Trade, Tastes and Nutrition in India*

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Abstract

This paper introduces habit formation into an otherwise standard model of international trade. Household tastes evolve over time to favor foods consumed as a child. In autarky, households prefer foodstuffs that are locally abundant and thus relatively inexpensive. The opening of trade causes a rise in the price of these preferred goods. Neglecting the correlation between tastes and agro-climatic endowments systematically overstates the short-run nutritional gains from agricultural trade liberalization, as consumers are less willing to substitute into cheaper imports than they would be without habit formation. I examine the predictions of this model of trade with habit formation using household survey data from India, where internal agricultural trade remains highly restricted. I identify tastes with the unexplained regional variation in household demand for agricultural products and find that regional tastes favor food crops that are well-suited to local agro-climatic conditions. I predict that the liberalization of internal agriculture trade in India will generate short-run caloric losses unless income gains from trade are relatively large, and that there would be no such losses if tastes were identical across the country. I also examine the consumption patterns of inter-state migrants, and find that they consume fewer calories for a given level of food spending than otherwise similar consumers. This effect only disappears two generations after migration, as tastes adjust to local prices. These findings, which reflect the higher prices of preferred origin-state goods in the migrant's destination state, further corroborate the assumptions of my model.

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1 Introduction

The impacts of agricultural trade on the developing world are currently of great interest to economists, policymakers and the media alike. In the last few years, surging demand from China and elsewhere has pushed up the traded prices of many food crops, with detrimental effects on consumers in many developing countries. At the same time, the Doha Round of global trade negotiations aims to both substantially liberalize agricultural trade and bring the full benefits of globalization to the developing world. In this paper, I explore a new channel which provides a more complete understanding of the nutritional impacts of agricultural trade on the poor through examining the neglected role of tastes in international trade.

Standard international trade theory assumes that preferences are identical across regions and independent of resource endowments. This paper explores the consequences of relaxing this assumption in a very natural way. I incorporate habit formation into an overlapping generations model of trade and demonstrate that this leads to regional food tastes that favor crops relatively well-suited to local agro-climatic endowments. This correlation between tastes and endowments systematically reduces the short-run nutritional gains from trade compared to models without habit formation. Using household consumption data from regions within India, I provide two sets of empirical evidence that support the model's predictions and I quantify the extent to which regional taste differences will alter the nutritional impact of trade if India were to liberalize its highly restricted internal agricultural markets.

I define tastes for food g as the component of the food budget share spent on g, $bshare_g$, that cannot be explained by the vector of prices, P, or total food expenditure, $food$; $bshare_g = tastes_g + h_g(P, food)$. Based on extensive evidence in the nutrition literature, I assume that adult tastes favor the foods consumed as a child and term this process habit formation. The first generation of adults, who value only calories and dietary variety, purchase large quantities of a region's relatively abundant (comparative advantage) agricultural goods, as these foods are relatively cheap under autarky. Their children are fed these locally abundant foods, and develop particular tastes for them in adulthood. Over many generations, a strong home bias in household consumption emerges endogenously through habit formation. The same affinities for local foods emerge if recipes and preparation techniques improve faster for commonly consumed foods. Therefore, households choose to purchase the familiar local foods that they know how to transform into high-quality meals.

At the time of trade liberalization, the preferred foods systematically rise in price in each region as these foods were relatively inexpensive in autarky, and trade equalizes prices across regions. Consumers spend a large portion of their incomes on these favored foods and are reluctant to substitute out of them and into less familiar imports, which can spell short-run nutritional losses unless trade brings substantial income gains.[1] Only decades after trade liberalization can consumers realize the

[1]The model is relevant to consumers who may be malnourished but are not starving. At very low levels of caloric intake, a starving household will presumably maximize caloric intake. However, this is not the situation for most of rural India. The 2,400 calories per day recommended for rural Indian life can be purchased for around forty percent of per-capita daily food expenditure, yet mean per-capita caloric consumption is below 2,100 calories per day (2004/5 NSS data).

full caloric gains from trade, as food tastes gradually adapt to favor the foods that trade has made affordable, eventually resulting in even larger caloric gains than a model without habit formation would predict.

The economy-wide production gains from trade also shrink with habit formation because habits bring autarky prices closer together by bidding up the price of each region's relatively cheap comparative advantage foods.[2] As in a standard trade model, these reduced production gains will be distributed unevenly, with some factor owners gaining and some losing from trade. If labor is mobile and combined with crop-specific land, landless laborers may well suffer caloric losses upon trade liberalization. This is because labor's nominal wage gains will be strictly smaller than the price rises in the locally abundant foods and this group spends a relatively large portion of their budget on these local staples.

The recent surge in world food prices provides supportive evidence of this link between tastes, trade and nutrition. In March 2006, Argentina banned all exports of beef for 180 days to lower the domestic price for beef-loving Argentinians.[3] In 2008, Vietnam, Cambodia and Egypt banned rice exports; Russia, Kazakhstan and Ukraine banned wheat exports; while Zambia and Malawi banned maize exports. In all of these cases, important agricultural exports are the preferred calorie sources of low income households. Trade-induced price rises increased hunger among the poor, and governments tried to reverse these effects by restricting trade and bringing prices of favored foods back towards autarky levels, rather than transferring income and allowing the poor to substitute into relatively cheap foods as a standard trade model would recommend.

I test my theory more directly by using detailed household survey data from India. India contains many agro-climatic zones and extremely varied diets, ranging from the temperate north, where wheat and milk products predominate, to the tropical south where rice, coconuts and seafood are favored. At the same time, India maintains extensive internal food-trade barriers in addition to its poor transport infrastructure. These barriers include tariffs at state borders, numerous licensing requirements for traders and physical movement restrictions. Despite much publicized economic reforms in the early 1990's, agriculture continues to be subject to enormous state intervention in the name of food self-sufficiency and agricultural markets are not integrated. Accordingly, my empirical work treats Indian regions like many small partially closed economies rather than one integrated economy. India provides an excellent opportunity to test the autarky predictions of my model, and to explore the potential impacts of agricultural trade liberalization between countries, such as the reforms proposed in the Doha round. However, by focusing on India, I am able to draw on the exhaustive consumption surveys collected in an identical manner over many regions where tastes vary widely.

In order to investigate the relationship between tastes and local resource endowments across India, my most difficult empirical task is estimating regional tastes. Tastes, defined as above with the further restriction that the $h_g(P, food)$ function is common across India, can be identified by

[2] Habit formation has allowed each region to exploit some of the gains from specialization many generations prior to liberalization, thereby reducing the production gains possible at the moment of trade liberalization.

[3] Argentinians consume more beef per person than any other nationality.

regressing household demand for agricultural products on a set of regional dummies and a sufficiently flexible set of common price and expenditure terms.[4] I use the Almost Ideal Demand System to guide the functional form of $h_g(P, food)$, and the regional component of the unexplained variation in budget shares spent on each food then provides my main taste measure. Under the null hypothesis of no regional taste differences, the coefficients on the regional dummies should be zero. However, I find highly significant coefficients as the large variation in budget allocations across India cannot be explained by regional differences in prices or other observables.

It is impossible to observe the impacts of trade liberalization in societies both with and without habit formation. Therefore, I use rural household survey data from 77 agro-climatic regions within India to provide empirical evidence for the mechanisms in my model that reduce the caloric gains from trade on the consumption side. In the first stage, I show that regions have stronger tastes for the foods that their agro-climatic endowments are relatively well-suited to producing, and these foods are inexpensive compared to other regions. To highlight the role of habit formation, I confirm that the ordering of tastes within a region responds to relative price changes between 1987 and 2005.[5] Therefore, more favored goods will be expected to rise in price if India were to liberalize internal trade as regional prices converge to a uniform price across the country. In the second stage, I verify that these expected price rises in more favored foods will negatively impact nutrition by showing that between 1987 and 2005, caloric intake declined more in regions where (non trade-induced) price rises were more concentrated in locally favored foods, controlling for changes in food expenditure.[6]

I confirm these results using a second approach. Inter-state migrants mimic small economies opening to trade, since upon migration they bring their original endowment and preferences but face a new set of prices. I show that inter-state migrants in India do carry their food tastes with them, consuming food bundles that are less similar to those consumed in their destination state and more similar to those consumed in their origin state. Migrant households consume fewer calories for a given level of food expenditure, because they continue to buy favored products from their state of origin that are now relatively expensive. This effect dissipates with the time spent in the new state, disappearing entirely about two generations after migration. These results even hold when I restrict attention to households in which only the wife of the household head moved for marriage, and so unobserved differences between migrants and non-migrants are less of a concern. Households in which the wife moved inter-state, rather than intra-state, spend more to purchase each calorie of food. Finally, mirroring the results from temporal price variation within regions, I find that for the 490 observed migration routes, the caloric intake from a given level of food expenditure declines more where relative price rises are more concentrated in migrants' preferred origin-state foods.

With these two sets of evidence in place, I proceed to calculate the quantitative importance of habit formation in muting the caloric gains from trade. Using the more conservative estimates

[4] I also include many demographic and seasonal controls and other household characteristics.

[5] The theory suggests that taste rankings should respond to the previous generation's relative prices, but unfortunately no price data are available for the time period when the 1987-88 adults were still children.

[6] Controlling for food expenditure allows me to perform the consumption side of the no habit formation counterfactual by asking how large are the food expenditure gains that would be required in order to fully compensate for the caloric decline that comes from tastes being correlated with the price changes at the time of trade liberalization.

from temporal price changes within regions, I predict the magnitude of the caloric reduction coming through tastes being correlated with price changes if India were to liberalize its internal agricultural trade (when food prices equalize across India).[7] Trade will have to generate income gains of 3.3 percent for India simply to maintain its pre-liberalization level of caloric intake, while no such gains would be necessary if tastes were identical across India. Poorer regions, which consume larger shares of the local staple foods predicted to rise in price, will require even larger income gains to avert absolute caloric declines.

Household incomes are likely to increase with liberalization through increased specialization in food production.[8] However, the 3.3 percent increase required to avoid caloric losses is larger than existing estimates of the static nominal income gains for typical rural households from other agricultural trade liberalization scenarios. The closest comparison is China, where reductions in caloric intake over the reform period (Du, Lu, Zhai, and Popkin 2006) were accompanied by the dismantling of extensive barriers to internal agricultural trade (Huang and Rozelle 2006).

In few countries is malnutrition a more important issue than in India, which has a higher prevalence of undernutrition than most of Sub-Saharan Africa (Deaton and Dreze 2008). My nutrition metric is caloric intake.[9] Low caloric intake directly concerns policymakers, especially with respect to populations on the edge of malnourishment. Food consumption itself has regularly been used as a measure of poverty. For example, in countries as diverse as the USA and India, poverty lines were initially derived from the amount of money required to meet basic caloric needs (Deaton 1997).

There are several reasons why economists should be concerned about poor nutrition. Sen (1999) has argued that improving the health of the poor and increasing their capabilities should be a goal of development in itself. Low caloric intake directly reduces productivity by reducing energy levels, health capital and the ability of the immune system to fight off infectious disease. These effects exert externalities on other members of society. Malnourished populations allow contagious diseases to spread more readily, and Fogel (1994) has argued that improved nutrition and its synergies with technological advance can account for much of the economic growth seen in the West since the Industrial Revolution.

Policymakers often cite explicitly paternalistic concerns. Many of the gains from proper nutrition come through good health later in life, which uninformed consumers may undervalue. Recent work highlights the substantial scarring effects of nutritional shortfalls at young ages on productivity, earnings and health in adulthood (Barker 1992, Case, Fertig, and Paxson 2005, Case and Paxson 2006). Accordingly, even the short-term nutritional declines that can occur during an episode of trade liberalization are of serious concern, because an entire generation malnourished as

[7] For India to achieve full market integration, it is likely that substantial transportation improvements will need to accompany the removal of legal barriers to trade.

[8] For the poor in India these gains will primarily come through nominal wage gains or falls in the average food price, since most rural households derive the majority of their income from labor. Even for small landholders, household labor income will likely dwarf their implicit rental income. The major income gains from trade accrue to the large-scale owners of land suitable for cultivation of the comparative advantage good.

[9] Of course caloric intake is not the same as nutrition, with vitamins and proteins also being important nutritional inputs. This is beyond the scope of this paper, but a more complete analysis should take account of the full nutritional impact of trade.

children will continue to suffer irremediable consequences for the rest of their lives.

The model suggests some simple policies that can accompany trade liberalization to mitigate any negative caloric impacts on the most vulnerable consumers. Many countries, including India, already subsidize purchases of staple foods by the poor, and these programs can be used to maintain low prices for the preferred local goods in the short-run. Information programs can also help to encourage the adoption of the newly cheap calorie sources. Such strategies were used extensively during the Irish potato famine to increase the consumption of imported maize that many Irish initially refused to eat, as they neither liked nor knew how to prepare it (Woodham-Smith 1991).

In section 2, I provide a diagrammatic discussion of the theory, with the formal proofs relegated to appendix A. Section 3 explains how I test the empirical relevance of the theory, and introduces the data and my methodology for estimating regional taste differences. In section 4, I investigate variations in tastes, prices, endowments and caloric intake across 77 regions of India. Section 5 uses data on inter-state migrants within India to confirm the results of the regional analysis. Section 6 discusses India's internal trade restrictions and predicts the likely impact of internal trade liberalization on caloric intake. Finally, section 7 offers a conclusion of my findings and discusses the policy implications.

2 Theoretical Background

The theoretical analysis proceeds in three stages. First, I discuss habit formation with particular reference to food tastes, which over many generations leads to preferences[10] becoming positively related to resource endowments. In the second stage, I demonstrate that the initial aggregate caloric gains from trade liberalization are reduced because price rises systematically occur in more preferred goods. The general equilibrium model is presented for two goods, which clearly shows the theoretical intuition. The empirical work, however, looks at the household consumption of 52 goods. Therefore, in the third stage, I show that for many goods, household caloric intake declines with the magnitude of the correlation between tastes and price changes, holding food expenditure constant.

2.1 Understanding Habit Formation in Food Consumption

I start by setting up a simple overlapping generations model with habit formation. I then justify my assumptions about the form of the utility function by reviewing the literature on the development of food preferences.

Identical individuals in a small region of the world live for two periods, childhood and adulthood. In the second period, individuals obtain factors of production, spend their full income from these factors and have a single child. Adults in generation t choose their relative consumption of the only two goods in the economy: rice, r, and wheat, w. Both the child and the parent consume the chosen consumption bundle, and form a single household.[11]

I model household demand in the following way. The budget share spent on rice is a function

[10] I use the term tastes and preferences interchangeably.

[11] Specifically, parents gain equal utility from their child's consumption as they do from their own consumption, and share the chosen bundle.

$h_r(.)$ of relative prices, p_r/p_w, total (food) expenditure, $food$, and a rice taste shifter, $tastes_r$:

$$bshare_{rt} = tastes_{rt} + h_r(\frac{p_{rt}}{p_{wt}}, food_t).$$

For the empirical identification of tastes, I assume that the function $h_r(.)$ is common across all regions. The budget share spent on rice increases with the tastes for rice and decreases with the relative price of rice. The main results from my paper carry through with a more general demand specification as long as stronger tastes for rice increase the relative consumption of rice at any price.

In the next period the child grows up and the bundle that he or she consumed as a child influences his or her adult preferences.[12] I will call this habit formation, with an adult developing tastes for the foods of which he or she consumed relatively more as a child.[13] Specifically,

$$tastes_{rt} = g(\frac{r_{t-1}}{w_{t-1}}), \text{ with } \frac{\partial tastes_{rt}}{\partial(\frac{r_{t-1}}{w_{t-1}})} > 0.$$

Therefore, the adult's utility function depends on both past and present consumption. These kinds of preferences have been studied extensively in the habit formation literature starting with Stone (1956) and Pollak (1970), and more recently by Becker and Murphy (1988).

Comparing welfare between groups using an ordinal utility function is not possible when the preferences of the groups differ. For example, successive generations can prefer their consumption bundle over the previous generation's consumption bundle, yet the final generation prefers the first generation's consumption bundle. Accordingly, I restrict my focus to analyzing caloric intake rather than welfare. Section 2.5 details an isomorphic model where welfare statements can be made as consumers have fixed preferences for food quality, and the quality level of a particular food depends on recipes and preparation techniques that develop alongside past consumption.

Particularly strong and enduring taste patterns characterize food consumption. Ample evidence in the psychology and nutrition literatures indicates that certain food preferences form in childhood. Children have a predisposition to respond neophobically to new foods, which is only overcome through repeated opportunities to consume a food (Birch 1999). The literature hypothesizes that this response serves a protective function, so that foragers can learn what foods are safe to eat. This is common across omnivores, and has been shown in experimental settings among both humans and rats. More directly, a mother's diet during pregnancy and lactation affects her child's preferences for flavors and foods in later life (Galef and Sherry 1973, Mennella, Jagnow, and Beauchamp 2001).

Social factors also play an important role in forming preferences. There is abundant experimental evidence, from humans and other mammals, that the young are more likely to accept new or disliked foods if they observe their mothers or other role models consuming them (Birch 1999). This effect works through two channels; role models both induce children to try a food for the first

[12] I assume that parents are myopic or that there is poor information about future prices, and so parents do not alter their child's diet to raise his or her expected utility under future relative prices.

[13] Habit formation may occur more quickly than this, which can be accommodated by including several stages of adult life, with past consumption influencing current preferences. For example, preferences for eating raw fish in sushi have developed rapidly in the West over a single generation (Bestor 2000).

time which overcomes the initial neophobia, and provide a pleasant context in which the food is eaten. As an example of the latter channel, second generation US immigrants from India may enjoy eating curry more than their non-Indian peers in part because of the positive association that has formed between consuming Indian food and dining at home with family members.

Crucially for my assumptions about habit formation, preferences gained in childhood persist in the available longitudinal data. Data from the Minnesota Heart Health Program (Kelder 1994) show that food preference rankings remain unchanged over 6 years.[14] Therefore, this extensive set of evidence supports my assumption that food preferences are positively related to the consumption patterns of the previous generation.

2.2 Modelling the Economy

With consumer preferences in place, I can now model the autarkic economy by bringing in the production side. I use a specific factors model that matches the realities of food production well.

A region has a fixed endowment of laborers, L, and two additional factors: land suitable for rice cultivation, T_r, and land suitable for wheat cultivation, T_w. Both rice and wheat are produced with constant returns to scale technology using labor and the single specific land factor, with diminishing returns to an increase in any one factor.[15] To grow wheat, a farmer requires well-drained soil, low humidity and moderate temperatures. Rice grows most easily in coastal plains, lowland deltas and tidal plains where paddies are submerged in water. These agro-climatic conditions are fixed over time and can explain why the arid plains of Rajasthan produce mainly wheat and West Bengal in the Ganges Delta produces mainly rice.

There is no migration[16] and factor endowments are fixed over generations. High transport costs and trade restrictions imply an initial equilibrium with autarky. In addition, there is no storage technology, so that all food is consumed in the period that it is produced. I define the unit for both goods as a single calorie of food.

Figure 1 describes the autarkic equilibrium. I first plot the production possibilities frontier (PPF), the locus of the maximum feasible combinations of wheat and rice that can be produced using a region's endowment.[17] The figure shows a bowed out PPF[18] for the home region which has a relatively larger endowment of rice land than wheat land. I represent preferences by an aggregate indifference curve for the whole economy. I assume that in the first generation, adult consumers have "neutral" tastes only for calories and dietary variety, corresponding to $tastes_{r1} = 1/2$, with the indifference curve perpendicular to the 45 degree line at any half-rice half-wheat bundle.[19]

[14] These food preference rankings were not elicited in experimental settings, and so there is a worry that the stability of these rankings results from steady relative prices. However all of the sample faced the same relative prices, yet there were substantial and persistent variations in food rankings, which can not be explained by the common price effects.

[15] All of the main results carry through to the Heckscher-Ohlin model where there are only two factors of production, T_r and T_w, which are required to produce both goods, but rice is relatively more intensive in factor T_r.

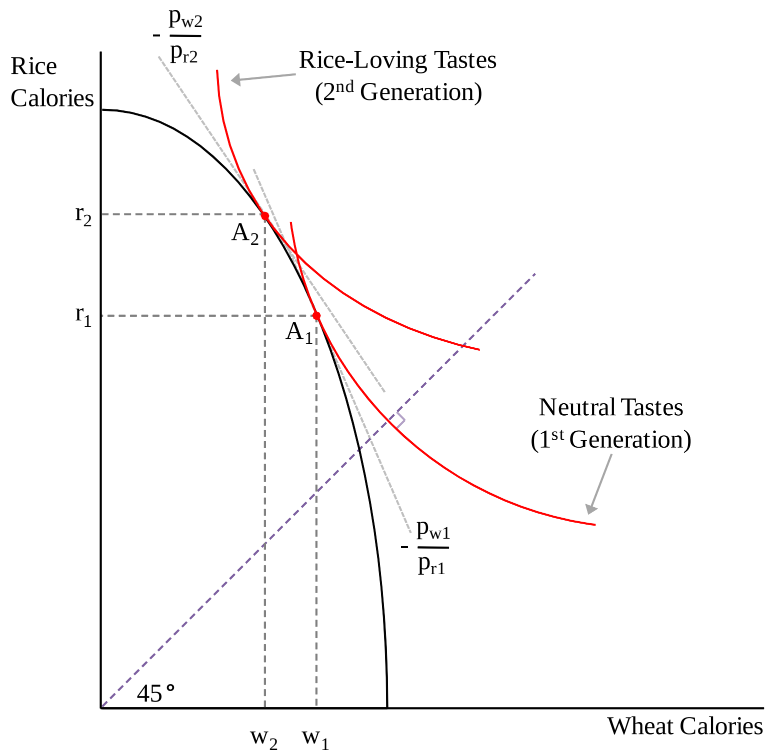
[16] This is a reasonable assumption in the case of India, where there is very little migration (Munshi and Rosenzweig 2007). In section 5, I study the impact of price changes faced by the small population of inter-state migrants.

[17] I assume technologies for converting land and labor into crops are identical across countries. The theory is equally applicable to technology differences, although such differences are less relevant for food production.

[18] The PPF bows out due to diminishing returns to each factor in the rice and wheat production functions.

[19] In the representation shown, consumers have a taste for variety and not simply for calories.

Figure 1: Habit Formation in a Two-Good Economy



Consumption occurs at point A_1, with relatively more rice than wheat consumed $(r_1/w_1 > 1)$.

The autarky relative price of rice, p_{r1}/p_{w1}, can be read off the figure and is equal to $-dw/dr$ at the point where the indifference curve is tangential to the PPF. Since rice land is abundant in the economy, labor flows into rice production to equalize the wage across sectors, increasing the relative production of rice. This higher relative production induces a drop in the rice price to equilibrate supply and demand and so $p_{r1}/p_{w1} < 1$. The full equilibrium is described in appendix A.1.

Tastes develop through habit formation, and so when the children of the first generation reach adulthood they have stronger tastes for rice than their parents as they consumed relatively more rice than wheat in their youth $(tastes_{r2} > tastes_{r1})$. I label the preferences of the second generation "rice-loving tastes" in figure 1. This generation has an increased relative demand for rice. As the endowment is fixed, the rice price must rise in order to induce an increase in the supply of rice and bring the market back into equilibrium $(p_{r2}/p_{w2} > p_{r1}/p_{w1})$. The second generation adults consume at A_2, with relative rice consumption even higher than in the previous generation $(r_2/w_2 > r_1/w_1)$.

Tastes for rice will continue to increase with each generation until generation s, when the price rise induced by the increased demand for rice is sufficiently large to leave relative rice consumption unchanged, $d(r_s/w_s)/d(r_{s-1}/w_{s-1}) = 0$. An interior steady state may not exist if habit formation is so strong that the price response is never large enough to negate fully the consumption increase.[20]

[20] In this case, consumers develop tastes only for rice and the price of wheat falls to zero.

In appendix A.5, I explore the conditions for the existence of an interior steady state in the case of Cobb-Douglas consumption and production functions. Such a steady state exists and is stable, with rice remaining cheaper than wheat ($p_{rs}/p_{ws} < 1$), as long as there is a sufficient love of variety (complementarity in consumption) so that tastes do not respond excessively to consumption changes.

It is an empirical question whether habit formation is sufficiently strong to make the good produced using the abundant factor relatively more expensive under autarky ($p_{rs}/p_{ws} > 1$). I will provide supportive empirical evidence for India that the price of a particular food is indeed cheaper in regions where resource endowments are relatively well-suited to growing that food crop. Accordingly, in the exposition that follows I will assume that, at the autarky steady state, rice remains relatively cheaper than wheat if rice land is more abundant in the region, $T_r > T_w$.[21]

Hypothesis 1: *A region develops tastes inversely related to the relative prices it faces. Therefore, tastes will become positively correlated with a region's relative resource endowments.* Proof under the assumption of homothetic preferences in appendix A.1.

Assumption 1: *Production functions and preferences are sufficiently well behaved, and habit formation is sufficiently muted, such that an interior steady state exists and $p_{rs}/p_{ws} < 1$.* Precise conditions appear in appendix A.2. Appendix A.5 characterizes the steady state for the Cobb-Douglas case.

Habit formation leads to something similar to the much used Armington (1968) home-biased preferences,[22] where preferences favor locally-produced varieties of a given good by assumption. Here, biased preferences for local goods are not ad hoc but emerge endogenously from endowments and are far more plausible for non-differentiated goods, where the region of origin cannot be inferred from the good itself.

