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Efficient barriers to trade: A sequential trade model with heterogeneous agents ☆

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ABSTRACT

This paper studies the choice of tariffs and other type of consumption taxes and subsidies in a flexible price version of the Prescott [Prescott, Edward C., 1975. Efficiency of the Natural Rate. Journal of Political Economy 83, 1229–1236.] hotels model. It is shown that a country with unstable demand may benefit from a tariff on imports. More surprisingly, the exporting country may also benefit from the tariff. In general, I consider the problem of a world planner who chooses country specific consumption taxes and subsidies. I show that buyers in countries that tend to consume relatively more in the high demand state should be taxed and buyers in countries that tend to consume relatively more in the low demand state should be subsidized.

1. Introduction

The predictability of demand is different across countries. Recently Stock and Watson (2003, Table 2) estimated the predictability of GDP for the G-7 countries. Their estimates imply that since 1984 the one-step ahead forecast RMSE for Japan was higher than the RMSE for the US by 90%. Aguiar and Gopinath (2007) found that emerging markets experience substantial volatility in trend growth and that the average standard deviation of change in output in emerging markets is about twice as that of developed markets. Here I study the implications of differences in predictability for the gains from trade question and the effect of barriers to trade.

The paper complements the analysis in Eden (2007). In this earlier paper I show that a country with a stable demand may suffer from trade with a country with unstable demand, and describe the trade patterns that may emerge. Here I focus on the choice of subsidies, taxes and tariffs. This leads to some surprising results. I show that a tariff, for example, may lead to a Pareto improvement over the free trade outcome.

I use a version of the Prescott (1975) hotels model. In Prescott's model, sellers of motel rooms set prices before they know how many buyers will arrive. Prescott assumes that cheaper rooms are sold first and therefore in equilibrium sellers face a tradeoff between price and the probability of making a sale.

In Prescott's example all motel rooms are the same and all buyers who arrive want a single room and are willing to pay up to the same reservation price. Dana (1998) has extended the rigid price version of the Prescott's model to the case of heterogeneous potential buyers who demand at most one unit and have different valuation and different probabilities of becoming active. He shows that firms in the Prescott model have incentives to offer advance-purchase discounts and in equilibrium advance purchase sales are made to low valuation customers. He concludes that because of price rigidity the equilibrium allocation may not be as good as the Walrasian outcome (first best) even when buyers have a demand for one unit only. Deneckere and Peck (2005) show that once we allow for heterogeneity, the allocation is not first best. But we can achieve the first best if we allow buyers to return for a second round of trading.

A flexible price version of the Prescott model is in Eden (1990, 2005) and Lucas and Woodford (1993). This approach assumes that buyers arrive sequentially, see all available offers and after buying at the cheapest available offer they consume and go elsewhere. I refer to this version of the Prescott model as the Uncertain and Sequential Trade (UST) model.

From a positive economics point of view it does not matter whether prices in the model are flexible or rigid. But for the question of efficiency, which is the focus of this paper, it does matter. I show that the UST outcome is efficient if the probability of becoming active does not depend on the buyer's type, even when buyers have different downward sloping demand functions. I now show by example that the UST allocation may not be efficient when the probability of becoming active depends on the buyer's type. In the example, countries benefit from barriers to trade.

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2. An example

I consider a single period economy with two goods (X and Y where lower case letters denote quantities) and two states of nature (1 and 2) that occur with equal probability. There are three types of agents. All types are risk neutral and get a large endowment of Y. Type 0 agents (sellers) can produce X at the per unit cost of λ units of Y, where in this example I assume: $\lambda=1$. Sellers derive utility only from Y and their utility function is: $u^0(x,y)=y$. Only sellers can produce X. The other two types are the potential buyers of X. Type 1 agents derive utility from both goods and their utility function is: $u^1(x,y)=U(x)+y$. Type 2 agents derive utility from X only in state 2. Their random utility function is: $u^2(x,y)=y$ in state 1 and $u^2(x,y)=V(x)+y$ in state 2. I assume that $U(x)=\alpha\ln(x)$ and $V(x)=\beta\ln(x)$, where $\alpha=20$ and $\beta=10$.

The number of buyers from each type is the same and is normalized to unity. I use $d(p)=\mathrm{argmax}U(x)-px=\alpha/p$ to denote the demand function of a type 1 agent at the price of p and $d^*(p)=\mathrm{argmax}V(x)-px=\beta/p$ to denote the demand of a type 2 agent in state 2. Type 1 buyers reside in country 1 (the home country) and type 2 buyers reside in country 2. There are sellers in both countries and the number of sellers in each country is known.

Production choices are made before the state is known.

2.1. Autarky

In country 1 there is no uncertainty about demand and therefore the standard Walrasian model can be applied. The price of X is $\lambda=1$ and the supply of X is $\alpha=20$. The buyer's surplus is: $20\ln(20)-20=39.915$.

In country 2 the good is sold only in state 2. In state 1 there is no demand and the output is wasted. The seller in country 2 chooses x to maximize $(1/2)px-x$. An interior solution to this problem requires: $p=2$. The price $p=2$ compensates the seller for the risk of not making a sale and at this price he is willing to produce any amount. Since in state 2 the demand at the price of 2 is 5, sellers will produce 5 units that will be sold and used only in state 2. Welfare is: $(1/2)10\ln(5)-5=3.047$.

2.2. Free trade

I now assume a fully integrated world. The cost of transporting goods across countries is small and will be treated as zero in most of the analysis. Trade is done on the internet in a sequential manner. Buyers who want to consume place orders. Those who get first on line buy at a low price. Those who go on line relatively “late” may have to pay a higher price for the good.

