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International trade, income distribution and welfare☆

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ABSTRACT

This paper studies the relationship between income distribution and international integration in a canonical trade setting with one change. In the standard model prices are solely a function of (constant) marginal costs and (constant) elasticities, implying that information on individual incomes are of no value to a firm. To allow a more realistic role for consumer level information, a firm's strategy space is expanded to include non-linear prices. Now profit maximizing firms use information on income distribution to design a product for each income class and set prices to induce each group to optimally select the appropriate option. Equilibrium involves designs below the first best for low income groups and above the first best for high income groups – welfare differences are more exaggerated than income differences. When countries with differing income distributions integrate this has implications for the size of these distortions, influencing the gains from trade both within and across countries. These implications are quantified and shown to be potentially significant factors affecting welfare outcomes from integration – with the consequences more pronounced at lower trade costs. The structure of trade and expenditure patterns that emerge also match a range of empirical findings. These results are driven by firm strategy based on income difference alone as preferences are assumed to be identical and homothetic across countries, placing the distribution of income at the center of the analysis.

1. Introduction

Models of international trade have traditionally used richness on the supply side to gain insight into why countries trade and the likely implications of integration. Any role for consumer heterogeneity is usually suppressed by adopting preferences that are both identical and homothetic. While analytically convenient, these assumptions (coupled with linear pricing) lead models of international trade to effectively ignore some of the most pronounced differences across individuals, regions and countries: income and spending patterns.

To date all efforts to gain insight into the consequences of this variation have started by relaxing the assumption of homotheticity, freeing up expenditure shares to depend not just on relative prices but also income levels. In contrast, this paper maintains the assumption of homothetic preferences and focuses on an alternative possibility – firms themselves might be interested in income differences, and may try to exploit this information to raise profits. That is, firms may try to discriminate across the different income groups.

To isolate the main implications of this behavior, we adopt the preference and technology structure of Krugman (1980). With homothetic preferences at its heart, this shuts down the mechanisms exploited by the previous literature.[1] Furthermore, its single sector structure means that expenditure shares don't vary with income. Nevertheless, differences in income across consumers translate into different consumer level demand functions. What we explore is the possibility that a firm might find a way to use this information to their advantage. Another benefit of this framework is that we have a very well understood benchmark for thinking about welfare – as set out in Arkolakis et al. (2012). Can we offer anything new in a setting where welfare outcomes are remarkably robust to variation in assumptions on market structure and firm heterogeneity? Despite

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[1] In our application we find it more intuitive to assume that consumers have preferences over the quality of the varieties that are aggregated in a CES utility function – Section 2 provides details. Consequently, doubling of a consumer's income will double their demand for quality of a variety at any given per unit price – the location of demand is proportional to income.

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all this structure intended to suppress any role for consumer heterogeneity and deliver broad welfare results, we show that nevertheless the gains from trade can vary across income groups within a country.

The key feature that drives this result is that we allow firms to not only recognize that consumers have different incomes but also be sophisticated enough to exploit this knowledge. The way firm set prices in Krugman (1980) lacks this level of sophistication. In particular firms are assumed to use linear prices, implying they are only interested in the curvature of the residual demand function when formulating their optimal strategies. Moreover, with CES preferences the elasticity of residual demand is constant and the same for all consumers. The combination of these two assumptions has relatively extreme implications for how firms respond as their information set is enriched. For example, if a firm is suddenly able to observe the income levels of each consumer, the best they can do under linear pricing is implement third degree price discrimination. However, with the elasticity of demand independent of income and the same for all consumers, a firm will not change their behavior, continuing to charge the same price per unit to all types. Contrary to what might be imagined, this additional consumer level information is then essentially of no value to a firm.

To incorporate a more realistic role for how this information is utilized, we expand a firm's strategy space to include non-linear prices. We follow the typical approach and assume that a firm knows the distribution of income but not an individual consumer's income. More formally this is a setting where a firm implements second degree price discrimination (SDPD). If a firm optimally chooses to exploit this consumer heterogeneity, it does so through the design of a menu of options (product line or "versioning") offered to a consumer.[2]

A particularly neat illustration of a product line is the iPad range. The initial offerings only had one dimension of variation, the quantity of gigabytes (GB): 16 GB, 32 GB and 64 GB. For the first two sizes the prices are \$499 and \$599.[3] If we use these prices to linearly project the price of a 64 GB machine we arrive at $\$399 + \$6.25(64) = \$799$, which is \$100 more than the actual price of \$699.[4] What's behind this pricing behavior – differences in cost, elasticity or something else? Industry sources confirm that the marginal cost of a GB is constant, so costs can't explain this variation. Additionally, the prices imply that the elasticity of demand is increasing in memory size, contrary to the typical assumption.[5] Using the implied elasticity from the 16 GB machine suggests that the 64 GB iPad would be priced over \$1100. Evidently a simple mark-up formula isn't employed, leaving scope for more sophisticated pricing strategies underlying product menus and their design. Moreover, the widespread use of product lines raises a broader question about their welfare implications, not only for a single product but also at an aggregate level.[6] A natural way to capture the broader welfare consequences of SDPD is through a general equilibrium framework – the approach adopted in this paper.

