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Article

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Unintended consequence of trade on regional dietary patterns in rural India

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Abstract

This paper investigates how trade liberalisation has contributed to a dietary shift from one dominated by traditional staples to one high in animal products, a trend that is associated with both improved intake in micronutrients, and higher rates of obesity and other diet-related diseases in developing countries. In the context of India's trade liberalisation in 1991, we examine whether the difference in consumption of cereals and animal products across rural regions before and after the reforms can be attributed to their differential degree of exposure to tariff reductions. The estimates reveal that trade reforms have a negative impact on cereal consumption through reducing edible oil prices and a positive effect on the consumption of animal products through enhancing consumer tastes towards these foods. These findings provide evidence for the role of trade in supporting dietary diversity and highlight the need for complementary policies to enhance the coherence between trade policy and nutrition actions.

Keywords: trade liberalisation, nutrition transition, India, diet

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Introduction

Many developing countries consider international trade of great importance for achieving economic growth. In recent years, increasing attention has been paid to the effect of trade policy on population health. One key pathway identified in the literature is the unintended relationship between changes in trade policy and the outcome on diets and thus nutrition (Blouin et al., 2009; Hawkes et al. 2010). In the developing world, there has been a dietary shift from one dominated by traditional staples to one high in animal products and other non-cereal food. Some studies claim that the adoption of a non-traditional diet is partly driven by trade liberalisation (Pingali and Khwaja, 2004; Thow and Hawkes, 2009; Kearney, 2010). However, the role played by trade reforms in this dietary transition, which we refer to as the trade-diet link, has been little researched in literature. The issue is further complicated by the fact that trade impacts on dietary patterns may not only pass through standard economic factors, such as income and food prices, but also tastes for different types of food. Nonetheless, little is known of the linkage between trade reforms and food tastes.

The decline in cereal consumption is the key feature of the dietary transition as cereals are the traditional preferred food and the major source of nutrients in many developing countries. This trend signals that diet has become more diversified than before, which contributes to a lower incidence of micronutrient deficiencies and hence improves health outcomes such as lower risk of maternal and infant mortality at birth and higher resistance to infections (Rashid et al., 2011). Another important characteristic of the transition is the rise in consumption of animal products. This trend has led to growing health concerns due to its association with obesity and diet-related non-communicable diseases (Kearney, 2010; Popkin et al., 2012). These two trends are apparent in the developing world. For instance, many researchers have documented a shift in Indian dietary pattern away from cereals to animal products and other foods (Rao, 2000; Shetty, 2002; Mittal, 2007;Oldiges, 2012). According to the Food and Agricultural Organisation (FAO), the calorie intake from cereals in India decreased from 1556kcal to 1461kcal from 1989 to 1998 while that of animal products and edible oils increased from 337kcal to 400kcal. In light of the nutritional and health implications, this paper addresses the identified gap in the literature by investigating how changes in trade impact the consumption of cereals and animal products.[1]

This paper utilises an exogeneous trade policy shift in India to identify the trade-diet link. Specifically, in 1991, an extensive trade liberalisation policy was launched in India in which tariff barriers were progressively reduced over the next few years. Unlike many other trade reforms, this liberalisation was sudden and largely externally imposed (Topalova, 2007). This implies that Indian households were unlikely to have expected these trade policy changes and adjusted their food consumption in advance. This ensures that any trade-diet links identified are therefore the outcome of trade liberalisation rather than changes driven by the anticipation of policy changes. Given its unanticipated nature, coupled with the dietary changes in recent decades, the Indian trade liberalisation in 1991 provides a clean, relevant and hence unique context for examining the role of trade in the dietary transition.

Our identification strategy builds on the work of Topalova (2007) which establishes a causal link between the Indian trade liberalisation and changes in poverty through exploring regional heterogeneity in the exposure to trade reforms. Under the liberalisation, each Indian region experienced different levels of reduction in trade protection because they had different pre-reform industrial compositions and tariffs for different industries were not cut uniformly. The overall tariff at a regional level can therefore be measured by the interaction term between the tariffs faced by industries and the share of a region's worker employed in these industries in 1991 (Topalova, 2007). Apart from poverty, this approach has been employed to identify the unintended impact of Indian trade liberalisation on development outcomes such as school attendance among children and relative female survival rate (Edmonds et al.,

[1] Apart from these two trends, dietary transition in developing countries is also characterised by the rise in consumption of processed food. However, it is not feasible to investigate the trade impact on Indian processed food demand due to data limitations.

2010; Chakraborty, 2015). This paper extends this approach to establish the trade-diet link in the context of rural India. Note that under this approach, we cannot evaluate the overall impact of tariffs on Indian diet. Rather, we investigate whether the changes in regional food consumption can be attributed to the reduction of trade protection at regional level.

With the measure of overall regional tariff, our analysis considers trade protection reduction in both agricultural and manufacturing sectors. Reforms in the former sector have a direct influence on dietary patterns through its price effect on food items. While tariff cuts in the latter sector does not affect prices of agricultural commodities directly, it may alter the relative prices between food and non-food and hence trigger changes in food consumption. Additionally, trade reforms in both sectors may increase income of workers and influence their interaction with foreign culture, leading to adjustments in their diet. These indirect impacts from the reforms in non-food industries are particularly important in the Indian trade liberalisation as manufacturing trade barriers were reduced in a much more radical scale than that in agricultural trade.

The empirical analysis is divided into 2 parts. The first section establishes the linkage between Indian trade liberalisation and the consumption of cereals and animal products. With control for endowment of cereal cropland, regional characteristics and time shocks, it is found that regions facing greater reductions in tariffs are likely to consume less cereals and more eggs, fish and meat. At sample mean, 1 percentage point tariff cut is correlated with a 0.03 percentage point increase in the food budget share on animal and a 0.07 percentage point decrease in that on cereals (relative to the national trend). These trade-food consumption links provide solid evidence for the role of trade reforms in facilitating diet diversification and hence driving some of the observed dietary shift in rural India.

The second part of the analysis uncovers the underlying mechanisms between trade reforms and the consumption of cereals and animal products, which are income, food prices and food tastes. Income and prices impose constraints on the amount of goods that can be obtained by a consumer while food tastes determine the utility that he/she will receive from the goods. We capture food tastes for cereals and animal products using the regional component of the food budget share equation which cannot be explained by prices, income and household characteristics. The estimates indicate that the Indian trade reforms are likely to have negatively affected cereal consumption by reducing the price for edible oils since they are regarded as a substitute for cereals. For animal product, the trade impact is channelled mainly through the enhancement in food tastes. Regions exposed to larger tariff declines appear to have stronger tastes for eggs, fish and meat, which in turn contributes to the relatively higher consumption of animal products.

The present paper contributes to an underdeveloped strand of the empirical literature on the linkage between trade and diet. For example, only a few studies have attempted to empirically relate trade policy changes to beverage consumption. Schram et al (2015) and Baker et al (2016) show that a reduction in trade and investment barriers may have increased sales of sugar-sweetened carbonated beverages in Vietnam and encouraged soft-drink production in Peru respectively.[2] We provide evidence for the unintended trade outcome on consumption of cereals and animal products, an area that has not been empirically addressed in the literature. It highlights the role of trade in encouraging diversification of diets from cereals towards animal products. To our knowledge, this paper is the first to identify the trade impact on food tastes. Our findings stress that apart from income and food prices, food tastes do play a key role behind the trade-diet link although the relative importance of these channels may vary from case to case.

The evidence on the dietary outcome of trade is of crucial importance to policymakers. In the 2014 Rome

[2] We are grateful to a referee for pointing us to this literature.

Declaration of Nutrition, governments from around the world acknowledged that *'trade policies are to be conductive to fostering food security and nutrition for all'* (FAO and WHO, 2014:2). Through investigating the exogenous Indian trade liberalisation in 1991, this paper offers evidence on the potential incoherence between trade policies and nutrition objectives. Our results reveal that while trade can promote good nutrition outcomes through enabling households to diversify their diets from cereals, it may also undermine the effectiveness of nutrition actions by encouraging higher consumption of animal products. This points to the need for complementary public policies to manage these unintended dietary outcomes of trade. Furthermore, the analysis on the mechanisms behind the trade-diet link provides policymakers a clearer picture on the channels through which trade can facilitate the diversification of diet and hence enable them to make better-informed policy decisions regarding achievement of nutrition targets.

The reminder of this paper is organised as follows. The next section reviews literature on the linkages between trade, diet and health. Section 3 provides the background of trade liberalisation in 1991. Section 4 describes the data and the diet diversity across Indian regions. Section 5 presents the empirical strategy and the results of the main specification. Section 6 investigates the importance of income, food prices and tastes as the channels behind the trade-diet link and Section 7 concludes.