Figure 2 shows how the nutrition of the region changes between the two generations. My nutrition metric is caloric intake, which is simply $r + w$ when the units of each good are defined in calories. The isocalorie line is perpendicular to the 45 degree line, with caloric intake at its feasible autarkic maximum when $p_r/p_w = 1$.[23] The second generation more readily consumes the abundant calorie source, rice. Therefore, as long as rice remains cheaper than wheat, the second generation ends up better nourished, with A_2 on a higher isocalorie line.[24] In each subsequent generation, caloric intake will further increase until a steady state is reached with $p_{rs}/p_{ws} < 1$.

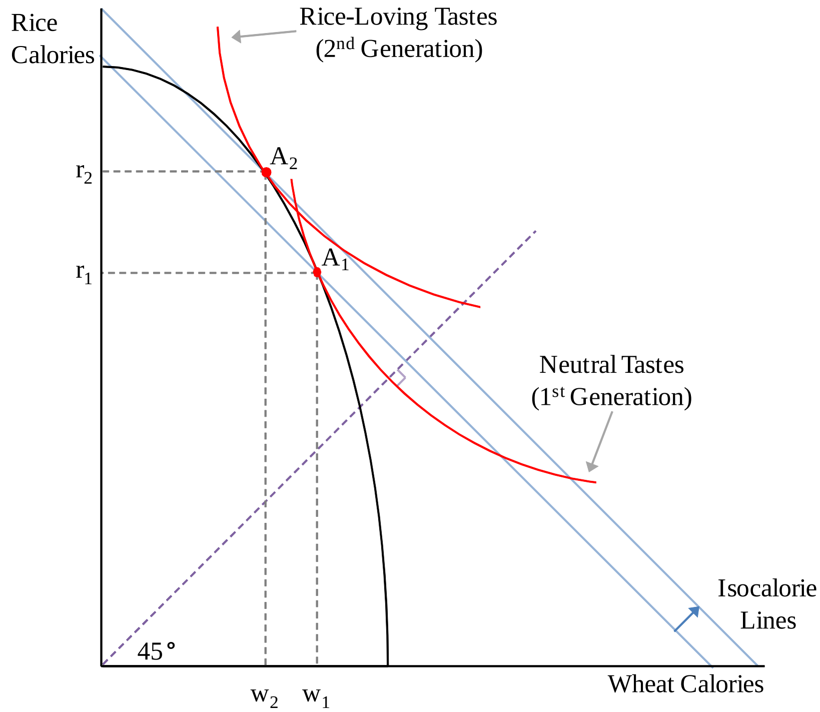
[21] If the reverse was true, then habit formation has changed which goods each region has a comparative advantage in, and more favored goods will fall in price upon liberalization.

[22] Armington home-biased preferences are used in the empirical trade literature to explain home-bias effects found in international trade data (Trefler 1995) as well as in most modern Computable General Equilibrium trade models.

[23] This follows directly from setting $d(r + w(r))/dr = 0$.

[24] The model ignores the fact that calories consumed are also an input into production. More physically intensive farming techniques require more calories. If changing tastes induce a movement of labor into the more physically demanding sector, there may be lower net nutrition. Ideally the calories used as inputs to production should be subtracted from total calories if data were available. There is no reason to expect that sectors where there is a resource comparative advantage are more physically intensive, which would be required to reverse these results.

Figure 2: Caloric Gains Through Habit Formation



Hypothesis 2: *The next generation will consume a larger total quantity of calories if tastes develop to favor the relatively cheap calorie source, as long as that calorie source remains relatively cheap.* Proof in appendix A.3.

The fact that caloric consumption increases with habit formation provides an evolutionary justification for a utility function that depends on past relative consumption. Habit formation would evolve endogenously from a simple game-theoretic evolutionary model. Societies exhibiting such traits will be better nourished and hence fitter in an evolutionary sense, making them able to outcompete other groups.

2.3 Opening the Economy to Trade

What happens when this small region liberalizes trade after many generations under autarky? Trade liberalization generally takes place in waves over several years, but tastes change only across generations. Therefore, I evaluate the short-run impact of a trade liberalization at time T, as shown in the timeline below, with tastes held fixed at their pre-liberalization values. I compare the case of habit formation, in which tastes in the region have already developed to favor the relatively abundant good, rice, against the case without habit formation, in which tastes are still neutral.

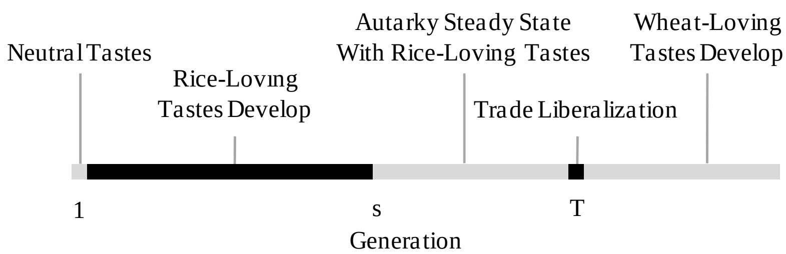
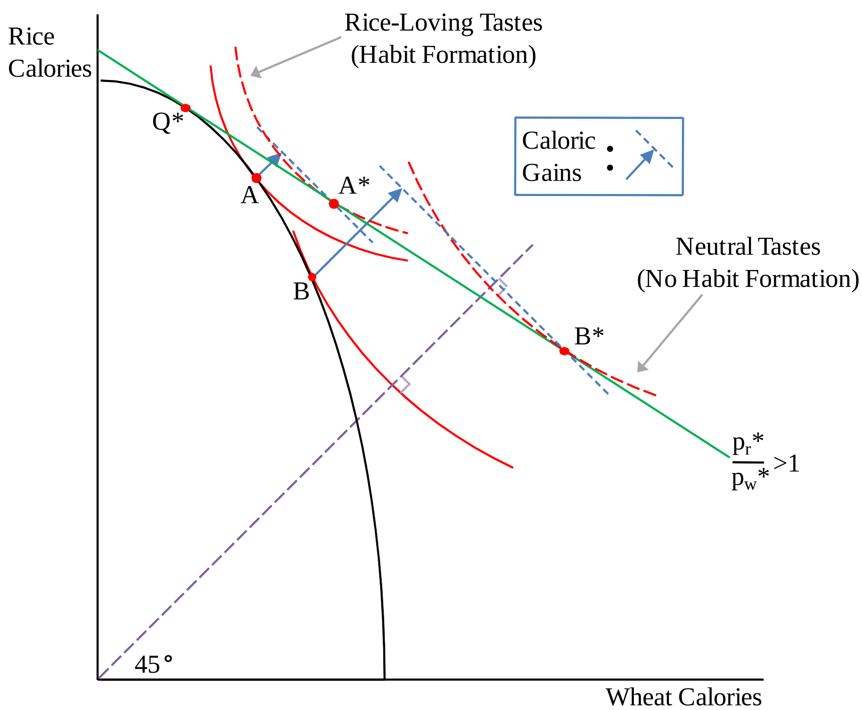


Figure 3 shows the new equilibrium for the region after opening to trade with a world where wheat is relatively cheap. Post trade values are denoted by asterisks. The world price line has a gradient shallower than -1 since $p_r^*/p_w^* > 1$ (wheat is relatively cheap). With trade, the region can separate its consumption and production decisions and produces at point Q*, where profits are maximized by increasing the region's specialization in rice production.

Figure 3: Trade Liberalization With and Without Habit Formation



Without habit formation, when tastes for rice and wheat are still neutral, the region consumes at point B under autarky and B* after trade liberalization. Caloric intake increases by the vector length of the arrow from point B to the isocalorie line passing through B*. With habit formation, tastes favor rice for the generation of adults alive at the time of trade liberalization. In this case, consumption moves from A to A*, and the aggregate caloric gains from trade are much smaller (the vector length of the arrow from A to the isocalorie line passing through A*). The aggregate caloric consumption with rice-loving tastes is smaller post trade liberalization compared with neutral tastes, but was larger pre trade (hypothesis 2), implying that the short-run aggregate caloric gains from trade shrink with habit formation.

Hypothesis 3: *Habit formation reduces the short-run aggregate caloric elasticities with respect to trade liberalization.* Proof under assumption 1 for $p_r^*/p_w^* \geq 1$ in appendix A.4.

In the generations following trade liberalization, the taste for rice will decline because the relative consumption of wheat rises. Increasing relative tastes for wheat will produce further caloric gains for future generations, as they spend an increasingly large share of their budget on wheat, the relatively cheaper calorie source post trade. After many generations the aggregate caloric intake will actually exceed that with neutral tastes, as consumers develop wheat-loving preferences. However, the effects on the current generation are of primary importance to elected policymakers, and accordingly I focus on these initial impacts in the paper.

The reduction in the aggregate caloric gains from trade derives from both the consumption and production sides of the economy. On the production side, habit formation brings autarky prices closer together by bidding up the price of the region's relatively abundant food, thereby reducing the gains from specialization at the moment of trade liberalization. On the consumption side, the caloric gains from trade are reduced for all consumers because they are less willing to take advantage of the falling wheat price. It is the consumption side that will be the focus of my empirical work, and in the next section I will separate the consumption effects from the production effects by looking at individual consumption, holding income fixed. This approach will also allow me to generalize the consumption impacts to the G good case and to analyze the distribution of these reduced short-run aggregate caloric gains among factor owners.

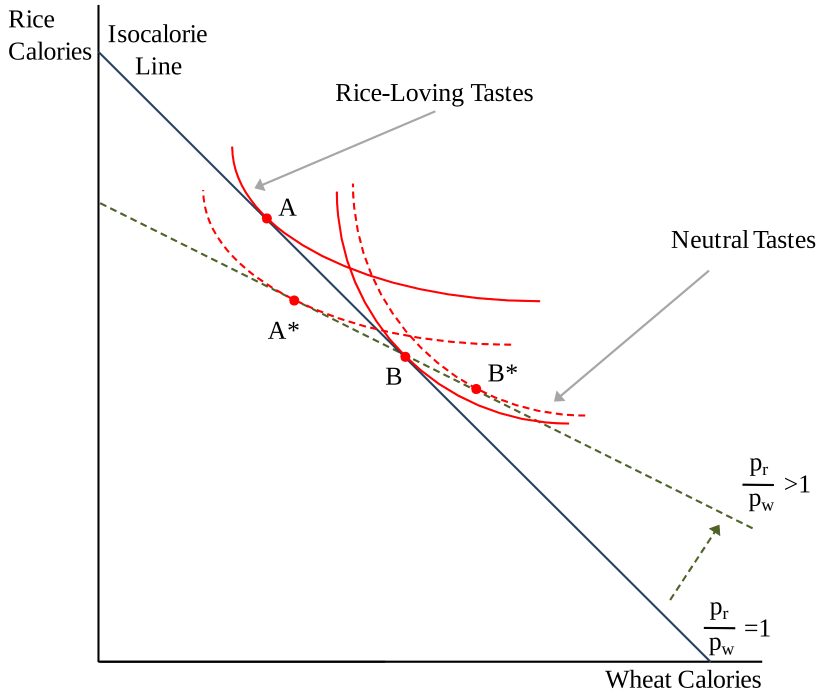
2.4 The Effect of Price Changes on Nutrition

The effects of trade liberalization on the consumption side can be more clearly illustrated by analyzing the effect of price changes on individuals, as opposed to the aggregate consumption and production effects described previously in a general equilibrium setting. My empirical data contain many heterogenous consumers with different initial factor incomes and whose income gains from trade will vary. Therefore, to motivate my empirical strategy, I will analyze how tastes alter caloric gains from trade on the consumption side in a partial equilibrium setting by holding incomes constant.

Figure 4 shows the consumption impact of an exogenous rise in the relative price of rice for an individual factor owner, holding income constant. For simplicity, I assume that one calorie of either wheat or rice can be purchased for the same price prior to the price change. Therefore, the edge of the consumer's budget set has a gradient of -1, which is also the isocalorie line. At this price the consumer will have the same caloric intake regardless of his or her relative tastes for rice and wheat.[25] In the diagram, I display the individual utility functions for two possible sets of preferences, rice-loving tastes and neutral tastes. A rice lover consumes relatively more rice at any price.

[25] Assuming there is no satiation in the consumption of either good.

Figure 4: The Effect of Price Changes on Individual Calorie Consumption



To explore the effect of a rise in the price of rice and an equally sized fall in the price of wheat ($p_r/p_w > 1$), I rotate the budget set counterclockwise around bundle B, thereby keeping income fixed by ensuring that this half-rice half-wheat bundle remains just affordable. If India liberalized its internal trade, these are the type of price changes that would be seen in regions abundant in rice land. The price of rice would rise, and the price of wheat fall, as regional prices move towards the Indian integrated equilibrium prices. The solid lines show the pre-price-change and the dashed lines the post-price-change situation. In the case of rice-loving tastes, caloric intake declines, with the new consumption bundle A* on a lower isocalorie line, while the opposite is true for the case of neutral tastes (caloric intake increases in the move to B*).

Caloric intake declines for rice-loving consumers through the combination of wealth and substitution channels. Rice-loving consumers initially spend a large portion of their budget on rice, and so a larger increase in expenditure would be required to afford their original consumption bundle after the relative price change. Because of their strong tastes for rice, these consumers are reluctant to substitute into the cheapening calorie source, wheat, which would allow them to avoid a decline in caloric intake while spending the same total amount on food. Therefore, consumers who have developed tastes that favor rice require larger increases in nominal food expenditure to maintain the same caloric intake when rice becomes relatively more expensive.[26]

The simple exposition in figure 4 holds nominal food expenditure constant, and the two goods are equally calorific prior to the price change. Trade also changes factor incomes which will affect

[26] This is the caloric equivalent of compensating variation.

total food expenditure, and so the budget set may also shift outwards. These production gains from trade will be discussed shortly. My empirical work estimates how large this increase in total food expenditure will have to be in order for India to maintain its average pre trade caloric intake upon internal trade liberalization. I then compare this figure to the required total food expenditure increase if regional tastes were identical across India.

The price per calorie will also vary for reasons unrelated to endowments, and so the price of rice may remain relatively cheap after the price change. For example, to produce one edible calorie, meat requires greater energy inputs than rice. A rise in the relative price of rice in a two-good (rice and meat) model will increase the relative consumption of meat. A lower willingness to substitute into meat due to rice-loving tastes will actually increase caloric intake though the substitution channel. However, the net effect of tastes on caloric intake will still be negative as rice-loving tastes increase the budget share spent on rice before the price change and so the real income decline is larger, reducing caloric intake through the wealth channel. If rice is a Giffen good for some consumers, rice consumption will rise after the price change, and meat consumption will fall considerably. However, this will generally still result in caloric intake decreasing unless rice remains a substantially cheaper calorie source after the price change.[27] In a many-good many-region model, while the relative price per calorie of different broad food groups may change with trade, the effects shown in figure 4 will be occurring within broad food groups, in which foods are similarly calorific. Consumers are reluctant to substitute from local cereals into the foreign cereals trade has made cheaper, and at the same time they are reluctant to substitute from local meats into foreign meats. Therefore, I will control for the initial price per calorie explicitly in the empirical work as this substitution between food groups of different caloric intensity is separate to habit formation increasing tastes for the foods produced with locally abundant factors that is at the heart of my model.

The effect of price changes on caloric intake shown in figure 4 can be derived for G goods subject to small equilibrium price deviations. The total calories consumed by an individual are equal to the sum of the quantities of each food consumed:

$$calories = food \sum_{g=1}^{G} \frac{bshare_g}{p_g}.$$

I log-linearize *calories* around the equilibrium price and apply the envelope theorem (budget shares remain approximately constant):[28]

$$\Delta \ln calories \simeq \Delta \ln food - \sum_{g=1}^{G} [tastes_g + h_g(P, food)] \left[\frac{food}{calories} \Big/ p_g \right] \Delta \ln p_g. \tag{1}$$

[27] Jensen and Miller (2008) provide evidence of Giffen behavior in extremely poor households in Hunan, China.

[28] In appendix B.2, I show the full log linearization that allows budget shares to change. To see the log linearization, note that caloric change can be approximated as follows; $(1 + \Delta \ln calories - \Delta \ln food) \simeq \frac{food}{calories} \sum_{g=1}^{G} \frac{bshare_g}{p_g}(1 - \Delta \ln p_g)$. P is the vector of G prices. Food expenditure is assumed to be additively separable from other expenditure. If this is not the case $h_g(P, income)$ should replace $h_g(P, food)$.

The log change in an individual's caloric intake, $\Delta \ln calories$, equals the log change in total food expenditure, minus the summation of the interaction between log price changes and both the budget shares and the inverse of the relative price per calorie of each good g. Tastes matter for caloric intake since $\Delta \ln calories$ decreases with the correlation between tastes and price changes.

Hypothesis 4: *For a given set of price changes, the greater the correlation between tastes and the price changes, the more caloric intake will decrease, conditional upon total food expenditure and the relative price per calorie.*

Up to this point, while I have shown that the aggregate caloric gains from trade shrink in a model with habit formation, I have not discussed the distribution of these reduced gains. Liberalizing agricultural trade will lead to production gains through specialization, and the total world output of calories will increase. Some of these production gains accrue to the small region through higher real food expenditure, and the representative consumer will generally consume more calories post trade. These expenditure increases will be distributed unevenly across factor owners. As with the Heckscher-Ohlin model, the real rental income accruing to the owners of rice land will rise, and the real rental income accruing to the owners of wheat land will fall. Habit formation reduces the aggregate production gains from trade by bringing autarky prices closer together, and so these income changes for landowners will be muted. At the same time all factor owners, including labor, will be negatively affected on consumption side through their more favored foods rising in price.

Most of the poor in the developing world have few productive assets other than their own labor, and so the likely impact on wages is particularly relevant for exploring the impact of agricultural trade on the poor.[29] Ruffin and Jones (1977) analyze the effect of trade liberalization on landless labor's real income in a very general specific factors model. The nominal income gain from trade for the mobile factor is a weighted average of the price changes. The authors term this fact the neoclassical ambiguity, since with a sufficiently large share of consumption in the high $\Delta \ln p_g$ goods, the real wage of labor may actually fall.[30] A similar result holds for caloric intake, as can be seen from equation 1. Landless labor can suffer absolute caloric losses from trade, with or without habit formation. However, habit formation produces a positive correlation between tastes and trade-induced price changes, and so larger increases in nominal food expenditure are needed to avoid a decline in caloric intake.[31] Absolute caloric losses are especially likely if landless laborers have particularly strong tastes for the comparative advantage foods, yet do not see a large rise in nominal income compared to other groups. This is quite possible, since landless laborers are typically one of the poorest groups in society, and the poor generally consume less diversified diets and disproportionately large

[29] In India 31 percent of rural households derive their livelihood primarily from agricultural labor and 33 percent from self-employment in agriculture (NSS 1987/88). However, most of the income for self-employed agricultural households with small landholdings comes from their labor rather than the implicit rental on their land.

[30] Ruffin and Jones (1977) assume that the tastes of laborers are not biased towards the comparative advantage good relative to the population as a whole and are independent of comparative advantage. They conclude that there is a presumption that labor will benefit from trade.

[31] Habit formation may also alter the distribution of the production gains from trade. Appendix A.5.1 shows that for the mobile factor, labor, any redistributed gains accruing to labor do not compensate for the consumption loss, and habit formation reduces labor's caloric gains from trade in the Cobb-Douglas case.

quantities of the cheap local staples that are expected to rise in price with trade liberalization. I will present supporting evidence for India that poor households do indeed require relatively larger nominal income rises at the time of trade liberalization in order to avoid caloric losses.

2.5 Welfare Implications Using Quality Improvements

This paper focuses on the nutritional consequences of trade liberalization, but I can also interpret the model in utility terms with a small alteration. The model is isomorphic to one where individuals have fixed preferences and there are transformation technologies for converting raw food products into palatable meals. The technologies encompass both recipes and preparation techniques. Improvements in the transformation technologies are functions of relative consumption,[32] resulting in complex regional cuisines that take advantage of local produce. Returning to the Indian example, a family in Rajasthan may be expert at transforming wheat into delicious roti (a flat bread), but may lack the ability to make a decent jhal-muri (a rice ball popular in West Bengal). Wheat-growing regions learn methods of transforming wheat into high quality meals faster than they learn how to improve the quality of rice dishes they rarely prepare. This reinterpretation allows for an evaluation of the welfare impacts of the model. The utility gains from trade liberalization are muted since consumers continue to buy the local foods that they prepare well rather than the now cheaper imported foods that they are less familiar with.[33] A pure information story also can produce similar results, in which consumers know about the existence and nutritional content of local foods, and are less familiar with the foods that trade makes relatively cheap. In appendix A.6, I formally show the isomorphism of the household technology and preference change models and prove that, for landless labor in the Cobb-Douglas case, the welfare elasticity with respect to trade liberalization declines if food transformation techniques develop proportionally to previous consumption.

Hypothesis 3*: *Food transformation technologies that improve with relative consumption reduce the short-run aggregate welfare elasticities with respect to trade liberalization.*

The historical example of the Columbian Exchange suggests that both tastes and transformation technologies for local foods reduce the initial gains from trade. Shortly following Columbus's "discovery" of the Americas, Europe imported potatoes and tomatoes. Initially they gained little favor. Tomatoes first found use as table ornaments in Italy, with the first recipe for tomato sauce appearing only in 1839 (Alexander 2000). Highly calorific and hardy potatoes were treated with trepidation and traditional staples continued to be preferred even in times of famine well into the 1800's. Eventually consumption increased with state intervention[34] and tastier preparation methods developed alongside, such as fried potato slices, with the first recipe emerging in France in 1795

[32]This has obvious similarities to the induced agricultural innovation of Hayami and Ruttan (1971).

[33]Diagrammatically, the production possibility frontier shifts out over time when quantity is measured in quality adjusted units. However, trade and prices are still related to physical quantities, and so visual presentation of the impacts of trade liberalization is not intuitive.

[34]Frederick the Great ordered the German peasantry to plant potatoes in 1744. The French, Austrians and Russians all subsequently used government policy to quicken potato adoption (Nunn and Qian 2008).

(Hess 2001). It took both core preference changes and preparation improvements for European consumers to experience large caloric and utility gains from these new crops.

3 Empirically Testing the Theory

It is impossible to observe the impacts of trade liberalization in societies both with and without habit formation. Therefore hypothesis 3, which compares the short-run caloric gains in a society with habit formation to one without, cannot be tested directly. However, the mechanisms in my model that reduce the caloric gains from trade on the consumption side can be tested. If a region has stronger tastes for the foods that its agro-climatic endowments are relatively well-suited to producing, and these foods are inexpensive compared to other regions (hypothesis 1 and assumption 1), the prices of these more favored foods will rise upon trade liberalization. Hypothesis 4, in which individual caloric intake declines when tastes correlate with price changes conditional on changes in total food expenditure, then implies that trade needs to generate larger increases in total food expenditure for an individual to avoid a caloric loss at the time of liberalization. If these two hypotheses are supported, this is strong evidence that habit formation will reduce the caloric gains from trade liberalization on the consumption side. Habit formation should also reduce the aggregate production gains from trade, but this I will not be able to test without observing autarky prices in a society without habit formation.

With the empirical estimate of the decline in caloric intake when tastes correlate with price changes from testing hypothesis 4, I can perform the consumption side of the counterfactual exercise suggested by hypothesis 3. I predict the size of the total food expenditure gains that will be required to avoid a short-run caloric loss if India were to liberalize its internal trade (such that current prices were to equalize across regions). I can then compare this figure to the predicted size of the total food expenditure gains that would be required to maintain caloric intake if prices were to equalize across regions yet tastes were identical across India.

To implement this empirical strategy, I first require an estimate of tastes. To match my Cobb-Douglas model in appendix A, I initially measure tastes by regional average budget shares. My second taste measure acknowledges that budget shares change with prices and incomes, and I estimate tastes as the unexplained regional variation in household demand for agricultural products, controlling for income, price and demographic effects.

I use two complementary empirical approaches. In section 4, I look across 77 National Sample Survey Organization (NSSO) regions in India, drawn along agro-climatic boundaries. The theory suggests that tastes are related to agro-climatic endowments, making this an appropriate unit. Inter-state tariffs, trade regulations and transportation costs, detailed in section 6.1, mean that markets in these regions are not fully integrated. I first show that regional tastes are positively correlated with relative endowments and negatively with regional prices through the process of habit formation (hypothesis 1 and assumption 1). Therefore, price rises would occur in more favored foods upon liberalization. Next, I demonstrate that the caloric loss between 1987 and 2005 was larger in regions where tastes were more correlated with the price changes over that period, controlling for changes in total food expenditure (hypothesis 4). These estimates allow me to perform the counterfactual exercise described above.

The second empirical approach in section 5 uses data on inter-state migrants between the 31 states of India. Here, rather than estimating the caloric change with temporal price changes as above, I use spatial price variation.[35] Migrants mimic a small economy opening up to trade, as they face their destination-state's prices upon migration, yet still have the preferences of the state in which they were born. First, I confirm that migrants bring their origin-state tastes with them. Then, I show that migrants consume fewer calories for a given level of food expenditure compared to similar people in the state they left behind. The relative size of this reduction depends on how correlated tastes in the sending state are with the price changes on the 490 observed migration routes (hypothesis 4). This effect disappears only two or three generations after migration, as tastes adjust to local prices.