An important characteristic of SDPD is that firm behavior and the resulting monopolistically competitive equilibrium is not just a function of the curvature of the demand functions but also their position. Specifically, the profit maximizing menu trades off the desire to extract rents from an income group (by offering a design close to the first best) against the cost that this provides an enhanced outside option for another income group/s. This trade-off is resolved by the relative size and frequency of income groups. As a consequence the distribution of income is a fundamental determinant of the design of the equilibrium product line.

A feature of this equilibrium is that product design is distorted relative to the first best. In general, products designed for low income types are below the first best, while the products targeted to the high income groups are above the first best.[7] It then follows that welfare differences are more exaggerated than income differences.

The critical role of the distribution of income in this outcome immediately implies that the integration of two countries with different income distributions alters product line design and consequently welfare. Insight into the implications are clearest when countries can be ranked in terms of income distribution. In particular, if a country's income distribution dominates the global distribution then the gains from free trade will be larger than predicted by the sufficient statistic measure developed by Arkolakis et al. (2012) (henceforth ACR).[8] Moreover, these gains are disproportionately concentrated at the bottom end of the income distribution. In this case, trade reduces the distortions from SDPD and the benefits are felt across the entire distribution of income. The opposite occurs in a country whose income distribution is dominated by the global distribution, as trade adds to the distortions from SDPD. Since these distortions are not captured by the standard model of international trade they represent a new dimension of welfare analysis.

Further insight follows from decomposing the gains from trade into those derived from additional varieties and those associated with the design of the menu of choices. Critically, these two components respond differentially to the level of trade costs. In particular, when trade barriers are relatively high, incremental liberalization is primarily about reducing the costs of serving a market and has little impact on menu design. Thus, for high trade barriers the gains from marginal liberalization follow a pattern familiar from the standard model and consistent with ACR. However, once trade barriers become sufficiently low, the potential for international arbitrage triggers a process of convergence in product design across countries. Since not all types in all countries gain from design convergence, there is potential for an incremental process of trade liberalization to stall – at the margin the negative effects for product design in one country can outweigh further savings from lower trade costs.

To examine the role of this mechanism, the model is quantified on the same data utilized by Costinot and Rodriguez-Clare (2014) (hereafter CRC). In common with CRC, the SDPD model has a component of welfare determined by the domestic expenditure share and the trade elasticity. In addition, this measure is multiplied by an adjustment factor that depends on product design. While decreases in domestic expenditure share raise welfare, changes in product design can be an offsetting force. To determine design changes, the equilibrium designs are derived for each income group in each country based on the observed national income distribution. The counter factual considered is complete integration – designs based on the

[2] See Shapiro and Varian (1998) and Phillips (2005) for a general discussion of "versioning" in the management literature.

[3] Apple typically refreshes its product line on an annual basis and occasionally has added additional sizes. However, the lower end of the product line is updated less frequently and remains in production longer.

[4] To put this number in context, the additional assembly cost of onshoring the closely related iPhone has been estimated at around \$65, "How the US lost out on iPhone work," *The New York Times*, 21 January, 2012.

[5] The ordering of price elasticities follows from $\sigma = p/(p-c)$.

[6] Empirical studies that document these practices include retail gasoline (Shepard (1991), textbooks (Clerides (2002), automobiles (Verboven (2002), telecommunications (Miravete and Röller (2003), advertising (Busse et al. (2005), cable TV (Crawford and Shum (2007), fast food (McManus (2007), paper products (Cohen (2011), Palazzolo and Orhun (2016), personal computers (Eizenberg (2014), CPUs (Nosko (2010), soft drinks (Marshall (2015), Hendel and Nevo (2013)). In addition to these products many other sectors use product lines but untangling cost and markup changes is often not straightforward. Another example where marginal cost is likely to be constant is the perfume industry. Consider Chanel $N^o 5$ – the best selling perfume in the world – is sold in three sizes, with the price per oz of the largest bottle 35% lower than the smallest bottle. This translates to a saving of \$175 for buying the larger bottle.

[7] Monopoly models of SDPD predict the first result but not the second. See for example Maskin and Riley (1984).

[8] Given the primitives of the model are from Krugman (1980), ACR predict that a sufficient statistic for welfare gains can be constructed based on the domestic expenditure share and the trade elasticity.