In state 1 only country 1 buyers want to consume and they will all be able to buy at the low price. In state 2 not all buyers will be able to buy at the low price and those who are “late” in placing their order will buy at the high price. Thus as in the autarkic case we have two prices but now the identity of those who buy at the low price (in state 2) is determined by a lottery that treats all active buyers symmetrically.

It is convenient to assume two hypothetical markets: The first market opens with probability 1 at the price of 1 and the second market opens with probability 1/2 at the price of 2. The supplies to the two markets are perfectly elastic and sellers satisfy the demand in markets that open. The minimum demand at the price of 1 is $d(1)=\alpha$ units. To satisfy the minimum demand sellers supply $x_1=d(1)=\alpha$ units to the first market.

In state 1, only type 1 buyers are active and they all buy in market 1. In state 2 both types are active. Since buyers are treated symmetrically, the average demand per buyer is: $A=(1/2)[d(1)+d^*(1)]=(1/2)(\alpha/1)+(1/2)(\beta/1)=(1/2)(\alpha+\beta)=15$ and $\Delta=x_1/A=2\alpha/(\alpha+\beta)=4/3$ buyers will be serviced in market 1. The fraction of buyers serviced in market 1 is: $\theta=\Delta/2=\alpha/(\alpha+\beta)=2/3$. The remaining $1-\theta=1/3$ buyers from each type will buy at the price 2. The demand in the second market is: $(1/3)(\alpha/2)+(1/3)(\beta/2)=(1/6)(\alpha+\beta)=5$. To satisfy the demand of all buyers who could not make a buy in the first market, sellers supply to the second market $x_2=5$ units.

Equilibrium is thus as a vector $(p_1, p_2, x_1, x_2, A, \Delta, \theta)$ such that:

$p_1=\lambda=1$ — the price in the first market;
$p_2=2\lambda=2$ — the price in the second market;
$x_1=d(p_1)=\alpha/p_1$ — first market clearing condition;
$A=(1/2)[d(p_1)+d^*(p_1)]$ — average demand in state 2 at the low price;
$\Delta=x_1/A$ — the number of buyers who buy at the low price in the high demand state;
$\theta=\Delta/2$ — the fraction of buyers who buy at the low price in the high demand state;
$x_2=(1-\theta)[d(p_2)+d^*(p_2)]=(1/6)(\alpha+\beta)$ — second market clearing condition.

This is equilibrium in the sense that at the equilibrium prices sellers cannot make profits and markets that open are cleared.

When transportation costs are literally zero, the identity of the sellers in each market is not determined. But if the buyer has to pay small transportation costs for shipping goods from the foreign country, he will prefer to buy from a local seller unless a foreign seller offers the good at a lower price. I therefore assume that only sellers from country 1 supply to the first market.[1]

In our numerical example, the quantities supplied to each market are the same as under autarky but now the identity of the buyers in each market is different and therefore the distribution of surpluses is different. The surplus for buyers in country 1 is: $(1/2)(20\ln(20)-20)+(1/2)\{(2/3)(20\ln(20)-20)+(1/3)(20\ln(10)-20)\}=37.604$. The surplus in country 2 is: $(1/2)\{(2/3)(10\ln(10)-10)+(1/3)(10\ln(5)-10)\}=5.358$. Thus, relative to autarky, country 2 gains from trade and country 1 looses from trade, but total surplus is the same: $37.604+5.358=42.962$.

2.3. Tariffs, export taxes and subsidies

Is it possible to improve on the free trade outcome? To answer this question I assume that there are governments in both countries that can affect prices. I limit the choice of policy instruments. The government in country 1 may choose a subsidy of $\sigma\geq 0$ per unit of the good bought by local buyers from local producers at the cheaper price of 1. It can also charge an export tax of $\eta\geq 0$ per unit. The government in country 2 may choose a tariff of $\tau^*\geq 0$ per unit, where $\tau^*+\eta\leq 1$.

The producer prices are 1 in the first market and 2 in the second market. Country 1 buyers pay $1-\sigma$ in the first market and 2 in the second market (the subsidy is given only if you buy from a local seller at the price of 1). Country 2 buyers pay $1+\tau^*+\eta\leq 2$ in the first market and 2 in the second market. Since country 1 buyers pay $1-\sigma$ per unit in the first market, sellers in country 2 cannot guarantee the making of a sale at a producer price of 1. Therefore when $\sigma>0$, only country 1 sellers supply to the first market. Because of small transportation costs, I assume that this is also the case when $\sigma=0$.

The clearing of the first market requires:

$$x_1=d(1-\sigma)=\frac{\alpha}{1-\sigma} \tag{1}$$

[1] When the buyer must pay ε units of Y per unit of X that is transported, there is no equilibrium in which sellers in country 2 supply to market 1. To see this, assume that sellers from country 2 sell in the first market at the producer price of 1 (otherwise, they make non zero profits). In this case, at the low demand state buyers pay $1+\varepsilon$ per unit and therefore sellers from country 1 can make profits by say selling at $1+\varepsilon/2$. The identity of the sellers in market 2 is less important to our analysis. In the presence of transportation costs, local sellers will satisfy the demand of local buyers who arrived late and could not make a buy in market 1. To see that this must be the case, note that if a seller sells to a foreign buyer at the price of 2 then a foreign seller can make profits by selling at the price of say, $2+\varepsilon/2$. In our numerical example, sellers in country 1 supply 20 units to market 1 and 10/3 units to market 2. Sellers in country 2 supply 5/3 units to market 2 (and nothing to market 1). In Eden (2007) transportation costs are explicit.