3.1 Data

Both empirical approaches utilize household data from the Indian NSSO. To examine patterns across regions in India, I use rural households from the 43rd round (1987-88), and in order to explore the impact of temporal price changes, I compare these to rural households from the 61st round (2004-05).[36] For comparing migrants with non-migrants, I only use the 1987-88 round, but I include all households as many migrants live in urban areas. Each round contains observations for 80,000 rural households and 45,000 urban households. The NSSO surveys also include records of the unit values paid for every food item consumed from a list of several hundred, which serve as my price data.[37] These prices correspond well to farm harvest prices and provide an enormous amount of price information at a very fine geographic level. The surveys also provide many household characteristics, other expenditures and migration details.

I obtain calorie data by multiplying each food's caloric content, as estimated by the NSSO, by the quantity consumed by each household over 30 days. All calorie measures are then converted into daily caloric intake per household member. I aggregate up to 52 of the most common food products.[38] This aggregation omits processed foods, beverages and non-food items because it is impossible to either match these products with agro-climatic endowments, or to obtain accurate unit values and caloric contents. While there was a substantial increase in the budget share of non-food and processed foods over the period, their total contribution to consumption remained

[35] There is a long tradition of using migrants to evaluate the impact of price changes, dating back to Staehle (1934).

[36] Both of these are the more comprehensive quinquennial thick rounds. The 43rd round is the earliest thick round available with extensive migration data linked to each consumption module and an almost full regional sample. The 61st round is the most recent thick round. The two rounds are sufficiently far apart to observe significant changes in relative prices within regions, comparable to a trade liberalization.

[37] For home produced foods, consumption is valued at the prevailing local farm-gate price. Unit values are not actual prices since quality will vary. However, with raw agricultural goods this is much less of a concern. See Deaton (1997) for a two stage procedure to sweep out quality effects.

[38] They are: Rice, Wheat, Jowar, Bajra, Maize, Barley, Small Millets, Ragi, Gram, Cereal Substitutes, Arhar, Moong, Masur, Urd, Peas, Soyabean, Khesari, Other Pulses, Milk Products, Vanaspati/Margarine, Mustard Oil, Groundnut Oil, Coconut Oil, Other Oil, Meat, Chicken/Eggs, Fish, Potato, Onion, Sweet Potato, Cauliflower, Cabbage, Brinjal, Lady Finger, Tomato, Chillis, Other Vegetables, Coconuts, Other Nuts, Banana, Mango, Oranges, Lemon, Guava, Other Fruits, Sugar, Garlic, Ginger, Turmeric, Black Pepper, Other Spices and Pan/Supari.

small, corresponding to only 2 percent of total caloric intake in 2004-05 by NSSO estimates.[39] Therefore, I look only at the relative tastes between the 52 foods and caloric intake conditional on total expenditure over these goods.[40]

To measure agricultural endowments, I use district-level agricultural data from Indian Harvest produced by the Centre for Monitoring Indian Economy, aggregated up to NSSO regions. Further regional data come from the Indian District Database (Vanneman and Barnes 2000) and weather data come from Willmott and Matsuura (2001).

3.2 Estimating Tastes

Obtaining a measure of local tastes presents my most difficult empirical task. I approach this in two ways and present results for both measures. Since preferences change only slowly over generations in my model, tastes will be fixed in the short run. Therefore, at any point in time, tastes can be identified using cross-sectional data, and I use the data from the 1987-88 survey.

The first taste measure comes directly from the structure of the fully-solved model used to characterize the steady state in appendix A.5. With Cobb-Douglas preferences food budget shares are constant, and so $bshare_g = tastes_g$ (with $\sum_{g=1}^{G} tastes_g = 1$). Therefore, I estimate tastes as the average regional share of the food budget spent on good g.

While budget shares provide a transparent and obvious taste measure, if preferences are not well represented by Cobb-Douglas utility functions, budget shares will vary with local prices and incomes for reasons unrelated to habit formation. Thus, for my preferred taste measure, I regress individual budget shares across India on income, prices and household characteristics, and attribute the regional variation remaining to local tastes. With a sufficiently flexible functional form, the tastes implicitly defined by $bshare_g = tastes_g + h_g(P, income)$ will be identified separately from the common price and income effects. My theory suggests that both prices and tastes will be determined by local endowments at the autarky steady state. However, this only leads to colinearity and the regional fixed effects remain consistent estimators of $tastes_g$.

I estimate these residual tastes using the functional form for $h_g(P, income)$ suggested by the Linear Approximate Almost Ideal Demand System (LA/AIDS) of Deaton and Muellbauer (1980a). In the basic AIDS specification, the budget share spent on food g in region r is a function of a good specific constant, log prices for every good and log real income. I allow this constant term to vary by region by including a full set of regional dummies, d_{gr}, and the coefficients on these dummies, $tastes_{gr}$, are my regional taste measure:

$$bshare_{gr} = tastes_{gr} d_{gr} + \sum_{g'} \gamma_{gg'} \ln p_{g'r} + \beta_g \ln \frac{income}{P_r}, \tag{2}$$

where p_{gr} is the price per calorie of good g in region r, $income$ is total expenditure and P_r is the regional price index. This specification derives from a "flexible functional form" cost (or expenditure)

[39] Results are unchanged when I include these product groups (using NSSO unit and calorie approximations).

[40] I will call this food expenditure, although it excludes processed foods and beverages.

function, $c(u,p)$, where the first-order terms, $tastes_{gr}$, vary by region:

$$\log c(u,p) = \alpha_0 + \sum_g tastes_{gr} \ln p_{gr} + \frac{1}{2}\sum_g \sum_{g'} \gamma^*_{gg'} \ln p_{gr} \ln p_{g'r} + u\beta_0 \prod_g p_{gr}^{\beta_g}.$$

This cost function, introduced by Diewert (1971), can be regarded as a second order approximation to any arbitrary cost function. Equation 2 is then obtained via Shephard's Lemma. The price index P_r is defined by $\log P_r = \alpha_0 + \sum_g tastes_{gr} \ln p_{gr} + 1/2 \sum_g \sum_{g'} \gamma_{gg'} \ln p_{gr} \ln p_{g'r}$ and $\gamma_{gg'} = \gamma_{g'g} = 1/2(\gamma^*_{gg'} + \gamma^*_{g'g})$. Following Deaton and Muellbauer (1980a), I approximate the price index P_r by a Stone index, $\ln P^*_r = \sum_g \overline{bshare}_{gr} \ln p_{gr}$, making the system linear.[41] The Marshallian own and cross-price elasticities in this demand specification depend on the taste parameter $tastes_{gr}$:[42]

$$\epsilon_{gg'r} = \frac{\gamma_{gg'} - \beta_g(tastes_{g'r} + \sum_{g''} \gamma_{g'g''} \ln p_{g''r})}{tastes_{gr} + \sum_{g'} \gamma_{gg'} \ln p_{g'r} + \beta_g \ln \frac{income}{P_r}} - \delta_{gg'}, \text{ where } \begin{cases} \delta_{gg'} = 1 \text{ if } g = g' \\ \delta_{gg'} = 0 \text{ if } g \neq g' \end{cases}.$$

I assume weak separability between the consumption of my 52 food groups and other expenditures. This allows the estimation of demands conditional upon total food expenditure (Deaton and Muellbauer 1980b). The alternative solution involves making arbitrary assumptions about non-food elasticities since the measurement of non-food unit values poses enormous difficulties.[43] Consequently, I amend equation 2 and replace budget shares with food expenditure shares and income with total expenditure on the 52 foods, $food_i$. I estimate the taste parameters, $tastes_{gr}$, by running equation 3 separately for each good using OLS over all i households, where the within region variation in prices, $food_i$ and Z_i allows identification of the other parameters in equation 2:

$$bshare_{gri} = tastes_{gr} d_{gr} + \sum_{g'} \gamma_{gg'} \ln p_{g'v} + \beta_g \ln \frac{food_i}{P^*_r} + \Pi Z_i + \varepsilon_{gri}. \tag{3}$$

I include additional demographic and seasonal controls Z_i and use survey weights.[44] I use median village prices, $p_{g'v}$, as the prices faced by households in village v (if at least one household purchased that good in the village).[45] Under the null hypothesis of no regional taste differences, all

[41] $\overline{bshare}_{gr}$ is the average budget share of good g in region r.

[42] The partial derivatives of the price elasticities with respect to tastes are as follows: $\partial\epsilon_{gg'r}/\partial tastes_{gr} = -\epsilon_{gg'r}/bshare_{gr} < 0$ if $g \neq g'$ and $\epsilon_{gg'r} > 0$ (the cross-price elasticity declines with $tastes_{gr}$ if the goods are substitutes). $\partial\epsilon_{ggr}/\partial tastes_{gr} = -(\epsilon_{ggr} + 1 - \beta_g)/bshare_{gr}$ if $g = g'$.

[43] For many non-food items such as services it is very hard to record the quantities purchased. These data are needed to calculate unit values. Many other non-food items are differentiated products with varying features and quality levels, which makes it almost impossible to calculate comparable unit values.

[44] Controls are included for the season of the survey as well as household size, household composition, religion, caste and primary activity. In theory, demand systems should satisfy adding up, homogeneity and symmetry when every individual consumes every item. Since in the data not one of the 128,000 households purchases all 52 foods, Deaton (1997) suggests that the OLS equation 3 should be interpreted as a linear approximation to the conditional budget share averaging over zero and non-zero purchases.

[45] The use of individual prices potentially imparts a bias (as measurement errors in individual prices also enter the food budget shares) and there are endogeneity concerns (if the price paid by the individual is correlated with omitted variables). Therefore I use the median prices paid by those consuming the good at the lowest available

these estimated $tastes_{gr}$ should be insignificant. The null is rejected, with highly significant $tastes_{gr}$ coefficients for almost all goods and regions (the mean t-statistic is 3.7 for the 3,952 $tastes_{gr}$).

Appendix B.1 addresses the robustness of these taste estimates. Although households take village prices as given, there are still possible endogeneity concerns. If markets are not perfectly integrated within regions, village taste shocks raise local prices and demands, leading to a correlation between prices and the error term. Therefore, I instrument for local village prices with the prices in a nearby village, where supply conditions will be similar. However, this nearby village's taste shock will be uncorrelated with the individual's error term. I also show that the rank ordering of tastes for a given food across the 77 regions is unbiased if the foods are substitutes for each other and price deviations within regions are only weakly correlated across foods. As a third robustness check, in case total food expenditure is endogenous to demand for a particular food, I instrument food expenditure with non-food expenditure, which allows me to bound this bias.[46] Finally, I allow for region specific $\gamma_{gg'}$ terms by drawing on additional data and price variation from the two adjacent NSSO thick rounds. In all four cases, the main results are robust to using these alternative tastes estimates.

4 Empirical Approach 1: Comparing Regions Across India

India contains 77 NSSO regions drawn along agro-climatic boundaries and within the borders of the 31 states.[47] Given the restrictions on agricultural trade within India that I document in section 6, I think of these regions as small economies at their autarkic steady states.

Figure 5 illustrates the variation in food expenditure shares and prices in 1987-88. In arid Western Rajasthan, wheat, bajra (pearl millet) and milk are the most important food sources. Households in Inland Eastern Maharashtra spend the largest portion of their food budgets on Jowar (Sorghum), while those in the Western Plains of West Bengal, by the Ganges Delta, devote a full 57 percent of their food budget to rice. In Southern Kerala, seafood and coconuts supplement rice as the major food sources. In all these cases, prices are relatively cheaper in the regions where the corresponding foods are consumed most. However, this price variation is insufficient to fully explain the enormous variation in food expenditure shares, and these unexplained components of food expenditure shares form my LA/AIDS taste estimates.

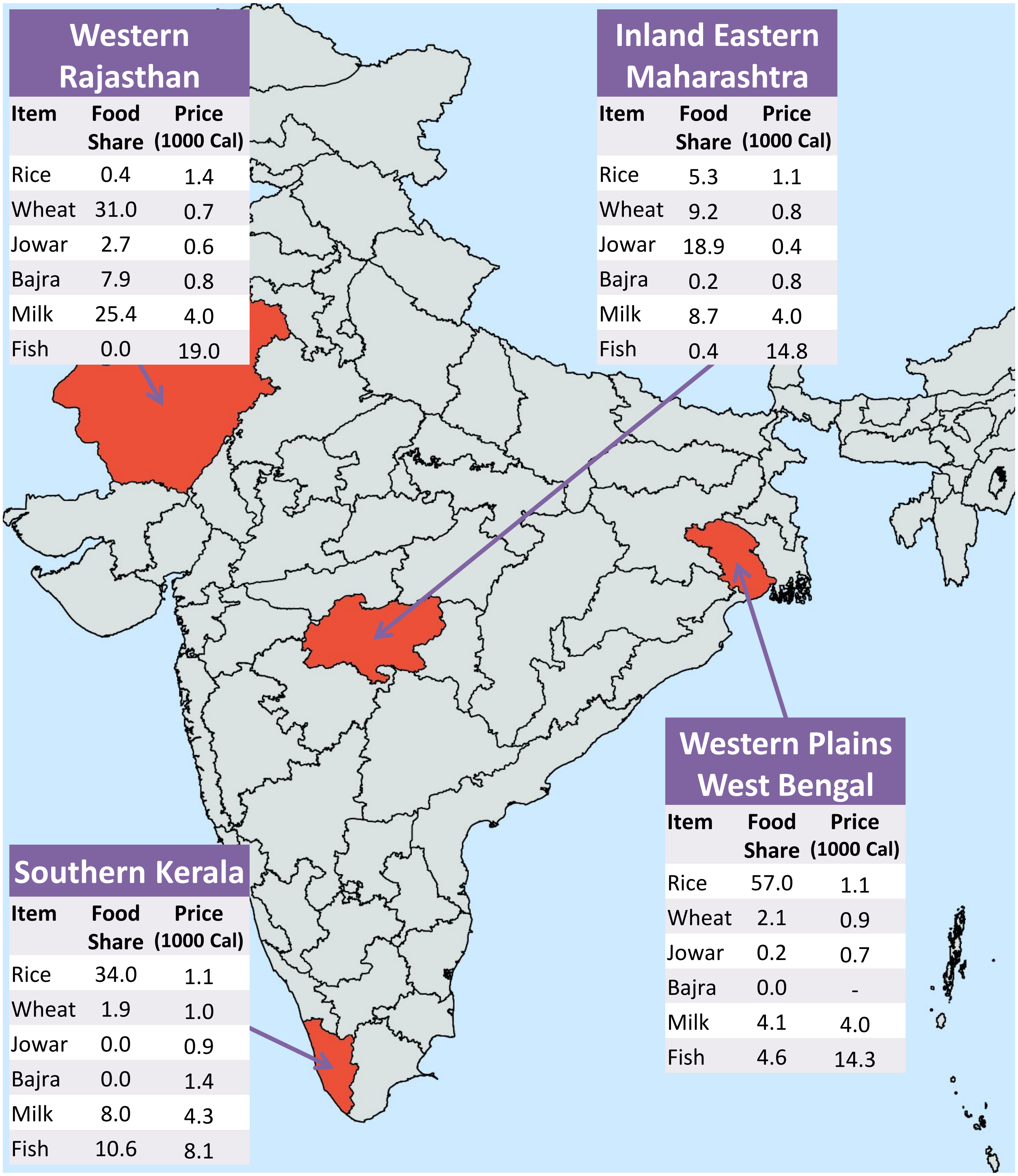
I restrict attention to rural households, which comprise around three-quarters of India's population. Rural households spend a larger portion of their income on food, and their tastes are likely to be more closely related to local endowments because of more traditional lifestyles, greater trade barriers with other parts of India and less food consumption that occurs outside the house.

geographic level above the household, starting at the village level and ending with one of five macro areas in India. This is better than losing all the observations from any village where a single price for one of the 52 goods is missing. Median rather than mean prices avoid problems with misreporting quantities that lead to extreme unit values.

[46] This strategy also deals with correlated measurement error concerns (as $food_i$ appears in the denominator of the food share) if the measurement error in non-food expenditure is independent of that in food expenditure.

[47] Four new states were formed in the 1990's, but regions did not change, bar Goa seperating from Daman and Diu. Only 76 regions have rural samples since only urban strata were sampled in Nagaland in 1987-88.

Figure 5: Price and Food Expenditure Share Variation Across Regions of India
(Percent of Total Food Expenditure Spent on Item and Rupee Median Price/1000 Calories 1987-88)



Western Rajasthan

Item	Food Share	Price (1000 Cal)
Rice	0.4	1.4
Wheat	31.0	0.7
Jowar	2.7	0.6
Bajra	7.9	0.8
Milk	25.4	4.0
Fish	0.0	19.0

Inland Eastern Maharashtra

Item	Food Share	Price (1000 Cal)
Rice	5.3	1.1
Wheat	9.2	0.8
Jowar	18.9	0.4
Bajra	0.2	0.8
Milk	8.7	4.0
Fish	0.4	14.8

Western Plains West Bengal

Item	Food Share	Price (1000 Cal)
Rice	57.0	1.1
Wheat	2.1	0.9
Jowar	0.2	0.7
Bajra	0.0	-
Milk	4.1	4.0
Fish	4.6	14.3

Southern Kerala

Item	Food Share	Price (1000 Cal)
Rice	34.0	1.1
Wheat	1.9	1.0
Jowar	0.0	0.9
Bajra	0.0	1.4
Milk	8.0	4.3
Fish	10.6	8.1

4.1 Tastes relate positively to relative endowments, negatively to prices

Habit formation in food consumption predicts that regional endowments above the Indian average should correspond to above average tastes for the food intensive in that endowment (hypothesis 1). Therefore, I regress my taste estimates on a measure of the relative agro-climatic endowment for each good in each region.

The specific factors model suggests using the area planted of a crop, $area_{gr}$, as the endowment, with relative endowments determining autarky prices across regions. In reality, land can be planted with a variety of crops, and the current cropping patterns may be affected by factors unrelated to the resource endowments that have shaped tastes over many generations.[48] Therefore, I require a measure of the agro-climatic endowment. I obtain this measure through a two-stage procedure that estimates the relative suitability of different regions for growing each crop.

In the first stage, I regress observed relative endowments on agro-climatic variables. My observed relative endowment measure is the difference between the proportion of a region's farmland and the proportion of India's farmland planted with a specific crop, averaged over a period prior to my household sample, 1970-1982:[49]

$$observed\_endowment_{gr} = \frac{area_{gr}}{\sum_{g'}^{G} area_{g'r}} - \frac{area_{gIndia}}{\sum_{g'}^{G} area_{g'India}}.$$

Therefore, a region with relatively more of its farmland devoted to rice than the average Indian region will have a positive relative endowment of rice and vice versa. I regress these observed relative endowments on agro-climatic variables, $RainTemp_{gr}$, allowing for crop-specific coefficients by interacting these variables with crop-specific dummies d_g:

$$observed\_endowment_{gr} = a_0 + a_{1g} RainTemp_r d_g + u_{gr}.$$

Following Dev and Evenson (2003), I choose a selection of $RainTemp_r$ variables that have large impacts on crop growth in the Indian sub-continent (mean temperature in January, April, July and October and mean rainfall for June, July and August). I then use the predicted values from this regression as my estimate of the true relative resource endowment, $endowment_{gr}$, that determines long-run tastes in autarky, $endowment_{gr} = \widehat{observed\_endowment}_{gr}$.

In the second stage, I regress my taste estimates on these predicted agro-climatic endowments:

$$tastes_{gr} = b_0 + b_1 endowment_{gr} + \varepsilon_{gr}. \tag{4}$$

Both stages are run simultaneously using Limited Information Maximum Likelihood.[50] As the

[48] For example, government subsidies and other agricultural policies as well as recent technological advances in agriculture have altered cropping patterns substantially in the last few decades.

[49] 1970 is the earliest year when area cropped can be calculated at the regional level in the Indian Harvest data set. Crop data can only be matched to 45 of the 52 goods, with animal products unmatched. For robustness, I also use the total output by crop as an alternative endowment measure and the results are almost identical.

[50] This is the same procedure as instrumentation with over 300 instruments (as agro-climatic variables are crop

magnitudes of tastes and observed endowments vary greatly over the 52 foods, I normalize both variables so that each food is mean zero, standard deviation one, across regions:[51]

Table 1: Tastes and Relative Resource Endowments

	(1)	(2)
	Taste Variable	
	$tastes_{gr}$ (Budget Shares)	$tastes_{gr}$ (LA/AIDS)
$endowment_{gr}$	1.656***	1.782***
	(0.48)	(0.59)
Observations	3375	3375

Note: Dependent variable, tastes, estimated using food budget shares and unexplained regional variation in food budget shares, with common price and expenditure controls (LA/AIDS). Tastes normalized mean 0, s.d. 1 by good. Independent variable, endowment, comprises the predicted values from regressing observed relative endowments, normalized mean 0 s.d. 1 by crop, on 7 monthly crop-specific rainfall and temperature variables. Two-stage estimation using Limited Information Maximum Likelihood. Robust standard errors. Constant not reported. * significant at 10%, ** 5%, *** 1%.

Table 1 presents the results of regression 4. If tastes develop to favor crops well-suited to local resource endowments, the coefficient on relative endowments should be positive. This hypothesis is supported, with significant positive coefficients on relative endowments for both taste measures.[52] Therefore regions which are relatively suited to growing a certain food have larger tastes for that food, compared to other regions. This effect is large, with a one standard deviation increase in the relative agro-climatic endowment associated with tastes that are 1.7 to 1.8 standard deviations higher. Within India, tastes have become correlated with relative endowments, even when I estimate tastes using the unexplained regional variation in budget shares controlling for local price and food expenditure effects that are common across India.

I assumed in the theoretical section that habit formation did not bid up the prices of the region's relatively abundant foods so much that these foods actually became relatively expensive compared to other regions. Under this assumption, trade liberalization tends to raise the price of preferred foods. I can verify whether this assumption holds for India by calculating the correlation between tastes and prices. There is no causation implied, with a negative correlation coming from the fact that both prices and tastes depend on local agro-climatic endowments.

Table 2 reports this correlation, again normalizing tastes and prices separately by food as mag-

specific). I use the Limited Information Maximum Likelihood Fuller-k estimator (c=1), as it is far more robust to a large number of weak instruments than two-stage least squares. The Kleibergen-Paap rk Wald F statistic is 3.20, significantly higher than the Stock and Yogo (2002) critical value of around 1.6 (5 percent size), below which the null of weak instruments cannot be rejected.

[51] This strategy compares relative tastes across regions for a single good with relative endowments across regions for that good. Results are very similar if I include good specific dummies instead of normalizing.

[52] There are worries about spatial correlation affecting the standard errors. I use the latitude and longitude of each state to apply the correction suggested by Conley (1999). This correction is only available for the GMM estimator, however in this case the standard errors are actually reduced by taking account of spatial correlation. This also holds for later regional regressions using OLS. Accounting for spatially correlated errors may actually increase the precision of my estimates, and so does not appear to be a worry.

Table 2: Correlations Between Tastes and Prices

	Pearson's product-moment correlation Prices$_{gr}$	[95% Conf.	Interval]
$tastes_{gr}$ (Budget Shares)	-0.071***	-0.103	-0.039
$tastes_{gr}$ (LA/AIDS)	-0.093***	-0.125	-0.061

Note: 3670 observations. Tastes estimated using food budget shares and unexplained regional variation in food budget shares, with common price and expenditure controls (LA/AIDS). Prices are regional median unit values. Both variables normalized mean 0, sd 1 by good. * significant at 10%, ** 5%, *** 1%. Confidence intervals based on Fisher's transformation.

nitudes vary greatly. Tastes are inversely correlated with prices, so that a region in which a food is more preferred has a lower price for that food compared to other regions. Together with the endowment results above, hypothesis 1 and assumption 1 are supported, namely that tastes are correlated with relative endowments and inversely correlated with prices. If India were to liberalize internal trade so that prices equalize across India, more preferred goods will rise in price and less preferred goods will fall.

4.2 Preference changes correlate inversely with price changes

Across regions of India, stronger tastes for a food correspond to larger relative endowments. This result is consistent with my theory of habit formation linking tastes to resource endowments. I can test this mechanism more directly by seeing if the changes over time in the ordering of tastes within a region relate to relative price changes.

Specifically, I estimate a new set of taste parameters using the 2004-05 cross-section and calculate the change in the rank of the taste coefficient over the 52 foods within each region between 1987-88 and 2004-05, $\Delta taste\_rank_{gr}$. Habit formation implies that relative tastes among foods respond to the relative price changes in the previous generation. Unfortunately price data from the previous generation are not available, and so I use the log change in prices between 1987-88 and 2004-05, $\Delta \ln p_{gr}$, which should have begun to affect the tastes observed in 2004-05. Having calculated these variables, I regress the change in the rank of the taste for a food on the log change in prices:[53]

$$\Delta taste\_rank_{gr} = b_0 + b_1 \Delta \ln p_{gr} + \varepsilon_{gr}.$$

Table 3 reports the results of this regression. The coefficient on the change in log price is negative, with foods becoming less preferred when their price rises compared to other foods in the region, as habit formation predicts.[54] This evidence suggests that the effects found in the previous

[53] Since I am using log changes, norming prices is no longer necessary to compare across foods. Results carry through if I replace the change in rank tastes with the change in absolute tastes normalized across foods, separately for each region and time period.

