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When to Go Local, When to Go Edible: Trade, Technology and Food Security

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We develop a variation of the Grossman-Helpman "Protection for Sale" model, where organized groups, representing various sectors of the economy, influence government policy. In particular, this paper focuses on the rise of food prices and a greater level of influence of a food sector lobby, relative to other political lobbies- and general consumer welfare. Governments, when considering their objectives, must consider food security along with consumer welfare and the objectives of other special-interest groups. We find that, as government emphasizes domestic food security, lobbies representing the food sector gain influence at the expense of other, non-food lobbies and the general population. In this framework, technology plays an important role. Technology, by increasing the rate at which the economy expands, allows government to reap the rewards of special interest participation in policy formation while increasing national welfare.[1]

JEL F13, O33, Q16, Q17, Q18

Keywords: Trade, Technology, Protection-For-Sale

This paper develops a variation of Grossman and Helpman's (1994) "Protection for Sale" (PFS) model. We posit a political economy trade model where organized groups, representing various sectors in an economy, influence government policy at the expense of general consumer welfare. The variation to the PFS framework that we introduce results from recent trends in global commodity prices.

Price increases in global commodities provide evidence that supply and demand relationships among the world's nations may be experiencing a new era of increased competition

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for basic resources. With the rise of China and more recently India, relatively stable demand functions for commodities such as oil, coal, steel, cement, and agricultural products may have permanently increased. In this scenario forces against free trade could gather renewed strength, portending a more tumultuous and less anodyne period for the global economy.

In particular, relations among trading partners may come under pressure as individual nations turn inward and place less emphasis on neighbors and the global economy. This change in behavior could have a significant impact on overall levels of, and the rate of increase in, global trade. For example, throughout history the dislocation in world trade volume brought about by increased world food prices has been mitigated by technological innovations both within and outside the food sector. Up to now, increases in food production, as a result of technology, have more than kept up with world population growth.[2] In addition, the serendipitous nature of innovation has meant that scientific discoveries, while fundamentally random in nature, result in continuous increases in productive capacity regardless of factor supply.[3]

This paper focuses on the rise of food prices and a greater level of influence of a food sector lobby relative to other political lobbies and general consumer welfare. When world food prices increase, national welfare is increasingly seen as dependent upon the securing of an adequate domestic food supply, either through reliable foreign sources, or increases in domestic production. New technology spurred on by innovation in the food sector helps to mitigate the

[2] As a result, over time, world food resources have increased at a rate such that, in the unforgettable words of Thomas Malthus, life has not been "nasty, brutish and short," world conflicts and plagues notwithstanding.

[3] James Burke, a British historian, in one episode of his BBC television program, "Connections," describes a chain of technological innovations that begins with the invention of the pike which eventually leads to the development of the Saturn V rocket and the moon landing. Or in his own inimitable style, "The introduction of the pike, a 14th century pointed weapon, led to the development of an infantry and subsequently to the landing on the moon. The infantry need food. Food spoiled. Bottles were sterilized. The British tried cans. Canned food spoiled. Gas could be stored in cans or thermos flasks, a device popular with polar explorers, brides and gas was 'hot-stuff'. It propelled rockets! - because a pike was invented."

overall effects of these price shocks. This result is produced both by increasing production of food and by incentives for more innovation due to higher food prices. Nevertheless, as government emphasizes domestic food security, lobbies representing the food sector gain influence at the expense of other, non-food lobbies and the general population.

This paper is organized as follows. Section I provides a brief literature review of the PFS methodology. Section II develops the trade model. Section III discusses implications of the model. Section IV concludes.

I. Literature Review

As conceived by Grossman and Helpman (1994), the PFS model predicts how trade and trade policy will be affected by organized lobbies representing various interest groups. When setting trade policy, the government considers political contributions from these interest groups. Both the specific interest groups' and overall consumer welfare are in the government's welfare function. The more organized the interest group, the greater the influence it wields at the expense of general welfare. Since the model was first posited, aspects of PFS have raised concerns about the theoretical results. In general, however, the framework has stood the test of time and much empirical work has lent support to the basic results.