2. Trade, diet and health: Review of related literature

Trade liberalisation has been widely recognised as a crucial factor in driving the dietary shift from one dominated by traditional staples to one higher in animal products. Different developing country examples have been employed to illustrate the potential linkage between trade policy and dietary changes. Thow (2009) demonstrates a trend towards reduced consumption of staples and an increase in consumption of meat and meat products, eggs and oils in China in the early 1990s when tariffs and non-tariff barriers were reduced markedly. Popkin et al. (2012) show that prices of vegetables oils in China have been significantly reduced with the decline in the barriers to edible oil imports. This is consistent with the argument of Drewnowski et al. (2008) which states that world trade has reduced the relative cost of dietary energy and hence increased the consumption of energy-dense food. In India, Pingali and Khwaja (2004) observe that adoption of diets that no longer conform to the traditional local habits with the increasing influence from globalisation. Indian consumers now exhibit strong taste for meat, fish and temperate zone fruits. Vepa (2004) also argues that globalisation has increased the consumption of high-calorie food and the incidence of obesity in the middle and higher-classes of India.

Looking at other continents, Thow and Hawkes (2009) find that trade policy changes have directly affected the availability and prices of meat and processed food in Central American countries. They also point out that the consumption of such foods has been rising in these countries. According to Martorell and Khan (1998), this dietary shift is associated with the increasing burden of obesity and non-communicable diseases reported in the region. The linkage between trade, diet and health has also been identified in the Pacific islands. Thow et al. (2011) demonstrate that trade policy changes in Fiji and Samoa have contributed to a reduced availability of traditional staples and increased availability of meat, fats and other processed foods.[3] Cassels (2006) notes that the ease of global food trade has contributed to a higher consumption of animal products and processed food, a lower consumption of carbohydrates and increased rates of obesity in the Federated States of Micronesia. Other research on the Pacific countries have also demonstrated the potential link between displacement of traditional diets and the concomitant increase in obesity rates and chronic diseases (Blouin et al., 2009).

Overall, there is agreement in literature that trade liberalisation has played a vital part in the shift of food consumption patterns from cereals to animal products in developing countries. This dietary development is likely to be further exacerbated with the continued increase in international trade (Thow and Hawkes,

[3] We thank a referee for bringing this paper to our attention.

2009). While the above case studies shed light on the potential connection between trade and diet, they provide limited insight on the causality due to the use of a descriptive methodology. This reflects that there is a gap in our knowledge on the effect of trade policies on dietary patterns (Rayner et al., 2006; Popkin et al., 2012). Furthermore, research on Central America and the Pacific has stressed the association between dietary transition and the risks of obesity and other diet-related diseases. Blouin et al. (2009) argue that the shift in dietary patterns is a vital pathway of the linkage between trade and health. This implies that the unintended consequence of trade on food consumption has a profound impact on the health development of people, which further highlights the need for empirical research on the trade-diet link.

3. Indian trade liberalisation in 1991

3.1. Background

The trade environment of India was highly restrictive in the early 1980s. The shift of development strategy to export-led growth was largely triggered by the double deficit faced by the Indian government in the late 1980s. The fiscal deficits reached 10.1 percent of the GDP due to the rapid expansion of government expenditure (Panagariya, 2008). The credit rating of India was therefore downgraded, which severely hit the confidence of investors and led to the surge of capital outflows. On the external front, the Gulf War in the Middle East caused a significant decline in the demand from key trading partners and also the remittance from Indian workers (Topalova, 2010). Coupled with the spike in oil prices, India was close to a balance of payment crisis. The external debt rose threefold from $20.6 billion in 1980-81 to $64.4 billion in 1989-90 (Panagariya, 2008).

In 1991, the Indian government unexpectedly turned to the International Monetary Fund (IMF) for assistance with its external payment. To fulfil the conditions for the IMF financial aid, India announced a series of sweeping trade reforms under the Eighth Five-Year Plan. These reforms came as a surprise to the Indian society owing to the several earlier attempts to avoid IMF loans and the associated conditionalities, the large number of members of the new cabinet who had been cabinet members in the past governments with inward-looking trade policies and the heavy reliance on tariffs as a source of revenues (Hasan et al., 2003)[4]. The average effective tariff rate was slashed from about 86% in 1989-90 to about 40% in 1991 and the maximum tariff was cut from 400% to 150% (Hasan et al., 2007). The tariffs across industries were greatly reduced and harmonised over the next few years. The government also eased the quantitative restrictions for many non-agricultural goods.

For the agriculture sector, while the restrictions on exports were reduced in the reforms, the structure of protection on imports was relatively untouched. From 1991 to 1997, livestock and fish cultivating industries in India experienced around 45% decrease in average tariff while that for cereals and oilseeds industries was less than 20%. In 1994, with the conclusion of the Uruguay Round trade negotiations, India committed to bind its tariffs on most commodities at rate ranging from 0% to 300%. The resulting Agreement on Agriculture took effect in January 1995. This agreement had limited real effect on Indian agricultural trade as the applied tariff rates at that time were considerably lower than the bound rates. Besides, imports of some agricultural products, including cereals and animal products remained under either quantitative restrictions or the control of state trading enterprises.

Further changes in trade policy were implemented in the Ninth Five-Year Plan (1997-2002) although the external pressure was no longer present. Many of the non-tariff barriers on agricultural imports were removed in this period. For instance, in 1999, imports of common varieties of rice with 50 percentage or more broken were allowed freely. The timeline in Figure 1 provides a summary of the major macroeconomic events in India from 1985 to 2002.

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[4] See Topalova (2007) for a more detailed discussion on the extent to which trade liberalisation was unanticipated by the society.

<Insert figure 1 here>

3.2. Endogeneity concerns of trade policy

A common concern over investigating the impact of trade policy changes is that industries with higher import penetration are likely to lobby for greater protection, in other words, lower tariff reduction (Trefler, 1993). This endogeneity issue would undermine the efficiency of an empirical strategy in estimating the trade impact. However, this is unlikely to be a problem for the Indian trade reforms due to two reasons. First, as mentioned in the last section, the liberalisation was initiated under external pressure from the IMF and was unlikely to have been anticipated by society. The chance that households and firms could adjust their consumption and production decision in advance was very slim. Second, the radical changes in tariffs were not confined to a specific group of industries, mitigating the concerns that structure of trade reforms was shaped by the lobbying of more productive industries.

To assess the exogeneity of Indian trade liberalisation, Topalova (2010) conducts several checks on the structure of the tariff reduction from 1987 to 2001. She finds that the changes in trade policy did not appear to have been selectively manipulated by policymakers as the movements of tariffs at the disaggregated product level were highly uniform until 1997. There is also no significant association between current productivity and future tariffs for the years 1989-96. It should be noted that the evidence on uniformity in tariff movement and correlation between current productivity and future tariff were only seen for the period until 1997. In view of the potential policy endogeneity in the second wave of trade liberalisation (1997-2002), this paper does not investigate the trade impact on regional dietary patterns beyond 1997.

4. Data and diet diversity across Indian regions

4.1. Data

The primary data in this study is the Indian household expenditure data from the 43rd and 45th to 53rd round of the National Sample Survey (NSS), covering 11 consecutive years from 1987 to 1997.[5] We aggregate over 100 food items into several food groups and focus on regional consumption of cereals and animal products which consist of eggs, fish and meat.[6] In total, over 70 Indian rural regions are studied.[7] We do not investigate the urban sector due to the endogeneity concern raised by Topalova (2010) over simultaneous reforms and pre-existing trends in urban areas, and the fact that the urban sector is likely to have much more exposure to foreign culture and food prior to the liberalisation, given the colonial history of India. For each rural region, we compute the average of food prices, food budget shares and monthly per capita expenditure (MPCE). The results of each year are then pooled to form a geographically repeated cross-section dataset of food expenditure patterns across Indian regions. Additionally, we obtain agricultural data from the Indian district database (Vanneman and Barnes, 2000) to construct a regional measure of cereal cropland endowment.

Calculating the exposure of trade reforms faced by each region requires data on the tariff rates in each industry and the industry composition of the region prior to the start of liberalisation. The latter is

[5] We restrain from using the data from the 55th round NSS as it employs both 7 and 30day questions for food items rather than the uniform 30 day recall period used in the previous rounds. Because of the possible influence of question by one recall on answer by another, the food consumption from this round is non-comparable to that of the earlier rounds (Sen and Himanshu, 2004).

[6] Milk is not counted in animal products since it plays a very different role compared to eggs, fish and meat. According to Sen (2004), milk is considered to be a pure food in Hindu religious rituals. It is one of the foods taken by Muslims to break the Ramadan fast. Moreover, it serves as the key source of protein in Indian traditional diet.

