patterns persist.

From a traditional economic viewpoint, the negative consequences of smoking alone do not justify any intervention. Rational consumers would foresee the future health costs and would take them fully into account when deciding whether and how much to smoke. They weigh the immediate benefits of a cigarette against the future costs and make a decision that maximizes their lifetime utility. Thus, apart from additional effects such as negative externalities or incorrect information about the risks and the addictive potential involved, there is no scope for government action.[9] Free trade is the best policy. Yet, there is substantial evidence that this is not quite true. Individuals lack self-control with regard to smoking, and thus make sub-optimal consumption decisions.[10] The traditional gains from trade argument does no longer hold. For the case of Taiwan, taking the theory to the data suggests that an individual with an average degree self-control may have lost at least 0.6 % of real income.

3 Modeling self-control problems

The way of modeling self-control problems is identical for the two trade models I will consider in the following sections. Self-control problems arise when individuals have time-inconsistent, present-biased preferences. They overvalue the immediate benefits of a good while neglecting the future costs of its consumption and consequently consume more than they would have judged to be optimal from a prior perspective.[11] Present-biased intertemporal preferences are characterized by discount factors which increase over time. In a discrete time setting, this key qualitative feature can be captured by assuming a quasi-hyperbolic discount function. Mainly because of its analytical tractability, such a function has been widely used to model self-control problems since Laibson (1997). Originally, it has been introduced by Phelps and Pollak (1968) to study intergenera-

[9] The rationale for intervention in the case of negative externalities and information failures and the available policy options are discussed extensively in Jha et al. (2000).

[10] See, for instance, Gruber and Mullainathan (2005), Hersch (2005), and Kan (2007).

[11] Similarly, if something has immediate costs, but generates future benefits, individuals with self-control problems will choose too little of it, a phenomenon that is also known as procrastination. Examples are studying for exams or saving for retirement.

tional altruism. With a quasi-hyperbolic discount function, the discounted utility of an individual at time t is

$$U_t(u_t, ..., u_T) \equiv u_t + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau \tag{1}$$

where u_t is the instantaneous utility in period t, $\beta \leq 1$, and $\delta \leq 1$. This formulation implies a discount factor of $\beta\delta$ between the current and the next period and a discount factor of δ between two consecutive periods in the future. For $\beta < 1$, the discount factor increases over time, and the individual revises her initial plans for future consumption once the future has arrived. The smaller is β, the larger is the individual's tendency to overvalue immediate benefits and the stronger is the self-control problem. For $\beta = 1$, the discount factor is constant, and we are back to a setting with time-consistent preferences.

Similar to O'Donoghue and Rabin (2006), I assume an instantaneous utility function of the form

$$u_t \equiv v(x_t) - c(x_{t-1}) + z_t \tag{2}$$

where x_t denotes consumption at period t of the good associated with self-control problems and $c(x_{t-1})$ describes the negative consequences of consumption that occurred one period ago. Good x may be a homogeneous good, as in the Ricardian model, or a differentiated good, as in the increasing returns to scale and monopolistic competition setting. Utility is quasilinear in z_t, which denotes consumption at period t of a composite good that is not subject to self-control problems and serves as a numéraire. Marginal benefits are assumed to be positive and decreasing, i.e. $v_x > 0$ and $v_{xx} < 0$. Marginal costs are also assumed to be positive, $c_x > 0$, but might be increasing, constant, or decreasing, i.e. $c_{xx} > 0$, $c_{xx} = 0$, or $c_{xx} < 0$, with the additional restriction that $v_{xx} - c_{xx} < 0$ to ensure that consumption is well-behaved.

In contrast to O'Donoghue and Rabin (2006), who allow for marginal utilities and marginal costs to differ across individuals, I abstract from heterogeneity in tastes, since this alone would make trade more beneficial for some persons than for others. Here, I want to focus on the role of differing degrees of self-control for the distributional consequences of trade and thus allow for heterogeneity in the self-control parameter β only. The traditional discount factor δ is assumed to be identical for all individuals, and is set to 1 for simplicity.

With the instantaneous utility function given in (2) and $\delta = 1$, the discounted utility at time t of an individual with self-control parameter β can be written as

$$U_t = v(x_t) - c(x_{t-1}) + z_t + \beta \left(v(x_{t+1}) - c(x_t) + z_{t+1} + ... + v(x_T) - c(x_{T-1}) + z_T \right). \tag{3}$$

In period t, the individual chooses a consumption allocation for the current period, x_t and z_t, and makes a plan of consumption allocations for all future periods, x_{t+1}, z_{t+1}, ..., x_T, z_T to maximize (3) subject to a budget constraint for each period t, $t+1$, ..., T. I assume that in each period an individual supplies one unit of labor inelastically and is paid the equilibrium wage. Borrowings and savings are ruled out, such that in each period total labor income is spent on consumption. Given the additively separable structure of preferences and the absence of borrowings and savings, the consumption decisions of different periods are independent. Hence, in period t, the individual chooses x_t and z_t to maximize $v(x_t) - \beta c(x_t) + z_t$ subject to the period t budget constraint, $p_t x_t + z_t = w_t$. Moreover, she plans to consume x_{t+1} and z_{t+1} in period $t+1$ to maximize $\beta \left(v(x_{t+1}) - c(x_{t+1}) + z_{t+1} \right)$ or, equivalently, $v(x_{t+1}) - c(x_{t+1}) + z_{t+1}$ subject to the period $t+1$ budget constraint, $p_{t+1} x_{t+1} + z_{t+1} = w_{t+1}$. However, once period $t+1$ has arrived, the discounted utility function is U_{t+1}. The individual revises the plans she has made one period ago and now chooses x_{t+1} and z_{t+1} to maximize $v(x_{t+1}) - \beta c(x_{t+1}) + z_{t+1}$ subject to the period $t+1$ budget constraint. Future costs of consumption weigh less heavily than they did one period ago. In principle, unless wages and prices change over time, an individual solves the same optimization problem in each period, and I will omit the time subscript for notational convenience. In each period, the individual chooses current consumption, maximizing $v(x) - \beta c(x) + z \equiv u^*(x, z)$, and makes a plan for future consumption, maximizing $v(x) - c(x) + z \equiv u^{**}(x, z)$, which will be revised one period later.

Given that the preferences of an individual with self-control problems change over time, defining an appropriate welfare criterion is inherently problematic. A common approach in the literature is to evaluate actual choices according to the individual's long-run preferences.[12] These preferences reflect the consumption plan the individual would like to commit to in advance if this was possible. I will follow this approach and measure an individual's welfare by $u^{**}(x, z)$. According to Kahneman (1994), one may interpret $u^*(x, z)$ as "decision utility", which governs an individual's consumption choices, and $u^{**}(x, z)$ as "experienced utility", which reflects the subjective well-being the individual derives from these choices. For an individual with time-inconsistent preferences, decision utility and experienced utility diverge, implying that the individual makes consumption choices which are not in her best interest, in the sense that they do not give her the highest possible level of happiness and satisfaction.

In the following section, I will focus on interior solutions to the optimization problem. If (x^*, z^*) is the actual choice maximizing $u^*(x, z)$, this implies that $v_x(x^*) - \beta c_x(x^*) - p =$

[12] See for example O'Donoghue and Rabin (1999), O'Donoghue and Rabin (2006), or Gruber and Köszegi (2004). For a discussion of alternative welfare criteria, see Bhattacharya and Lakdawalla (2004).