One of the early empirical papers to use the PFS framework, Goldberg and Maggi (1999), confirms the overall results of the model using data on U.S. import barriers. A later work by McCalman (2004) on trade barriers using data on Australia, also verifies the predictions of the PFS model. More recently, a survey of innovations on the original PFS by Imai, et. al., (2008) indicates that the model remains robust to considerable variation in terms of model specification and empirical results. These variations include firm size, foreign and domestic lobbies, lobbies

at different stages of production, organized labor and labor mobility, and quotas as outcome variables versus tariffs posited in the original model. Bombardini (2004) finds that firm size plays a role in level at which firms participate in lobbying activities. Mitra, et. al., (2002) using data on Turkey and comparing a small open economy under differing political regimes, find that the weight the government places on general welfare is higher under democracy. Facchini et. al., (2006), using non-tariff barriers rather than the original tariff specification, find the PFS model is confirmed using data on quotas. They find that while tariffs may allow governments to fully capture any rents derived from protection, quotas also allow substantial rent-capturing. This indicates that the model is robust to non-tariff barriers as well. These extensions to PFS indicate both the soundness of the basic model structure, and the value of additional explanatory constructs.

Our variation of the original PFS model's lobbying influence is a response to an external shock: price increases in global food markets. Higher food prices, which occurred globally in 2008, jeopardize a country's level of food security—the ability of all people at all times to access affordable food (Naylor et al., 2007). For the billion people in the world that live on less than one dollar per day, higher food prices make their lives even more difficult. Already, as Banerjee and Duflo (2007) explain, many of the poorest people in the world consume fewer calories over time, are frequently sick or weak and have vision problems, which may result from poor nutrition and a lack of calories.

Decreasing the number of people who experience food insecurity requires a country's policy focus. Even though poor people who inhabit rural areas are less likely to challenge the legitimacy of their government, it is increasingly clear that the public sector must address the perceived food and nutritional needs of its citizens (Pinstrup-Andersen and Herforth, 2008).

Bhattacharya et al., (2002) find in the U.S. that the correlation between food insecurity and poverty varies depending upon age group. However, the correlation in the working-age group (18 – 64) is strong. In our model, depending on the government's focus on growth, greater emphasis may be placed on the segment of the population that contributes more to potential GDP growth.

Increasing food insecurity due to rising food prices may have trade effects in terms of trade agreements. Riezman (1999) indicates that bilateral trade agreements may facilitate or hinder free trade depending upon the size of trading blocs. However, increasing world food prices may preclude bilateral trade agreements if national food security considerations override relations with trade partners. This could make free trade more or less likely depending upon a country's size and basic food needs.

Several criticisms, which our model addresses, have been made concerning the theoretical underpinnings of the PFS framework. One criticism is to question whether lobbies "buy" protection modeled in a menu auction format or whether some other type of political influence is "purchased," such as access to politicians or government officials. Even more fundamental, campaign contributions may be relatively stable as a percentage of GDP in countries such as the U.S., where private donors, the main source of such contributions, rarely give the maximum amount. By itself, then, the leverage by such donors over politicians setting government policy for rent-seeking, may be minimal (Ansolabehere, et. al., 2003). Our model, by explicitly separating special interest into two groups along with overall consumer welfare, can be thought as much a question of gauging national political-economic priorities as it is of specific sectors buying protection. As a result, determining the weight the government places

on the welfare of various groups should help reveal why specific measures (tariffs, quotas etc.) are used for trade policy.

Another concern focuses on the continuum of equilibria that are derived from menu auction models. This criticism is based upon the assumption that participants in the auction truthfully reveal their preferences via their respective bids. Intuitively, such a restriction is not required for our model. Any stochastic tremble related to the mechanism by which the government chooses which sectors to favor is minimized by the overarching concern associated with national food security. Whether an individual lobbyist pays the proper cost for protection (gets in the room so-to-speak) is secondary to the fact he is representing a given sector. If that sector is perceived by the government to be a priority, a sector representative may get a "discount" on the entrance fee to the room. However, Eicher and Osang (2002) counter both criticisms, finding that higher contributions are associated with higher tariffs, and at a level that is more reasonable than Goldberg and Maggi's (26% vs. 88% owning sector specific inputs).