[7] The NSS regions are used as the geographical unit of analysis since some survey rounds do not record the districts (a more disaggregated unit than regions) where household resides. Moreover, the district samples from multiple surveys may not be consistent over time as the boundary of districts is sometimes redefined across rounds (Panagariya, 2008).

acquired from the Indian Census carried out in 1991, which gives the number of workers in each region at 3 digit industry level. Tariff data comes from multiple sources. The manufacturing tariffs are adopted from Aghion et al. (2008) which map the tariff data at the 6 digit level of the Harmonised System (HS) to the 3 digit industry codes using the concordance of Debroy and Santhanam (1993) (thereafter DS). For the trade protection faced by primary sector, we match the product-level tariff rate from Topalova (2010) to the industries based on DS. Since this dataset does not cover all items listed in DS, we utilise the HS tariff data from the World Integrated Trade System database to fill in the gap.[8]

With limited disaggregated data on non-tariff barriers (NTBs), it is not feasible to construct a time-varying measure of NTBs across regions and hence they are not accounted for in the empirical analysis. While this may reduce the precision of the estimated impacts of tariff reduction in this paper, it does not undermine the empirical strategy because of the high positive correlation between NTBs and tariffs revealed in research for other developing countries (Topalova, 2007). The ignorance of NTBs only implies that some of the trade effect captured is attributed by the decline in NTBs instead of tariff cuts.

During the period of liberalisation, the Indian government also reformed foreign direct investment (FDI) policy and de-licensed many industries. The rate of foreign investment increased from 40% to 51% for high technology and high investment industries in 1991. According to Arnold et al. (2016), the scope of foreign ownership in major service sectors was improved but remained limited. FDI in agricultural sector continued to be highly regulated. Under the Industries (Development and Regulation) Act of 1951, industries in the manufacturing sector were required to obtain a license for various production activities such as the establishment of a new factory and product lines (Aghion et al., 2008). In 1991, the licensing requirement for most industries was abolished with the exception of some strategic sectors. To isolate the effect of trade liberalisation from these contemporaneous reforms, we construct regional indicators of FDI reform and industrial delicensing with data from Aghion et al. (2008). Summary of data sources and descriptive statistics can be found in the Appendix.

4.2. Regional diet diversity

While cereals have always been at the centre of the traditional India diet, there are many variations in dietary habits across regions. Wheat is the basic meal for regions in the North, which are characterised by the dominance of wheat cultivation. But rice is the key staple for the rice producing regions in the South and East. Vegetables and animal products are added to complement the flavour and nutritional value of the main grain (Sen, 2004). In spite of the common belief, the majority of Indians are non-vegetarian. In 1994, less than 20% of the total population did not eat meat, fish and eggs at all. This figure varies from 5% to 69% across Indian states (Achaya, 1994)[9]. There are also massive regional differences in terms of consumption of eggs, fish and meat. For example, in 1987-88, fish took up 10.6% in food budget of Southern Kerala but less than 1% in Western Rajasthan (Atkin, 2013).

<Insert figure 2 here>

A look at the data reveals that there are obvious shifts in the pattern of regional diet diversity in the sample period. Figure 2 compares the kernel density function of the regional food budget share on cereals and eggs, fish and meat in 1987 and 1997. As one would expect, a higher proportion of food expenditure is spent on staples rather than animal products. Over the years, cereal consumption at regional level has become less diverse and shifted to the left (i.e. decreased) and that of animal products has moved to the right (i.e. increased). This reflects the increase in the dietary importance of eggs, fish and meat relative

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8 The trend of tariffs reduction for the ones covered in Topalova (2010) is matched with that of the uncovered items if they share the same tariff rates in 1990, 1992 and 1999. Despite the data difference, our tariff measure is comparable with the district-level estimates in Topalova (2010) and the state-level estimates in Hasan et al. (2007).

9 State is a higher geographical classification than region. In India, there are about 30 states which can be further disaggregated into over 70 regions, the geographical unit of interest in this paper.

to cereals, which is in line with the dietary shift documented by the literature on Indian food consumptions.

The scatter plot in figure 3 shows the difference in budget share on cereals and animal products of each region between 1987 and 1997. The rural regions are classified into 4 income groups based on its average MPCE in 1987. There are considerable variations in the dietary changes across regions. Most of the regions are located in the lower right quadrant of the plot, suggesting that they consumed more eggs, fish and meat and fewer cereals in 1997 than in 1987. While the richer regions tend to have more dramatic changes in their average budget share on cereals and animal products, there is no conclusive relationship between the regional income at the baseline and their changes in food consumption.

<Insert figure 3 here>

To further illustrate the regional diversity in food consumption, dietary changes of a few selected regions are given in Table 1. Northern Orissa and Delhi were the poorest and richest regions in 1987 respectively. In general, richer regions tend to consume less cereals and more animal products, with the exception of Delhi. Among all regions in our sample, Southern Rajasthan experienced the largest decline in cereal consumption. From 1987 to 1997, its average share of food expenditure on cereals had decreased from 47% to 22%. The increase in animal product consumption was most obvious in Lakshadweep in which the food budget share on eggs, fish and meat rose from 23% to 29%.

<Insert table 1 here>

Coastal and Ghats of Karnataka was the region most affected by the trade reforms as its industries faced relatively larger tariff reductions.[10] From 1987 to 1997, its food budget share on cereals had decreased by 3% while that on animal products increased by 6%. On the other hand, Mozoram, the region least exposed to the liberalisation, experienced a 11% increase in its food expenditure share on cereals and a less than 1% decrease in that on eggs, fish and meat from 1987 to 1997. Coupled with the exogeneous trade policy shift, the diverse dietary patterns within India presents an ideal environment for exploring the impacts of trade reforms on the consumption of cereals and animal products.

5. Trade and the dietary composition in rural India

This section explains the empirical strategy used to identify the regional trade impact on the Indian food consumption of cereals and animal products. We first exploit the regional difference in industrial composition prior to the reforms in measuring the changes in tariff protection faced by the rural regions. We move on to discuss the baseline specification used to study the trade-diet link. The estimation results show that regions more exposed to tariff reductions are found to consume relatively less cereals but more eggs, fish and meat, after controlling for the regional difference in cereal cropland endowment. The last part in this section establishes the robustness of results.

5.1. Measuring trade exposure

Following Topalova (2007), the exposure to foreign trade faced by a region can be captured by the interaction between the share of the region's population employed by various industries on the eve of the economic reforms and the reduction in tariff barriers in these industries. The regional tariff, $tariff_{rt}$, is thus:

$$tariff_{rt} = \frac{\sum_n Worker_{rn,1991} \cdot T_{nt}}{Total\ Worker_{r,1991}} \quad (1)$$

where T_{nt} is the nominal ad valorem tariff faced by industry n at time t. $Worker_{rn,1991}$ indicates the number of workers in industry n in region r in 1991, which is divided by the total number of

[10] The degree of exposure to trade reforms is measured by the regional tariff calculated in section 5.

workers in region r. Non-traded industries, including services, trade, transportation, construction and industries involved in growing cereals and oilseeds, are assigned zero tariffs for all years[11]. The control variables for FDI reform (FDI_{rt}) and industry delicensing ($Delic_{rt}$) are constructed in a similar manner[12].

Owing to the assignment of zero tariffs, $tariff_{rt}$ is dependent on the share of people involved in non-traded sector. In India, the majority of people working in non-traded industries are cereal and oilseed growers. So in regions with a larger non-traded sector, traditional staples are locally abundant and relatively inexpensive. These regions are, therefore, likely to consume disproportionately more traditional staples, implying that the regional tariff is correlated to initial food consumption levels through non-traded sector. Besides, these regions tend to record a lower reduction in trade protection since their initial level of $tariff_{rt}$ is lower, which constitute a potential negative bias in the tariff estimates. To address this concern, we follow Topalova (2007) to instrument $tariff_{rt}$ with a non-scaled tariff, $nstariff_{rt}$:

$$nstariff_{rt} = \frac{\sum_n Worker_{rn,1991} \cdot T_{nt}}{Total\ TWorker_{r,1991}} \quad (2)$$

in which the denominator is now replaced by the total workers in traded industries in region r ($Total\ TWorker_r$). As workers in non-traded industries are ignored in computing the total number of workers, this measure is not sensitive to the size of non-traded sector. Table 2 presents the first stage regression of the IV approach, which shows that $nstariff_{rt}$ are strongly correlated with $tariff_{rt}$. The high value of the F-statistics on the excluded instruments rejects the presence of weak instruments. Hence, the non-scaled tariff is a valid instrument for the regional tariff.