0 and $z^* = w - px^*$. Similarly, if (x^{**}, z^{**}) is the ideal choice maximizing $u^{**}(x,z)$, it must be that $v_x(x^{**}) - c_x(x^{**}) - p = 0$ and $z^{**} = w - px^{**}$. From the first order conditions, one can immediately replicate three basic results of O'Donoghue and Rabin (2006). First, for all p and all $\beta < 1$, $x^* > x^{**}$, meaning that people with self-control problems consume more than optimal of the good with immediate benefits and future costs. Second, actual consumption increases as the self-control problem gets worse, $dx^*/d\beta = -c_x(x^*)/-(v_{xx}(x^*) - \beta c_{xx}(x^*)) < 0$. And third, actual consumption increases as the price declines, $dx^*/dp = -1/-(v_{xx}(x^*) - \beta c_{xx}(x^*)) < 0$.

4 Ricardian model

I will now incorporate these time-inconsistent preferences into a classic Ricardian two countries, two goods model of international trade. To analyze the welfare effects of trade, I will compare the autarky and the trade equilibrium for consumers with different degrees of self-control in both countries. An example will help to illustrate the results.

4.1 Model description

For concreteness, I name the two countries Home and Foreign, and index all variables and parameters by H and F, respectively. I assume that in each period, there is a continuum of individuals with mass L_H in Home and L_F in Foreign. Each individual maximizes her decision utility $u^*(x,z)$ with respect to x and z as described in the previous section. Individuals within each country differ with respect to their degree of self-control, as described by the cumulative distribution functions $H(\beta)$ and $F(\beta)$. Given that each individual supplies one unit of labor inelastically, total labor supply in each period is L_H in Home and L_F in Foreign. It is used to produce goods x and z according to the following production functions:

$$Q_{iH} = \frac{L_{iH}}{a_{iH}} \text{ and } Q_{iF} = \frac{L_{iF}}{a_{iF}} \text{ with } i = x, z \tag{4}$$

where Q_{iH} is the output of good i in country H, L_{iH} is the total amount of labor used in sector i in country H, and a_{iH} are the units of labor needed to produce one unit of good i in country H. Labor is mobile intersectorally, but not internationally, and goods and factor markets are perfectly competitive.

4.2 Autarky and trade equilibrium

Since individual decisions at different points in time are independent of one another, and production technologies as well as labor supply do not change over time, the equilibrium allocations and prices will be identical for each period in autarky and for each period under trade, respectively. An autarky equilibrium in Home for any period consists of inputs (L_{xH}, L_{zH}), outputs (Q_{xH}, Q_{zH}), a consumption tuple (x, z) for each individual, and prices (p_H, w_H) such that (i) individual consumption choices are feasible and maximize $u^*(x, z)$, given prices, (ii) firms' input and output choices are feasible and maximize profits, given prices, (iii) labor markets clear, $L_{xH} + L_{zH} = L_H$, and (iv) goods markets clear, $L_H \int x(p_H, w_H, \beta)dH(\beta) = Q_{xH}$ and $L_H \int z(p_H, w_H, \beta)dH(\beta) = Q_{zH}$. The analogous definition applies to Foreign.

A trade equilibrium for any period are inputs, outputs, consumption tuples in both countries, and prices (p, w_H, w_F) such that (i) to (iii) continue to hold in each country, (iv') world goods markets clear, $L_H \int x(p, w_H, \beta)dH(\beta) + L_F \int x(p, w_F, \beta)dF(\beta) = Q_{xH} + Q_{xF}$ and $L_H \int z(p, w_H, \beta)dH(\beta) + L_F \int z(p, w_F, \beta)dF(\beta) = Q_{zH} + Q_{zF}$, and (v) trade is balanced. These equilibrium definitions are those of a classic Ricardian model, with the exception that individuals are heterogeneous in the preferences governing their consumption behavior.

Due to the intersectoral mobility of labor, wages are equalized across sectors within each country. When both goods are produced and consumed in each country in the autarky equilibrium, perfect competition requires that prices equal marginal costs in both sectors in Home and Foreign. With the price of good z being normalized to 1 and p_H^A and p_F^A denoting the autarky equilibrium prices of good x in Home and Foreign, this implies $p_H^A = a_{xH}/a_{zH}$ and $p_F^A = a_{xF}/a_{zF}$. Hence, autarky equilibrium prices are solely determined by production technologies. I assume that Foreign has a comparative advantage in producing good x, meaning that $a_{xH}/a_{zH} > a_{xF}/a_{zF}$. Under this assumption, the relative price of the good associated with self-control problems is higher in Home than in Foreign in the autarky equilibrium. When borders open up, the relative price of good x in the trade equilibrium, p^T, is bounded by the two autarky prices, $p_F^A \leq p^T \leq p_H^A$.[13] However, trade only has an effect on welfare if the relative price changes. Therefore, I will concentrate on the more interesting case where $p_F^A < p^T < p_H^A$. In this case, each country

[13] Recall that individual and thus aggregate demand for good x is decreasing in p. For $p^T < p_F^A$, production of good x would fall to zero in both countries while demand would increase relative to the autarky equilibrium, resulting in excess demand. Similarly, for $p^T > p_H^A$, production of good x would rise while demand would decrease, resulting in excess supply.

fully specializes in the production of the good in which it has a comparative advantage and the world supply of good x is L_F/a_{xF}, while the world supply of good z is L_H/a_{zH}.[14]

4.3 Welfare effects of trade liberalization

Given that consumption and production decisions in different periods are independent of one another, it is irrelevant in which period trade is liberalized to decide whether an individual benefits from opening up borders. One can simply compare her experienced utility for trade equilibrium choices with her experienced utility for autarky equilibrium choices. The difference may then be interpreted as the per period gain from trade measured in units of the numéraire z. For an individual in Home with self-control parameter β it is

$$\begin{aligned} G_H &= u^{**}(x_H^{*T}, z_H^{*T}) - u^{**}(x_H^{*A}, z_H^{*A}) && (5) \\ &= \underbrace{u^{*}(x_H^{*T}, z_H^{*T}) - u^{*}(x_H^{*A}, z_H^{*A})}_{\text{traditional gains (>0)}} - \underbrace{(1-\beta)\left(c(x_H^{*T}) - c(x_H^{*A})\right)}_{\text{loss due to increased overconsumption (>0)}} && (6) \end{aligned}$$

with (x_H^{*T}, z_H^{*T}) denoting the individual's decision utility maximizing choice in the trade equilibrium and (x_H^{*A}, z_H^{*A}) denoting her decision utility maximizing choice in the autarky equilibrium. Since $p^T < p_H^A$ and x^* is decreasing in p, $x_H^{*T} > x_H^{*A}$. The first part of equation (6) reflects the traditional gains from trade, which would arise if the consumer had time-consistent preferences and her experienced utility coincided with her decision utility. These gains are unambiguously positive as can be shown with standard revealed preference arguments. The second part of equation (6) only applies if the individual has time-inconsistent preferences and $\beta < 1$. It reflects the fact that the individual does not fully take into account the increase in costs when consuming more of good x in response to the price decline. The resulting inefficiency reduces the traditional gains from trade, and total gains from trade may become negative.