Finally, the main prediction of the PFS model has been criticized as "unintuitive." The model predicts a positive relationship between the level of protection and import penetration rather than between protection and change in import penetration. The idea is that an increase in import penetration in a given sector can be linked to a loss, over time, in comparative advantage of the domestic competitor. However, in our model, protection could be positively related to either the level or change in import penetration because national food security, not comparative advantage, is a key motivator.

II. The PFS Model with Food Security

In this section we add a food security equation to the PFS framework. In our model, two competing lobbying groups exist. One lobbying group represents the sector affected by an

external shock of higher food prices, and the other group represents lobbying for all other sectors in the economy. The government represents the competing interests of each lobbying group, as well as consumers.

Goldberg and Maggi (1999) simplify the PFS model. We adopt a similar approach. In particular, a continuum of individuals exists, with population size of one. Individuals have identical preferences:

$$U = c_0 + \sum_{i=1}^{n} u_i + (c_i) \tag{1}$$

where c_0 denotes consumption of the numeraire good, c_i is consumption of good i, and u_i is an increasing concave function. The demand for good i is given as $d_i(p_i)$. Demand is the inverse of $u'_i(\cdot)$. An individual's indirect utility with income y_i is:

$$V_i = y_i + \sum_{i=1}^{n} s_i (p_i) \tag{2}$$

where $s(p) = u(d(p)) - pd(p)$.

Labor input produces the numeraire good one-to-one, so that wage equals one. Every other good is produced by labor and a sector-specific input. In this framework, there are $n + 1$ inputs. The returns to factor i depend on p_i: $\pi_i(p_i)$. Hotelling's lemma implies $\pi'_i(p_i) = y_i(p_i)$, where $y_i(p_i)$ is the supply of good i.

Government implements an export subsidy if the good is exported and an import tariff if the good is imported. The policy introduces a wedge between local and (exogenous) international price. Lump-sum redistribution of tariff revenue occurs.

As in the Goldberg and Maggi (1999) framework, the aggregate welfare function, which is derived by summing indirect utilities over all individuals, is the sum of labor income, tariff revenue, and returns to specific factors:

$$W = 1 + \sum_{i=1}^{n} \pi_i + \sum_{i=1}^{n} t_i^s M_i + \sum_{i=1}^{n} s_i \tag{3}$$

where $M_i = d_i - y_i$.

Next we develop political structure. Suppose with a subset of sectors $L_1 \subset \{1, 2, .. m\}$ owners of specific factors form lobbies concerned with food production, specifically, edible crops and livestock. Each individual owns his own unit of labor and one specific factor. Let T_j denote technology used in {1, 2,…m} sectors and α_j denote the fraction of people who own specific factor j. To achieve food security, a country must consider domestic production (y_j) and nutritional needs (h_j). Food production available for export is given as $z_j = y_j - h_j$. Summing indirect utilities over all individuals who belong to lobby j and rearranging, the food security function is given as:

$$F_j = \left(\frac{1}{T_j}\right)[\pi_j + \alpha_j \left(1 + \sum_{j=1}^{m} t_j^s \, NI_j + \sum_{j=1}^{m} s_j\right)] \tag{4}$$

where net imports (NI_j) equals $M_j - z_j$ and M_j denotes imports.

The F function is our key modification to the Grossman and Helpman (1994) model. While the specific motivating factor for this modification is the current high level of world food

commodity prices and concomitant food security considerations, we could accommodate other global shocks as easily.[4]

The nutritional needs variable, h_j, could be measured in a number of ways. One possibility would be to use a measure of caloric intake as compared to a nutritional minimum daily intake requirement standard. The problem with such a measure is that it would not adjust for cross-national physiological and demographic differences when comparing populations and determining national food requirements. A better way to think of national nutritional needs would be calorie elasticities (Logan 2005). Calorie elasticity allows for a unit-free measure that quantifies food demand as a function of income and/or expenditures. Comparisons of countries with different average income levels and thus underlying tastes and preferences, would be possible. In addition, sensitivity to changes in world food prices, as reflected in different calorie elasticities, yields a variable with solid microeconomic foundations.