[54] Demand shocks would tend to increase both $\Delta \ln p_{gr}$ and $\Delta taste\_rank_{gr}$ and bias the coefficient upwards, and so the true b_1 is likely to be even more negative.

section resulted from habit formation responding to relative prices over many generations.[55]

Table 3: Taste Changes and Price Changes Between 1987-88 and 2004-05

	(1) $\Delta taste\_rank_{gr}$ (Budget Shares) 1987-88 to 2004-05	(2) $\Delta taste\_rank_{gr}$ (LA/AIDS) 1987-88 to 2004-05
$\Delta \ln p_{gr}$	-0.709***	-0.959***
	(0.14)	(0.16)
Constant	0.914***	1.471***
	(0.19)	(0.23)
Observations	3492	3492
R^2	0.01	0.01

Note: Dependent variable $\Delta taste\_rank_{gr}$ is the change in the estimated rank of tastes over 52 goods. $tastes_{gr}$ estimated using food budget shares and unexplained regional variation in food budget shares, with common price and expenditure controls (LA/AIDS). Independent variable is the change in the log of regional median unit values. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

4.3 Caloric intake declines with the correlation of tastes and price changes

I now show that if prices rise in more preferred foods, as predicted in section 4.1, there will be negative caloric effects. To do this I test the fourth hypothesis, that the greater the correlation between tastes and price changes, the more caloric intake decreases, conditional upon total food expenditure and the relative price per calorie. As above, I examine the price and caloric changes that occurred between 1987-88 and 2004-05 over the 76 regions sampled in both periods.[56]

I require a specification for how tastes and price changes impact caloric intake, and my regression specification comes directly from equation 1, the log linearization of caloric change. As discussed in section 2.4, I separate the approximate impact of tastes from the relative price per calorie by taking a first order Taylor expansion around the average budget share and average inverse relative price per calorie, $J_{gr} = (food_r/calories_r)/p_{gr}$:

$$\Delta \ln calories_r \simeq \Delta \ln food_r - \overline{J_r} \sum_{g=1}^{52} [tastes_{gr} + h_g(P_r, food_r)] \, \Delta \ln p_{gr} + \overline{bshare_r} \sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}.$$

[55] An alternative explanation is that consumers purchase complementary stocks of durables which may appear like habit formation. This is not plausible over this time frame, since any cooking or food preparation equipment costs relatively little and can be used with a variety of foods.

[56] The price changes over this period were not related to comparative advantage, as regions with larger endowments and tastes for a good actually saw smaller price rises. Section 6.1 discusses the lack of domestic food trade liberalization over the period. The observed price changes may have resulted from vote maximizing local politicians attempting to keep their region's preferred local foods affordable for the poor.

This suggests regressing caloric change on the regional sum of tastes interacted with price changes:

$$\Delta \ln calories_r = b_0 + b_1 \sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr} + b_2 \sum_{g=1}^{52} h_g(P_r, food_r) \ln p_{gr} + b_3 \Delta \ln food_r + b_4 \sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr} + \varepsilon_r. \quad (5)$$

I measure $\Delta \ln calories_r$ by the log change in the mean total calories consumed per person per day in region r, and $\Delta \ln food_r$ by the log change in the mean monthly total food expenditure per person in region r.

If the approximation is reasonable, there are sign predictions on the population-averaged slope coefficients. The change in regional caloric intake should decline with a measure of the correlation between tastes and price changes, $\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$, ($b_1 < 0$). There should be a similar effect for the explained component of the budget share when using the LA/AIDS tastes measure, ($b_2 < 0$). Additionally, the change in regional caloric intake should increase with larger increases in food expenditure, ($b_3 > 0$), and when expensive calorie sources rise in price the most, ($b_4 > 0$).

Table 4 reports the results of regression 5.[57] Columns 1 and 2 contain unweighted estimates of the average regional coefficients. In columns 3 and 4, the coefficients are representative of the Indian population as a whole, with each region's observation weighted by its 1987-88 total survey weight. Over the period, the average Indian caloric intake from the 52 foods declined from 2,200 to 2,000 calories per day. This decline was larger in regions where the price changes correlated more strongly with tastes (b_1 significantly less than zero).[58] Table 4 also provides strong support for the other three sign predictions.

If households reduce non-food expenditure in response to rising prices for more favored foods, the caloric decline will be tempered. Table 15 in the appendix shows the results of rerunning regression 5, but replacing $\Delta \ln food_r$ with the change in total expenditure on all goods, $\Delta \ln expenditure_r$. The magnitude of the caloric reduction coming from tastes correlating with price changes declines by about half as expenditure is partially reallocated towards food. However, conditional upon total expenditure, caloric intake still declines with the correlation between tastes and price changes.

The approximation used to obtain regression 5 assumed that budget shares were fixed in the short run. This ignores any income effects that lower demand for inferior goods with low prices per calorie. The omission is likely to reduce the coefficient on $\Delta \ln food_r$. Since tastes are positively related to relative endowments, $\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$ will also be correlated with the size of the income gains from price changes and may bias b_1 downwards. The full log linearization detailed

[57] Because LA/AIDS tastes are treated as independent variables but are themselves estimated, I bootstrap the household sample 1000 times and run the taste estimation and then regression 5. These additional errors should be added to the standard errors reported in table 4 that assume tastes are measured without error. However, the additional error generated is miniscule, with the standard error on b_1 increasing by less than 0.005 in column 2. There is also no evidence that the estimated b_1 is suffering from attenuation bias, with the mean value of b_1 from the bootstrap almost exactly equal to the observed coefficient.

[58] This result is not simply coming from larger aggregate price rises in some regions. Results are unchanged when the price changes are demeaned by region.

Table 4: Caloric Change and the Correlation of Tastes with Temporal Price Changes

	(1)	(2)	(3)	(4)
	$\Delta \ln calories_r$ 1987-88 to 2004-05			
	(Unweighted)		(Weighted)	
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$ (Budget Shares)	-0.358***		-0.610***	
	(0.11)		(0.083)	
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$ (LA/AIDS)		-0.354***		-0.600***
		(0.11)		(0.083)
$\sum_{g=1}^{52} h_g(P_r, food_r) \Delta \ln p_{gr}$ (LA/AIDS)		-0.296**		-0.566***
		(0.14)		(0.10)
$\Delta \ln food_r$	0.590***	0.595***	0.736***	0.732***
	(0.048)	(0.047)	(0.049)	(0.049)
$\sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}$	2.906*	2.828*	1.873	1.942*
	(1.58)	(1.60)	(1.17)	(1.16)
Constant	-0.371***	-0.383***	-0.249***	-0.258***
	(0.11)	(0.11)	(0.078)	(0.078)
Observations	76	76	76	76
R^2	0.58	0.58	0.71	0.71

Note: Dependent variable is the log change in caloric intake per person between 1987-88 and 2004-05. Independent variables come from the log linearization of caloric intake. Tastes estimated using food budget shares and unexplained regional variation in food budget shares, with common price and expenditure controls (LA/AIDS). J_{gr} is inverse relative price per calorie. Regressions weighted by a region's total survey weight where indicated. Robust standard errors. * significant at 10%, ** 5%, *** 1%. The standard errors become smaller when corrected for spatial correlation and are unchanged when whole procedure is bootstrapped to account for the fact that tastes are themselves estimated.

in appendix B.2 includes an additional term, $\sum_{g=1}^{52} calshare_{gr} \Delta \ln bshare_{gr}$, which represents the decline in calories from a shift in budget shares to more expensive calorie sources. However, there is no evidence of this bias, as including the additional term makes the coefficient of interest, b_1, even more negative, as shown in table 15.

As a further robustness check, I instrument for $\Delta \ln food_r$ with the log change in non-food expenditure, $\Delta \ln non\ food_r$. A shock that increases the demand for calories, such as changing work patterns, will also affect food expenditure and result in a positive correlation between $\Delta \ln food_r$ and the error term, biasing b_3 upwards. However, there will be a negative or no correlation with $\Delta \ln non\ food_r$, and the true value of b_3 will be bounded between the instrumented and uninstrumented estimates. These results are also shown in table 15, and b_1 is essentially unchanged in the two specifications, implying that the endogeneity of food expenditure is not a major problem.

Putting the three central empirical results together, I have shown that tastes positively relate to relative endowments through habit formation, and that the correlation between tastes and price changes reduces caloric intake for a given level of food expenditure. These results hold when I measure tastes by the unexplained regional variation in budget shares, controlling for common price and expenditure effects, and are robust to correcting for price endogeneity and region-specific second order price effects in the estimation of tastes (shown in appendix B.1). Consequently, any caloric gains from trade liberalization will be muted and there may well be absolute caloric losses as consumers continue to purchase their favorite local foods that systematically rise in price. In section 6, I turn to quantifying the size of this negative drag on caloric intake by predicting the increase in aggregate total food expenditure required to avoid absolute caloric losses if India were to liberalize its internal agricultural trade.

5 Empirical Approach 2: Migrants as Small Open Economies

As further evidence for my hypotheses, I exploit spatial rather than temporal price differences. Migrants moving with their labor endowment and the tastes of their origin state face the prices of their destination state. This mimics a small open economy exposed to world prices upon trade liberalization. I define inter-state migrants as households in which either the household head or their spouse emigrated from another state in India.[59]

To identify the causal caloric impacts of the price changes faced by a migrant, I must assume that migrants do not differ from non-migrants in unobservable ways, after controlling for total food expenditure and other information in the dataset.[60] Therefore, I estimate all the regressions using two additional specifications. I focus only on households in which the wife of the household head moved specifically for the purpose of marriage (either within or between states),[61] and I compare households in which the wife moved inter-state versus intra-state. Since women typically live in their husband's village upon marriage, this covers about two-thirds of the wives in the dataset. The *"wife move"* sub-sample limits attention only to households in which the wife moved to her husband's village upon marriage. The *"wife move 2"* sub-sample restricts the set of observations even more, only selecting households in which the husband still lives in the village of his birth and so the wife is likely to be moving into the extended household of her husband's family.[62] Table 16 in the appendix contains descriptive statistics for these samples. Both of these strategies assume that the wife carries some of her preferences into household food purchasing decisions, but avoid the most severe selection problems that arise when the household head chooses to migrate for better

[59] If both emigrated, I use the household head's migration information.

[60] To obtain the results I find, migrants would need to consume higher price per calorie foods than non-migrants with similar incomes for reasons unrelated to the tastes of their origin state. The bias may be expected to work in the other direction. For example migrants may have more adaptable tastes and be more willing to try unfamiliar foods than the general population, or migrants may be more likely to be manual laborers and consume carbohydrate heavy diets with a low price per calorie.

[61] I exclude the women who moved state jointly with their husbands at the time of marriage.

[62] Inter-state migrant households comprise 7.99 percent of the full weighted sample, 7.26 percent of the *wife move* sample and 5.40 percent of *wife move 2* sample.

employment opportunities.[63]

5.1 Migrants bring their tastes with them

The first test verifies that migrants maintain some of their origin-state's tastes when they move. In order to do this, I first calculate the mean food budget share spent on each of the 52 goods in each of the 31 states. I then compute the correlation between the average bundle of every state s and the bundle of every household. This produces 31 data points for each household i, who originally lived in origin state o and now reside in destination state d; $\rho_{iods} = corr_g(bshare_{ig}, bshare_{\overline{s}g})$.[64] I regress all of these ρ_{iods} correlations on five dummy variables: the household lives in that state $\mathbf{I}_{d=s}$, the household lives in that state but is an inter-state migrant $\mathbf{I}_{d=s,o\neq s}$, the household does not live in that state $\mathbf{I}_{d\neq s}$, the household does not live in that state but originally migrated from there $\mathbf{I}_{d\neq s,o=s}$ and the household does not live in that state but lives in the same broad area of India $\mathbf{I}_{d\neq s,nearby=s}$:[65]

$$\rho_{iods} = b_1\mathbf{I}_{d=s} + b_2\mathbf{I}_{d=s,o\neq s} + b_3\mathbf{I}_{d\neq s} + b_4\mathbf{I}_{d\neq s,o=s} + b_5\mathbf{I}_{d\neq s,nearby=s} + \varepsilon_{is}.$$

Table 5: Comparing Bundles of Migrants and Non-Migrants

	(1)	(2)	(3)
		$\rho_{iods} = corr_g(bshare_{ig}, bshare_{\overline{s}g})$	
	Full Sample	Wife Move Sample	Wife Move 2 Sample
$\mathbf{I}_{destination=s}$	0.811***	0.805***	0.804***
	(0.0012)	(0.0015)	(0.0016)
$\mathbf{I}_{destination=s,origin\neq s}$	-0.0210***	-0.0288***	-0.0251***
	(0.0037)	(0.0060)	(0.0072)
$\mathbf{I}_{destination\neq s}$	0.483***	0.450***	0.447***
	(0.0011)	(0.0015)	(0.0016)
$\mathbf{I}_{destination\neq s,origin=s}$	0.112***	0.139***	0.135***
	(0.0042)	(0.0063)	(0.0079)
$\mathbf{I}_{destination\neq s,nearby=s}$	0.181***	0.199***	0.199***
	(0.0014)	(0.0020)	(0.0021)
Observations	3,920,725	1,653,633	1,474,205
R^2	0.77	0.75	0.74

Note: Dependent variable is correlation between household food budget shares and mean shares for state s (31 observations per household). Independent variables are indicators for household's origin o and current (destination) d state. In the full sample there are 126,475 households of which 11,336 are migrants. Robust standard errors. All regressions survey weighted and clustered further by household. * significant at 10%, ** 5%,*** 1%.

[63] Although Rosenzweig and Stark (1989) suggest that long distance marriages are a risk mitigating mechanism, and so households who engage in inter-state marriages may have more variable incomes.

[64] Since I create 31 data points from each household observation, I will cluster standard errors at the household.

[65] This last variable controls for the fact that migrants are more likely to come from nearby states, and that could drive the effect picked up by the $\mathbf{I}_{d\neq s,o=s}$ dummy. I divide India into five broad areas. Similar results are found when I use the distance between states instead of $\mathbf{I}_{d\neq s,nearby=s}$.

If migrants bring their origin-state tastes with them, then being a migrant reduces the correlation between their consumption bundle and the average consumption bundle of their destination state ($b_2 < 0$), and increases the correlation with the average consumption bundle of their origin state ($b_4 > 0$). As shown in table 5, the data support these sign predictions. Reassuringly, I also find that non-migrants' bundles are more similar to their current state than to other states ($b_1 > b_3$), and nearby states have more similar bundles than distant ones ($b_5 > 0$).[66] This holds for the full sample and the two subsamples of wives who moved for marriage, as well as when I include a large number of additional controls.[67] Column 1 shows that the bundle of an average household has a correlation of 0.811 with its own state's average bundle, and this falls to 0.790 for migrant households. The correlation is only 0.483 with states in other areas of India, but rises by 0.112 if they originally migrated from that state. In conclusion, migrant households maintain some of the preferences of their origin state after migration.

5.2 Migrants consume fewer calories for a given level of food expenditure

I now investigate whether migrants consume fewer calories than those that stayed behind, controlling for total food expenditure. Since migrants' tastes are no longer inversely correlated with local prices, the foods they find particularly tasty now cost relatively more.[68] The expenditure terms absorb any income gain from moving (similar to the production gains from trade).

I regress caloric intake per person per day, $calories_i$, on a migrant-household dummy, $migrant_i$:

$$calories_i = b_0 + b_1 migrant_i + a_1 \ln food_i + a_2 \ln food_i^2 + \sum_o \gamma_o d_o + \Pi Z_i + \varepsilon_i. \quad (6)$$

I flexibly control for total food expenditure, $food_i$, with a quadratic in $\ln food_i$ and include an extensive set of demographic and seasonal controls Z_i.[69] Finally, I include origin-state dummies, d_o, so that the coefficient on $migrant_i$ picks up the difference in caloric intake between those that stayed in the origin state and those that left.[70]

Table 6 shows the results of this regression for the three samples. Inter-state migrants consume fewer calories for a given level of food expenditure ($b_1 < 0$), even when just comparing inter-state

[66] Some of the positive correlation picked up by the current state dummy, $\mathbf{I}_{d=s}$, is purely mechanical, since I am correlating individual budget shares with their state mean budget shares. However, this bias towards 1 will be small as the average state sample contains over 4,000 households.

[67] These controls include food expenditure terms, the age of the household head and spouse, the education level of the household head, rural-urban origin destination dummies, scheduled caste or tribe, religion, main household activity and household composition variables. Table 17 presents these regressions.

[68] The preferred origin-state foods are relatively expensive in the destination state because prices and tastes are inversely correlated, as shown in table 2 across regions. The same relationship holds across states, where the correlation between normalized state-level tastes and median state prices is -0.08 (95 percent interval from -0.129 to -0.023).

[69] I use log food expenditure as, like income, food expenditure is distributed log normally (while caloric intake is not). The additional controls are age variables, the education level of the household head, rural-urban origin destination dummies, scheduled caste or tribe, religion, main household activity and household composition variables.

[70] Migrants may be moving to locations with higher prices for all goods. These concerns are partially met by including dummies for every rural-urban migration combination. As an additional check, the regressions are rerun with destination dummies. This compares the caloric intake of migrants with those living in their destination whose tastes have already adapted to the local prices. Migrants still consume fewer calories per rupee spent, although the magnitude of the caloric loss decreases by about one third. These results are reported in table 20 in the appendix.

Table 6: Caloric Intake of Migrants Compared to Non-Migrants

	(1)	(2)	(3)
	Daily Calories Per Person $calories_i$		
	Full Sample	Wife Move	Wife Move 2
$migrant_i$	-107.2***	-115.0***	-43.87**
	(18.2)	(17.0)	(18.2)
$\ln food_i$	-2777***	-3787***	-3959***
	(963)	(588)	(630)
$\ln food_i^2$	478.1***	585.8***	609.6***
	(115)	(67.1)	(72.1)
Observations	124,578	52,836	47,501
R^2	0.50	0.66	0.67

Note: Daily calories per person regressed on inter-state migrant dummy, log food expenditure terms, origin-state dummies and controls Z_i, with the full results shown in tables 18 and 19. Robust standard errors. All regressions survey weighted. * significant at 10%, ** 5%, *** 1%.

to intra-state wife migrations in columns 2 and 3.[71] Being an inter-state migrant corresponds to the consumption of over 100 fewer calories per person per day, or about 5 percent of total caloric intake, controlling for log food expenditure. The caloric loss is smaller in the third column, where wives move to their husband's village of birth. This is reasonable, as these households are likely to be more traditional and contain other members of the husband's family, and so the out-of-state wife might be expected to have a smaller say in overall household food purchasing decisions, and the extended family will be familiar with the recipes and preparation techniques that take best advantage of the local foods. The quadratic food expenditure terms imply that for a household at the Indian average, a 10 percent rise in food expenditure corresponds to the consumption of 150 more calories per person per day.

In tables 18 and 19 in the appendix, I exclude the expenditure controls and show that migrants do not actually consume fewer calories, as their food expenditure is higher than those who stayed behind. Part of this derives from the production gains from trade that made the large migration costs worthwhile, as migrants have significantly higher total and food expenditure compared to non-migrants in both their origin and destination states. However, they consume approximately the same number of calories as both non-migrant groups, and this drives the results found above.

Combining this evidence with that shown in the previous section suggests that migrant households consume substantially fewer calories for a given level of food expenditure as they continue to consume the favored products from their origin state that are now relatively expensive in their destination state. I will perform a stronger test of hypothesis 4 shortly, by demonstrating that this

[71] As with the regional regressions, I replace total food expenditure with total expenditure to verify that there is not full reallocation between food and non-food expenditure. The conditional caloric loss is reduced but only slightly, as shown in appendix tables 18 and 19. Additionally, as calories and food expenditure are calculated using the same raw data, measurement error may induce an upward bias on a_1 and a_2. However, results are unchanged when I instrument food expenditure with non-food expenditure.

caloric reduction for a given level of food expenditure is larger when the price changes faced upon the particular migration route correlate more strongly with the tastes of the migrant's origin state.

5.3 Caloric loss from migration shrinks over time

Migrant households' tastes will gradually adapt to favor the relatively cheap goods in their destination state through the process of habit formation. This will bring caloric gains (hypothesis 2). I test this hypothesis by supplementing the previous regression specification with the length of time since a wife moved, interacted with whether the wife is an inter-state migrant:[72]

$$calories_i = b_0 + b_1 migrant_i + b_2 yrsaway_i + b_3(migrant_i \times yrsaway_i) \\ + a_1 \ln food_i + a_2 \ln food_i^2 + \sum\nolimits_o \gamma_o d_o + \Pi Z_i + \varepsilon_i.$$

Table 7 shows the results of this regression, which once more support the habit formation hypothesis. One more year in the destination state increases daily caloric intake per person for a given food expenditure by an additional 2.6 calories ($b_3 > 0$). The coefficient is of a similar magnitude for the *wife move 2* specification, where the husband has never moved village, but is no longer significant. The number of years required for the tastes of an inter-state wife's household to fully adapt is b_1/b_3, or 65 years when the wife moved to another state upon marriage and 49 years when she moved to another state and to her husband's village of birth. Over many years and several generations, habit formation alters tastes to favor locally cheap foods, and there are corresponding caloric gains.

Table 7: Caloric Intake of Intra-State and Inter-State Wife Households Over Time

	(1)	(2)
	Daily Calories Per Person $calories_i$	
	Wife Move Sample	Wife Move 2 Sample
$migrant_i$	-167.0***	-77.13***
	(25.2)	(27.0)
$yrsaway_i$	5.318***	4.245***
	(0.64)	(0.67)
$migrant_i \times yrsaway_i$	2.582**	1.561
	(1.09)	(1.18)
Observations	52,800	47,465
R^2	0.66	0.67

Note: Daily calories per person regressed on an inter-state wife dummy, $migrant_i$, the years since a wife moved village and years interacted with being an inter-state wife. Log food expenditure terms, controls Z_i and origin-state dummies omitted, with full results shown in table 19. Robust standard errors. All regressions survey weighted. * significant at 10%, ** 5%, *** 1%.

[72] By focusing only on households in which the wives moved for marriage, I can control for caloric changes that depend on the length of time since the wife moved for marriage, $yrsaway_i$. This is necessary as the time since the wife moved will be correlated with demographic unobservables.

5.4 Caloric loss larger when tastes are correlated with price changes

In the final test, I show that the more origin-state tastes correlate with the price changes upon a particular migration route, the larger is the caloric loss, controlling for food expenditure. The specification mirrors that used in section 4.3 for temporal price changes across regions, except here I use the spatial price changes when moving from origin state o to destination state d.

Before running such a regression, I require an estimate of the caloric change, controlling for total food expenditure, for each origin-destination migration route. I regress the log of caloric intake on the controls in regression 6 and a complete set of $migrant_{iod}$ dummies that take the value 1 when a migrant moved from o to d. The 490 λ_{od} coefficients on $migrant_{iod}$ provide the estimates of the caloric change along each route, controlling for total food expenditure:

$$\ln calories_i = a_0 + \sum_o \sum_d \lambda_{od} \times migrant_{iod} + a_1 \ln food_i + a_2 \ln food_i^2 + \sum_o \gamma_o d_o + \Pi Z_i + \varepsilon_i.$$

In the second stage, I regress the sum of origin tastes multiplied by the price differences between o and d, $\sum_{g=1}^{52} tastes_{go} \Delta \ln p_{god}$, on the estimated $\widehat{\lambda_{od}}$ coefficients, as in equation 5.[73] As before, I include a term to control for the relative price per calorie, but omit the $\Delta \ln food_{od}$ term as the $\widehat{\lambda_{od}}$s already condition upon total food expenditure:

$$\widehat{\lambda_{od}} = b_0 + b_1 \sum_{g=1}^{52} tastes_{go} \Delta \ln p_{god} + b_2 \sum_{g=1}^{52} h_{go}(P_o, food_o) \Delta \ln p_{god} + b_4 \sum_{g=1}^{52} (J_{go} - \overline{J_o}) \Delta \ln p_{god} + \varepsilon_{od}.$$

The sample size is much larger compared to the regression across regions, with 490 observed origin-destination migration routes.[74] I estimate taste parameters and obtain prices for 1987-88 as before, but now by state rather than by region.[75]

Table 8 shows the results of this regression. The greater the correlation between origin tastes and the price changes faced on individual migration routes, the larger the decline in the number of calories obtained from a given level of food expenditure ($b_1 < 0$). These coefficients are slightly larger than those estimated from temporal price variation across regions. The fact that the results are of the same sign and order of magnitude provides strong evidence that caloric intake is negatively impacted when tastes correlate with price changes.

6 The Impact of Internal Trade Liberalization in India

6.1 Background on Agricultural Trade in India

I briefly review the current state of Indian agricultural trade before assessing the potential impact of domestic liberalization. Despite wide ranging economic reforms over the last two decades,

[73] Since I do not have historical price data, I use the price differences at the time of the survey, and must assume there were similar relative price differences between states at whichever time the migrant moved.

[74] Many of these $\widehat{\lambda_{od}}$ coefficients are estimated from very few observations and are imprecise. To increase efficiency, I also run the regression weighting each observation by the number of migrants in the sample who moved from o to d and the results are very similar to the weighted regression.

[75] Many migrants move between rural and urban sectors, and so I now use the full rural and urban sample.