The gains from trade for an individual in Foreign can be obtained by replacing H by F in equations (5) and (6). As for an individual in Home, they can be divided into a traditional part and a component that is due to the self-control problem. The traditional part is again positive. In contrast to the Home country, however, the second component is negative. This is because the relative price of the good associated with self-control problems rises in Foreign compared to autarky, $p^T > p_F^A$, and consumption declines, $x_F^{*T} < x_F^{*A}$. Trade effectively mitigates the self-control problem by reducing the costs that cause inefficient consumption since they are not fully taken into account. Thus, the total

[14] Complete spezialization occurs whenever a country is neither too small nor too large relative to the world demand for the good in which it has a comparative advantage.

gains from trade for any individual in Foreign are unambiguously positive, no matter whether the individual suffers from self-control problems or not.

Summing up, if there exists an autarky equilibrium and a trade equilibrium in which Home specializes in the production of good z and Foreign specializes in the production of good x, and if each individual consumes both goods x and z in autarky and under trade, which I will assume throughout, then the following is true:

Proposition 1

1. *If the individual lives in Home, she gains from trade for $\beta = 1$ and may gain or lose from trade for $\beta < 1$.*

2. *If the individual lives in Foreign, she gains from trade for all $\beta \leq 1$.*

When are consumers in Home more likely to lose from trade? Some comparative static helps to answer this question. First, an important determinant of the benefits from trade liberalization is the degree of self-control. Yet, a larger self-control problem does not necessarily imply that an individual is more likely to lose. The derivative

$$\frac{\partial G_H}{\partial \beta} = -(1-\beta)\left(c_x(x_H^{*T})\frac{\partial x_H^{*T}}{\partial \beta} - c_x(x_H^{*A})\frac{\partial x_H^{*A}}{\partial \beta} \right) \tag{7}$$

suggests that it depends on how strongly individuals with different degrees of self-control react to the price reduction from p_H^A to p^T. If consumers with low self-control are more price responsive than those with high self-control, their problem of overconsumption gets worse more than it does for those with high self-control, and they experience a smaller gain or a larger loss in utility, respectively. Consumers with lower self-control are more price responsive if the following assumption is satisfied:

Assumption 1 *For all x, $2c_{xx}(v_{xx} - \beta c_{xx}) < c_x(v_{xxx} - \beta c_{xxx})$.*

It is sufficient for $c_x(x^*)\partial x^*/\partial \beta$ to be decreasing in x^* and thus for the gains from trade in Home to be increasing in β. Assumption 1 is satisfied for most commonly used utility functions when costs are linear or quadratic, e.g. for log utility and linear costs.[15]

Analogously, if individuals in Foreign with low self-control are more price responsive than those with high self-control, they benefit more from the price increase from p_F^A to p^T, as they reduce their overconsumption more than those with high self-control do. Therefore, assumption 1 is also sufficient for the gains from trade in Foreign to be decreasing in β.

[15] Assumption 1 is not satisfied e.g. for quadratic utility and linear costs, $v(x) = -b(x-a)^2$ with $b > 0$, $a > 0$ and $c(x) = cx$. In this case, demand functions for good x are linear, and the slope is independent of β. Hence, as the price of good x falls, individuals with low self control consume more to the same extent as individuals with high self-control do and thus make the same gains from trade.

Proposition 2 *If assumption 1 is satisfied, $\partial G_H/\partial\beta > 0$ and $\partial G_F/\partial\beta < 0$, that is in Home individuals with higher self-control gain more from trade, while in Foreign individuals with lower self-control gain more from trade.*

In the optimal taxation framework of O'Donoghue and Rabin (2006), the same assumption is sufficient for small taxes on good x to create Pareto-improvements if the tax proceeds are redistributed in a lump-sum fashion and individuals differ only with respect to β. This is not surprising, given that in a Ricardian setting a tax and trade liberalization have the same effect in the Home country: they both change the relative price p, albeit in opposite directions. When a small tax is levied and individuals with self-control problems are sufficiently price responsive, the price hike helps them to reduce their overconsumption, and this effect outweighs their loss in real income. When trade is liberalized and individuals with self-control problems are sufficiently price responsive, the decline in price exacerbates their overconsumption, thus reducing their gains in real income. If all individuals were forced to bear an equal share of the hypothetical costs that would arise if the government wanted to guarantee trade prices in an autarky situation by subsidizing good x, then everybody in Home would be weakly worse off under free trade. However, these costs do not have to be borne under free trade, and thus at least those individuals with $\beta = 1$ are better off.

Whether and by how much an individual benefits from trade also depends on the extent to which the trade price differs from the autarky price. The trade price is determined through supply and demand in general equilibrium, and thus depends on population size, technology, and the distribution of preferences. With $G(\beta)$ denoting the world distribution of β and p^T denoting the corresponding trade price, one gets the following result:

Lemma 1

1. *The equilibrium price p^T is decreasing in L_F and increasing in L_H and a_{xF}.*
2. *For any two distribution functions $G'(\beta)$ and $G(\beta)$ with $G'(\beta) \geq G(\beta)$ for all β, $p^{T'} \geq p^T$.*

An increase of the population in Foreign which leaves the distribution $F(\beta)$ unaffected decreases the equilibrium price, because it increases aggregate supply more than aggregate demand. An increase of the population in Home, however, only increases aggregate demand, and thus leads to a higher equilibrium price. Furthermore, as a_{xF} increases, production of good x gets less efficient and the equilibrium price rises, all other things being equal. This simply follows from totally differentiating the goods market clearing condition $L_H \int x(p^T, \beta)dH(\beta) + L_F \int x(p^T, \beta)dF(\beta) = L_F/a_{xF}$. Note that the demand for good x is independent of income for an interior solution because of the quasilinear structure of preferences. Using that the world distribution of β is the weighted sum of the distributions in Home and Foreign, $G(\beta) = (L_H H(\beta) + L_F F(\beta))/(L_H + L_F)$, the goods market clearing condition can be rewritten as $(L_H + L_F) \int x(p^T, \beta) dG(\beta) = L_F/a_{xF}$. When the distribution changes from $G(\beta)$ to $G'(\beta)$ such that more people have less self-control, aggregate demand increases, and ceteris paribus the equilibrium price must rise.

Knowing how the equilibrium price p^T depends on the parameters of the model, the next step is to analyze how it affects the individual gains from trade.

Proposition 3

1. *If the individual lives in Home and has $\beta = 1$, her gains are decreasing in p^T. If she has $\beta < 1$, her gains are decreasing in p^T if and only if $-x_H^{*T} < (1-\beta) c_x \frac{\partial x_H^{*T}}{\partial p^T}$.*

2. *If the individual lives in Foreign, her gains are increasing in p^T for all $\beta \leq 1$.*

In Home, a smaller equilibrium price p^T has two effects. It increases the traditional gains from trade as the imported good becomes cheaper, but it also worsens the inefficiency due to overconsumption for those individuals who suffer from self-control problems, as can be seen from the derivative $\partial G_H/\partial p^T = -x_H^{*T} - (1-\beta) c_x \partial x_F^{*T}/\partial p^T$. For an individual with $\beta < 1$, both effects work into opposite directions, and the gains from trade are only decreasing in p^T if the traditional effect dominates the overconsumption effect. Overall, the relationship between G_H and p^T does not need to be monotonic. Like in the example in section 4.4, it may happen that the gains from trade for an individual with self-control problems first rise as p^T falls, and then decline as p^T moves further away from the autarky price. For an individual with $\beta = 1$, the overconsumption effect vanishes and $\partial G_H/\partial p^T = -x_H^{*T} < 0$.