The assumption concerning the export variable, $z_j = y_j - h_j$, simplifies the model by not including food storage. However, later iterations could include some fraction of excess food production stored for future consumption and thus lowering future food insecurity considerations. Net imports, NI_j, was chosen for model clarity, rather than the usual net exports. As a result, the FOC with respect to $F(\cdot)$ and NI has the expected sign (i.e., $\partial F'(\cdot)/\partial NI' > 0$). Intuitively one would expect that as imports increase food security would decrease. In terms of our model this would be indicated by an increase in the weight the government puts on food security. Put another way, in the model below, as NI increases, γ increases. The FOC with respect to $F(\cdot)$ and Z has the expected sign ($\partial F'(\cdot)/\partial Z' < 0$). The more food that is available for

[4] Global warming and environmental and energy issues are the most obvious candidates. However, less immediate concerns but potentially long-term issues such as links between national welfare and technological lead or openness to trade could also be addressed by the model.

export, the lower the level of food insecurity. Finally, with respect to $F(\cdot)$ and T_i, $\partial F'(\cdot)/\partial T_i' < 0$, meaning that, as technology improves, food insecurity declines.

The technology variable, T_j, in its current form, does not take into account endogenous affects of higher food prices on R&D expenditures in the food sector. However, predictions of technology adoption in the food and agriculture industry are problematic given available technology, cost of inputs, tastes, and incomes along with nutritional needs (Edelman and Fewell 1985). In terms of price supports and tariffs, changes in government policy through commodity price supports may result in faster adoption of new technology, thereby increasing production and diminishing food insecurity. Still, there is evidence that any gains from faster adoption are offset by price distortions and resource misallocation, further attenuating endogeneity issues. (Miller and Tolley 1989). Theoretically, however, both the level of expenditure and source of innovation are not necessarily related to the amount of innovation available and ultimately utilized in a given industry. It is precisely the serendipitous nature of ideas and their practical applications that make technology such a powerful engine for economic growth. Innovation from any sector, and any country, could impact production in any other sector of an economy in unpredictable yet beneficial ways.

With the F function, technological developments, both domestic and foreign, could increase domestic production and/or decrease the price of food. This would influence a country's demand for food and overall food security. In particular, increases in the technology available to the food sector, by increasing domestic production or lowering domestic food production costs, would reduce the weight the government would place on special interests in that sector. This could have the result of increasing the returns to both the owners of the food sector and the share to national welfare without the distortionary consequences of increased protection. Finally,

significantly higher world food prices could have the effect of overcoming Baumol's disease, via increased use of technology.[5] The longer world commodity prices remain high, or increase faster than recent historical rates, the greater the push for R&D investment (Nordhaus 2006).

Next, we describe the aggregate welfare of the category of lobbies $L_2 \subset \{1, 2, .. m\}$ that are concerned with non-food-production sectors. Let α_k denote the fraction of people who own specific factor k. Assume each individual owns a unit of labor and at most one factor of production. Summing indirect utilities of individuals who belong to lobby k and rearranging, we obtain lobby k's well being:

$$W_k = \pi_k + \alpha_k \left(1 + \sum_{k=m+1}^{n} t_k^s M_k + \sum_{k=m+1}^{n} s_k \right) \tag{5}$$

where the objective is $W_k - C_k$. The variable C_k denotes contributions paid to government.

The government's objective is a combination of welfare and contributions. However, in our model, government is also concerned with food security:

$$U^G = \beta W + \gamma \sum_{j \in L_1}^{n} C_i + (1 - \gamma - \beta) \sum_{i \in L_2}^{n} C_i \tag{6}$$

where $\beta \in [0, 1]$ captures the weight of welfare, $\gamma \in [0, 1]$ captures the weight of food security in the government's objective, and $(1 - \gamma - \beta) \in [0, 1]$ captures the weight for non-food sectors.

We assume a Nash bargaining solution, where trade policies are selected to maximize the joint surplus of all parties:

[5] Baumol's disease here is defined as the differing productivity growth between various sectors in an economy Technologically stagnant sectors show higher than average costs and prices and take a rising share of national (7) while exhibiting slower average productivity growth.

$$\Omega = \beta W + \gamma \sum_{i \in L_1}^{n} F_i + (1 - \gamma - \beta) \sum_{i \in L_2}^{n} W_i$$

Equilibrium conditions depend on the decision-making process of government and particular parameter values. A priori, the model does not provide predictions concerning specific contributions from the parties involved.