<Insert table 2 here>

This measure of regional tariff would, however, be problematic if factors were reallocated across Indian regions in response to trade policy changes. As highlighted by Topalova (2010), the portion of population who moved for economic or employment reasons was minimal from 1983 to 1999. There was no visible change in the pattern of internal migration after the reforms of 1991. Furthermore, domestic markets in India were far from integrated due to high state tariffs and poor transport infrastructures (Atkin, 2013). Hence, with the limited mobility of factors in India, the regional measure of trade protection will give an insightful answer to the question of whether regions more exposed to tariff reduction experienced more changes in their consumption of cereals and animal products.

It is important to emphasise that the above regional tariff accounts for reforms in both food and non-food industries. This general measure has two advantages over a food-related or agricultural tariff variable. First, as discussed in Section 3.1, the Indian manufacturing sector experienced more radical reduction in trade barriers than the agricultural sector during the period of interest. This implies that neglecting reforms in non-food industries are likely to greatly underestimate the extent of Indian trade liberalisation. Second, trade reforms in the manufacturing sector can have important influence on dietary patterns. It may alter the relative prices between food and non-food and hence trigger resource reallocation across industries within a region. For instance, a cut in tariff on textile machinery can improve

[11] As argued by Topalova (2007), the treatment of industries growing oilseeds and cereals as non-traded industries is justified by that fact that the imports of all the product lines of these industries were only allowed to the state trading monopoly until 2000.

[12] $FDI_{rt} = \sum_i \omega_{rn} \cdot FDI_{nt}$ where ω_{rn} is the share of worker in industry n in total employment in manufacturing sector and FDI_{nt} is the number of 6 digit products within industry n that were opened to automatic approval of foreign equity up to 51 percent at time t. For delicensing, $Delic_{rt} = \sum_i \omega_{rn} \cdot Delic_{nt}$ where $Delic_{nt}$ is a dummy variable which takes the value of unity if the industry has been delicenced. Note that FDI_{nt} is only available for the manufacturing sector. This is unlikely to cause substantial bias because FDI in other sectors continued to be highly regulated and FDI in secondary sector constituted over 80% of the FDI stocks in the sample period (Chakraborty and Nunnenkamp, 2008).

the productivity of the cotton textile industry, which increases the demand for cotton and encourages farmers to use more land to cultivate cotton instead of food crops. This can potentially cause changes in food prices and therefore affect food consumption. In addition, liberalisation in the manufacturing sector may also influence dietary patterns through the income or taste channel. For example, workers in non-food related industries may benefit from an increase in income as a result of greater trade opening, which enables them to adjust their food consumption pattern. Manufacturing trade may also affect their interaction with foreign culture, motivating Indian households to adopt a diet (more diverse) different from the traditional ones. Hence, to fully capture the dietary impact of trade liberalisation, this paper considers both food and non-food industries when measuring the regional exposure to trade reforms.

5.2. Baseline regression

The next step is to establish whether there is a linkage between trade liberalisation and the observed shifts in Indian dietary patterns. This can be achieved by testing if regions facing larger tariff cuts experienced greater changes in consumption of cereals and animal products. For each food group f , the following reduced form equation, (3), is estimated:

$$W_{rt} = \alpha + \beta_1 tariff_{rt} + \beta_2 tariff_{rt} \cdot Endowment_r + D_r + \tau_t + \varepsilon_{rt} \qquad (3)$$

Following the main stream food literature, food consumption is measured by W_{rt}, the regional average percentage of food expenditure spent on food group f at time t.[13] This measure accounts for changes in total food consumption caused by an increase in non-food expenditure or a decline in calories need and therefore serves as a better measure of the relative dietary importance than quantity consumed.

$tariff_{rt}$ is the regional measure of exposure to trade liberalisation discussed above. It is interacted with the cereal cropland endowment of region r, $Endowment_r$, to allow the trade impact to vary across regions with different agro-climatic endowments. As pointed out by Atkin(2013), these land characteristics play a key role in determining the caloric effect of trade. He shows that food habits are developed towards crops that are relatively well-suited to the local agro-climatic endowment since these foods are relatively abundant and therefore cheaper in the period of autarky. At the time of liberalisation, while the locally abundant crops rise in price with the increase in foreign demand, they remain the preferred food due to the presence of food habits, which in turn erode the calorie gains from trade. Following this intuition, the trade impact on dietary intake is dependent on food habits and hence regional land characteristics. As in Atkin (2013), we measure the land characteristics of a region by its relative land endowment for crop growing. With our focus on cereal intakes, $Endowment_r$ is defined as the portion of regional cropland planted with cereal crops in 1971. Note that apart from cereals, this measure also affects the trade impact on consumption of other foods, including animal products, as regions with relative more cereal cropland and thus stronger habits of consuming cereals are less likely to change their dietary patterns in response to trade liberalisation.[14]

The heterogeneity across regions, such as diet tradition and religion composition is controlled by the inclusion of region dummies (D_r). Since $Endowment_r$ is a region-specific but time-invariant measure, its main effect on budget shares is absorbed by the regional fixed effect. A time fixed effect (τ_t) is included to account for average changes in food budget share across all regions and also any macroeconomic shocks in year t. The coefficient of $tariff_{rt}$ thus does not capture the aggregate effect of Indian tariff reforms on food consumption but rather the relative impact on regions with different degrees of trade exposure. Standard errors are clustered by state-year level for all estimations.

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[13] Following items are dropped in the calculation of total food expenditure due to the difficulty in unit conversion and their insignificance in consumption patterns: ice-cream, other milk products, other meat, other birds, other egg products, other fresh fruits, other dry fruits, salt, spices, processed food and beverages. The total food expenditure calculated in this paper constitutes 91% of the actual total expenditure reflected in the data in 1987.

[14] We thank an anonymous referee for pointing out the importance of land characteristics in determining the dietary impacts of tariff reduction.

<Insert table 3 here>

In table 3, we first estimate equation (3) without the control for cereal cropland endowment and find that regional tariffs are not linearly linked to food budget shares on either cereals or eggs, fish and meat (column 1 and 4). The interaction with $Endowment_r$ greatly improves the significance of the tariff measure, as seen in other columns. This confirms the importance of land characteristics and thus habit formation in explaining the effect of trade liberalisation on regional diets. The preferred specification of this paper is given in columns 3 and 6 in which controls for other reforms are added into the estimation.[15] Regions with a higher concentration of industries that were more exposed to losses in trade protection are found to have relatively lower cereal consumption but higher animal product consumption. At sample mean, a 1 percentage point tariff cut is correlated with a 0.03 percentage point increase in the food budget share on animal and a 0.07 percentage point decrease in that on cereals (relative to the national trend). This evidence supports the role of trade liberalisation in promoting dietary diversity and hence driving the observed shifts in Indian diet. The highly significant interaction terms reflect that the trade-food consumption link is generally weaker in regions with relatively higher endowment of cereal cropland, in other words, stronger food habits of cereal consumption, which is consistent with Atkin (2013)'s argument that habit formation erodes calorie gains from trade.

To further understand how these dietary effects of trade vary with regional land characteristics, we evaluate the coefficients of regional tariff at plausible levels of $Endowment_r$ using the estimates of the preferred specification. As shown in table 4, the magnitude of tariff effects on both cereal and animal product consumption decreases with the level of cereal cropland endowment. For a region with half of cropland growing cereals, a 1 percentage point tariff reduction increases budget share on eggs, fish and meat by 0.047 percentage point and decreases that on cereals by 0.152 percentage point. At high levels of $Endowment_r$, while these regional trade effects on cereal and animal product consumption switch signs, they are no longer statistically significant. Recall that the overall effect of tariffs on diet are absorbed by the time dummies and therefore cannot be evaluated under our regional analysis approach, the insignificant tariff effects in table 4 do not imply that the Indian trade reforms had no impact on the food consumption of regions with high portion of land growing cereal crops. Rather, they show that these regions were relatively unaffected by trade reforms compared to other regions with weaker food habits. Overall, the above results reflect that trade liberalisation has opposite regional effects on cereal and animal products and these effects diminish with the strength of food habits.

<Insert table 4 here>

5.3. Robustness Checks

Though the approach advocated by Topalova (2007) has been applied to various contexts, it has been criticised by Hasan et al. (2007) and Panagariya (2008) on the assignment of a zero tariff to non-traded industries. They argue that goods may be non-traded due to prohibitively high tariffs and hence that approach underestimates protection in areas intensive in the production of non-traded goods. To test whether the above result is sensitive to how the tariff measure is constructed, we follow Hasan et al. (2007) to refrain from using non-tradable employment weight in the computation of regional tariff. The resulting variable is equivalent to the non-scaled tariff calculated with equation (2). Column 1 in table 5 presents the corresponding OLS estimates. The contrasting trade impact on regional cereal and animal product consumption is consistent with the preferred specification and remains significant.

[15] In table A3, we report the estimates with no instrumental variable.