In Foreign, both effects work in the same direction, as can be seen from the derivative $\partial G_F/\partial p^T = \left(1/a_{xF} - x_F^{*T}\right) - (1-\beta) c_x \partial x_F^{*T}/\partial p^T$. A larger equilibrium price p^T increases the traditional gains from trade as the exported good becomes more expensive,[16] and it reduces the inefficiency due to overconsumption. Thus, the gains from trade unambiguously rise with p^T for all individuals in Foreign.

One may not only be interested in the individual gains from trade, but also in the gains from trade for a country as a whole. However, without assuming a specific utility and cost function and a particular distribution of β, it is difficult to make any statement about the sign and the size of a country's gains from trade, at least for Home. Clearly, if all individuals in Home are fully self-controlled, the country's gains from trade are positive.

[16] Note that $z_F^{*T} = w_F^T - p^T x_F^{*T} = p^T/a_{xF} - p^T x_F^{*T} = p^T \left(1/a_{xF} - x_F^{*T}\right)$, using that marginal costs must equal the price in equilibrium, $w_F^T a_{xF} = p^T$. Hence, in a trade equilibrium where individual consumption of z is positive and the individual welfare analysis in this chapter applies, it must be that $1/a_{xF} - x_F^{*T} > 0$.

Taking this as a starting point, one can think about what happens if more and more individuals in Home suffer from self-control problems. This has two effects: First, the equilibrium price p^T rises, and second, the gains of individuals with lower β weigh more heavily. A rising price unambiguously hurts those who are still fully self-controlled, and given that individuals with self-control problems can never make higher gains than those who are fully self-controlled as long as assumption 1 is satisfied, the country's gains from trade cannot rise as one moves from a situation with no self-control problems to a situation where at least some individuals in Home have self-control problems. Yet, comparing two different distributions of self-control problems in Home is impossible without further information due to the fact that individuals with low self-control may actually benefit from a rising price. The Foreign country's gains from trade are always positive, and if assumption 1 is satisfied, they are the higher the more individuals in Foreign suffer from self-control problems.

However, even if the Home country's gains from trade are negative, trade can be made a Pareto-improvement. The government in Home just has to introduce a tariff on the imported good x such that the consumer price under trade equals the autarky price, and redistribute the tariff revenue in a lump sum fashion. In this case, the traditional gains due to specialization are preserved, and losses due to increased overconsumption are avoided. Thus, Pareto-gains from trade are possible, but they require government action. Also note that a tariff on the sin good will reduce the equilibrium price in Foreign, thereby reducing the gains that can be achieved abroad.

To illustrate the results derived in this section and to give an idea of how large the gains or losses due to trade liberalization may in fact be, I will provide an example with a concrete utility and cost function and feasible parameter values in the following section.

4.4 Example

Suppose $v(x) = 2\sqrt{x}$ and $c(x) = x$ for all individuals in Home and Foreign. Then the interior solution to the decision utility maximization problem is $x^* = 1/(\beta + p)^2$ and $z^* = w - p/(\beta + p)^2$. Using the equilibrium prices and wages in autarky and under trade, an individual's gains from trade in Home and Foreign can be calculated as

$$G_H = \left(\frac{1}{(\beta + p^T)} - \frac{1}{(\beta + \frac{a_{xH}}{a_{zH}})} \right) - (1 - \beta) \left(\frac{1}{(\beta + p^T)^2} - \frac{1}{(\beta + \frac{a_{xH}}{a_{zH}})^2} \right) \tag{8}$$

$$G_F = \left(\frac{1}{(\beta + p^T)} - \frac{1}{(\beta + \frac{a_{xF}}{a_{zF}})} + \frac{p^T}{a_{xF}} - \frac{1}{a_{zF}} \right) - (1 - \beta) \left(\frac{1}{(\beta + p^T)^2} - \frac{1}{(\beta + \frac{a_{xF}}{a_{zF}})^2} \right). \tag{9}$$

The first part of each equation reflects the traditional gains, which are unambiguously positive if each country fully specializes in its comparative advantage good and the individual consumes both goods x and z in autarky and under trade. The second part describes the change in welfare due to a change in overconsumption, which is negative in Home and positive in Foreign. Thus, in Foreign, all individuals unambiguously gain from trade, while in Home, individuals with self-control problems may lose from trade if the traditional gains are overcompensated by the welfare loss due to increased overconsumption. Whether this will actually happen depends on the individual's self-control parameter β and on the equilibrium price p^T, which solves the goods market clearing condition and depends on the distribution of β in Home and in Foreign, the population sizes L_H and L_F and the technology parameter a_{xF}.

I assume that the self-control parameter β is uniformly distributed on the interval $[0.4, 1]$ in Home and in Foreign. Empirical evidence on the distribution of the self-control parameter β is still limited. Most studies that estimate models with hyperbolic discounting estimate a single β for the whole sample. For instance, Laibson et al. (2007) use a consumption-savings model and estimate a β of about 0.7. Shui and Ausubel (2005) take the results of an experiment in the credit-card market and estimate a present-bias factor of 0.8, while Fang and Silverman (2009) implement a model of labor supply and welfare participation and get an estimate for β of about 0.34. An exception is Paserman (2008), who estimates the degree of hyperbolic discounting in a job search model for different groups of workers. His estimate for β is 0.4 for low income workers (1st quartile of the wage distribution), 0.48 for medium income workers (2nd and 3rd quartile of the wage distribution), and 0.89 for high income workers (4th quartile of the wage distribution). To sum up, even though most studies cannot reject the hypothesis that individuals are hyperbolic discounters, the estimates vary considerably depending on the model used and the assumptions made, and information about the distribution of β that go beyond its mean are scarce. Therefore, a uniform distribution of β on $[0.4, 1]$ with mean 0.7 does not seem to be implausible.

The remaining parameter values have to be chosen such that (i) Foreign has a comparative advantage in good x, (ii) the equilibrium price lies between the two autarky prices p_F^A and p_H^A, and (iii) each individual with $\beta \in [0.4, 1]$ in Home and Foreign has strictly positive demand for x and z in autarky and under trade. One set of parameter values that satisfies conditions (i) to (iii) is $L_H = 6$, $a_{xH} = 0.3$, $a_{zH} = 0.4$, $L_F = 1$, $a_{xF} = 0.2$ and $a_{zF} = 0.4$.

For these parameter values, the gains from trade in Home and Foreign for individuals with different degrees of self-control are displayed in figure 1. To ease interpretation, they are indicated in percent of the individual's experienced utility in autarky. A fully self-