To find equilibrium trade policies, we rewrite Ω as:

$$\Omega = \beta + \gamma \alpha_{L1} \left(\frac{1}{T_j}\right) + (1 - \gamma - \beta)\alpha_{L2} \tag{8}$$

$$+ \sum_{j=1}^{m} [\beta + \gamma(\frac{1}{T_j})I_i]\pi_j + \sum_{k=1}^{n} [\beta + (1 - \gamma - \beta)K_i]\pi_k + \beta \sum_{i=1}^{n} (t_i^s M_i + s_i)$$

$$+ \gamma \alpha_{L1} \sum_{j=1}^{m} \left(\frac{1}{T_j}\right)(t_j^s N I_i + s_j) + (1 - \gamma - \beta)\alpha_{L2} \sum_{k=1}^{n} (t_k^s M_k + s_k)$$

where I_i is a dummy variable that takes a value of one if the food industry is organized and zero if not, while K_i is a dummy variable that takes a value of one if all other industries are organized and zero if not. In addition α_{L1} and α_{L2} represent the share of the population owning factors in the Food industry and Other industries, respectively.

The first-order condition for tariff t_i^s is:

$$\frac{\partial \Omega}{\partial t^s_i} = (\beta + \omega I_i + \varphi K_i)X_i + (\beta + \omega \alpha_{L1} + \varphi \alpha_{L2})(t_i^s M_i' - X_i) - (\omega \alpha_{L1})(t_i^s Z_i' + Z_i) = 0 \tag{9}$$

where $\omega = \gamma \tau_i$, $\tau_i = \frac{1}{T_i}$ and $\varphi = 1 - \gamma - \beta$. This yields

(10)

$$t_i^s = \frac{\left[\left[(I_j - \alpha_{L1})\omega + (K_i - \alpha_{L2})\varphi\right]\frac{X_i}{-M_i'} + \omega\alpha_{L1}\left(\frac{Z_i}{-M_i'}\right)\right]}{\beta + \omega\alpha_{L1} + \varphi\alpha_{L2} + \omega\alpha_{L1}\left(\frac{Zi}{M_i'}\right)}$$

The same equation can be expressed in terms of relevant elasticities:

$$\frac{t_i}{1 + t_i} = \frac{\left[\left[(I_i - \alpha_{L1})\left(\frac{\gamma}{T_i}\right) + (K_i - \alpha_{L2})(1 - \gamma - \beta)\right]\left(\frac{q_i}{e_i^I}\right) + \left(\frac{\gamma}{T_i}\right)\alpha_{L1}\left(\frac{\Gamma_i}{e_i^E}\right)\right]}{\left[\beta + \left(\frac{\gamma}{T_i}\right)\alpha_{L1} + (1 - \gamma - \beta)\alpha_{L2} + \left(\frac{\gamma}{T_i}\right)\alpha_{L1}\left(\frac{e_i^c}{e_i^F}\right)\Gamma_i\right]} \qquad (11)$$

where $q_i \equiv X_i/M_i$, import penetration ratio; $\Gamma_i \equiv Z_i/M_i$, excess food production to import ratio; $e_i^I \equiv$ import demand elasticity; $e_i^E \equiv$ excess food import demand elasticity; $e_i^c \equiv$ caloric elasticity; and $e_i^F \equiv$ food import demand elasticity.

III. Imports, Technology and Food Security

The final equation indicating the optimum tariff level, at first glance, yields results that accord with intuition. As production increases in any sector, those owning specific factors in that sector benefit from increased domestic prices. This increase in domestic prices, however, could be mitigated by higher import demand elasticity, which would cause average tariff levels to decrease. Higher import demand elasticity could indicate either access to more foreign food suppliers, or greater price sensitivity resulting in larger deadweight losses from domestic price distortions (Goldberg and Maggi 1999). An additional factor comes into effect when the food sector is considered, which includes the effects of technology along with excess domestic food production.