Given that changes in trade policy take time to implement and trade exposure may be affected by other simultaneous shocks which are not captured by the time dummies and control variables, we replicate the main specification with lagged tariff and report the result in column 2. Both sign and significance of tariff measure and the interaction term are similar to main findings.

One concern over the estimates in table 3 is that they may pick up a common trend between tariff reduction and dietary pattern, such as the development in mass media and communication technology in 1990s, rather than the actual trade effect on food consumption. We perform two falsification tests in table 5 to address this issue. In column 3, we follow Topalova (2007) to test if changes in dietary pattern prior to the reform (from 1987 to 1991) are correlated with the post-reform changes in the tariff measure (from 1992 to 1997). The coefficients on regional tariff and its interaction with cereal cropland endowment are statistically insignificant. Column 4 gives the result of the second falsification test in which the budget shares on cereals or eggs, fish and meat at time t is regressed on trade shock evaluated between $t+1$ and $t+6$. Only observations prior to 1992 are used in this column. The results have the opposite signs to the main findings and are statistically insignificant. These test results therefore demonstrate that our results are unlikely to be biased by the underlying factors that correlate with trade liberalisation and dietary changes.

<Insert table 5 here>

Next, we employ median budget share on cereals and eggs, fish and meat in the regions as the dependent variable so as to take account of potential outliers. Our results in column 5 show that the coefficients on regional tariffs and its interaction with $Endowment_r$ are not sensitive to the outliners in the household level data.

Besides budget share, food consumption is often measured by the calorie intake from the corresponding food. We convert the quantity of food consumed into calorie intake and use its logarithm form as the outcome variable for robustness check. The conversion is done by multiplying the quantity consumed of each food item with its calorie value and then adding together these results across all food items. Data on calorie content of each food item is obtained from the NSS report on nutritional intake in India published in 1996.[16] As reported in column 6, the trade estimates on calorie intake for cereals and animal products share the same sign as previous results reported in table 3 although not always statistically significant.

As discussed earlier, the regional tariff variable accounts for reforms in both agricultural and manufacturing industries. We check whether our results are sensitive to the use of a food-related tariff in table 6.[17] This food-related tariff is calculated using a formula similar to that of the general measure (i.e. equation (1)). It is captured by the interaction term between tariffs faced by food-related industries (i.e. the agricultural sector and food-processing industries) and the employment share of these industries in 1991. Again, we instrument it with a non-scaled food-related tariff to account for the endogeneity bias caused by the assignment of zero tariff. Looking at columns (3) and (6), both the signs and significance of the tariff measure are consistent with the main findings estimated with the general tariff variable. Nevertheless, there are some differences in the magnitude of the coefficients, indicating that trade reforms in non-food sector also have an impact on regional food consumption. As this effect would be neglected under the use of food-related tariff, we argue that the general tariff is a better variable for this study.

<insert table 6 here>

[16] It is available at http://catalog.ihsn.org/index.php/catalog/2622/download/39007.

[17] We thank an anonymous referee for drawing our attention to the importance of food-related tariffs.

Finally, tables A3-A5 in the appendix provide the sensitivity check of our findings against several alternative samples. One potential bias arises from the use of both `thick' (i.e. 43rd and 50th) and `thin' rounds of NSS data in the construction of our dataset. Since the sample size of the thin rounds is considerably smaller than the thick ones, there have been concerns over their representativeness. In regard to this, we replicate the analysis with a sample restricted to data from the 'thick' rounds. The contrasting trade outcome on regional consumption of cereals and animal products continues to hold. We also examine whether the trade impacts on regional diet are sensitive to data from a particular year. The results are consistent with our main findings, implying that potential bias from the difference in survey designs across NSS rounds is minimal. These robustness checks provide solid support for the contrasting and opposing trade impact on regional food consumption for cereals and eggs, fish and meat.[18]

6. Mechanism behind trade-diet link

How do trade reforms affect consumption of cereals and animal products? Standard Neo-Classical economic theory suggests that consumers make their consumption decision by maximising the utility that they can receive from the good subject to their budget constraint. The ability to purchase food is determined by food prices and income. Hence, regions may exhibit different dietary trends if the Indian trade liberalisation has heterogeneous effects on their level of prices and income. On the other hand, with differential degrees of exposure to trade liberalisation, regions may develop different tastes for cereals and animal products, affecting the utility they receive from consuming those goods and hence their food consumption decision. In this section, the Topalova (2007)'s approach illustrated before is employed to investigate how trade reforms may affect regional food consumption through income, food prices and tastes.

6.1. Income effect

An increase in income potentially motivates households to consume better food and thus triggers dietary adjustment (Fabiosa, 2013). Earlier research on Indian food consumption has shown that food is a normal good in general, implying that households will increase their consumption of food along with a rise in income. The income elasticity of demand for eggs, fish and meat is found to be higher than that of cereals in both Mittal (2007) and Kumar et al. (2011). This indicates that if regions composed of industries with higher exposure to tariff cuts experience a higher increase in income, households residing in these regions are likely to consume relatively more animal products and fewer cereals, contributing to the observed dietary shifts.

The relationship between trade reforms and income has been well-established by literature. Frankel and Romer (1999) provide evidence on the positive impact of trade on the average income of the country. This is later confirmed by Irwin and Terviö (2002) in which the endogeneity of trade is controlled. While the country-wide effect of trade liberalisation on income tends to be positive, it may have diverse impacts at regional level. Through comparing average MPCE in 1987-88 with that in 1999-2000, Topalova (2007) and (2010) evidence that Indian rural districts which were more exposed to the Indian trade reforms experienced slower progress in poverty reduction. In the contrary, with additional data in 1993-94, Hasan et al. (2007) find no evidence of a negative link between trade and consumption at both state and regional level.

In this paper we focus on the annual regional variation across 11 years rather than the overall difference, such that the relationship between income and tariff measures may not be the same as the ones estimated in the earlier papers. Additionally, those papers assign a tariff rate in 1997 to measure the

[18] In Appendix C, we provide an alternative specification in which regional tariff is interacted with food price index, a proxy for food availability, instead of the endowment measure. The contrasting trade impacts on regional cereal and animal product consumption continue to hold.

trade openness in 1999-2000, which may lead to bias in the estimates because tariff rates continued to decline during the second wave of trade liberalisation after 1997. To identify the annual trade effect on income at regional level, the following equation is estimated:

$$lnMPCE_{rt} = \alpha + \beta_3 tariff_{rt} + D_r + \tau_t + \varepsilon_{rt} \quad (4)$$

where $lnMPCE_{rt}$ is the logarithm of regional mean of real MPCE, which is used as a proxy for income since the NSS did not collect data on household income.[19] As in the main analysis, $tariff_{rt}$ is instrumented by non-scaled tariff to overcome the endogeneity problems induced by the assignment of zero tariff.

<Insert table 7 here>

The first two columns in table 7 report the IV estimates of equation (4). Although the coefficients of MPCE are statistically insignificant, they share the same sign as the ones in Topalova (2007) and (2010). Apart from the direct impact on income, trade reforms may also affect dietary patterns by reducing the amount of income needed to spend on non-food items and hence allowing households to allocate more on food consumption. To account for this potential income channel, we regress the logarithm of real monthly per capita non-food expenditure (MPCNE) on the regional tariff. The coefficients on tariff measure reported in columns 3 and 4 suggest no significant correlation between trade liberalisation and regional difference in MPCNE. Therefore, income is unlikely the channel which the regional trade impacts on Indian food consumption came through.

6.2. Price effect

The Indian trade reforms may have increased or decreased the prices of cereals and animal products, depending on whether they are imported or exported. With the increase in foreign supply, prices of imported food are likely to decline with tariff cuts. Exported food tends to be more expensive after liberalisation due to the rising demand from the global market. According to UN Comtrade data, Indian exports of cereals had been increasing at a much faster rate than its imports between 1988 and 1997. This signals an increase in international demand for the traditional staples produced in India, which may make them more expensive for local households. The price of animal products is less likely to have gone up following the trade reforms as the growth rate of imports was faster than that of exports. Additionally, as pointed out by Thow (2009), the rising imports and decreased costs of animal feeds from developed countries has increased the availability of feed in developing countries, which facilitate increased animal production at a lower cost and thus reduces the relative price of animal products. If these trade-induced price changes are found at regional level, it would help explain the impact of tariff cuts on regional food consumption.

However, the trade-induced price changes at regional level could be minimal due to imperfect price transmission to domestic markets. As stated by Winters et al. (2004), price changes at the border may have no influence on local prices in some rural areas as the local market is isolated from the rest of the economy. This is consistent with the findings of Marchand (2012) in which tariff changes are not perfectly transmitted to the state-level domestic prices in rural India. Indeed, as the trade of cereals and animal products was heavily restricted in the period of interest and the Indian government had been subsidising traditional staples to ensure food security, local prices of cereals and animal products might not be affected by the reduction in tariffs discussed in Section 3.1.