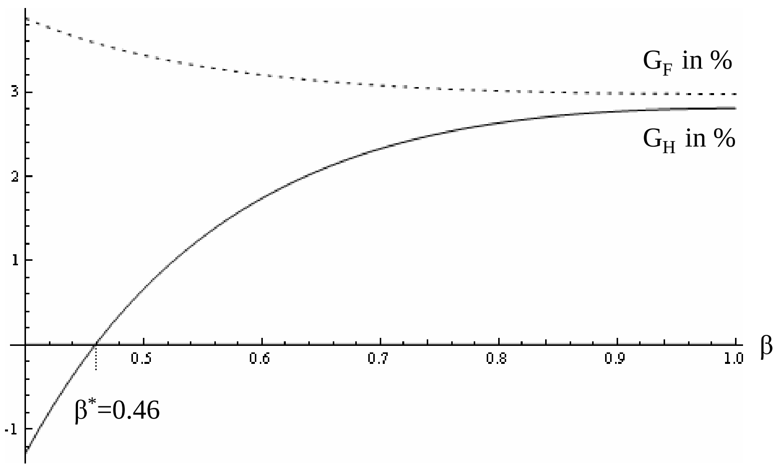

Figure 1: Individual gains in Home and Foreign

controlled individual in Home gains about 2.8% from trade. In other words, free trade allows an individual with $\beta = 1$ to increase consumption of the composite good by about 2.8%, all else being equal. The welfare gains are the lower, the stronger is the self-control problem: an individual with $\beta = 0.6$ gains only about 1.6% from trade. For an individual with $\beta = \beta^* = 0.46$, the loss due to increased overconsumption and the traditional gains exactly compensate, and an individual at the lower end of the distribution loses by more than 1.2%. Given that the chosen utility function satisfies assumption 1, it is not surprising that the individual gains from trade in Home are increasing in β. In Foreign, the individual gains from trade are positive and decreasing in β for all $\beta \in [0.4, 1]$. A fully self-controlled individual can consume about 3% more of the composite good under trade than in autarky, while an individual at the lower end of the distribution gains more than 3.8% from trade.

In addition to the self-control parameter β, the equilibrium price under trade is crucial for an individual's gains from trade. While the gains from trade are decreasing in p^T for a fully self-controlled individual in Home, the relationship is non-monotonic for individuals with low self-control. Their gains, measured in percent of autarky experienced utility, increase if the equilibrium price under trade falls only slightly below the autarky price in Home, but decrease and eventually become negative if p^T declines further, which happens, for instance, if the population in Foreign grows.[17]

[17]For the given parameter values with $L_F = 1$, the equilibrium price is $p^T = 0.52$, and at this price the gains from trade for an individual with $\beta = \beta^* = 0.46$ have fallen to zero.

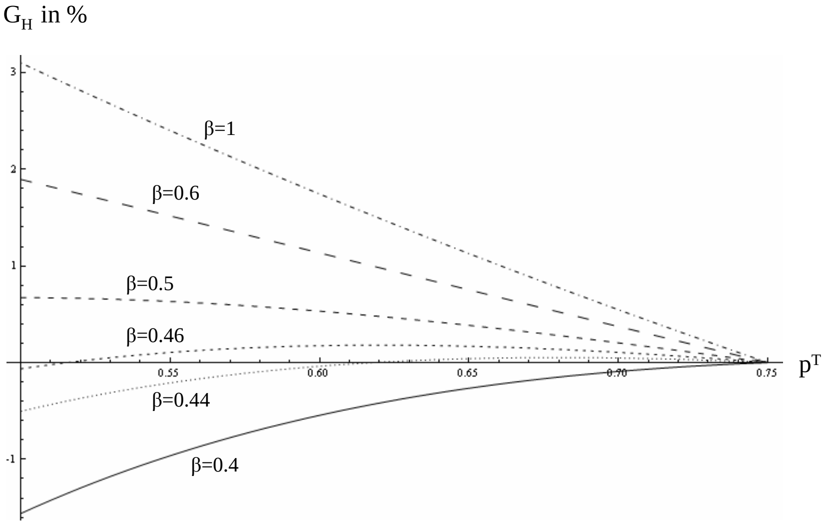

Figure 2: Individual gains in Home for different β as a function of p^T.

Finally, with a uniform distribution of the self-control parameter β, the gains from trade for a country as a whole are proportional to the area under the respective curve in figure 1. In this specific example, they are positive in both Home and Foreign.

5 New trade model

I will now turn to a new trade model, characterized by increasing returns to scale and monopolistic competition, and show that in such a framework the welfare implications of trade may differ from those in a Ricardian model. First, individuals in both countries may lose from trade, and second, even fully self-controlled individuals may lose if there is heterogeneity in the degree of self-control across countries.

5.1 Model description

Individuals have time-inconsistent preferences for two goods as described in section 3, with the exception that good x is now a differentiated good with a continuum of varieties. I denote consumption of variety i by $x(i)$, with $i \in [0, N]$. N is the mass of varieties and is determined endogenously. As before, I denote consumption of the composite numéraire good by z. In each period, an individual supplies l units of labor inelastically and gets a labor income of wl. Hence, in each period, an individual chooses $x(i)$, $i \in [0, N]$, and z to maximize her decision utility $u^*(x(i), i \in [0, N], z) = v(x(i), i \in [0, N]) - \beta c(x(i), i \in [0, N]) + z$ subject to the budget constraint $\int_0^N p(i)x(i)di + z = wl$. Her welfare is measured in terms of experienced utility, $u^{**}(x(i), i \in [0, N], z) = v(x(i), i \in [0, N]) - c(x(i), i \in [0, N]) + z$.

To make the model analytically tractable, I assume a specific functional form for $v(\cdot)$ and for $c(\cdot)$, i.e.

$$\begin{aligned} u^*(x(i), i \in [0, N], z) = \quad & \underbrace{\alpha \int_0^N x(i)di - \frac{1}{2}\rho \int_0^N x(i)^2 di - \frac{1}{2}\eta \left(\int_0^N x(i)di \right)^2}_{v(x(i), i \in [0, N])} \\ & -\beta \underbrace{\gamma \int_0^N x(i)di}_{c(x(i), i \in [0, N])} + z \end{aligned} \tag{10}$$

with $\alpha > 0$ and $\rho > \eta > 0$. Similar functional forms for $v(\cdot)$ have been used for example by Ottaviano et al. (2002) and Melitz and Ottaviano (2008). The parameter α reflects the intensity of preferences for the differentiated good relative to the composite good, while $\rho > \eta$ implies that the individual likes to spread consumption of good x over as many varieties as possible. This love of variety is the greater, the higher is ρ. For a given value of ρ, η describes the substitutability between varieties. They are the closer substitutes, the higher is η. For the future costs of consumption, only the total amount of the differentiated good matters. It is irrelevant how this amount is split between the different varieties. To give an intuition for this assumption, note that for the probability of getting lung cancer, it certainly matters how much an individual smokes. It seems however secondary whether she smokes Marlboro, Camel or Lucky Strike cigarettes. Similarly, whether an individual becomes obese and suffers from diabetes might depend on how many bars of chocolate she eats per day. Whether this is milk chocolate or white chocolate is however less important.

I assume that labor supply and thus income are sufficiently large and that the preference for the differentiated good is sufficiently strong, such that all individuals have positive demand for each variety $i \in [0, N]$ and for the composite good.[18] In this case, the demand of an individual with self-control parameter β for each variety $i \in [0, N]$ is given by

$$x(i) = \frac{\alpha - \beta\gamma}{\rho + \eta N} + \frac{\eta N \bar{p}}{\rho(\rho + \eta N)} - \frac{p(i)}{\rho} \tag{11}$$

with $\bar{p} = \frac{1}{N} \int_0^N p(i)di$ being the average price of the differentiated good.

For the moment, I focus on a single country and assume that it is populated by a continuum of individuals with mass L. These individuals may differ in their degree of

[18] Assumption 2 imposes restrictions on the parameters of the model which ensure that this will indeed be the case in equilibrium.

self-control, as described by the cumulative distribution function $H(\beta)$. If all individuals in the support of $H(\beta)$ have a positive demand as given by equation (11), the aggregate demand for each variety $i \in [0, N]$ is

$$X(i) = L\left(\frac{\alpha - \bar{\beta}\gamma}{\rho + \eta N} + \frac{\eta N \bar{p}}{\rho(\rho + \eta N)} - \frac{p(i)}{\rho}\right) \tag{12}$$

where $\bar{\beta} = \int \beta dH(\beta)$ is the average β in the population.