Excess food production is potentially different from increases in production elsewhere in the economy. Since we do not consider food storage in this version of our model, food

producers would have an incentive to sell as much of their excess production on the world market as possible. Higher tariffs would allow for market segmentation, although domestic producers could then be charged with dumping by foreign competitors in other countries. However, as technology available to the food sector increases, average tariff levels in that sector decline, mitigated by Γ_i, the ratio of excess food production to imports. As world food prices increase, and a country with a comparative advantage in food production increases this advantage via technology, food producers will move up their supply curves and the overall industry supply curve will shift up and to the right. If the comparative advantage is extreme and/or increases in excess food production large as a result of technology, tariffs could even become negative, i.e., an export tax.[6]

Changes in tariffs in the Food sector are also sensitive to how dependent a country is on food imports as indicated by e_i^E, excess food import demand elasticity. As a country becomes more dependent on foreign sources of food, the government may institute policies that promote domestic food production. Higher tariffs on food imports could be one of these policies both decreasing demand for imports and helping domestic food producers. Recent work using a PFS model for the food-processing industry in the U.S. and import elasticities yield plausible results for weights put on general welfare (Lopez and Matschke, 2006). A case could be made for the opposite result, however. As dependence upon foreign food sources increases, lobbyists for foreign food producers, via lobbying efforts, could advocate for lower tariffs (Gawande, et. al., 2004).

[6] Argentina provides an example of this possibility. Argentinean food producers enjoy relatively low production costs and are extremely competitive on the world market. In addition, the Argentine government badly needs sources of revenue. Recently there has been major social unrest in the countryside as farmers and livestock producers protest against the government's attempts to exploit this cost advantage and raise already high export taxes (*The Economist*, 2008).

Technology could play an additional role in setting trade policy given its importance in food processing. A country which produces relatively less of its own basic food, but has a developed food-processing sector, may be less exposed to wide swings in world food prices. The more organized the food-processing sector is as evidenced by the amount of technology used, the greater the influence on trade policy and access to foreign suppliers of basic foodstuffs. This is a case where the "downstream" food processing industry would wield influence over domestic "upstream" food producers (Gawande and Krishna, 2005). This could yield the counterintuitive result of lower-than-expected average tariff levels in the food sector despite relatively large exposure to higher world food prices.[7]

An interesting term in the final equation is the ratio of e_i^C, caloric elasticity, to e_i^F, food import demand elasticity. Calorie elasticity allows for comparison of nutritional needs across countries with different tastes, preferences, and most germane to our model, income levels. Countries with higher average per capita incomes would be less sensitive to changes in food prices relative to lower income countries. Lower income countries should then, ceteris paribus, have greater nutritional needs and a commensurately higher e_i^C. Food import elasticity is a measure of the overall dependence of a country on foreign sources of food and the number and reliability of sources. A country with higher per capita food imports and/or relatively few foreign food suppliers would have a lower e_i^F. Thus, a higher-income country dependent on just a few foreign suppliers of food would have few incentives to raise tariffs on food as indicated by a higher ratio of the two elasticities, $(\frac{e_i^C}{e_i^F})$. The government would place greater weight on general welfare than specific interests in the food sector. Higher income-per-capita would be a

[7] Such a result is analogous to how countries with few oil resources can diminish their exposure to swings in world oil prices through large, technically advanced refining capacity.

proxy for a better-represented consumer. Contrast this result with a lower-income country, an under-represented consumer, and a well organized food sector. A lower $\frac{e_i^C}{e_i^F}$ would result with commensurately higher average tariffs in the food sector indicating the relative weight the government places on the two groups.

In general, the inclusion of different unit-free elasticities in the final result allows for a cross-country comparison of food requirements, technology, and openness to trade, with respect to national security. The usual difficulties involving countries with different average income levels and concomitant underlying tastes and preferences, political systems, and relative resource endowments, would be diminished.

IV. Conclusion

This paper considers the domestic response to rising world food prices. However, our model could also accommodate external shocks such as global climate change and the resulting response of environmental lobbies, or a permanent rise in energy costs and the response of energy lobbies. A further extension would be to make endogenous the choice of competing lobbies/sectors as a function of changing external world prices/conditions. We add technology to the model to acknowledge the role of innovation in economic growth. Technology, by increasing the rate at which the economy expands, allows government to reap the rewards of special interest participation in policy formation, while still increasing national welfare.

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