To identify the trade impact on regional food prices, we replace the dependent variable of equation (4)

[19] We deflate the MPCE and MPCNE using the consumer price index (CPI) data from the World Bank World Development Indicator Database.

with the real price of food groups per kilogram.[20] Apart from cereals and eggs, fish and meat, we also estimate the trade impact on regional food prices of edible oils and other food for comparison purposes.[21] Edible oils are separated from other foods due to the fact that it is a key import of India and its prices increased at a much slower rate than that of other foods during the sample period.

There are a few ways the general tariff measure may affect the real price of a particular food item. First, tariff cut on this item can have a direct impact on its price in local market and the magnitude of this effect is subject to the effectiveness of price transmission. Second, tariff changes in other food or manufacturing goods may alter the real price of that food item through influencing the average price of consumer goods in Indian market. Third, the trade impact on food prices may go through input-output linkages. By enhancing the access to cheaper or higher quality inputs, opening of input trade may reduce unit production cost of certain types of food and thus lower their prices in domestic market.

<Insert table 8 here>

Looking at table 8, the estimates in columns 1 to 4 do not support a trade effect on prices of cereals and eggs, fish and meat at regional level. These results are unsurprising because of the strict government controls on cereal and animal product trade. Given that India is dependent on imports for edible oils, it is expected that we should observe a positive relationship between tariffs and edible oil price. This is confirmed by the results in columns 5 and 6 which reveal that regions experiencing greater exposure to trade reforms enjoy a relatively lower price of edible oils. On the other hand, other food in these affected regions appears to be more expensive than their counterparts (columns 7 and 8). How these associations may contribute to the relationship between trade liberalisation and food consumption for cereals and animal products is subject to the substitutability among these goods for Indian households, which will be addressed in the later part of this section. Overall, while the results in table 8 show a possible linkage between trade reforms and prices of edible oils and other food, there is no evidence for a price difference in cereals and animal products across Indian regions facing differential degrees of reductions in trade protection.[22]

6.3. Taste effect

Recent trade literature have pointed out that trade integration may contribute to the evolution of tastes because goods are not only consumed for their functional utility value but also for their symbolic meaning in terms of cultural identity and social values (e.g. Bala and Van Long, 2005; Maystre et al., 2014). Indeed, through increased interaction with foreign culture, the opening of trade may create a demonstration effect. Such effect encourages local people to imitate food consumption patterns of the more advanced countries on the grounds that the others have better information or higher social status (James, 1987). This is consistent with Hawkes (2010) which argues that trade is a main driver of westernisation of diet because it makes food choices which are already attractive to consumer even more so. Consequently, by encouraging the imitation of western diet, which is often characterised by relatively higher consumption of meat, eggs, dairy products and potatoes, trade liberalisation may have enhanced the food tastes towards animal products and thus increased the consumption of these foods.

In addition, Thow (2009) states that the opening of trade has in some ways skewed the incentive of food consumption through improving the availability and affordability of animal products. Undeniably, trade liberalisation has greatly enhanced consumers' access to varieties of food that were not previously

[20] For each food group, the prices for the regional average unit value are adjusted for measurement error, quality effects and households size using the methodology purposed by Majumder et al. (2012). Like MPCE, food prices are adjusted for the inflation rate calculated from the CPI.
[21] Other food includes pulses, vegetables, fruits and milk.
[22] The estimation results of trade impact on budget shares for edible oils and other food are available upon request.

available to them (Pingali and Khwaja, 2004). Their food choices are no longer constrained to local produce. Households may prefer to diversify their food consumption since greater variety in diets is generally perceived as more palatable and pleasant (Ruel and Garrett, 2004). Traditional staples may therefore be viewed as less desirable and become more likely to be substituted by other foods.

Tastes are hard to observe and quantify. We follow Atkin (2013) to attribute the across-region difference in household demand to regional food tastes (θ_{rf}). This indicator is obtained by estimating the "linear approximate" almost identical demand system (LA/AIDS). For each year, the following budget share equation is estimated separately for cereals and eggs, fish and meat with OLS[23]:

$$w_{if} = \theta_{rf} D_r + \sum_f \gamma_f \, ln \, P_f + \beta \, ln \left[\frac{m_i}{P_r^*}\right] + \zeta Z_i + \varepsilon_i \qquad (5)$$

The dependent variable (w_{if}) is share of food expenditure that household i spent on food group f. m denotes the monthly per capita food expenditure. To make demand system linear, the price index (P_r^*) is approximated by a Stone index ($lnP_r^* = \sum_f \, \overline{w}_{if} lnP_{fr}$). A vector of household characteristics, Z, is added as control variables, which includes age and gender of the household head, household size, proportion of adult males and adult females in the household and the share of times that meals are consumed outside home by that households. Regional dummies (D_r) are added to create regional taste indicators. The coefficients, θ_{rf}, are essentially the regional component of the budget share equation which cannot be explained by prices, total food expenditure and household demographics.

In table 9, we estimate the trade impact on food tastes by using θ_{rf} as the outcome variable in equation (4). The positive sign for tariff measures in the first two columns suggests that tastes for cereals are likely to be weaker in regions more exposed to tariff declines. However, this association is not statistically significant. In contrast, for animal products, the estimates reveal a strong association between tariff cuts and regional food tastes in rural India. Regions whose workers are on average more exposed to foreign competition are shown to prefer animal products more than other regions. This result supports food tastes as a key channel through which trade liberalisation encouraged the diet diversification observed in India.

<Insert table 9 here>

6.4. The combined effects

The above analysis reveals that regions that experienced larger reductions in trade protection tend to enjoy cheaper edible oils, face a higher price for other food and have stronger tastes for animal products. By regressing the food budget share on cereals and animal products against MPCE, food prices and the corresponding food tastes, we check whether these results are consistent with the trade impacts on regional food consumption shown in table 3. If regional components in the budget share equation do capture the contemporary tastes across regions, one would expect to observe positive coefficient estimates. This is apparent in both specifications in table 10.

In figure 4, we articulate tariff estimates in tables 7 to 9 with the results in table 10 to illustrate how the channels identified previously contribute to the observed dietary shift. The positive coefficient on food prices in column 1 of table 10 suggests that edible oils and other food are considered substitutes to cereals by rural households. Given that their edible oil prices are relatively lower after the reform, regions experiencing higher tariff cuts are likely to consume relatively fewer cereals (lines 1 and 4 in figure 4). On the other hand, with the price of other food being relatively higher in regions more exposed to reductions in trade protection, the regional consumption of cereals is likely to be higher as a result (lines 2 and 5 in

[23] Refer to Atkin (2013) for the detailed explanation of the demand system.

figure 4). This dietary outcome of trade is, however, offset by the trade-induced changes in edible oil price, causing the overall trade impact on regional cereal consumption to be negative (table 3).

<Insert table 10 here>

<Insert figure 4 here>

For eggs, fish and meat, the coefficient for price of other food is negative and statistically significant in column 2 of table 10, indicating a complementary relationship between these foods. This implies that regions more exposed to trade cuts are likely to consume relatively less animal products as other food becomes relatively more expensive (lines 2 and 6 in figure 4). But this association is likely to be counteracted by the positive linkage between trade reforms and tastes for animal products. Regions with employment concentrated in industries losing tariff protection are likely to have a stronger taste for animal products, which makes them consume more eggs, fish and meat as reflected by the positive coefficient for food taste in column 2 (lines 3 and 7 in figure 4). Hence, compared to income and prices, food tastes are a more important channel of transmission between trade reforms and regional consumption of animal products in rural India[24].

Overall, the mechanism analysis reveals that the trade liberalisation in 1991 has had a negative impact on cereal consumption through reducing the edible oil prices and a positive effect on the consumption of animal products through enhancing the food tastes towards them in rural India. While the relative importance of these channels is likely to vary from case to case, our findings are consistent with Deaton and Drèze (2009) who argue that that some changes in Indian food habits are not easily explained by standard factors like changes in income and prices. It also reaffirms the findings of Herrmann and Roder (1995). Through investigating the absolute and relative difference in food consumption across OECD countries between 1978 and 1988, they show that food tastes are more influential than food prices and income on changes in dietary patterns over time.[25]

7. Conclusion

Motivated by the dietary shift from a traditional staple based diet to one with higher consumption of animal products in developing countries, this paper investigates the unintended dietary outcome of trade in the context of Indian liberalisation in 1991. Our findings reveal a statistically significant linkage between the trade reforms and the regional food consumption in rural India. Regions with a higher concentration of industries that were more exposed to tariff reductions are shown to consume relatively less cereals and more eggs, fish and meat. This evidence provides support to the argument that trade liberalisation has played a role in supporting diet diversity and thus driving the observed shift in dietary habit. We also examine the possible channels behind this trade-diet link. The estimates indicate that Indian liberalisation reduces the cereal consumption largely by lowering the price of edible oils since they are viewed as substitute to cereals. On the other hand, the positive trade impact on the consumption of animal products is mainly driven by the enhancement in food tastes.