As in the previous section, the numéraire good z is produced with constant returns to scale under perfectly competitive conditions. The units of good z are normalized such that producing one unit of good z requires one unit of labor. This implies an equilibrium wage of $w = 1$. Each variety $i \in [0, N]$ of the differentiated good is produced by a single firm with zero marginal costs and fixed costs F. The firm chooses $p(i)$ to maximize profits, $\Pi(i) = p(i)X(i) - F$, taking the average price $\bar{p}$ of the differentiated good and the number of firms N as given. This is a central feature of monopolistic competition: since there is a continuum of competitors, each firm has a negligible effect on the market, and there is no direct strategic interaction. There is only indirect interaction through the average price $\bar{p}$, which influences the aggregate demand for the differentiated good and thus for each variety. Another central feature of monopolistic competition, which is assumed in the following, is free entry and exit of firms.

5.2 Autarky equilibrium

The definition of an autarky equilibrium is analogue to the one given in section 4.2, with the exception that inputs, outputs and consumption allocations as well as prices are now defined for each variety $i \in [0, N]$ of the differentiated good. Also, the market clearing condition must hold for each variety $i \in [0, N]$. Like prices, N is taken as given by individuals and firms and will be determined endogenously in equilibrium as firms can freely enter and exit the market.

Since the different varieties enter symmetrically into the utility function (10) and firms have identical marginal costs of zero, each firms chooses the same profit maximizing price, which depends on the number of competitors as well as on the average price for the differentiated good,

$$p(i) = \frac{\rho(\alpha - \bar{\beta}\gamma) + \eta N \bar{p}}{2(\rho + \eta N)} \text{ for all } i \in [0, N]\,. \tag{13}$$

Intuitively, if N increases, competition becomes fiercer, and the firm must lower its price. If $\bar{p}$ rises, substitutes become more expensive, and the firm can charge a higher price for its own product. This effect is the stronger, the closer are the substitutes. Due to symmetry, $\bar{p} = p(i) = p$ and (13) collapses to

$$p = \frac{\rho(\alpha - \bar{\beta}\gamma)}{2\rho + \eta N}. \tag{14}$$

Aggregate demand for each variety at the profit maximizing price then is

$$X = L\frac{\alpha - \bar{\beta}\gamma}{2\rho + \eta N}. \tag{15}$$

With free entry, firms must make zero profits in equilibrium, $\Pi = pX - F = 0$. Substituting in (14) and (15) and solving for N gives

$$N^* = \frac{(\alpha - \bar{\beta}\gamma)\sqrt{\frac{\rho L}{F}} - 2\rho}{\eta}. \tag{16}$$

The equilibrium mass of varieties increases if the intensity of preferences for the differentiated good rises, if the average degree of self-control decreases, or if the population size increases. All this might be interpreted as an increase in market size. Increasing fixed costs however reduce the equilibrium mass of varieties. If they get too large relative to market size, N will be zero in equilibrium. Plugging (16) back into (14) and (15) gives the equilibrium price and the equilibrium aggregate consumption of each variety $i \in [0, N]$,

$$p^* = \sqrt{\frac{\rho F}{L}} \tag{17}$$

$$X^* = \sqrt{\frac{LF}{\rho}}. \tag{18}$$

Note that both the equilibrium price and aggregate consumption of each variety are independent of the average degree of self-control, $\bar{\beta}$. They only depend on fixed costs F, the parameter ρ, and the population size L. Individual consumption of each variety will be a fraction L of aggregate consumption, corrected by a factor that accounts for deviations from the average degree of self-control,

$$x^* = \frac{\sqrt{\frac{LF}{\rho}}\left((\alpha - \beta\gamma)\sqrt{\frac{\rho L}{F}} - \rho\right)}{L\left((\alpha - \bar{\beta}\gamma)\sqrt{\frac{\rho L}{F}} - \rho\right)}. \tag{19}$$

In equilibrium, an individual who has higher self-control than the average consumes less of the sin good than the average, and vice versa. To ensure that all demands as well as the equilibrium mass of varieties are positive and equations (16) to (19) indeed characterize an autarky equilibrium, I make the following assumption:

Assumption 2 *For all β in the support of $H(\beta)$, the parameters of the model satisfy the following conditions:*

1. $l\eta/\sqrt{\frac{\rho F}{L}} > \alpha - \beta\gamma > \sqrt{\frac{\rho F}{L}}$
2. $\alpha - \bar{\beta}\gamma > 2\sqrt{\frac{\rho F}{L}}$

The first condition ensures that $x^* > 0$[19] and $z^* = l - N^*p^*x^* > 0$. The second parameter restriction guarantees that the equilibrium mass of varieties is positive. All conditions can be satisfied if the fixed costs are sufficiently small relative to the intensity of preferences for the differentiated good and if the individual labor supply is sufficiently large.

The experienced utility in the autarky equilibrium, which depends on the individual degree of self-control, is then given by

$$u^{**} = \underbrace{N^*x^*\frac{1}{2}(\alpha - \beta\gamma - p^*) + l}_{\text{traditional part}} - \underbrace{(1-\beta)\gamma N^*x^*}_{\text{loss due to overconsumption}} . \tag{20}$$

Similar to the Ricardian setting, it can be split into two parts, a traditional one and one which reflects the reduction of well-being due to overconsumption and cancels for $\beta = 1$.

5.3 Welfare effects of trade liberalization

How to think about trade liberalization within this framework? The traditional way is to look at two economies with identical preferences and production technologies and interpret trade simply as an increase in the mass of consumers L that can be reached by each firm. As borders open up, producers in both countries can serve the domestic and the foreign market and take advantage of economies of scale in production. The equilibrium price falls. At the same time, individuals in both countries gain access to more varieties. Even though they consume less of a single variety, their overall consumption of the differentiated good increases. Both the decreasing price and the increasing choice benefit the fully self-controlled individuals. The traditional part of the experienced utility is decreasing in p^* and increasing in N^*x^*. Those individuals who suffer from self-control

[19]Hence, it is assumed that even though consumption of the differentiated good entails future costs, every individual consumes a tiny little bit of it. This simplifies the analysis considerably without changing the main insights.

problems may however be worse off in both countries, since they do not correctly take into account the increasing costs of consuming more of the differentiated good, and their loss due to increased overconsumption may overcompensate their conventional gains from trade.

Within the present framework, however, trade does not only have an impact on the size of the market that is served by each firm. Given that already individuals within one country are heterogeneous in their degree of self-control, it is very likely that the two trading countries are characterized by different cumulative distribution functions. And unless both cumulative distribution functions have the same mean, the average degree of self-control in the open economy $\bar{\beta}^T$ will be different from the average degrees of self-control in the two closed economies. If the average self-control problem is more severe in Foreign than in Home, that is $\bar{\beta}_F < \bar{\beta}$, then $\bar{\beta}^T$ will be smaller than $\bar{\beta}$. A smaller average degree of self-control has a positive effect on aggregate demand, all else equal. As a result, more varieties become available, and the total amount of the differentiated good an individual in Home consumes increases. The effect of a decrease in the average degree of self-control thus goes into the same direction as the effect of an increase in market size. It benefits the fully self-controlled individuals in Home, while it may hurt individuals with low self-control. However, if the average self-control problem is less severe in Foreign than in Home, that is $\bar{\beta}_F > \bar{\beta}$, then $\bar{\beta}^T$ will be larger than $\bar{\beta}$, and considered in isolation, this hurts the fully self-controlled individuals in Home, while it may benefit those individuals that lack willpower. In combination with an increase in the mass of consumers, the welfare consequences of trade are much more ambiguous and depend on which of the two opposing effects dominates. Nevertheless, if $\bar{\beta}^T$ is smaller than or equal to $\bar{\beta}$, one can find a sufficient condition for the individual gains from trade in Home to be positive.