Table 8: Caloric Change and the Correlation of Tastes with Spatial Price Changes

	(1)	(2)	(3)	(4)
$\widehat{\lambda_{od}}$ Caloric Change with Migration (Controlling for Total Food Expenditure)	Unweighted		Weighted	
$\sum_{g=1}^{52} tastes_{go} \Delta \ln p_{god}$ (Budget Shares)	-0.713***		-0.878***	
	(0.14)		(0.11)	
$\sum_{g=1}^{52} tastes_{go} \Delta \ln p_{god}$ (LA/AIDS)		-0.741***		-0.878***
		(0.15)		(0.11)
$\sum_{g=1}^{52} h_{go}(P_o, food_o) \Delta \ln p_{god}$ (LA/AIDS)		-0.613***		-0.878***
		(0.15)		(0.12)
$\sum_{g=1}^{52} (J_{go} - \overline{J_o}) \Delta \ln p_{god}$	7.769***	8.455***	-2.976	-2.968
	(2.78)	(2.61)	(2.53)	(2.80)
Constant	-0.0631***	-0.0674***	-0.0186	-0.0186
	(0.018)	(0.018)	(0.012)	(0.013)
Observations	490	490	490	490
R^2	0.10	0.10	0.35	0.35

Note: Dependent variable is the predicted log change in caloric intake per person after migration from o to d, flexibly controlling for log food expenditure. Independent variables come from the log linearization of caloric intake. Tastes estimated using food budget shares and unexplained state variation in food budget shares, with common price and expenditure controls (LA/AIDS). J_{gr} is the inverse relative price per calorie. Regressions are weighted in columns 3 and 4 by the total survey weight of the migrants on each migration route. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

India's agricultural sector remains highly restricted. While there has been new legislation at the national (Union) level to liberalize domestic markets, these measures have been applied erratically at best because agricultural policy is under the exclusive constitutional remit of state governments.[76]

Interventionist food policies were initially enacted in response to the perceived failures of private trade in the Bengal famine of 1943. The Essential Commodities Act (1955) entitles both governments and states to impose restrictions on "trade and commerce in, and the production, supply and distribution of foodstuffs."[77] Other agricultural acts control to whom farmers and traders are allowed to sell and at what price. All traders require licenses, have restricted access to credit and must follow over 400 rules that govern food trade (Planning Commisson of India 2001).

Internal trade is further restrained through state tariffs and district-level entry taxes, Octroi, collected at often corrupt checkpoints (Das-Gupta 2006). This is in addition to the extremely

[76] For example, the Agricultural Produce Marketing Acts was amended in 2003 to allow farmers to sell their produce directly to buyers for the first time. Only about half of the states have so far incorporated the amendment and in most cases with substantial changes.

[77] Some of the numerous state-level and even district-level restrictions that remain are detailed in FAO (2005).

poor transport infrastructure across India, which is perhaps the biggest hindrance to trading bulky agricultural goods within India. State governments are also directly involved in the purchase and sale of food. The Commission on Agricultural Costs and Prices sets minimum support prices for farmers that are only available in certain regions, while state levies require private mills to supply grain at a fixed price, which is then sold to the poor through the Public Distribution System at prices chosen by each state. Jha, Murthy, and Sharma (2005) discuss these numerous restrictions in more detail, and show that as a result wholesale rice markets across India are not integrated. The lack of integration is evident in the NSS data, in which the dispersion of regional prices actually increased between 1987-88 and 2004-05.[78]

Although there has been little progress reforming the domestic market, if India had fully liberalized all external trade, the domestic agricultural market would have become integrated. However, external agricultural trade has only seen limited reform in the years following India's 1991 liberalization. The initial tariff reductions did not cover agricultural goods at all. The impetus for agricultural liberalization came from the Agreement on Agriculture which India committed to as a founding member of the WTO. This agreement required the conversion of all non-tariff barriers and quantitative restrictions into tariffs by 2002, but left domestic support untouched. However, tariff levels were set sufficiently high to choke imports in all but pulses and oilseeds.[79] As a result, the FAO (2003) reports that there was little impact from the liberalization of agricultural trade under the Agreement on Agriculture between 1997 and 2002.[80]

India still maintains high tariffs, agricultural import monopolies, state trading enterprises and export restrictions that maintain a "highly interventionist agricultural development policy regime" (Athukorala 2005). Accordingly, alongside the domestic restraints detailed above, agricultural trade within India remains highly restricted, and internal markets are far from integrated.[81]

6.2 The Caloric Impact of Internal Trade Liberalization in India

In this section, I use my previous empirical results to predict the caloric impact of the liberalization of internal agricultural trade in India, such that prices are equalized across regions. If high transport costs are a major contributor to the lack of agricultural market integration within India, then these estimates are most relevant to a liberalization process that includes substantial infrastructure investments at the same time as the removal of other barriers to internal trade.

I calculate the predicted caloric loss on the consumption side coming from regional tastes correlating with these equalizing price changes, and the rise in total food expenditure that would be

[78] The average over 52 foods of the cross-regional coefficients of variation of rural median food prices rose from 0.51 in 1987-88 to 0.53 in 2004-05. Similarly, the average pairwise correlation between the median prices of the 52 foods in any two regions declined from 0.85 to 0.83 between the two surveys.

[79] In these two categories India is not self-sufficient and the government itself controls a substantial portion of imports via government agencies. In the words of (Gulati 1998), the Indian Government followed the following rule: "Allow imports if there was a net deficit and allow exports if there was a comfortable surplus."

[80] Agricultural exports did, however, respond positively to the 20 percent devaluation of the rupee in 1991.

[81] Therefore, my theoretical mechanism cannot explain the decline in caloric intake that has occurred across India in the last 20 years. In fact relative prices across regions have moved in the opposite direction to that suggested by relative endowments. For example rice was already relatively cheap in large rice growing areas, and has become more so over the reform period.

required to avoid absolute caloric losses. These estimates can be contrasted with the predicted caloric loss from the same price changes if regional tastes were equal to the average Indian tastes and were independent of regional endowments.[82] Comparing these two numbers provides an estimate of the bias on the consumption side from ignoring taste differences when predicting the nutritional impact of agricultural trade liberalization.

To proceed, I use the more conservative estimate of the elasticity of caloric change with the correlation between tastes and price changes, $\widehat{b_1}$, that comes from the regression across regions (regression 5 shown in table 4).[83] Under the assumption that all regions have the same elasticity, the predicted reduction in $\Delta \ln calories_r$ attributable to tastes correlating with resource endowments through habit formation is $\Delta \ln \widehat{calories}_r^{HF} = \widehat{b_1} \sum_{g=1}^{G} tastes_{gr} \Delta \ln p_{gr}^{lib}$. In order to estimate the likely impact of internal liberalization today, I use regional taste estimates $tastes_{gr}$ for rural households from the most recent thick NSSO survey (2004-05). For the predicted equalizing price changes, $\Delta \ln p_{gr}^{lib}$, I use the log difference between the Indian median price and the median price in region r, again from 2004-05.[84] For the counterfactual society, in which tastes are independent of endowments, I assume that tastes are identical across regions and equal to the average Indian tastes for each good, $\overline{tastes_g}$. In this case, the predicted reduction coming from tastes correlating with price changes is $\Delta \ln \widehat{calories}_r^{NHF} = \widehat{b_1} \sum_{g=1}^{G} \overline{tastes_g} \Delta \ln p_{gr}^{lib}$.

Table 9: The Negative Caloric Impact on Rural Households Coming From Tastes Being Correlated with the Price Changes at the Time of Indian Internal Trade Liberalization

All-India Predicted Means	(1) Actual Tastes $\Delta \ln \widehat{calories}_r^{HF}$	(2) Identical Tastes $\Delta \ln \widehat{calories}_r^{NHF}$	(3) Difference
Budget Shares Tastes	-0.0349***	-0.00412	-0.0308***
	(0.0067)	(0.0086)	(0.0041)
$\Delta \ln food$ expend. to avoid caloric loss	0.0475	0.0056	0.0419
$\Delta \ln expenditure$ to avoid caloric loss	0.0439	0.0052	0.0387
LA/AIDS Tastes	-0.0265*	-0.00364	-0.0229***
	(0.016)	(0.017)	(0.0037)
$\Delta \ln food$ expend. to avoid caloric loss	0.0362	0.0050	0.0312
$\Delta \ln expenditure$ to avoid caloric loss	0.0333	0.0046	0.0287

Note: 77 observations weighted by a region's total survey weight. $\Delta \ln \widehat{calories}_r^{HF}$ is the predicted log change in calories on the consumption side coming from regional tastes correlating with equalizing price changes in India using data from 2004-2005. $\Delta \ln \widehat{calories}_r^{NHF}$ is the predicted impact if tastes were identical across regions of India. Robust standard errors for means. * significant at 10%, ** 5%, *** 1%.

The results shown in table 9 suggest that, holding total food expenditure constant, there will be an average caloric loss of between 2.7 and 3.5 percent coming from the correlation between tastes

[82] This counterfactual only addresses the effects of habit formation on the consumption side as the autarky prices, and hence the price changes upon liberalization, would be different in a society without habit formation.

[83] I use the coefficient from the weighted regression that is representative of India.

[84] These are the median prices paid by the consumers who actually purchase the good.

and price changes. With identical tastes across India, the caloric loss from this channel would be essentially zero. Therefore, by correlating tastes with endowments, habit formation leads to a reduction in caloric intake of between 2.3 and 3.1 percent for rural households, holding total food expenditure constant (average caloric intake was 1,985 calories in 2004/05).

The estimated coefficient on total food expenditure in regression 5 was between 0.73 and 0.74. Therefore, trade will have to generate income gains that increase average total food expenditure by 3.6 to 4.7 percent in order to compensate for the caloric loss that comes from the correlation of tastes and price changes. Using the coefficients from table 15, the total expenditure gains required are very similar and lie between 3.3 and 4.4 percent.

The magnitudes of these required income gains on the consumption side are large enough to raise the concern that the static production gains may be insufficient to avoid an average caloric loss at the time of internal trade liberalization. General equilibrium trade models have been used to estimate the production gains from agricultural trade liberalization that come through greater specialization. Huang, Jun, Xu, Rozelle, and Li (2007) estimate that China's agricultural liberalization, which accompanied its unique and stringent 2001 WTO accession, increased nominal food expenditure for the average farm household by 1.1 percent by 2005, with real food consumption actually falling by about 1 percent. Anderson and Valenzuela (2007) predict that full liberalization of world agricultural trade would result in the value added by farmers increasing by only 0.3 percent for lower-income developing countries (India in particular would suffer a 2.3 percent decline coming from reduced domestic protection).[85] These low estimates of the static income gains from trade suggest that absolute caloric losses for rural households are quite possible if India were to fully liberalize its internal agricultural trade.

The negative caloric impacts that come from tastes correlating with price changes will not be spread uniformly across India. Figure 6 plots the predicted caloric loss from internal trade liberalization, holding food expenditure constant, against the mean per-capita expenditure of the region in 2004-05 (using my preferred LA/AIDS taste estimates). The circle sizes are proportional to the population in each region. There is a highly significant positive slope, with poorer regions more likely to suffer caloric losses on the consumption side if India were to liberalize its internal trade.[86] The poorer regions spend larger portions of their incomes on local staple foods, and so will be harder hit on the consumption side when comparative advantage foods rise in price.[87]

My estimates assume that the elasticity of caloric change with respect to the correlation be-

[85] Indian farmers would increase their value added from global agricultural trade liberalization by 3.2 percent if India had no existing tariffs. This paper uses the GTAP-AGR model. In another paper using the World Bank Linkage model, Anderson, Martin, and van der Mensbrugghe (2006) give nominal unskilled wage changes for the case of full global trade liberalization, with nominal unskilled wages rising by 0.4 percent worldwide and real unskilled wages rising by 1.2 percent.

[86] There is a similarly significant positive relationship when I deflate expenditure by a Stone price index based on national budget shares. However, it is not clear whether any price index makes sense with different tastes across regions.

[87] I find evidence that poorer regions spend a larger portion of their budget on foods that are expected to rise in price. The mean per-capita expenditure of a region is strongly negatively correlated with the budget share spent on the foods that are relatively cheap (a correlation of -0.522 with a 95 percent confidence interval of between -0.668 and -0.338). Part of this result is driven by the fact that poorer regions have lower agricultural prices on average.

tween price changes and tastes is not smaller in poorer regions. Table 10 shows the results of regression 5 run separately for the richer and poorer regions. The elasticity is actually larger in poorer regions, suggesting that poorer regions will suffer even larger caloric losses conditional upon total food expenditure than those shown in figure 6.

If I use my cruder taste measure, the budget share, I can calculate the predicted caloric change for each household, using household budget shares and unit values. Now different income groups can possess different tastes within each region, as would be the case with habit formation under non-homothetic preferences. Figure 7 shows a locally weighted regression of individual per-capita expenditure against the predicted caloric loss, controlling for total food expenditure, again using my elasticity estimate from regression 5. The rich, who consume more diversified diets, are predicted to gain in caloric terms, while the poorest suffer the most through their tastes being correlated with price changes. Caloric inequality across India will increase unless trade liberalization brings the largest income gains to the poorest rural households.

The full distribution of caloric intake before and after trade liberalization can also be calculated in this manner. Figure 8 shows that the correlation between tastes and equilibrating price changes shifts the distribution of caloric intake to the left, holding total food expenditure constant. Households consuming less than 1,750 calories per person face the gravest risk of malnutrition. Therefore, nutritionists will particularly worry that the predicted distribution of caloric intake post trade liberalization, holding total food expenditure constant, shows an increase in the number of households that fall into this zone.

This analysis focuses solely on the caloric loss on the consumption side coming from tastes being correlated with local resource endowments. The theory of habit formation suggests that the economy-wide production gains from trade will also shrink as regional tastes bring autarky prices closer together. However, this cannot be verified empirically because of the impossibility of observing autarky prices in the absence of habit formation. Habit formation may also change the distribution of these reduced production gains.[88] The consumer price changes that I use to estimate the caloric elasticities were not the result of internal trade liberalization, being inversely related to endowments. Inferring the relationship between tastes and the size of the income gains from trade-induced producer price changes is not feasible using these data as the political economy factors that were likely to have determined the price changes in my sample period may have also altered incomes directly.[89] Understanding how habit formation affects the distribution of the production gains from trade will therefore require the analysis of more detailed agricultural production data.

7 Conclusions and Policy Implications

International trade theory generally assumes that tastes are identical across regions and independent of endowments. In this paper, I show that habit formation in food consumption leads to

[88] If there are larger income gains for the most undernourished groups compared to a society without habit formation, policymakers may be unconcerned that habit formation mutes the aggregate caloric gains from trade.

[89] For example, regions where price movements were more correlated with resource endowments (and therefore tastes) may have had more free-market policies in general, and saw faster income growth accordingly.

regional food tastes that favor crops relatively well-suited to local agro-climatic endowments. This connection erodes the short-run caloric gains from trade liberalization on both the production side (by bringing the autarky and world trade prices closer together) and the consumption side (by limiting the substitution out of the foods that rise in price at the time of liberalization). Only decades after trade liberalization can consumers realize the full caloric gains from trade, as food tastes and preparation techniques gradually adapt to favor the foods that trade has made affordable.

I verify the empirical relevance of the consumption side of the model by exploring India's non-integrated domestic agricultural markets. Regional tastes, measured by the unexplained regional variation in household demand for agricultural products, correlate positively with agro-climatic endowments and negatively with local prices. Between 1987 and 2005, the ordering of tastes for the 52 foods within each region responded to relative prices as habit formation would suggest. Over the same period, caloric intake declined more in regions where price rises were more concentrated in locally favored foods, controlling for changes in food expenditure.

I confirm these results by looking at the consumption patterns of inter-state migrants within India, who obtain fewer calories for a given level of food expenditure as their favored foods cost more outside their origin state. This effect dissipates with time, only disappearing several generations after migration. For the 490 observed migration routes, the caloric intake from a given level of food expenditure declines more where price rises are more concentrated in migrants' preferred origin-state foods.

My findings imply that if India were to liberalize its internal agricultural trade, the prices of preferred foods will rise in each region. Consumers are reluctant to substitute away from these foods, and trade must generate larger income gains in order to avoid caloric losses, as compared to a society without habit formation. I predict the magnitude of the required increase in income to be between 3.3 and 4.4 percent, which is generally larger than the estimated static nominal income gains from other agricultural trade liberalization scenarios. The poor, who consume larger shares of local staple foods, will be especially hard hit through this mechanism, with the proportion of the rural population who consume less than 1,750 calories per day likely to rise unless trade brings substantial nominal income gains to the poorest households.

These results have important policy implications. If agricultural trade liberalization reduces the caloric intake of the poor, from levels already bordering on malnutrition, there will be serious consequences. It is impossible to compensate in later life for nutritional shortfalls at a young age, and an entire generation will be damaged. The most harmful nutritional impacts can be avoided by accompanying agricultural liberalization with temporary food subsidies for favored local staples, specifically targeted at households on the edge of malnourishment. Many developing countries already have large-scale food distribution systems in place, making this measure easy to implement. As was the case with the introduction of the potato in Europe, governments can also take direct measures to encourage the adoption of foods that trade has made relatively cheap, ensuring that the full caloric gains from trade arrive more quickly.

Taking local taste differences seriously also has ramifications for estimating Computational General Equilibrium models. These have become an important and common tool in understanding the impacts of various trade liberalization scenarios, and their predictions influence policymakers. The use of home-biased Armington preferences, where consumers prefer domestic to foreign varieties of any good, has become commonplace in order to match the observed trade flows upon liberalization. Welfare effects hinge critically on the elasticities of substitution between foreign and domestic varieties (Hertel, Hummels, Ivanic, and Keeney 2007), yet such preferences are ad hoc and improbable for homogenous agricultural commodities. Developing my model of habit formation that links local endowments with cross-price elasticities of substitution can produce Armington-like results but with a firm theoretical grounding for agricultural goods.

Tastes matter for trade. Neglecting their role overstates the caloric gains from agricultural trade liberalization, and masks potential nutritional losses for the poorest members of society.

Figure 6: The Predicted Caloric Losses from Liberalization and Regional Expenditure
(Total Food Expenditure Held Constant, LA/AIDS Tastes, Markers Proportional to Population)

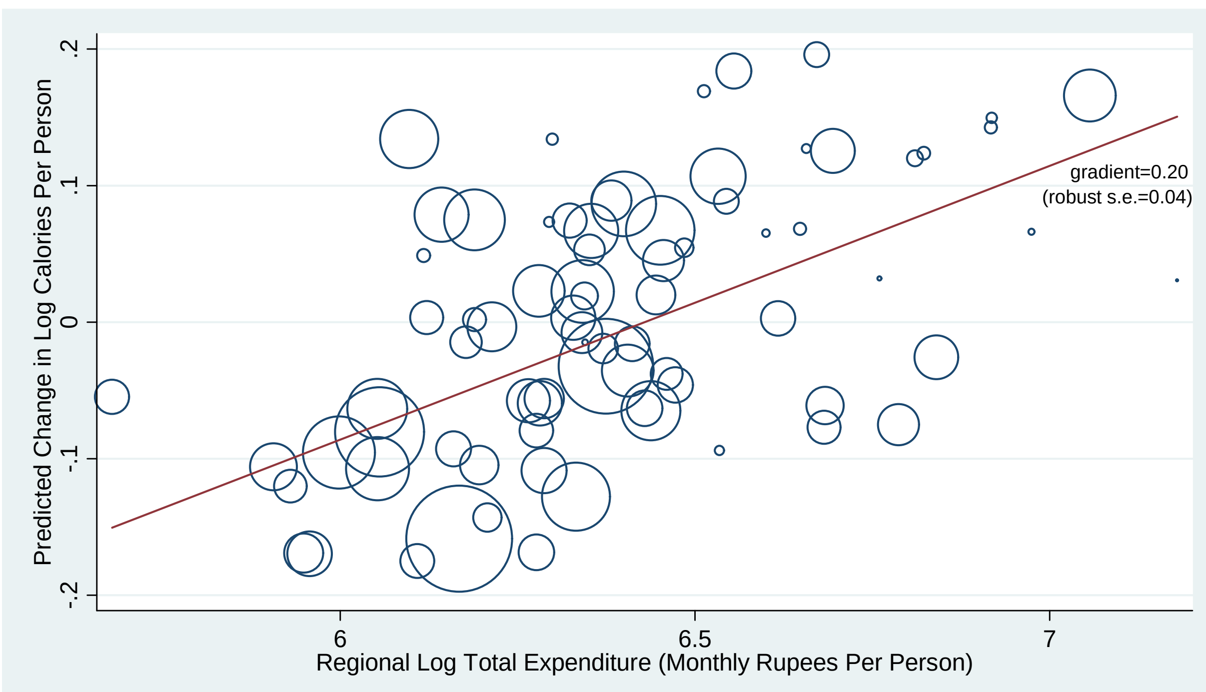


Figure 7: The Predicted Caloric Losses from Liberalization and Household Expenditure
(Total Food Expenditure Held Constant, Household Budget Share Taste Estimates)

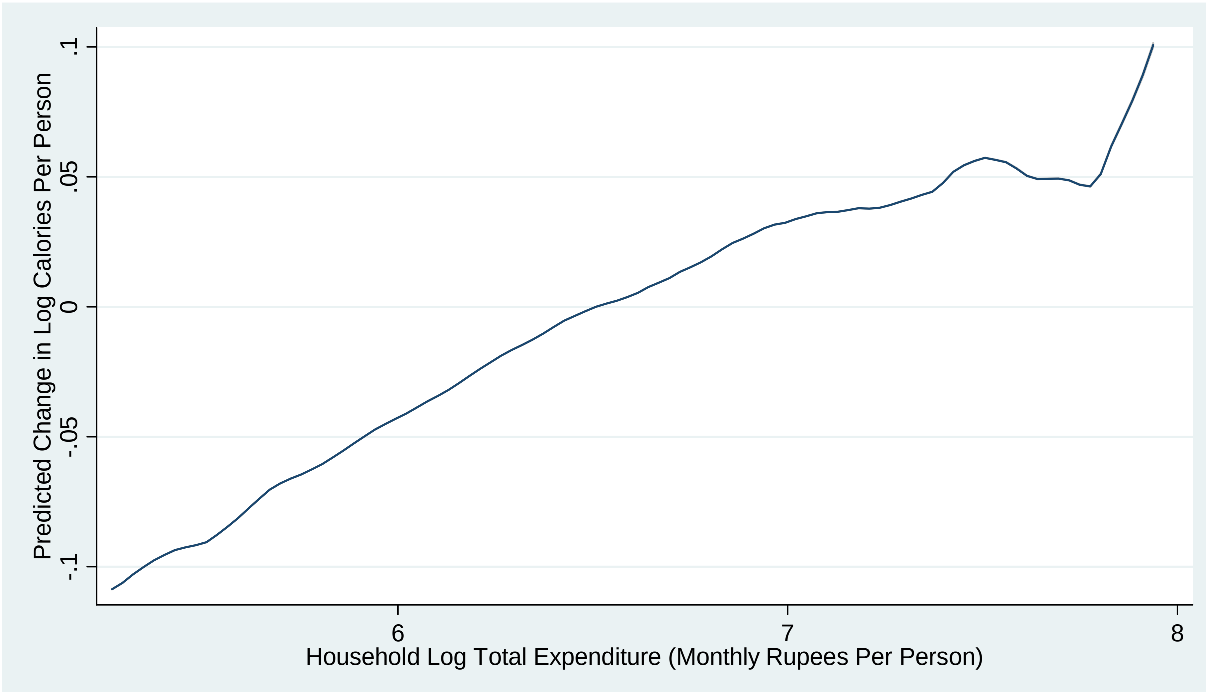


Figure 8: The Distribution of Caloric Intake Pre and Post Trade Liberalization
(Total Food Expenditure Held Constant, Household Budget Share Taste Estimates)

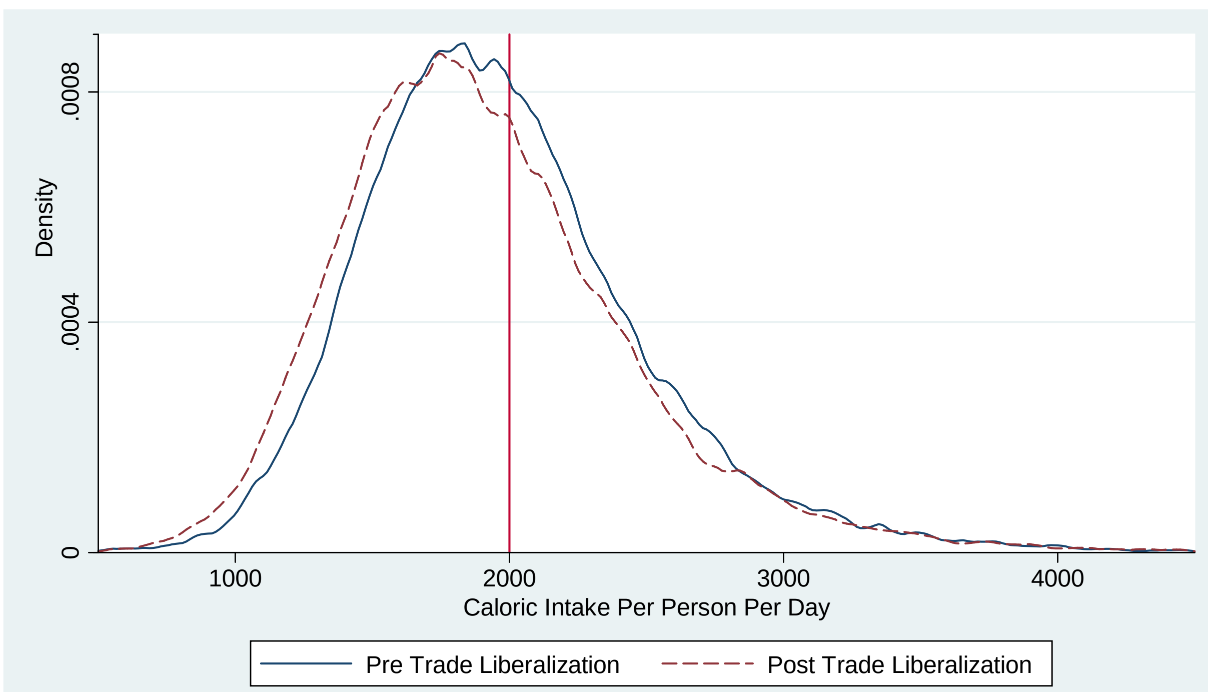


Table 10: Caloric Change and the Correlation Between Tastes and Temporal Price Changes for Richer and Poorer Regions

	(1)	(2)
	$\Delta \ln calories_r$ 1987-88 to 2004-05	
	Richer Half of Sample	Poorer Half of Sample
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$ (LA/AIDS)	-0.158	-0.645***
	(0.13)	(0.12)
$\sum_{g=1}^{52} h_g(P_r, food_r) \Delta \ln p_{gr}$ (LA/AIDS)	-0.109	-0.633***
	(0.13)	(0.17)
$\Delta \ln food_r$	0.720***	0.691***
	(0.089)	(0.067)
$\sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}$	3.462**	1.042
	(1.32)	(2.18)
Constant	-0.760***	-0.152
	(0.13)	(0.095)
Observations	38	37
R^2	0.76	0.75

Note: Dependent variable is the log change in caloric intake per person between 1987-88 and 2004-05. The independent variables come from the log linearization of caloric intake. J_{gr} is the inverse relative price per calorie. Regressions are weighted by a region's total survey weight. The sample is split by a region's average monthly per-capita expenditure in 1987/88. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

Appendices

A A Simple Model of Habit Formation and Trade

A.1 Proof of Hypothesis 1:

In the specific factors model, the proof that preferences become correlated with relative resource endowments proceeds as follows. The production functions for rice and wheat have constant returns to scale and diminishing returns. One unit of each good provides one calorie.