Our results provide valuable insights on the nutritional implications of trade liberalisation. Through reducing consumption of cereals and increasing that of animal products, trade liberalisation can have both positive and negative influences on the health development in developing countries. While the newly developed diet is likely to provide a higher variety of micronutrients, it is also associated with

[24] We examine if the mechanism analysis is sensitive to the inclusion of food-related tariff in table A6. The findings have generally consistent signs and significance as the ones under the general tariff variable. This suggests that the dietary impact of trade estimated in this paper is partly driven by the reforms in food-related industries.

[25] In unreported result, we examine the channels behind the trade-diet link using the alternative samples discussed in the Section 5.3. The results are largely consistent with our findings in table 7-10.

increased risk of obesity and other diet-related non-communicable disease. Rather than pointing to the use of trade policy in addressing nutritional and health goals, which is likely to be inefficient and restricted by the World Trade Organisation commitments, this paper highlights the need for identifying complementary policies to manage these unintended dietary outcomes of trade. In particular, the importance of food tastes as the channel behind the trade-diet link implies that apart from income and price policies, more attention should be given to education and other information policies so as to enhance the coherence between trade and nutrition actions.

One caveat is that with the use of regional tariff and time dummies, this paper does not identify the overall effect of trade opening on the consumption of cereals and animal products in India, which would have been useful in assessing the relative importance of liberalisation versus other socio-economic factors, such as income growth and urbanisation, in driving the observed dietary shift (Popkin, 2002; Kearney, 2010)[26]. Nevertheless, the regional outcome of trade is of significant interest to policymakers since the problem of malnutrition differs greatly across regions in developing countries. For example, in India, the percentage of underweight women (BMI <18.5) was 47% in Orissa but 11% in Sikkim while the figure for overweight women (BMI >23) was 10% and 29% respectively. Through comparing the trade impacts on diet across regions, the findings of this paper shed light on the one of the potential causes of these regional malnutrition problems and thus serve as an important input for the formulation of regional food and health policies.

[26] Identifying the trade impacts on Indian diet at national level is difficult due to limitation of tariff data and the concern on isolating the overall trade impacts from other macroeconomic shocks.

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Tables

Table 1. Changes of budget share on cereals and EFM of selected regions

Region	MPCE in 1987 (in Indian rupee)	Cereals			Eggs/ Fish/ Meat		
		1987	1997	Change*	1987	1997	Change*
Northern Orissa	108	0.684	0.698	0.013	0.055	0.045	-0.010
Southern Rajasthan	132	0.470	0.218	-0.251	0.014	0.041	0.027
Coastal and Ghats of Karnataka	219	0.416	0.390	-0.026	0.081	0.137	0.056
Mozoram	254	0.320	0.428	0.108	0.176	0.172	-0.004
Lakshadweep	272	0.245	0.256	0.011	0.226	0.287	0.061
Delhi	340	0.185	0.173	-0.012	0.033	0.056	0.023

*in absolute term

Table 2 First stage regression for rural India

	Tariff
Non-scaled tariff ($nstariff_{rt}$)	0.152***
	(0.012)
F-statistics	171.21
Observations	810
R-squared	0.936

Note: The Regressions are estimated with constant, region and time dummies. Regressions are weighed with the number of people in the region. Robust standard errors clustered at state-year level are given in parenthesis. F-statistics are calculated for the significance of the excluded instrument in the regression. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 3. Trade liberalisation and food consumption in rural India

	Cereals			Eggs. Fish and Meat		
Definition Of tariff	IV-Tariff$_t$ (1)	IV-Tariff$_t$ (2)	IV-Tariff$_t$ (3)	IV-Tariff$_t$ (4)	IV-Tariff$_t$ (5)	IV-Tariff$_t$ (6)
Tariff	0.058	0.421***	0.422***	-0.022	-0.112**	-0.114**
	(0.075)	(0.128)	(0.128)	(0.022)	(0.050)	(0.049)
Tariff*Endowment		-0.524***	-0.541***		0.130*	0.135**
		(0.173)	(0.168)		(0.068)	(0.067)
FDI reform			0.083			-0.024
			(0.052)			(0.017)
Delicensing			0.012			-0.025***
			(0.021)			(0.005)
Observation	810	810	810	810	810	810
R-squared	0.950	0.951	0.951	0.962	0.962	0.964

Note: All regressions are estimated with constant, region and time dummies. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis.. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 4 Estimated effects of 1% change in tariff at plausible level of cereal cropland endowment

	Cereals		Eggs, fish and meat	
Endowment	Tariff effect	Standard error	Tariff effect	Standard error
0	0.422***	0.128	-0.114***	0.049
0.1	0.368***	0.115	-0.101***	0.043
0.2	0.314***	0.102	-0.087***	0.038
0.3	0.260***	0.091	-0.074***	0.032
0.4	0.206***	0.079	-0.060***	0.027
0.5	0.152**	0.069	-0.047**	0.024
0.6	0.098*	0.059	-0.033*	0.019
0.7	0.045	0.075	-0.019	0.020
0.8	-0.010	0.081	-0.006	0.022
0.9	-0.064	0.087	0.008	0.026
1	-0.118	0.097	0.021	0.030

Note: Estimation based on results in column 3 and 6 of table 3

Table 5. Robustness checks

Dependent variable	Average budget share				Median budget share	Ln(Calorie)
Definition of tariff	Non-scaled $Tariff_t$	IV-$Tariff_{t-1}$	IV-$Tariff_t$	IV-$Tariff_t$	IV-$Tariff_t$	IV-$Tariff_t$
	(1)	(2)	(3)	(4)	(5)	(6)
			*Panel A: Regional consumption of **cereals***			
Tariff	0.088***	0.308**	0.301	-0.227	0.414***	0.783*
	(0.028)	(0.140)	(0.422)	(0.196)	(0.140)	(0.465)
Tariff*Endowment	-0.115***	-0.695***	-0.189	0.001	-0.518***	-0.493
	(0.036)	(0.165)	(0.469)	(0.285)	(0.188)	(0.612)
Observation	810	737	73	368	810	810
R-squared	0.952	0.953	0.033	0.959	0.946	0.810
			*Panel B: Regional consumption of **eggs, fish and meat***			
Tariff	-0.023*	-0.121**	-0.153	0.022	-0.052	0.577
	(0.012)	(0.061)	(0.288)	(0.056)	(0.066)	(1.027)
Tariff*Endowment	0.029*	0.205***	0.256	0.011	0.149*	-0.075
	(0.017)	(0.079)	(0.313)	(0.076)	(0.086)	(1.025)
Observation	810	737	73	368	778	778
R-squared	0.963	0.964	0.063	0.976	0.966	0.811

Note: All regressions are estimated with constant, region and time dummies and controls for other reforms. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff in column 2 to 6. In column 3, the dependent variables are budget share in 1991 minus budget share in 1987 and tariff measures and FPI are measured as the difference between 1997 and 1992. For column 4, only observations prior to 1992 are used and the different between regional tariffs, FPI and their interaction from $t+6$ and $t+1$ are the regressors. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 6: Robustness checks using food-related tariff

	Cereals			Eggs. Fish and Meat		
Definition Of tariff	$FoodTariff_t$ (1)	$IV\text{-}FoodTariff_t$ (2)	$IV\text{-}FoodTariff_t$ (3)	$FoodTariff_t$ (4)	$IV\text{-}FoodTariff_t$ (5)	$IV\text{-}FoodTariff_t$ (6)
FoodTariff	0.085	0.304***	0.314***	-0.017	-0.071*	-0.076**
	(0.074)	(0.108)	(0.107)	(0.021)	(0.039)	(0.038)
FoodTariff*Endowment		-0.313*	-0.336**		0.082	0.087
		(0.171)	(0.166)		(0.057)	(0.056)
Other reform controls	No	No	Yes	No	No	Yes
Observation	810	810	810	810	810	810
R-squared	0.949	0.949	0.949	0.962	0.962	0.963

Note: All regressions are estimated with constant, region and time dummies. Regressions are weighed with the number of people in the region. Other reform controls are FDI reform and industrial delicensing Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 7. Trade liberalisation and total expenditure in rural India

	Log real MPCE		Log real MPCNE	
	(1)	(2)	(3)	(4)
Tariff	-0.477	-0.523	-0.820	-0.096
	(0.318)	(0.328)	(0.490)	(0.318)
FDI reform		0.357		0.157
		(0.218)		(0.224)
Delicensing		0.004		-0.082
		(0.077)		(0.108)
Observations	810	810	810	810
R-squared	0.973	0.974	0.940	0.926