Proposition 4 *Consider an individual with self-control parameter β living in a country in which the average degree of self-control is $\bar{\beta}$. Suppose assumption 2 is satisfied in autarky. If the country starts trading with another country in which the average degree self-control is equal to or lower than $\bar{\beta}$, the individual gains from trade if $\beta \geq 2 - (\alpha - \sqrt{\frac{\rho F}{L}})/\gamma$.*

For a proof, see the appendix. Thus, individuals with sufficiently strong self-control gain from trade, provided that the average degree of self-control is not higher in the country they start trading with than in their own country. Their gains increase with the size of the population in the foreign country. What the finding also suggests is that individuals with low self-control can lose from trade, and for this to happen, it is irrelevant in which of the two trading countries they live in if both countries are characterized by similar distributions of self-control. In other words, with increasing returns to scale and monopolistic competition, individuals with low self-control may lose from trade in both countries, in contrast to the Ricardian setting, where at most individuals with low self-control in the importing country can be worse off as borders open up.

Another novelty compared to the Ricardian setting is that a changing average degree of self-control opens up the possibility that in at most one country even the fully self-controlled individuals lose from trade. The intuition behind this result is that if a country opens up its borders to a country in which the average degree of self-control is very high and hence demand for the sin good is rather low, firms have to reduce their prices considerably to capture these new consumers. Since firms cannot price discriminate across countries, their revenues fall despite a larger market size. This effect leads to less firms and hence less varieties in the trade equilibrium, which hurts the fully self-controlled individuals.[20] However, numerical simulations indicate that the conditions for this to actually happen are rather restrictive. In fact, the fully self-controlled individuals in Home can only lose if the average degree of self-control in Foreign exceeds one, implying that the individuals in Foreign are overly self-controlled and rather have a problem of underconsumption than one of overconsumption, possibly not consuming the differentiated good at all in autarky. Just to give an example, $\alpha = 15$, $\gamma = 10$, $\bar{\beta} = 0.75$, $L = 15$, $\eta = 10$, $\rho = 20$, $F = 10$, and $l = 2$ is a set of parameter values that satisfies assumption 2. If in Foreign the average degree of self-control is $\bar{\beta}_F = 1.2$ and the population size is $L_F = 10$, then the average degree of self-control in the open economy is $\bar{\beta}^T = 0.93$, and the total population is $L^T = 25$, implying that assumption 2 continues to hold under trade. For these parameter values, a fully self-controlled individual in Home loses about 0.06% from trade in terms of experienced utility, or, to put it differently, in terms of consumption of the numéraire good. Hence, even if the parameter values are such that losses indeed occur, they are quantitatively negligible, in particular if the expenditure on the differentiated good represents only a small fraction of income, that is if l is large. If the average degree of self-control is smaller than or equal to one in both Home and Foreign, the fully self-controlled individuals on both sides of the border always gain from trade. Given the empirical evidence on the distribution of self-control problems summarized in section 4.4, this seems to be the more probable scenario.

[20] Note that the negative effect of trade liberalization on the number of varieties is not specific to a situation in which there is heterogeneity across countries in the degree of self-control, but may occur more generally whenever there is heterogeneity across countries in the preferences for the differentiated good, as captured by α, or in the future costs of consumption, as reflected by γ. Opening up borders to a country in which the average preference for the differentiated good is relatively low or the average future cost of consumption is comparatively high can also lead to less firms and less varieties, and hence make individuals in the country with high demand for the differentiated good worse off.

5.4 Quantifying the welfare effects of trade in cigarettes

An example that motivated the analysis of the welfare effects of trade in the presence of self-control problems was the liberalization of trade in cigarettes. One of the countries which were forced to open their markets to foreign cigarette imports was Taiwan. Until 1986, the market for cigarettes in Taiwan was protected by high import tariffs and restrictive quotas, and the share of imported cigarettes in total consumption was less than 2%. When Taiwan liberalized the imports of cigarettes from the U.S. in 1987, the price of imported cigarettes declined substantially and the share of imported cigarettes in total consumption rose to 18%. Detailed time series data on cigarette consumption and prices as used by Hsieh et al. (1999) allows to quantitatively asses the welfare implications of this movement towards free trade.[21]

To this end, I compute experienced utility as given in equation (20) for an average individual in Taiwan in 1986 and 1987. The difference may then be interpreted as the gain in real income due to the liberalization of trade in cigarettes. Total consumption N^*x^* is the number of packs sold per individual. It was 114 in 1986 and 124 in 1987. The price p^* is calculated as the average price of domestic and imported brands, weighted with their respective market shares in 1987.[22] The average price was 30 in 1986 and 28.4 in 1987. Per capita income l also originates from Hsieh et al. (1999). It was 157.624 in 1986 and I assume it to be constant until 1987 to abstract from welfare gains induced by economic growth, for instance. Income and prices are measured in New Taiwanese Dollars and deflated to 1991 values. The individual degree of self-control β is set to the population average $\bar{\beta} = 0.7$ as estimated by Laibson et al. (2007). Estimates for the health costs of cigarette consumption γ range from 20 \$ (Sloan et al., 2004) to 222 \$ (Viscusi and Hersch, 2008) per pack. Converting and deflating these values to 1991 New Taiwanese Dollars suggests that γ is in the range of 400 to 4000. Finally, the parameter α can be inferred from the price elasticity of cigarette consumption.[23] Estimates for the price elasticity of demand range from -0.5 to -1.2. I take an intermediate value of $\epsilon = 0.8$, evaluated at a price of 29.2.[24]

With this parameterization I find that even for moderate health costs of smoking, an individual with average self-control in Taiwan lost from the liberalization of trade in

[21] I am deeply indebted to Chee-Ruey Hsieh, Teh-Wei Hu, and Chien-Fu Jeff Lin for providing me with their data.

[22] Alternatively, I could weigh prices with market shares in 1986. In this case, the average price would not fall as much after trade liberalization, and the traditional gains from trade would be even smaller.

[23] With symmetric varieties, total cigarette consumption can be calculated as $Nx = N(\alpha - \beta\gamma - \bar{p})/(\rho + \eta N)$. Then the price elasticity of total cigarette consumption with respect to the average price is $\epsilon_{Nx,\bar{p}} = -\bar{p}/(\alpha - \beta\gamma - \bar{p})$, and hence $\alpha = -\bar{p}(\epsilon - 1)/\epsilon + \beta\gamma$.

[24] Given this data on consumption, prices, and income, and given the actual population size L of Taiwan, I can find reasonable parameter values for η, ρ, and F such that assumption 2 is satisfied and equation (20) indeed characterizes experienced utility in the autarky and trade equilibrium, respectively.

cigarettes. For $\gamma = 400$, the loss would amount to 0.6 % of real income. For $\gamma = 2000$, the loss would already amount to 6.3 % of real income, and for $\gamma = 4000$, the loss would even exceed 50 % of real income. From this I conclude that losses from trade in the presence of self-control problems are not only a theoretical possibility but do occur in practice.