I will first model the production side of the economy. The population is divided into laborers and factor (land) owners. Each labor owner possesses one unit of labor and there is L total labor in the economy. The distribution of rice land, T_r, and wheat land, T_w, among the population will be left unmodeled. Q_r and Q_w are the outputs of the two goods produced from labor and their specific factor:

$$\begin{aligned} Q_r &= f_r(T_r, L_r), \\ Q_w &= f_w(T_w, L_w), \\ \frac{\partial f_i}{\partial T_i} &> 0, \frac{\partial f_i}{\partial L_i} > 0, \frac{\partial^2 f_i}{\partial T_i^2} < 0, \frac{\partial^2 f_i}{\partial L_i^2} < 0, \frac{\partial^2 f_i}{\partial T_i \partial L_i} > 0. \end{aligned}$$

I normalize the price of wheat to 1:

$$p_w = 1, p_r = p.$$

Labor is divided between rice and wheat production and factor clearing implies that all the labor in the economy is exhausted. Labor is free to move between the two sectors and so marginal returns in the two sectors are equalized:

$$\begin{aligned} L &= L_r + L_w, \\ p\frac{\partial f_r}{\partial L_r} &= \frac{\partial f_w}{\partial L_w}, \\ \frac{\partial L_r}{\partial p} &= \left[\frac{-\frac{\partial^2 f_w}{\partial L_w^2}}{\frac{\partial f_r}{\partial L_r}} - \frac{\frac{\partial f_w}{\partial L_w}}{(\frac{\partial f_r}{\partial L_w})^2} \frac{\partial^2 f_r}{\partial L_r^2} \right]^{-1} > 0. \end{aligned}$$

The specific factors T_w and T_r are fixed over generations. However, I calculate the derivatives with respect to the specific factors to see how initial endowments affect the initial equilibrium:

$$\begin{aligned} p\frac{\partial^2 f_r}{\partial L_r \partial T_r}\partial T_r + p\frac{\partial^2 f_r}{\partial L_r^2}\partial L_r &= -\frac{\partial^2 f_w}{\partial L_w^2}\partial L_r + \frac{\partial^2 f_w}{\partial L_w \partial T_w}\partial T_w, \\ \frac{\partial L_r}{\partial T_r} &= -\frac{p\frac{\partial^2 f_r}{\partial L_r \partial T_r}}{\frac{\partial^2 f_w}{\partial L_w^2} + p\frac{\partial^2 f_r}{\partial L_r^2}} > 0, \frac{\partial L_r}{\partial T_w} = \frac{\frac{\partial^2 f_w}{\partial L_w \partial T_w}}{\frac{\partial^2 f_w}{\partial L_w^2} + p\frac{\partial^2 f_r}{\partial L_r^2}} < 0. \end{aligned}$$

I define the relative production of rice, r, as z. Individual producers take prices as given, and so I can calculate the relative supply response to price changes, as well as to differing quantities of the initial endowments:

$$\begin{aligned} z &= \frac{Q_r}{Q_w} = \frac{f_r(T_r, L_r)}{f_w(T_w, L_w)}, \\ \frac{dz}{dp} &= \frac{1}{f_w}\frac{df_r}{dp} - \frac{f_r}{f_w^2}\frac{df_w}{dp} = \frac{1}{f_w}\frac{\partial f_r}{\partial L_r}\frac{\partial L_r}{\partial p} + \frac{f_r}{f_w^2}\frac{\partial f_w}{\partial L_w}\frac{\partial L_r}{\partial p} > 0, \\ \frac{dz}{dT_r} &= \frac{1}{f_w}\frac{df_r}{dT_r} - \frac{f_r}{f_w^2}\frac{df_w}{dT_r} = \frac{1}{f_w}\frac{\partial f_r}{\partial T_r} + \frac{f_r}{f_w}\frac{\partial f_r}{\partial L_r}\frac{\partial L_r}{\partial T_r} + \frac{f_r}{f_w^2}\frac{\partial f_w}{\partial L_w}\frac{\partial L_r}{\partial T_r} > 0, \\ \frac{dz}{dT_w} &= \frac{1}{f_w}\frac{df_r}{dT_w} - \frac{f_r}{f_w^2}\frac{df_w}{dT_w} = \frac{1}{f_w}\frac{\partial f_r}{\partial L_r}\frac{\partial L_r}{\partial T_w} + \frac{f_r}{f_w^2}\frac{\partial f_w}{\partial L_w}\frac{\partial L_r}{\partial T_w} - \frac{f_r}{f_w^2}\frac{\partial f_w}{\partial T_w} < 0. \end{aligned}$$

I now turn to modelling the demand side of the economy. I assume demand is homothetic so that the distribution of factors across the economy does not impact relative consumption decisions. Relative tastes for rice, $tastes_r$, increase the budget share spent on rice, $bshare_r = \theta_r$, conditional on the relative rice price:

$$\theta_r = tastes_r + h_r(p) \text{ where } h_r'(p) \leq 0.$$

I define the relative consumption of r as γ. Individual consumers take prices as given, and so I can calculate the price response of relative demand, as well as the impact of changes in tastes:

$$\begin{aligned} \gamma &= \frac{\theta_r}{p(1-\theta_r)} = \frac{tastes_r + h_r(p)}{p(1 - tastes_r - h_r(p))}, \\ \frac{d\gamma}{dp} &= \frac{p(1-\theta_r)h_r'(p) - \theta_r((1-\theta_r) - ph_r'(p))}{p^2(1-\theta_r)^2} < 0, \\ \frac{d\gamma}{dtastes_r} &= \frac{1}{p(1-\theta_r)^2} > 0. \end{aligned}$$

Market clearing equilibrates relative supply and demand under autarky, with the equilibrium values superscripted with a:

$$z^a(p, T_r, T_w) = \gamma^a(tastes_r, p).$$

I will use the derivatives calculated for relative supply and demand to assess the impact of relative endowments on prices and tastes.[90]

Two different regions at the beginning of time have the same preferences that favor each good equally and technologies are identical in the two sectors. Region 1 is endowed with $T + x$ units of rice growing land T_r and T units of wheat growing land T_w. Region 2 has the reverse relative endowments, nT units of rice growing land T_r and $n(T + x)$ units of wheat growing land T_w. The population of region 1 is L, while region 2 has a population of nL. Region 2 is much bigger than region 1 as n is large.

In a hypothetical economy with the balanced endowments, $T = T_w = T_r$, raising the endowment of T_r to region 1's initial endowment will raise the relative production of rice since $\frac{dz}{dT_r} > 0$, bringing the economy out of equilibrium. The price will have to fall to reduce the relative production and raise the relative consumption of rice until equilibrium is reestablished because $\frac{dz}{dp} > 0$ and $\frac{d\gamma}{dp} < 0$. The opposite effect will occur when the endowment of T_w is increased to obtain region 2's initial endowment.[91] Therefore in the first generation, the region where rice is relatively abundant consumes relatively more rice and has a lower relative price for rice.

Tastes for rice, $tastes_{r,t}$, change over generations t through the process of habit formation. They are positively related to the past generation's relative consumption through adult tastes that favor foods consumed as a child:

$$tastes_{r,t} = g(\gamma_{t-1}^a) \text{ with } g'(\gamma_{t-1}^a) > 0.$$

[90] These were partial equilibrium derivatives as I did not impose equality between relative supply and relative demand until now.

[91] The homogenous of degree one production functions mean that the two regions are comparable since the scaling factor n only affects absolute quantities, not the relative measures reffered to here.

In the second generation, habit formation increases the tastes for rice in region 1 (the relatively rice abundant region) compared to region 2, as γ^a_{t-1} is larger in region 1.[92]

This proves hypothesis 1: *A region develops tastes inversely related to the relative prices it faces. Therefore, tastes will become positively correlated with a region's relative resource endowments.*

A.2 Details of Assumption 1:

For the existence of a steady state I require that a fixed point exists where relative consumption does not change with an increase in tastes, so that

$$tastes_{r,t} = g(\gamma^a_t(tastes_{r,t}, p_t)).$$

For stability and a steady state which converges without oscillating, an increase in tastes today must lead to a less than proportional increase in tastes tomorrow, as tastes approach the steady state from below:

$$\begin{aligned} tastes_{r,t} &= g(\gamma^a_{t-1}(tastes_{r,t-1}, p_{t-1})), \\ 0 &< \frac{dg(\gamma^a_{t-1}(tastes_{r,t-1}, p_{t-1}))}{dtastes_{r,t-1}} < 1. \end{aligned}$$

I assume such a fixed point exists and is stable, and that the steady state has a price less than 1 and so is an interior steady state where both rice and wheat continue to be consumed. These steady state values are reached in generation s:

$$\begin{aligned} tastes_{rs} &= g(\gamma^a_s(tastes_{rs}, p_s)), \\ p_s &< 1. \end{aligned}$$

These conditions are characterized for the Cobb-Douglas case in appendix A.5.

A.3 Proof of Hypothesis 2:

Assuming the rise in the rice price necessary to equilibrate the economy is not so large that p rises above the hypothetical balanced-endowment economy's autarky price of $p = 1$, tastes in period 2 will be inversely correlated with autarky prices. The aggregate caloric maximum is at $p = 1$, found by setting $\frac{dcalories}{dr} = 0$ along the edge of the production possibilities frontier. Caloric intake increases with a rise in p up to that point as the production possibilities frontier is concave.

$$\begin{aligned} calories &= r + w(r) \\ \frac{dcalories}{dr} &= 1 + \frac{dw}{dr} = 1 - p \end{aligned}$$

The rice price increases in region 1 with habit formation, as the increased tastes for rice raise demand for rice. The rice price was initially below 1 and therefore the aggregate caloric intake

[92] This increases the relative consumption of rice bringing about a price response (since endowments are fixed). To bring production into equilibrium, the price of rice must rise as $\frac{dz}{dp} > 0$ and $\frac{d\gamma}{dp} < 0$.

increases with habit formation as long as rice remains relatively cheap ($p < 1$).

A.4 Proof of Hypothesis 3:

Region 1 integrates with the much larger region 2, and takes region 2's prices as given at the time of trade liberalization. Post trade values are superscripted with an asterisk. The new world price is $p^* > 1$. Tastes are fixed and I look only at region 1 and the generation initially affected by trade liberalization. Upon trade liberalization, rice is now relatively more expensive ($p^* > 1$) and caloric intake increases in wheat consumption. With an exogenous world price, the consumption decision can be separated from the production decision and relative consumption is determined by

$$\gamma = \frac{tastes_{rt} + h_r(p^*)}{p(1 - tastes_{rt} - h_r(p^*))}, \text{ where } \frac{\partial \gamma}{\partial tastes_{rt}} > 0,$$

with the budget set defined by

$$p^* r^* + w^* \leq p^* Q_r^* + Q_w^*.$$

Caloric intake is now decreasing in rice consumption and the taste for rice, as wheat is relatively cheap:

$$\begin{aligned} calories^* &= r^* + w^* = (1 - p^*)(\frac{tastes_{rt} + h_r(p^*)}{p^*})(p^* Q_r^* + Q_w^*) + p^* Q_r^* + Q_w^*, \\ \frac{dcalories^*}{dtastes_{rt}} &= \frac{(1 - p^*)}{p^*}(p^* Q_r^* + Q_w^*) < 0. \end{aligned}$$

With habit formation, steady state $tastes_{rs}$ favor rice, and so caloric intake is lower than if tastes were neutral as in the first generation (without habit formation, the neutral tastes, $tastes_{r1} = \frac{1}{2}$, of the first generation are also the tastes of every subsequent generation). The relatively higher consumption of rice reduces caloric intake compared to the no habit formation society facing the same world price p^* and hence the same budget set.

The autarky price in region 2 will also be reduced by habit formation (as tastes for wheat bid up the price of wheat). Therefore, the caloric intake post trade in a world without habits will be even larger than if the post trade price was p^*, as wheat will be even cheaper at the time of liberalization and the greater production gains from trade will allow consumption at a point beyond that obtainable in the habit formation world:

$$\begin{aligned} \frac{dcalories^*}{dp^*} &= (1 - p^*)(\frac{-(tastes_{rt} + h_r(p^*))}{p^{*2}} Q_w^* + (\frac{h_r'(p^*)}{p^*})(p^* Q_r^* + Q_w^*)) + (Q_r^* - r^*) > 0, \\ \text{as } p^* &> 1 \text{ and region 1 exports rice, } (Q_r^* - r^*) > 0. \end{aligned}$$

Habit formation increased the aggregate caloric intake of each generation up to the steady state generation s (hypothesis 2). Therefore since aggregate caloric intake was lower pre trade and higher post trade without habit formation, this implies that habit formation reduces both the aggregate caloric gains from trade as well as the caloric elasticities with respect to trade liberalization.

This proves hypothesis 3 for the case where $p^* > 1$: *Habit formation reduces the short-run* *aggregate caloric elasticities with respect to trade liberalization.*

If $p^* = 1$ in both the habit and no habit worlds, the caloric intake post trade is identical, but was higher pre trade with habit formation so that the absolute gains and elasticities are also reduced. If $p_s < p^* < 1$, the impact is ambiguous, although the change in caloric intake and the caloric elasticity are still likely to be reduced as long as the relative endowment $\frac{T_r}{T_w}$ is not very close to 1, as the economy-wide production gains are much smaller with habit formation (as p_s is higher than the autarky price without habit formation, p_1).

A.5 Characterization of the Steady State with Cobb-Douglas Functional Forms

Here I solve the model outlined in the theory section with specific functional forms. For simplicity I choose Cobb-Douglas production functions exhibiting constant returns to scale, so that $h_r(p) = 0$. The basic model is about preferences changing and so to abstract from other differences between the two goods I make the two production technologies equally labor intensive. I focus on region 1 where $T_r > T_w$:

$$\begin{aligned}
Q_{rt} &= L_{rt}^{\beta} T_r^{1-\beta}, \\
Q_{wt} &= L_{wt}^{\beta} T_w^{1-\beta}, \\
0 &< \beta < 1.
\end{aligned}$$

Let $p_{rt} = p_t$ and the price of one unit of wheat be the numeraire $p_{wt} = 1$. Factors earn marginal products in competitive equilibrium, resulting in the following factor pricing equations, where ω_t are wages, π_{rt} the returns to rice land and π_{wt} the returns to wheat land:

$$\begin{aligned}
\omega_t &= \frac{dp_t Q_{rt}}{dL_{rt}} = p_t \beta (\frac{T_r}{L_{rt}})^{1-\beta}, && (7) \\
\omega_t &= \frac{dQ_{wt}}{dL_{wt}} = \beta (\frac{T_w}{L_{wt}})^{1-\beta}, && (8) \\
\pi_{rt} &= \frac{dp_t Q_{rt}}{dT_r} = p_t (1-\beta) (\frac{L_{rt}}{T_r})^{\beta}, && (9) \\
\pi_{wt} &= \frac{dQ_{wt}}{dT_w} = (1-\beta) (\frac{L_{wt}}{T_w})^{\beta}. && (10)
\end{aligned}$$

Factor clearing implies that all the labor in the economy is exhausted. Wages will be equalized across both sectors as workers are mobile. By feeding in this factor clearing condition I obtain relative prices as a function of the labor in each sector:

$$\begin{aligned}
L_{rt} + L_{wt} &= L, && (11) \\
p_t &= (\frac{T_w}{T_r} \frac{L_{rt}}{(L - L_{rt})})^{1-\beta}. && (12)
\end{aligned}$$

Utility is Cobb-Douglas and so budget shares are independent of prices. The budget share spent on rice is therefore simply $tastes_{rt}$ and in the first generation tastes are neutral and $tastes_{r1} = \frac{1}{2}$:

$$U_t(r_t, w_t) = r_t^{tastes_{rt}} w_t^{1-tastes_{rt}}.$$

I provide a functional form for habit formation, where tastes for rice depend on the previous generations relative consumption of rice, but with a dampening parameter ν. This determines how much tastes for rice respond to an increase in relative rice consumption:

$$tastes_{rt} = \frac{(r_{t-1})^{\nu}}{(r_{t-1})^{\nu} + (w_{t-1})^{\nu}}, \quad \nu > 0.$$

The Cobb-Douglas preferences imply the following demand functions, where m_t is total factor income:

$$\begin{aligned} r_t &= tastes_{rt}\frac{m_t}{p_t}, \\ w_t &= (1 - tastes_{rt})m_t. \end{aligned}$$

Because demand is homothetic, everyone in the economy spends the same proportion of their income on each good. Therefore product market clearing for good r implies that:

$$L_{rt}^{\beta} T_r^{1-\beta} = tastes_{rt}\frac{(\omega_t L + \pi_{rt} T_r + \pi_{wt} T_w)}{p_t}. \tag{13}$$

Now I solve for equilibrium prices and labor allocation in generation t by combining the product market clearing condition 13 with the factor pricing equations 7-10 and the factor clearing equation 11.

$$\begin{aligned} L_{rt} &= tastes_{rt} L, \\ p_t &= (\frac{T_w}{T_r}\frac{tastes_{rt}}{(1 - tastes_{rt})})^{1-\beta}, \\ \omega_t &= \beta(\frac{T_w}{L})^{1-\beta}(\frac{1}{1 - tastes_{rt}})^{1-\beta}. \end{aligned}$$

These are the prices and labor allocation in generation t conditional on $tastes_{rt}$. However $tastes_{rt}$ is a function of the previous generation's demands with habit formation. By feeding the demands and prices in generation $t-1$ into $tastes_{rt} = \frac{(r_{t-1})^{\nu}}{(r_{t-1})^{\nu}+(y_{t-1})^{\nu}}$, I obtain the difference equation for $tastes_{rt}$:

$$tastes_{rt} = \frac{1}{1 + ((\frac{tastes_{r,t-1}}{(1-tastes_{r,t-1})})^{-\beta}(\frac{K}{T})^{1-\beta})^{\nu}}. \tag{14}$$

Solving for the steady state, I set $tastes_r = tastes_{rt} = tastes_{r,t-1}$ and rearrange. Steady-state values are identified by the subscript s:

$$tastes_{rs} = \frac{1}{1+(\frac{T_w}{T_r})^{\frac{(1-\beta)\nu}{1-\beta\nu}}},$$
$$p_s = (\frac{T_w}{T_r})^{\frac{(1-\nu)(1-\beta)}{1-\beta\nu}}.$$

The steady-state $tastes_{rs}$ are greater than a half, with tastes favoring rice consumption, as long as $T_r > T_w$ and $\beta\nu < 1$ (tastes do not respond excessively to relative consumption). Therefore tastes develop for the relatively abundant (comparative advantage) good, r in this example. This is hypothesis 1; tastes positively correlate with endowments. The steady state price remains less than 1 if $\nu < 1$.

The stability of the steady state without oscillation requires that $0 < \frac{df(tastes_{r,t-1})}{tastes_{r,t-1}} < 1$ at the steady state, where $f(tastes_{r,t-1}) = tastes_{rt} = (1+((\frac{tastes_{r,t-1}}{(1-tastes_{r,t-1})})^{-\beta}(\frac{T_w}{T_r})^{1-\beta})^{\nu})^{-1}$ from the difference equation 14:

$$\frac{df(tastes_{r,t-1})}{dtastes_{r,t-1}} = -(1+(\frac{1}{tastes_{r,t-1}}-1)^{\beta\nu}(\frac{T_w}{T_r})^{(1-\beta)\nu})^{-2}[(\frac{T_w}{T_r})^{(1-\beta)\nu}\beta\nu(\frac{1}{tastes_{r,t-1}}-1)^{\beta\nu-1}(-\frac{1}{tastes^2_{r,t-1}})].$$

Feeding in the steady state value of $tastes_{rs}$ and simplifying:

$$\frac{df(tastes_{r,t-1})}{dtastes_{r,t-1}} = \beta\nu.$$

A sufficient condition for tastes to be correlated with endowments, a stable steady state to exist and the steady state relative price of rice to be strictly less than 1 is $\nu < 1$. This rules out the possibility that preferences respond to past consumption to such a large degree that they overturn the resource comparative advantage. In this case the high demand for rice actually makes it relatively more expensive, but it continues to be consumed in ever larger amounts. This is related to how much a consumer values variety, as with $\nu \geq 1$ tastes increase to such an extent that they overwhelm the disutility from consuming a less varied diet. In the empirical section I show that this assumption holds for India, as prices for a food are relatively cheaper in regions where tastes are stronger for that food.

A.5.1 Caloric Impact of Trade Liberalization on Labor

I will now look at landless workers' (owners of one unit of labor only) calorie consumption both in the first generation (the steady state without habit formation) and at the autarky steady state with habit formation. One unit of each good provides one calorie. Therefore total calories consumed, $calories$, equals $r + w$. Feeding the wage into the demand functions, I obtain the total calories consumed at time t for a worker possessing only a single unit of labor:

$$\begin{aligned} calories_t &= tastes_{rt}\frac{\omega_t}{p_t} + (1 - tastes_{rt})\omega_t, \\ calories_t &= tastes_{rt}^{\beta}\beta(\frac{T_r}{L})^{1-\beta} + (1 - tastes_{rt})^{\beta}\beta(\frac{T_w}{L})^{1-\beta}. \end{aligned} \tag{15}$$

I differentiate caloric intake with respect to $tastes_{rt}$. Caloric intake increases as tastes adjust to favor rice ($tastes_{rt}$ rises) as shown in hypothesis 2:

$$\begin{aligned} \frac{dcalories_t}{dtastes_{rt}} &= (\frac{1}{L})^{1-\beta}\beta^2[T_r^{1-\beta}tastes_{rt}^{\beta-1} - T_w^{1-\beta}(1 - tastes_{rt})^{\beta-1}], \\ \frac{dcalories_t}{dtastes_{rt}} &> 0 \text{ if } (\frac{T_w}{T_r}\frac{tastes_{rt}}{(1 - tastes_{rt})})^{1-\beta} = p_t < 1. \end{aligned}$$

What happens to the caloric consumption of landless labor for the adult generation alive at the time a small region at its autarky steady state, s, opens up to trade? The world price favors wheat, $p^* > 1$, and the small region is a price taker. The equalization of wages across the two sectors pins down the relative labor allocation through equation 12. I denote the new post-trade equilibrium values with an asterisk superscript:

$$\begin{aligned} p^* &= (\frac{T_w}{T_r}\frac{L_{rs}^*}{(L - L_{rs}^*)})^{1-\beta}, \\ L_{rs}^* &= \frac{(p^*)^{\frac{1}{1-\beta}}L}{\frac{T_w}{T_r} + (p^*)^{\frac{1}{1-\beta}}}, \\ \omega_s^* &= \beta(\frac{T_w + T_r(p^*)^{\frac{1}{1-\beta}}}{L})^{1-\beta}. \end{aligned}$$

I calculate the total caloric intakes before ($calories_s$) and after ($calories_s^*$) trade liberalization, as a function of tastes at the steady state, $tastes_{rs}$:

$$\begin{aligned} calories_s &= tastes_{rs}^{\beta}\beta(\frac{T_r}{L})^{1-\beta} + (1 - tastes_{rs})^{\beta}\beta(\frac{T_w}{L})^{1-\beta}, \\ calories_s^* &= tastes_{rs}\frac{1}{p^*}\beta(\frac{T_w + T_r(p^*)^{\frac{1}{1-\beta}}}{L})^{1-\beta}. + (1 - tastes_{rs})\beta(\frac{T_w + T_r(p^*)^{\frac{1}{1-\beta}}}{L})^{1-\beta}.. \end{aligned}$$

Therefore, the caloric elasticity with respect to trade liberalization is simply:

$$\frac{calories_s^* - calories_s}{calories_s} = \frac{[\frac{tastes_{rs}}{p^*} + (1 - tastes_{rs})]\beta(\frac{T_w + T_r(p^*)^{\frac{1}{1-\beta}}}{L})^{1-\beta}}{tastes_{rs}^{\beta}\beta(\frac{T_r}{L})^{1-\beta} + (1 - tastes_{rs})^{\beta}\beta(\frac{T_w}{L})^{1-\beta}} - 1.$$

Differentiating this expression with respect to $tastes_{rs}$ shows how the caloric elasticity varies with preferences:

$$\frac{d\frac{calories_s^*}{calories_s}}{dtastes_{rs}}N = [\frac{1}{p^*}-1][\frac{1}{p_s}+(\frac{1-tastes_{rs}}{tastes_{rs}})] - \beta[\frac{1}{p^*}+(\frac{1-tastes_{rs}}{tastes_{rs}})][\frac{1}{p_s}-1],$$

$$N = \frac{[tastes_{rs}^{\beta}(\frac{T_r}{T_w})^{1-\beta}+(1-tastes_{rs})^{\beta}][\frac{1}{p*}+(\frac{1-tastes_{rs}}{tastes_{rs}})]}{(1+\frac{T_r}{T_w}(p^*)^{\frac{1}{1-\beta}})^{1-\beta}} > 0, p_s = (\frac{T_w}{T_r}\frac{tastes_{rs}}{1-tastes_{rs}})^{1-\beta}.$$

I compare a society where habits favor the comparative advantage good with a society where there are fixed neutral preferences. To do this I feed in the neutral preferences, $tastes_{r1} = tastes_{rs} = \frac{1}{2}$, and calculate the change in caloric elasticity with respect to trade liberalization as tastes for the comparative advantage good increase. This does not assume that preferences evolve precisely as described in the previous section, only that they are positively related to past relative consumption:

$$\frac{d\frac{calories_s^*}{calories_s}}{dtastes_{rs}}N = [\frac{1}{p^*}-1][\frac{1}{p_s}+1] - \beta[\frac{1}{p^*}+1][\frac{1}{p_s}-1]. \quad (16)$$

I sign this expression when $T_r > T_w$ and $p^* > p_s$, so the area has a comparative advantage in its relatively abundant good r. Here $tastes_{rs} > \frac{1}{2}$ with habit formation. The standard case is $p^* \geq 1 > p_s$ where the world is evenly endowed with the two factors or has a relatively more of the factor required to produce good r. Both terms of equation 16 are negative (or zero for the first term if $p^* = 1$). Therefore, the elasticity of caloric intake with respect to trade liberalization is reduced when preferences develop to favor the comparative advantage good.[93] This is hypothesis 3 in the paper.

A.6 Welfare Implications of Model with Quality Improvements

The utility function can be rewritten as follows:

$$\begin{aligned} U(r,w) &= \widetilde{r}^{\frac{1}{2}}\widetilde{w}^{\frac{1}{2}}, \\ \widetilde{r} &= A_t r^{2\alpha_t}, \\ \widetilde{w} &= A_t w^{2(1-\alpha_t)}. \end{aligned}$$

The actual quantities of rice and wheat consumed are r and w, while $\widetilde{r}$ and $\widetilde{w}$ are the quality-adjusted quantity consumed. This model is isomorphic to the model where tastes change over generations. Here, relative technologies for converting raw food ingredients into meals, α_t and $(1-\alpha_t)$, respond to the previous generation's physical consumption in the same way tastes responded to past relative consumption. A_t is the absolute technological progress in generation t.[94] This model is discussed

[93] In the case $p_s < p^* < 1$, so that the area has a comparative advantage in rice but the world endowment also favors the production of rice, the sign cannot be determined. The sign will generally be negative unless p^* is much smaller than 1 or the price change $p^* - p_s$ is very small. In these cases the rice-loving preferences that develop with habit formation are still more suited to world prices than the neutral preferences, and so being less willing to substitute into the expensive calorie source (wheat) actually makes consumers better off in caloric terms.

[94] Over generations there will be absolute utility gains as the transformation technologies improve. This enters the utility function multiplicatively, while α_t determines how those technology gains are shared between the two goods. Since I am analyzing the instantaneous gains from trade upon liberalization, the equivalent comparison to

in section 2.5, and since preferences are fixed, welfare gains from trade can be evaluated.

Proceeding in the same way as above. I show that the welfare elasticity of trade liberalization for landless labor decreases if transformation technologies favor the relatively abundant comparative advantage good: $\frac{d(U^W-U^A)/U^A}{d\alpha_s} > 0$ if $T_r > T_w$ and $p^* > 1 > p_s$:[95]

$$\begin{aligned} U^A &= A_s(\alpha_s \frac{\omega_s}{p_s})^{\alpha_z}((1-\alpha_z)\omega_s)^{1-\alpha_s}, \\ U^W &= A_s(\alpha_s \frac{\omega_s^*}{p^*})^{\alpha_s}((1-\alpha_s)\omega_s^*)^{1-\alpha_s}, \\ \frac{U^W-U^A}{U^A} &= \frac{(\alpha_z \frac{1}{p^W})^{\alpha_z}((1-\alpha_z))^{1-\alpha_z}\beta(\frac{K+T(p^W)^{\frac{1}{1-\beta}}}{L})^{1-\beta}}{(\alpha_z^{\beta}\beta(\frac{T}{L})^{1-\beta})^{\alpha_z}((1-\alpha_z)^{\beta}\beta(\frac{K}{L})^{1-\beta})^{1-\alpha_z}} - 1. \end{aligned}$$

The log change is a monotonic transform of $\frac{U^W-U^A}{U^A}$ and is more easily differentiated:

$$\begin{aligned} \log U^W - \log U^A &= \log \frac{\alpha_s^{(1-\beta)\alpha_s}(1-\alpha_s)^{(1-\beta)(1-\alpha_s)}(\frac{1}{p^*})^{\alpha_s}(T_w + T_r(p^*)^{\frac{1}{1-\beta}})^{1-\beta}}{T_r^{(1-\beta)\alpha_s}T_w^{(1-\beta)(1-\alpha_s)}}, \\ \frac{d(\log U^W - \log U^A)}{d\alpha_s} &= (1-\beta)[\log \frac{T_w}{T_r}(\frac{1}{p^*})^{\frac{1}{1-\beta}} \frac{\alpha_s}{(1-\alpha_s)}]. \end{aligned}$$

Therefore, if $\alpha_s = \frac{1}{2}$, the counterfactual where transformation technologies develop independent of relative consumption, this derivative is negative when $T_r > T_w$ and $p^* > 1 > p_s$. Increasing α_s, so that transformation technologies favor the good made with the relatively abundant factor, reduces the welfare elasticity of trade liberalization. This is the amended hypothesis 3* in the paper.

B Robustness Results

B.1 Robustness of Taste Estimates

There are several econometric reasons why the LA/AIDS taste estimates may be inconsistent. The endogeneity of prices is a general issue in demand estimation, with the literature highlighting differentiated products as a particular concern since these often have promotions and quantity discounts (Dhar, Chavas, and Gould 2003). As all the foods in the sample are raw agricultural commodities, this should not be a substantial problem for rural India. My paper details how tastes vary at the level of the agro-climatic region, and these regional taste differences are picked up by the regional dummy variables. However, if tastes also vary at the village level and village markets are not fully integrated within regions, village taste peculiarities will change local demand and therefore local prices. Since I cannot include a village-level taste dummy and village-level prices,

the case of habits and no habits becomes a situation where there is equal total technological progress A_t, but it is either primarily focussed on the more consumed good or shared evenly between the two goods.

[95] With Cobb-Douglas production functions, Melvin and Waschik (2001) show that labor's welfare is minimized at autarky prices, and so any price changes are welfare improving. However, here i show that the welfare gain with trade is smaller in a world with habit formation. For other constant elasticity of substitution production functions, Melvin and Waschik (2001) show that welfare losses for labor upon trade liberalization are possible.

this is a case of omitted variable bias.

To clarify the situation, I rewrite equation 3 by sweeping out the region dummies, and omitting the expenditure and demographic terms for neater exposition:

$$\widetilde{bshare}_{gri} = \sum_{g'} \gamma_{gg'} \widetilde{\ln p}_{g'riv} + \widetilde{\varepsilon}_{gri}, \tag{17}$$

$$\widehat{\boldsymbol{\gamma}}_g = \boldsymbol{\gamma}_g + (\frac{1}{n}\sum_i \widetilde{\ln \boldsymbol{p}}_{riv} \widetilde{\ln \boldsymbol{p}}'_{riv})^{-1} \frac{1}{n} \sum_i \widetilde{\ln \boldsymbol{p}}_{riv} \cdot \widetilde{\varepsilon}_{gri}. \tag{18}$$

The price faced by all households i in village v is $p_{g'riv}$.[96] The $G \times 1$ vector of the 52 coefficients on prices, $\gamma_{gg'}$s, for the good g regression is $\boldsymbol{\gamma}_g$. I define a region average for a generic variable x as $\overline{x}_{g'r} = \sum_{i \in r} x_{g'ri}$, a region demeaned variable $\widetilde{x}_{g'ri} = x_{g'ri} - \overline{x}_{g'r}$ and a $G \times 1$ vector $\widetilde{\boldsymbol{x}}_{ri}$ of the G variables $\widetilde{x}_{g'ri}$ for each household i. The estimated parameters from this regression will be identical to those when the region effects are included because of the Frisch-Waugh theorem. I can recover the fixed effects by using the OLS first order conditions from regression 3:[97]

$$\widehat{tastes}_{gr} = \overline{bshare}_{gr} - \sum_{g'} \widehat{\gamma}_{gg'} \overline{\ln p}_{g'r}. \tag{19}$$

The village-level taste deviations (α_{grv}) for village v are the omitted variable and are mean zero at the region level, $\widetilde{\varepsilon}_{gri} = \alpha_{grv} + \widetilde{\epsilon}_{gri}$. The price is determined by equalizing village-level aggregate supply y_v^s and aggregate demand y_v^d:

$$y_v^s = \sum_{j \in v} z_{grj}(p_{grv}) + Z_{gr}(p_{grv}),$$

$$y_v^d = \sum_{i \in v} \frac{food_i \times bshare_{gri}(\alpha_{grv})}{p_{grv}} + Y_{gr}(p_{grv}).$$

In the equations above, z_{grj} is one producer j's supply of good g, Z_{gr} is the out-of-village supply that increases with the village price p_{grv} and Y_{gr} is the out-of-village demand that decreases with p_{grv}. $E[\widetilde{\ln p}_{griv} \alpha_{grv}] > 0$ since α_{grv} raises $bshare_{gri}$, and so raises the equilibrium price.

Instrumenting the 52 prices requires 52 instruments that are correlated with $\ln p_{grv}$ but uncorrelated with α_{grv}. Hausman (1994) suggests using prices from other markets which have been partly determined by the same supply shifters $Z_{gr}(p_{grv})$ but are not correlated with village tastes α_{grv}.[98] Accordingly, I instrument each village price with the price in a nearby village in the same district,

[96] Only one of the village and household identifiers are necessary, and I will use only the village identifier when referring to village level supply and demand. Otherwise I use both identifiers on price terms.

[97] As shown by Kennan (1989), there may also be an additional bias in estimating $\gamma_{gg'}$ from individual demand shocks, such as income, that does not disappear with aggregation. However this bias will become small as long as there is a sufficient village level component to this individual shock.

[98] There has been a heated debate between Hausman and Bresnahan about the validity of these instruments. Most of the discussion centers around whether such promotions as national advertising campaigns shift tastes simultaneously across all markets. This is not an issue here as my food products are generally undifferentiated and I explicitly control for regional taste shifters.

which should be affected by similar supply shocks.[99] The main results are robust to using these instrumented taste measures and are reported in tables 11 through 14.[100] For these instrumented results to be consistent, village tastes and hence deviations from regional average tastes cannot be spatially correlated. If they are, more distant prices may be suitable instruments, although these prices will also be much more weakly correlated with village prices.

I can approach the endogeneity of prices in another way and avoid instrumentation altogether. The bias in $\widehat{tastes}_{gr}$ should only increase the dispersion of the taste estimates and not their rank ordering under certain conditions. I derive the bias by combining equation 18 and 19, where $\overline{\ln \boldsymbol{p}}$ is the $G \times R$ matrix of regional prices $\overline{\ln p}_{g'r}$ and $\boldsymbol{tastes}_g$ is the $R \times 1$ vector of regional tastes for good g:

$$\widehat{\boldsymbol{tastes}}_g - \boldsymbol{tastes}_g = -\overline{\ln \boldsymbol{p}}'((\frac{1}{n}\sum_i \widetilde{\ln \boldsymbol{p}}_{riv}\widetilde{\ln \boldsymbol{p}}'_{riv})^{-1}\sum_i \widetilde{\ln \boldsymbol{p}}_{riv} \cdot \alpha_{griv}).$$

If this bias increases monotonically with $tastes_{gr}$, $\frac{d(\widehat{tastes}_{gr} - tastes_{gr})}{dtastes_{gr}} > 0$, then the rank ordering will remain unchanged. To proceed I simplify the problem further and assume that all goods are substitutes, so that village-specific tastes for good g lower the price for good g':

$$\begin{aligned} E[\widetilde{\ln p}_{griv}\alpha_{grv}] &= c_1 > 0, \\ E[\widetilde{\ln p}_{g'riv}\alpha_{grv}] &= c_2 < 0. \end{aligned}$$

I assume the variance-covariance matrix of region demeaned prices is approximately diagonal, meaning that the deviations from region average prices within a village for each good are approximately independent:

$$\begin{aligned} E[\widetilde{\ln \boldsymbol{p}}_{riv}\widetilde{\ln \boldsymbol{p}}'_{riv}]^{-1} &\approx \begin{bmatrix} \omega_{g=1} & \ldots & \omega_1 \\ \omega_1 & \ldots & \omega_1 \\ \omega_1 & \ldots & \omega_{g=G} \end{bmatrix}, \\ \omega_1 &\approx 0, \omega_{g'} \approx [\sum_i \widetilde{\ln p}^2_{g'riv}]^{-1} > 0. \end{aligned}$$

Finally, I replace $\overline{\ln p_{gr}}$ with its best linear predictor conditional upon regional tastes, $tastes_{gr}$. The theory of habit formation and regional endowments outlined in this paper, and verified for India, provides signs for the taste terms. Strong regional tastes for food g are associated with lower regional prices for that food (both are determined by endowments). Similarly, strong regional tastes for good g are associated with higher prices for good g', as relative endowments are lower:

[99] I instrument prices in the village with prices in the next village in the district according to the NSS village number. For the highest numbered village in the district, I use prices in the lowest numbered village.

[100] There are 52 first-stage regressions. These instruments may be somewhat weak. The average first stage F-stat is 13.6. The Kleibergen-Paap rk Wald F-statistic is 0.375 for the full first-stage. Stock and Yogo (2002) do not report critical values for more than 3 endogenous regressors.

$$\overline{\ln p_{gr}} = \psi_1 tastes_{gr} + \sum_{g' \neq g} \psi_2 tastes_{g'r} + u_{gr},$$
$$\psi_1 < 0, \psi_2 > 0.$$

Under the null hypothesis, tastes do not evolve through habit formation and are independent of regional prices, $\psi_1 = \psi_2 = 0$. The estimates of regional tastes should then be zero and unbiased.

With this simplifying structure in place I can calculate how the bias in $\widehat{tastes}_{gr}$ changes with the size of $tastes_{gr}$:

$$\frac{d(\widehat{tastes}_{gr} - tastes_{gr})}{dtastes_{gr}} = -\psi_1 \omega_g c_1 - \sum_{g' \neq g} \psi_2 \omega_{g'} c_2 > 0.$$

The dispersion of the taste estimates increases if tastes vary at the village-level and markets within regions are not integrated, but the rank ordering of tastes remains unchanged. Therefore, normalized taste measures across regions should still pick up the relative tastes for food g. Normalized tastes were already used to test the prediction that tastes are positively correlated with endowments and negatively with prices. Results for regression 5 using normalized tastes (mean 0 standard deviation 1) are shown in tables 13 and 14. Normalization removes the relative importance of each good in caloric consumption (for example changes in the rice price will have a larger impact on calories than changes in the price of black pepper). Accordingly, instead of the summation measure, I use a correlation between normalized tastes and price changes, weighted by the national budget shares[101] for each good, $\rho_r^T = corr_g(tastes_{gr}, \Delta \ln p_{gr})$. As before, the coefficient on $corr_g(tastes_{gr}, \Delta \ln p_{gr})$ is negative.

Total food expenditure may also be correlated with the demand for individual foodstuffs. Fortunately, I know how much the household spent on other expenditures and this allows me to bound the bias. If food expenditure increases with higher demand for a food, other expenditures will necessarily decline with a fixed income, biasing the coefficients in the other direction. Therefore $food_i$ can be instrumented with other expenditures, and the true coefficients should lie somewhere between the uninstrumented and instrumented results. The estimated coefficients, shown in tables 11 through 14, are very similar, suggesting that the endogeneity of food expenditure in the demand estimation is not a major concern. If the measurement error in food and non-food expenditure is independent, this instrumentation strategy also avoids biased parameters that would result from an imperfect measure of food expenditure appearing both in the denominator of the food budget share and on the right hand side of equation 3.

The $\gamma_{gg'}$ terms on prices may also vary by region and be correlated with taste differences. This will lead to biased estimates of $tastes_{gr}$ as the region dummy absorbs the region specific price terms. Including the region specific price effect in the error term makes this bias clear:

[101] Results are unchanged if I use the national caloric share instead.

$$\varepsilon_{gri} = \sum_{g'}(\gamma_{gg'r} - \gamma_{gg'}) \ln p_{g'r} + \nu_{gri},$$
$$\widehat{tastes}_{gr} = tastes_{gr} + \sum_{g'}(\gamma_{gg'r} - \gamma_{gg'})\overline{\ln p_{g'r}}.$$

The population-averaged $\gamma_{gg'}$s are consistently estimated assuming the rank condition holds, the mean zero error term ν_{gri} is strictly exogenous and $E(\gamma_{ggr} - \gamma_{gg} \mid \widetilde{\ln p_{gri}}) = 0$ (Wooldridge 2005).[102] However the $tastes_{gr}$s are still biased as they include the regional $\gamma_{gg'}$ deviation.

Allowing elasticities to vary by region substantially reduces the degrees of freedom in estimating equation 3 and asks too much of the limited village price variation within regions. One possibility is to use the 38th and 50th thick rounds (1983 and 1993/4) to add extra price variation. I assume tastes are constant over the short-run (10 years in this case) and then estimate equation 3 on a region-by-region basis. Tables 11 through 14 show the main regressions rerun using this measure of tastes as a further robustness check. While allowing $\gamma_{gg'}$ to vary by region attenuates the coefficients, the signs remain the same and the coefficients are significantly different from zero.

It is also possible to make a similar argument to the one above, with regional variation in $\gamma_{gg'}$ only increasing the dispersion of tastes but not changing their rank ordering. In this case, I require $\frac{d\gamma_{gg'r}}{dtastes_{gr}} > 0$ and $\frac{d\gamma_{ggr}}{dtastes_{gr}} < 0$ for $\frac{d(\widehat{tastes}_{gr} - tastes_{gr})}{dtastes_{gr}} > 0$, so that the budget share spent on good g increases when there are price rises in other goods and decreases when the price of good g rises. If this is satisfied, by the same logic as I outlined above in the case of village-specific tastes, the dispersion of tastes will increase but not the ranking despite $\gamma_{gg'}$ varying by region, and therefore the normalized taste results shown in tables 13 and 14 should be valid.

B.2 Robustness of Regional Caloric Change Regression

Accounting for changing budget shares in the log-linearization of caloric intake leads to the following specification, where $calshare_g$ is the share of good g in total caloric intake:

$$\Delta \ln calories \simeq \Delta \ln food - \sum_{g=1}^{52} [bshare_g] \left[\frac{food}{calories} \Big/ p_g \right] \Delta \ln p_g + \sum_{g=1}^{52} calshare_g \Delta \ln bshare_g,$$

$$\Delta \ln calories_r = b_0 + b_1 \sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr} + b_2 \sum_{g=1}^{52} h(P_r, food_r) \Delta \ln p_{gr} + b_3 \Delta \ln food_r$$
$$+ b_4 \overline{bshare_r} \sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr} + b_5 \sum_{g=1}^{52} calshare_{gr} \Delta \ln bshare_{gr} + \varepsilon_r.$$

This regression is run and the results presented in columns 2 and 5 of table 15. The coefficient on $\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$ actually becomes more negative, implying that the omission of the additional

[102] The last assumption is that price deviations within regions are uncorrelated with differences in $\gamma_{gg'}$ across regions. This is plausibly satisfied.

$\sum_{g=1}^{52} calshare_{gr} \Delta \ln bshare_{gr}$ term was not responsible for the negative coefficient on b_1.

Table 11: Robust Taste Estimates and Relative Resource Endowments

(LA/AIDS Tastes)	(1) $tastes_{gr}$ (Prices Instrumented)	(2) $tastes_{gr}$ ($food_i$ Instrumented)	(3) $tastes_{gr}$ (Regional $\gamma_{gg'r}$)
$endowment_{gr}$	1.929	1.803***	0.102**
	(1.21)	(0.57)	(0.051)
Observations	3375	3375	3278

Note: Dependent variable, tastes, estimated using the unexplained regional variation in food budget shares, with common price and food expenditure controls. Price instruments for taste estimation are prices for 52 goods in nearby village. $food_i$ instrument for taste estimation is non-food expenditure. Regional $\gamma_{gg'r}$ $tastes_{gr}$ are estimated by running LA/AIDS separately on each region. $endowment_{gr}$ are predicted values from regressing observed relative endowments on agro-climatic endowments by crop using Limited Information Maximum Likelihood as in table 1. Both tastes and observed relative endowments normalized mean 0, s.d. 1 by good. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

Table 12: Correlations Between Robust Taste Estimates and Prices

	Pearson's product-moment correlation Prices$_{gr}$	[95% Conf.	Interval]
$tastes_{gr}$ (Prices Instrumented)	-0.036**	-0.069	-0.004
$tastes_{gr}$ ($food_i$ Instrumented)	-0.084***	-0.116	-0.051
$tastes_{gr}$ (Regional $\gamma_{gg'r}$)	-0.027*	-0.059	0.006

Note: 3670 observations. Tastes estimated using the unexplained regional variation in food budget shares, with common price and food expenditure controls. Price instruments for taste estimation are prices for 52 goods in nearby village. $food_i$ instrument for taste estimation is non-food expenditure. Regional $\gamma_{gg'r}$ $tastes_{gr}$ are estimated by running LA/AIDS separately on each region. Prices are regional median unit values. Both variables normalized mean 0, s.d. 1 by good. * significant at 10%, ** 5%, *** 1%. Confidence intervals based on Fisher's transformation.