6 Conclusion

The present paper has analyzed the consequences of time-inconsistent preferences for the welfare effects of trade liberalization within two different trade models. In a classic Ricardian model with constant returns to scale and perfect competition, it crucially depends on the direction of trade whether an individual is better or worse off as borders open up. In the exporting country, all individuals are better off, and they are the better off, the higher is the equilibrium price of the sin good and the lower is their degree of self-control. In the importing country however, while the fully self-controlled individuals gain from trade, those individuals with self-control problems may lose from trade, and this is the more likely, the stronger is their self-control problem, provided that they are sufficiently price-sensitive.

These findings may seem rather intuitive, but they are sensitive to the assumptions on production technology and market structure. In a new trade model with increasing returns to scale and monopolistic competition, the equilibrium price falls and the variety of products available to consumers rises in both countries as borders open up, provided that the average degrees of self-control in the two countries are similar. A lower price and a larger variety benefit the fully self-controlled individuals, while they may hurt consumers with a lack of willpower in both countries. What is quite surprising, however, is that even the fully rational individuals can lose in such a setting. This will be the case if they start trading with a country inhabited by overly self-controlled individuals and if the negative effect of a rising average degree of self-control on the available product variety dominates the positive effect of an increasing market size.

One real world example where self-control problems matter for the welfare effects of trade and where government action is required to make trade a Pareto-improvement over autarky is the case of trade in cigarettes. The empirical evidence on self-control problems with regard to smoking is strong, and the effects of trade on the consumption of cigarettes as well as the health consequences are well documented. The case of Taiwan demonstrates that losses from trade in cigarettes due to self-control problems do indeed occur. Yet, the theoretical analysis also qualifies for trade in other goods, such as unhealthy food, as mentioned in the beginning, or alcohol. For instance, after Sweden joined the European Union in 1995, it gradually liberalized trade in alcohol. The result were falling prices and an increased variety, which are partly responsible for an upsurge in alcohol abuse in Sweden (Daley, 2001). Similarly, when Finland opened up its borders to Estonia in 2004 within the framework of the expansion of the European Union, nearly unlimited amounts of low priced alcohol became available, with adverse effects on Finish public health (Finish Ministry of Social Affairs and Health, 2006).

The preceding analysis suggests that in all of these cases, the welfare effects of trade liberalization may be less positive than traditional models suggest. It provides a first hint at which factors actually matter for the distribution of the gains from trade across individuals and across countries when individuals have self-control problems and can serve as a point of reference for policy recommendations.

Certainly, the analysis can be refined. So far, I have abstracted away from heterogeneity in tastes, and this may be an important determinant of whether taxes or tariffs are Pareto-improving, as O'Donoghue and Rabin (2006) have shown. Possible extensions of the model include the introduction of income effects, in combination with borrowings and savings. Such effects might be rather irrelevant for smoking, but they are certainly important for more expensive goods such as illicit drugs. Including income effects does however make a welfare analysis with time-inconsistent agents an even more serious issue, given that utility units cannot simply be expressed in terms of income or a numéraire good. An alternative way to connect different periods of time is to remove the functional separability between immediate benefits and future costs. This is for example what Gruber and Köszegi (2004) do when they analyze the welfare effects of taxes on addictive goods. If consumption decisions of different periods are connected, it matters whether individuals are aware of their self-control problem or not, and this may have interesting implications also for trade. In addition, the connection between different periods of time opens up the possibility for intertemporal trade, and this also seems worth to analyze. Finally and most importantly, more empirical research is needed, especially with respect to the distribution of the self-control parameter β within a population and across countries, to determine how many individuals lose, and what is the magnitude of their losses. To conclude, there is much need and room for further research, empirical as well as theoretical, and taking into account new insights from behavioral economics in international trade theory promises new results.

Appendix

Proof of proposition 4. Note that if assumption 2 is satisfied in autarky, i.e. for $\bar{\beta}$ and L, it will also be satisfied under trade, i.e. for $\bar{\beta}^T = (\bar{\beta}L + \bar{\beta}_F L_F)/(L + L_F) \leq \bar{\beta}$ and $L^T = L + L_F \geq L$ where $\bar{\beta}_F$ and L_F denote the average degree of self-control and the mass of consumers in the foreign country, respectively. Then the gains from trade for an individual with self-control parameter β are

$$
\begin{aligned}
G \quad = \quad & \frac{\left(\alpha - \bar{\beta}^T\gamma - 2\sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}} - 2(1-\beta)\gamma\right)}{2\eta\left(\alpha - \bar{\beta}^T\gamma - \sqrt{\frac{F\rho}{L^T}}\right)} \\
& - \frac{\left(\alpha - \bar{\beta}\gamma - 2\sqrt{\frac{F\rho}{L}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L}} - 2(1-\beta)\gamma\right)}{2\eta\left(\alpha - \bar{\beta}\gamma - \sqrt{\frac{F\rho}{L}}\right)}
\end{aligned}
$$

The derivative of G with respect to $\bar{\beta}_F$ is

$$
\frac{\partial G}{\partial \bar{\beta}_F} \quad = \quad -\frac{L_F\gamma\sqrt{\frac{F\rho}{L^T}}\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}} - 2(1-\beta)\gamma\right)}{2\eta L^T\left(\alpha - \bar{\beta}^T\gamma - \sqrt{\frac{F\rho}{L^T}}\right)^2}
$$

and the derivative of G with respect to L_F is

$$
\begin{aligned}
\frac{\partial G}{\partial L_F} \quad = \quad & \frac{F\rho}{4\eta(L^T)^2\sqrt{\frac{F\rho}{L^T}}\left(\alpha - \bar{\beta}^T\gamma - \sqrt{\frac{F\rho}{L^T}}\right)^2} \\
& \cdot\left[\left(\alpha - \bar{\beta}^T\gamma - 2\sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \bar{\beta}^T\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\right. \\
& + \left(\alpha - \bar{\beta}^T\gamma - 2\sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \bar{\beta}^T\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}} - 2(1-\beta)\gamma\right) \\
& \left. + \left(\alpha - \bar{\beta}^T + 2\left(\bar{\beta} - \bar{\beta}_F\right)\frac{L\gamma}{L^T}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}}\right)\left(\alpha - \beta\gamma - \sqrt{\frac{F\rho}{L^T}} - 2(1-\beta)\gamma\right)\right]
\end{aligned}
$$

If $\beta \geq 2 - (\alpha - \sqrt{\frac{\rho F}{L}})/\gamma$, then $\beta \geq 2 - (\alpha - \sqrt{\frac{\rho F}{L+L_F}})/\gamma$ for all $L_F \geq 0$, which is equivalent to $\alpha - \beta\gamma - \sqrt{\frac{\rho F}{L^T}} - 2(1-\beta)\gamma \geq 0$ and $\frac{\partial G}{\partial \bar{\beta}_F} \leq 0$. If, in addition, $\bar{\beta}_F \leq \bar{\beta}$, then all terms in equation (21) are positive and $\frac{\partial G}{\partial L_F} > 0$. Given that the gains from trade are zero for $\bar{\beta}_F = \bar{\beta}$ and $L_F = 0$, they must be strictly positive for all $\bar{\beta}_F \leq \bar{\beta}$ and all $L_F > 0$.

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