Table 13: Caloric Change, Robust Taste Estimates and Temporal Price Changes (Unweighted)

	(1)	(2)	(3)	(4)
(LA/AIDS Tastes)	$\Delta \ln calories_r$ 1987-88 to 2004-05 (Unweighted)			
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$	-0.355***			
(Prices Instrumented)	(0.12)			
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$		-0.351***		
($food_i$ Instrumented)		(0.12)		
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$			-0.345***	
(Regional $\gamma_{gg'r}$)			(0.11)	
$corr_g(tastes_{gr}, \Delta \ln p_{gr})$				-0.118***
(Normed tastes)				(0.039)
$\sum_{g=1}^{52} h_g(P_r, food_r) \Delta \ln p_{gr}$	-0.369***	-0.338**	-0.335***	
	(0.12)	(0.13)	(0.11)	
$\Delta \ln food_r$	0.589***	0.591***	0.594***	0.506***
	(0.048)	(0.048)	(0.048)	(0.052)
$\sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}$	2.878	2.882*	2.806*	1.941
	(1.57)	(1.58)	(1.61)	(1.47)
Constant	-0.369***	-0.381***	-0.389***	-0.677***
	(0.11)	(0.11)	(0.11)	(0.061)
Observations	75	76	76	76
R^2	0.58	0.58	0.60	0.55

Note: Dependent variable is the log change in caloric intake per person between 1987-88 and 2004-05. The independent variables come from the log linearization of caloric intake. J_{gr} is the inverse relative price per calorie. Tastes estimated using the unexplained regional variation in food budget shares, with common price and food expenditure controls. Price instruments for taste estimation are prices for 52 goods in nearby village. $food_i$ instrument for taste estimation is non-food expenditure. Regional $\gamma_{gg'r}$ $tastes_{gr}$ are estimated by running LA/AIDS separately on each region. Normed tastes uses correlation between $\Delta \ln p_{gr}$ and tastes normalized mean 0 s.d. 1 by good, with correlation weighted using national food budget shares for each good. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

Table 14: Caloric Change, Robust Taste Estimates and Temporal Price Changes (Weighted)

	(1)	(2)	(3)	(4)
(LA/AIDS Tastes)	$\Delta \ln calories_r$ 1987-88 to 2004-05 (Weighted)			
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$	-0.597***			
(Prices Instrumented)	(0.082)			
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$		-0.566***		
($food_i$ Instrumented)		(0.090)		
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$			-0.604***	
(Regional $\gamma_{gg'r}$)			(0.086)	
$corr_g(tastes_{gr}, \Delta \ln p_{gr})$				-0.0967***
(Normed tastes)				(0.033)
$\sum_{g=1}^{52} h_g(P_r, food_r) \Delta \ln p_{gr}$	-0.655***	-0.522***	-0.600***	
	(0.094)	(0.11)	(0.088)	
$\Delta \ln food_r$	0.739***	0.724***	0.735***	0.511***
	(0.049)	(0.049)	(0.050)	(0.057)
$\sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}$	1.533	1.911*	1.858	1.173
	(1.17)	(1.09)	(1.20)	(1.64)
Constant	-0.248***	-0.290***	-0.255***	-0.665***
	(0.074)	(0.085)	(0.080)	(0.066)
Observations	75	76	76	76
R^2	0.72	0.72	0.71	0.56

Note: Dependent variable is the log change in caloric intake per person between 1987-88 and 2004-05. The independent variables come from the log linearization of caloric intake. J_{gr} is the inverse relative price per calorie. Tastes estimated using the unexplained regional variation in food budget shares, with common price and food expenditure controls. Price instruments for taste estimation are prices for 52 goods in nearby village. $food_i$ instrument for taste estimation is non-food expenditure. Regional $\gamma_{gg'r}$ $tastes_{gr}$ are estimated by running LA/AIDS separately on each region. Normed tastes uses correlation between $\Delta \ln p_{gr}$ and tastes normalized mean 0 s.d. 1 by good, with correlation weighted using national food budget shares for each good. Regressions are weighted by a region's total survey weight. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

Table 15: Caloric Change, Tastes and Temporal Price Changes: Additional Specifications

(LA/AIDS)	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \ln calories_r$ 1987-88 to 2004-05					
		(Unweighted)			(Weighted)	
$\sum_{g=1}^{52} tastes_{gr} \Delta \ln p_{gr}$	-0.146	-0.428***	-0.324**	-0.335***	-0.730***	-0.581***
	(0.14)	(0.12)	(0.14)	(0.11)	(0.093)	(0.11)
$\sum_{g=1}^{52} h_g(P_r, food_r) \Delta \ln p_{gr}$	-0.0693	-0.372**	-0.270*	-0.309**	-0.725***	-0.545***
	(0.17)	(0.14)	(0.16)	(0.13)	(0.12)	(0.12)
$\Delta \ln expenditure_r$	0.364***			0.445***		
	(0.062)			(0.055)		
$\Delta \ln food_r$		0.645***			0.806***	
		(0.052)			(0.048)	
$\Delta \ln food_r$ (Instrumented with $\Delta \ln nonfood_r$)			0.547***			0.710***
			(0.13)			(0.12)
$\sum_{g=1}^{52} (J_{gr} - \overline{J_r}) \Delta \ln p_{gr}$	2.649*	2.304	2.768*	2.154	1.685*	1.972*
	(1.38)	(1.55)	(1.51)	(1.87)	(1.00)	(1.12)
$\sum_{g=1}^{52} calshare_{gr} \Delta \ln bshare_{gr}$		0.159**			0.152***	
		(0.061)			(0.050)	
Constant	-0.427***	-0.314***	-0.363***	-0.315**	-0.158*	-0.255***
	(0.14)	(0.10)	(0.12)	(0.13)	(0.084)	(0.080)
Observations	76	76	76	76	76	76
R^2	0.37	0.63	0.58	0.45	0.76	0.71

Note: Dependent variable is the log change in caloric intake per person between 1987-88 and 2004-05. The independent variables come from the log linearization of caloric intake. J_{gr} is the inverse relative price per calorie. Tastes estimated using the unexplained regional variation in food budget shares, with common price and food expenditure controls. $\Delta \ln food_r$ instrumented by two stage least squares using $\Delta \ln nonfood_r$ in columns 3 and 6, with a first stage F-stat of 14.35 and 16.74 respectively. Regressions are weighted by a region's total survey weight where indicated. Robust standard errors. * significant at 10%, ** 5%, *** 1%.

Table 16: Table of Means for Migrants and Non-Migrants

Variable	Full Sample		Wife Move Sample		Wife Move 2 Sample	
	Non-Mig	Migrant	Non-Mig	Migrant	Non-Mig	Migrant
Calories	2160.7	2228.8	2194.3	2222.8	2194.8	2257.7
(Per Person Per Day)	(4.2)	(34.0)	(5.6)	(18.3)	(5.8)	(22.1)
Food Expenditure	99.7	128.7	96.2	119.0	94.5	109.7
(Monthly Rupees/Person)	(0.3)	(1.8)	(0.4)	(1.5)	(0.4)	(1.7)
ln(Food Expenditure)	4.494	4.706	4.465	4.655	4.450	4.580
(Monthly Rupees/Person)	(0.003)	(0.010)	(0.003)	(0.013)	(0.003)	(0.014)
Total Expenditure	171.6	258.1	162.2	229.0	156.6	196.0
(Monthly Rupees/Person)	(0.7)	(4.9)	(1.0)	(7.8)	(0.8)	(3.8)
Years Since Moved			21.1	20.1	21.3	21.1
for Marriage			(0.1)	(0.3)	(0.1)	(0.3)
Age of Household Head	44.7	44.0	44.1	43.7	44.2	44.1
	(0.1)	(0.2	(0.1)	(0.3)	(0.1)	(0.4)
Illiterate	0.49	0.32	0.49	0.36	0.51	0.43
	(0.00)	(0.01)	(0.00	(0.01)	(0.00)	(0.01)
Above Primary	0.20	0.37	0.19	0.34	0.17	0.28
Education	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Household Size	6.37	6.17	6.64	6.64	6.68	6.89
	(0.02)	(0.06)	(0.02	(0.09)	(0.02)	(0.11)
Rural Household	0.80	0.47	0.86	0.57	0.88	0.71
	(0.00)	(0.01)	(0.00	(0.01)	(0.00)	(0.01)
Observations	115,069	9,898	49,431	3,868	44,945	2,565

Note: Means of non-migrant and migrant households from 1987-1988 NSS survey. For wife move samples, migrants are wives who moved inter-state, as opposed to intra-state, at the time of marriage separately from their husbands. Wife Move 2 sample only includes wives who moved to their husband's village of birth. Standard errors in parentheses. All means survey weighted.

Table 17: Comparing Bundles of Migrants and Non-Migrants (Reporting Controls)

	(1)	(2)	(3)
		$\rho_{iods} = corr_g(bshare_{ig}, bshare_{\bar{s}g})$	
	Full Sample	Wife Move	Wife Move 2
$\mathbf{I}_{destination=s}$	-0.458***	-1.026***	-1.009***
	(0.085)	(0.10)	(0.11)
$\mathbf{I}_{destination=s,origin\neq s}$	-0.0451***	-0.0425***	-0.0316***
	(0.0040)	(0.0061)	(0.0071)
$\mathbf{I}_{destination\neq s}$	-0.786***	-1.382***	-1.367***
	(0.085)	(0.10)	(0.11)
$\mathbf{I}_{destination\neq s,origin=s}$	0.108***	0.125***	0.127***
	(0.0040)	(0.0063)	(0.0077)
$\mathbf{I}_{destination\neq s,nearby=s}$	0.181***	0.203***	0.203***
	(0.0014)	(0.0020)	(0.0021)
$\ln food$	0.493***	0.731***	0.725***
	(0.038)	(0.045)	(0.047)
$\ln food^2$	-0.0479***	-0.0733***	-0.0725***
	(0.0042)	(0.0048)	(0.0051)
age household head	0.000813**	0.00656***	0.00624***
	(0.00033)	(0.00067)	(0.00070)
age household head^2	-0.00000608*	-0.00000601	-0.00000409
	(0.0000034)	(0.0000054)	(0.0000056)
age spouse	-0.00354***	-0.000757	-0.000519
	(0.00081)	(0.0013)	(0.0014)
adult males		-0.00659***	-0.00642***
		(0.00041)	(0.00043)
adult females	0.00507***	0.00464***	0.00461***
	(0.00086)	(0.0013)	(0.0014)
children	-0.0000212	-0.000431	-0.000485
	(0.00051)	(0.00072)	(0.00075)
head literate ($\leq$ primary)	0.0377***	0.0372***	0.0372***
	(0.0021)	(0.0028)	(0.0029)
head > primary educ.	0.0317***	0.0391***	0.0416***
	(0.0024)	(0.0033)	(0.0035)
urban-urban mig.	-0.00856***	-0.0194***	-0.0261***
	(0.0033)	(0.0051)	(0.0057)
rural-urban mig.	-0.0181***	0.00600	-0.000791
	(0.0039)	(0.0049)	(0.0054)
urban-rural mig.	-0.0458***	-0.0355***	-0.0416***
	(0.0050)	(0.0057)	(0.0065)
Observations	3,864,925	1,637,916	1,472,531
R^2	0.77	0.76	0.75

Note: Dependent variable is the correlation between household food budget shares and mean shares for state s (31 observations per hhold). Independent variables are indicators for origin o and current d state. Constant, religion, caste, household type and subround dummies not shown. Robust standard errors. All regressions survey weighted and clustered further at individual household. * significant at 10%, ** 5%, *** 1%.

Table 18: Caloric Intake of Migrants Compared to Non-Migrants (Reporting Controls)

	(1)	(2)	(3)
	Daily Calories Per Person $calories_i$ (Full Sample)		
$migrant_i$	-107.2***	-92.23***	38.66
	(18.2)	(32.9)	(33.6)
$\ln food$	-2777***		
	(963)		
$\ln food^2$	478.1***		
	(115)		
$\ln total\ expenditure$		284.6	
		(236)	
$\ln total\ expenditure\ ^2$		67.34***	
		(23.8)	
age household head	9.707***	18.30***	22.51***
	(0.94)	(1.23)	(1.40)
age household head^2	-0.0957***	-0.156***	-0.169***
	(0.011)	(0.012)	(0.014)
adult males	10.02***	5.510**	19.44***
	(2.10)	(2.60)	(3.16)
adult females	1.072	-0.398	-19.06***
	(4.26)	(2.78)	(3.43)
children	-6.115	-35.55***	-106.1***
	(5.22)	(1.73)	(2.16)
head literate ($\leq$ primary)	-69.61***	-37.71***	110.2***
	(5.29)	(8.26)	(9.59)
head $>$ primary educ.	-261.3***	-153.8***	257.4***
	(35.8)	(10.2)	(9.21)
urban-urban mig.	-440.6***	-400.7***	-170.2***
	(26.2)	(12.2)	(12.5)
rural-urban mig.	-290.3***	-276.8***	-114.0***
	(10.4)	(16.5)	(17.7)
urban-rural mig.	-39.81***	-41.61***	8.542
	(11.9)	(13.9)	(16.3)
Observations	124,578	124,578	124,578
R^2	0.50	0.29	0.10

Note: Daily calories per person regressed on an inter-state migrant dummy that takes the value 1 if either the household head or his spouse migrated from another state. Constant, religion, caste, household type, subround and origin-state dummies not shown. Robust standard errors. All regressions survey weighted. * significant at 10%, ** 5%, *** 1%.

Table 19: Caloric Intake of Intra-State and Inter-State Wife Households (Reporting Controls)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Daily Calories Per Person $calories_i$							
	Wife Move Sample				Wife Move 2 Sample			
$migrant_i$	-115.0***	-99.16***	21.91	-167.0***	-43.87**	-43.02**	35.72	-77.13***
	(17.0)	(17.1)	(18.7)	(25.2)	(18.2)	(18.7)	(22.3)	(27.0)
$yrsaway_i$				5.318***				4.245***
				(0.64)				(0.67)
$migrant_i$ $\times yrsaway_i$				2.582**				1.561
				(1.09)				(1.18)
$\ln food$	-3787***			-3788***	-3959***			-3958***
	(588)			(588)	(630)			(630)
$\ln food^2$	585.8***			585.9***	609.6***			609.4***
	(67.1)			(67.1)	(72.1)			(72.2)
$\ln total$ $expenditure$		-783.6				-1676***		
		(489)				(545)		
$\ln total$ $expenditure^2$		179.2***				272.1***		
		(49.5)				(55.5)		
age head	9.576***	14.06***	21.09***	9.182***	9.862***	14.01***	20.91***	9.567***
	(1.37)	(1.62)	(2.09)	(1.37)	(1.43)	(1.69)	(2.17)	(1.43)
age head^2	-0.114***	-0.148***	-0.179***	-0.119***	-0.115***	-0.145***	-0.175***	-0.119***
	(0.013)	(0.016)	(0.021)	(0.013)	(0.014)	(0.016)	(0.021)	(0.014)
age spouse	2.652***	3.845***	3.022***	-1.517*	2.425***	3.217***	2.555**	-0.907
	(0.69)	(0.86)	(1.12)	(0.82)	(0.73)	(0.89)	(1.17)	(0.86)
adult males	7.021**	7.848**	24.31***	5.928*	4.504	6.224	25.32***	3.675
	(3.08)	(3.86)	(4.89)	(3.08)	(3.18)	(4.02)	(5.08)	(3.19)
adult females	2.833	-2.653	-9.414*	1.951	0.157	-3.579	-8.098	-0.465
	(3.17)	(3.99)	(5.08)	(3.18)	(3.28)	(4.10)	(5.32)	(3.28)
children	-12.10***	-33.88***	-102.0***	-12.82***	-12.06***	-33.03***	-100.0***	-12.64***
	(2.02)	(2.12)	(2.63)	(2.02)	(2.08)	(2.20)	(2.72)	(2.08)
literate $\leq$ primary	-66.96***	-50.05***	99.15***	-67.00***	-70.40***	-51.32***	98.78***	-70.50***
	(6.41)	(7.89)	(9.95)	(6.40)	(6.71)	(8.15)	(10.4)	(6.70)
$>$ primary educ.	-215.1***	-145.7***	248.1***	-212.5***	-210.2***	-148.8***	237.3***	-208.2***
	(12.2)	(12.5)	(12.5)	(12.2)	(12.6)	(13.2)	(13.3)	(12.7)
urban-urban mig.	-486.8***	-455.1***	-177.0***	-478.5***	-456.5***	-430.0***	-198.9***	-451.0***
	(16.6)	(18.5)	(17.7)	(16.5)	(17.1)	(18.8)	(19.3)	(17.1)
rural-urban mig.	-287.9***	-264.0***	-112.1***	-283.2***	-241.3***	-219.3***	-109.2***	-238.7***
	(11.5)	(13.5)	(15.2)	(11.5)	(12.1)	(14.5)	(16.4)	(12.1)
urban-rural mig.	-61.85***	-51.77***	7.354	-57.58***	-79.22***	-55.41***	-1.979	-75.37***
	(12.4)	(15.3)	(19.0)	(12.4)	(13.7)	(16.7)	(21.9)	(13.6)
Observations	52,836	52,836	52,836	52,800	47,501	47,501	47,501	47,465
R^2	0.66	0.45	0.14	0.66	0.67	0.47	0.14	0.67

Note: Daily calories per person regressed on an inter-state wife dummy, $migrant_i$, and the years since moving with an interaction for being an inter-state wife. Wife Move 2 sample only includes wives who moved to their husband's village of birth. Constant, religion, caste, household type, subround and origin-state dummies not shown. Robust standard errors. All regressions survey weighted. * significant at 10%, ** 5%, *** 1%.

Table 20: Caloric Intake of Migrants Compared to Non-Migrants in Destination State

	(1)	(2)	(3)
		Daily Calories Per Person $calories_i$	
	Full Sample	Wife Move Sample	Wife Move 2 Sample
$migrant_i$	-73.70***	-91.20***	-33.36*
	(16.9)	(15.8)	(17.2)
$\ln food$	-2775***	-3740***	-3962***
	(960)	(584)	(630)
$\ln food^2$	477.7***	580.3***	610.2***
	(114)	(66.7)	(72.2)
age household head	10.00***	9.880***	9.932***
	(0.96)	(1.36)	(1.43)
age household head^2	-0.0996***	-0.113***	-0.114***
	(0.012)	(0.013)	(0.014)
adult males	10.70***	7.679**	4.721
	(2.09)	(3.06)	(3.18)
adult females	-0.607	2.161	0.707
	(4.02)	(3.13)	(3.26)
children	-6.667	-11.82***	-11.86***
	(5.13)	(2.02)	(2.09)
head literate ($\leq$ primary)	-67.46***	-64.49***	-69.97***
	(5.25)	(6.34)	(6.66)
head $>$ primary educ.	-266.4***	-223.6***	-217.4***
	(35.7)	(12.2)	(12.8)
rural household	357.0***	341.3***	302.1***
	(14.8)	(11.0)	(11.7)
Observations	124,967	53,335	47,547
R^2	0.50	0.66	0.67

Note: Daily calories per person regressed on an inter-state migrant dummy. Constant, religion, caste, household type, subround and destination-state dummies not shown. Robust standard errors. All regressions survey weighted. * significant at 10%, ** 5%, *** 1%.

References

ALEXANDER, D. (2000): "The Geography of Italian Pasta," *The Professional Geographer*, 52(3), 553–566.

ANDERSON, K., W. MARTIN, AND D. VAN DER MENSBRUGGHE (2006): "Market and Welfare Implications of Doha Reform Scenarios," in *Agricultural Trade Reform and the Doha Development Agenda*, ed. by K. Anderson, and W. Martin, chap. 12. World Bank.

ANDERSON, K., AND E. VALENZUELA (2007): "Do Global Trade Distortions Still Harm Developing Country Farmers?," *Review of World Economics*, 143(1), 108–139.

ARMINGTON, P. S. (1968): *A Theory of Demand for Products Distinguished by Place of Production.* International Monetary Fund, Research Dept.

ATHUKORALA, P. C. (2005): "Agricultural Trade Policy Reforms in India," *South Asia Economic Journal*, 6(1), 23.

BARKER, D. J. (1992): *The Fetal and Infant Origins of Adult Disease*. BMJ Publishing Group.

BECKER, G. S., AND K. M. MURPHY (1988): "A Theory of Rational Addiction," *The Journal of Political Economy*, 96(4), 675–700.

BESTOR, T. C. (2000): "How Sushi Went Global," *Foreign Policy*, 121, 54–63.

BIRCH, L. L. (1999): "Development of Food Preferences," *Annual Review of Nutrition*, 19(1), 41–62.

CASE, A., A. FERTIG, AND C. PAXSON (2005): "The Lasting Impact of Childhood Health and Circumstances," *Journal of Health Economics*, 24, 365–389.

CASE, A., AND C. PAXSON (2006): "Stature and Status: Height, Ability, and Labor Market Outcomes," NBER Working Papers 12466, National Bureau of Economic Research.

CONLEY, T. G. (1999): "GMM Estimation with Cross Sectional Dependence," *Journal of Econometrics*, 92(1), 1–45.

DAS-GUPTA, A. (2006): "Internal Trade Barriers in India: Fiscal Check-posts," *South Asia Economic Journal*, 7(2), 231.

DEATON, A. (1997): *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. Johns Hopkins University Press.

DEATON, A., AND J. DREZE (2008): "Nutrition in India: Facts and Interpretations," RPDS Working Papers, Princeton University.

Deaton, A., and J. Muellbauer (1980a): "An Almost Ideal Demand System," *American Economic Review*, 70(3), 312–326.

——— (1980b): *Economics and Consumer Behavior*. Cambridge University Press.

Dev, S. S. M., and R. E. Evenson (2003): "Rural Development in India: Rural, Non-farm, and Migration," Working paper, Stanford Centre for International Development.

Dhar, T., J. P. Chavas, and B. W. Gould (2003): "An Empirical Assessment of Endogeneity Issues in Demand Analysis for Differentiated Products," *American Journal of Agricultural Economics*, 85(3), 605–617.

Diewert, W. E. (1971): "An Application of the Shephard Duality Theorem: A Generalized Leontief Production Function," *Journal of Political Economy*, 79(3), 481.

Du, S., B. Lu, F. Zhai, and B. M. Popkin (2006): "A New Stage of the Nutrition Transition in China," *Public Health Nutrition*, 5(1a), 169–174.

FAO (2003): "WTO Agreement on Agriculture: The Implementation Experience - Developing Country Case Studies," Report, Food and Agriculture Organization of the United Nations.

FAO (2005): "Towards An Indian Common Market: Removal of Restrictions on Internal Trade in Agriculture Commodities," Report, Food and Agriculture Organization of the United Nations.

Fogel, R. W. (1994): "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy," NBER Working Papers 4638, National Bureau of Economic Research.

Galef, Jr., B. G., and D. F. Sherry (1973): "Mother's Milk: A Medium for Transmission of Cues Reflecting the Flavor of Mother's Diet," *Journal of Comparative and Physiological Psychology*, 83(3), 374–8.

Gulati, A. (1998): "Indian Agriculture in an Open Economy: Will it Prosper?," *India's Economic Reforms and Development: Essays for Manmohan Singh*, pp. 122–46.

Hausman, J. A. (1994): "Valuation of New Goods under Perfect and Imperfect Competition," NBER Working Papers 4970, National Bureau of Economic Research.

Hayami, Y., and V. W. Ruttan (1971): *Agricultural Development: An International Perspective.* John Hopkins University Press.

Hertel, T., D. Hummels, M. Ivanic, and R. Keeney (2007): "How Confident Can We Be of CGE-Based Assessments of Free Trade Agreements?," *Economic Modelling*, 24(4), 611–635.

Hess, K. (2001): "The Origin of French Fries," *Petits Propos Culinaires*, 68, 39–48.

Huang, J., Y. Jun, Z. Xu, S. Rozelle, and N. Li (2007): "Agricultural Trade Liberalization and Poverty in China," *China Economic Review*, 18(3), 244–265.

Huang, J., and S. Rozelle (2006): "The Emergence of Agricultural Commodity Markets in China," *China Economic Review*, 17(3), 266–280.

Jensen, R. T., and N. H. Miller (2008): "Giffen Behavior and Subsistence Consumption," *American Economic Review*, 98(4), 1553–1577.

Jha, R., K. V. B. Murthy, and A. Sharma (2005): "Market Integration in Wholesale Rice Markets in India," ASARC Working Papers 2005-03, Australian National University.

Kelder, S. H. (1994): "Longitudinal Tracking of Adolescent Smoking, Physical Activity, and Food Choice Behaviors," *American Journal of Public Health*, 84(7), 1121–1126.

Kennan, J. (1989): "Simultaneous Equations Bias in Disaggregated Econometric Models," *The Review of Economic Studies*, 56(1), 151–156.

Melvin, J., and R. Waschik (2001): "The Neoclassical Ambiguity in the Specific Factor Model," *Journal of International Trade & Economic Development*, 10(3), 321–337.

Mennella, J., C. Jagnow, and G. Beauchamp (2001): "Prenatal and Postnatal Flavor Learning by Human Infants," *Pediatrics*, 107(6).

Munshi, K., and M. Rosenzweig (2007): "Why is Mobility in India so Low? Social Insurance, Inequality, and Growth," Working paper, Brown University.

Nunn, N., and N. Qian (2008): "Columbus's Contribution to World Population and Urbanization: A Natural Experiment Examining the Introduction of Potatoes," Working paper, Harvard University.

Planning Commisson of India (2001): "Internal Trade," in *Tenth Five Year plan (2002–2007)*, chap. 7.8. New Delhi.

Pollak, R. A. (1970): "Habit Formation and Dynamic Demand Functions," *The Journal of Political Economy*, 78(4), 745–763.

Rosenzweig, M. R., and O. Stark (1989): "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India," *The Journal of Political Economy*, 97(4), 905.

Ruffin, R., and R. W. Jones (1977): "Protection and Real Wages: The Neoclassical Ambiguity," *Journal of Economic Theory*, 14(2), 337–48.

Sen, A. K. (1999): *Development as Freedom*. Oxford University Press.

Staehle, H. (1934): "The Reaction of Consumers to Changes in Prices and Income: A Quantitative Study in Immigrants' Behavior," *Econometrica*, 2(1), 59–72.

Stock, J. H., and M. Yogo (2002): "Testing for Weak Instruments in Linear IV Regression," NBER Working Papers T0284, National Bureau of Economic Research.

Stone, R. (1956): *Quantity and Price Indexes in National Accounts*. Organisation for European Economic Co-operation.

Trefler, D. (1995): "The Case of the Missing Trade and Other Mysteries," *The American Economic Review*, 85(5), 1029–1046.

Vanneman, R., and D. Barnes (2000): "Indian District Data, 1961-1991: Machine-readable Data File and Codebook," http://www.inform.umd.edu/districts/index.html.

Willmott, C. J., and K. Matsuura (2001): "Terrestrial Air Temperature and Precipitation: Monthly and Annual Time Series 1950–1999," http://climate.geog.udel.edu/ climate.

Woodham-Smith, C. (1991): *The Great Hunger*. Penguin Books.

Wooldridge, J. M. (2005): "Fixed-Effects and Related Estimators for Correlated Random-Coefficient and Treatment-Effect Panel Data Models," *Review of Economics and Statistics*, 87(2), 385–390.