Note: All regressions are estimated with constant, region and time dummies. Regressions are weighted by number of Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 8. Trade liberalisation and food prices in rural India

	Cereals		Eggs, Fish and Meat		Edible Oils		Other Food	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff	-0.086	-0.123	-0.462	-0.534	1.255***	1.202***	-0.856***	-0.893***
	(0.214)	(0.216)	(0.390)	(0.409)	(0.393)	(0.378)	(0.286)	(0.286)
FDI reform		0.268*		0.528*		0.317		0.266
		(0.161)		(0.318)		(0.230)		(0.168)
Delicensing		-0.027		-0.035		-0.202***		-0.035
		(0.044)		(0.066)		(0.050)		(0.060)
Observations	810	810	810	810	810	810	810	810
R-squared	0.987	0.987	0.955	0.955	0.974	0.975	0.978	0.978

Note: All regressions are estimated with constant, region and time dummies. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 9. Trade liberalisation and regional food tastes in rural India

	Cereals		Eggs, Fish and Meat	
	(1)	(2)	(3)	(4)
Tariff	0.209	0.225	-0.120***	-0.123***
	(0.156)	(0.158)	(0.031)	(0.032)
FDI reform		-0.133		0.014
		(0.099)		(0.024)
Delicensing		-0.016		-0.015**
		(0.036)		(0.006)
Observations	810	810	810	810
R-squared	0.995	0.995	0.994	0.994

Note: Contemporary taste is measured by the regional component of the budget share equation which cannot be explained by prices and total food expenditure. All regressions are estimated with constant, region and time dummies. Tariff is instrumented by non-scaled tariff. Regressions are weighed with the number of people in the region. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table 10. Determinants of dietary patterns of Indian rural households

	Budget share (Cereals)	Budget share (Eggs, Fish and Meat)
	(1)	(2)
Log real MPCE	-0.042***	0.009***
	(0.010)	(0.003)
Log real price		
Cereals	0.091***	-0.021***
	(0.016)	(0.004)
Eggs/ Fish / Meat	-0.016**	0.007***
	(0.007)	(0.002)
Edible oils	0.013*	0.001
	(0.007)	(0.005)
Other food	0.023**	-0.016***
	(0.010)	(0.003)
Contemporary taste		
Cereals	0.382***	
	(0.027)	
Eggs/ Fish / Meat		0.546***
		(0.032)
Observations	810	810
R-squared	0.979	0.984

Note: Contemporary taste is measured by the regional component of the budget share equation which cannot be explained by prices and total food expenditure. Regressions are weighed with the number of people in the region. Robust standard errors clustered at state-year level are given in parenthesis. All regressions are estimated with constant, region and time dummies. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Figures

Figure 1 Timeline of trade liberalisation in India, 1985-2002

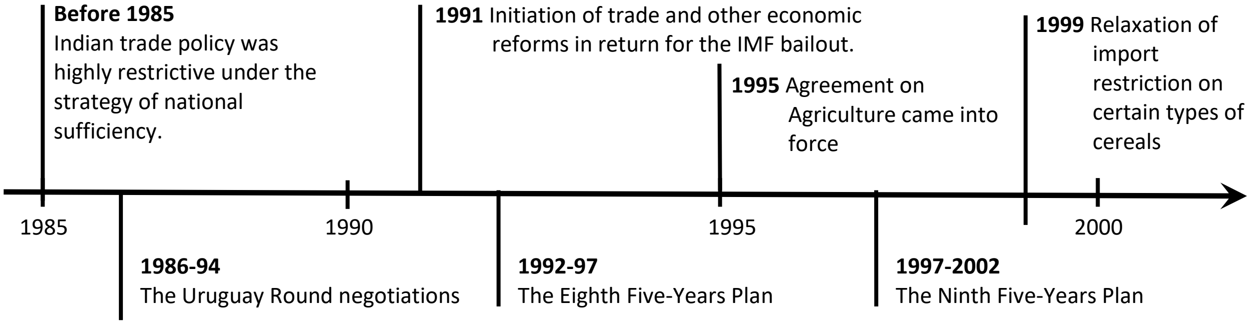


Figure 2 Distribution of regional average budget share on cereals and eggs, fish and meat, 1987 and 1997

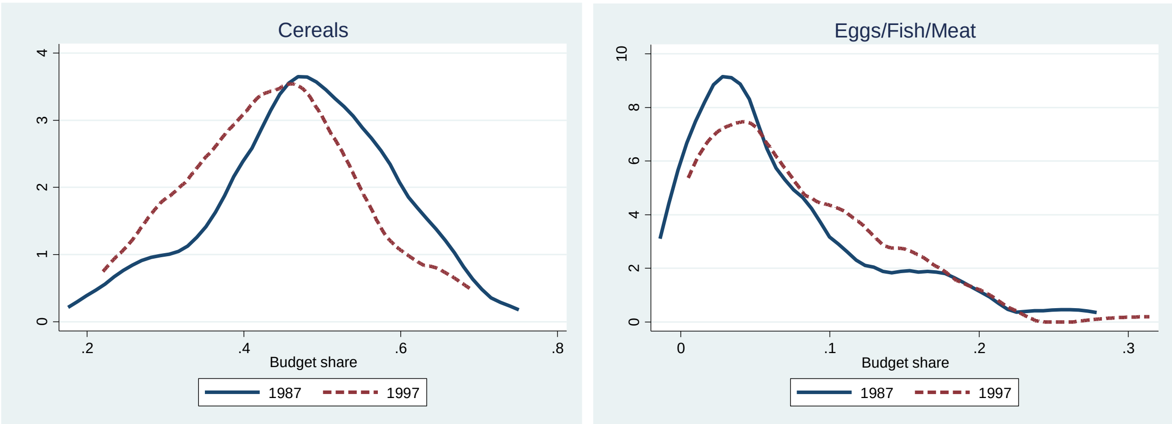


Figure 3. Changes in regional food consumption in rural India from 1987 to 1997

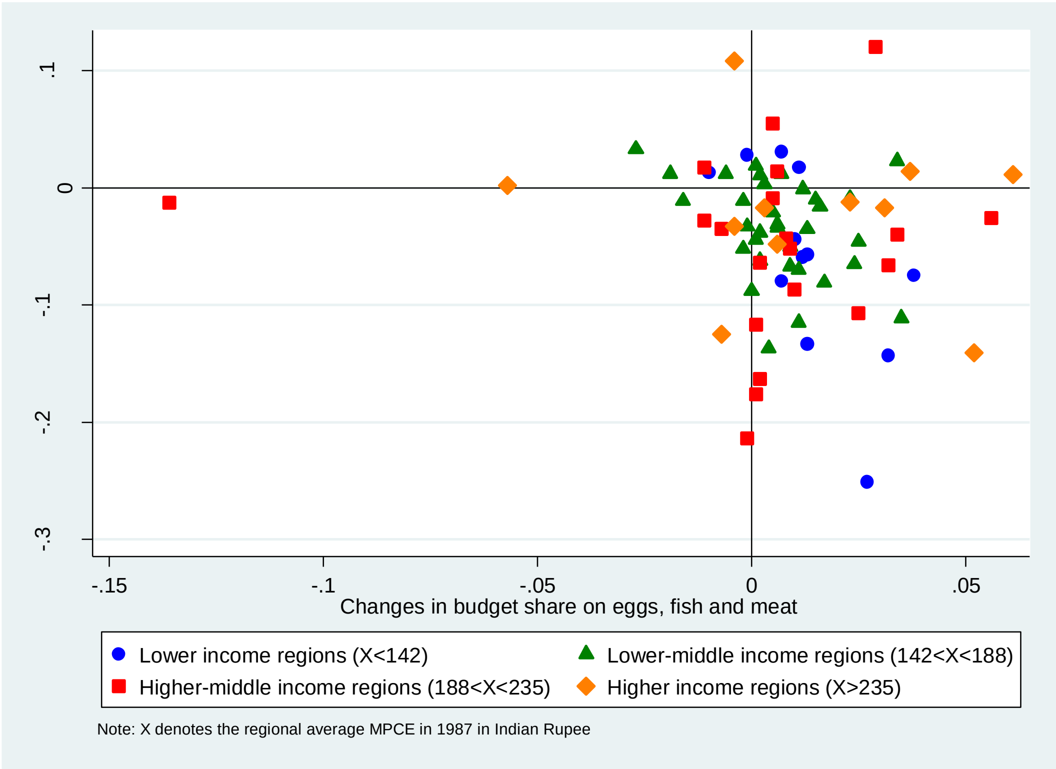
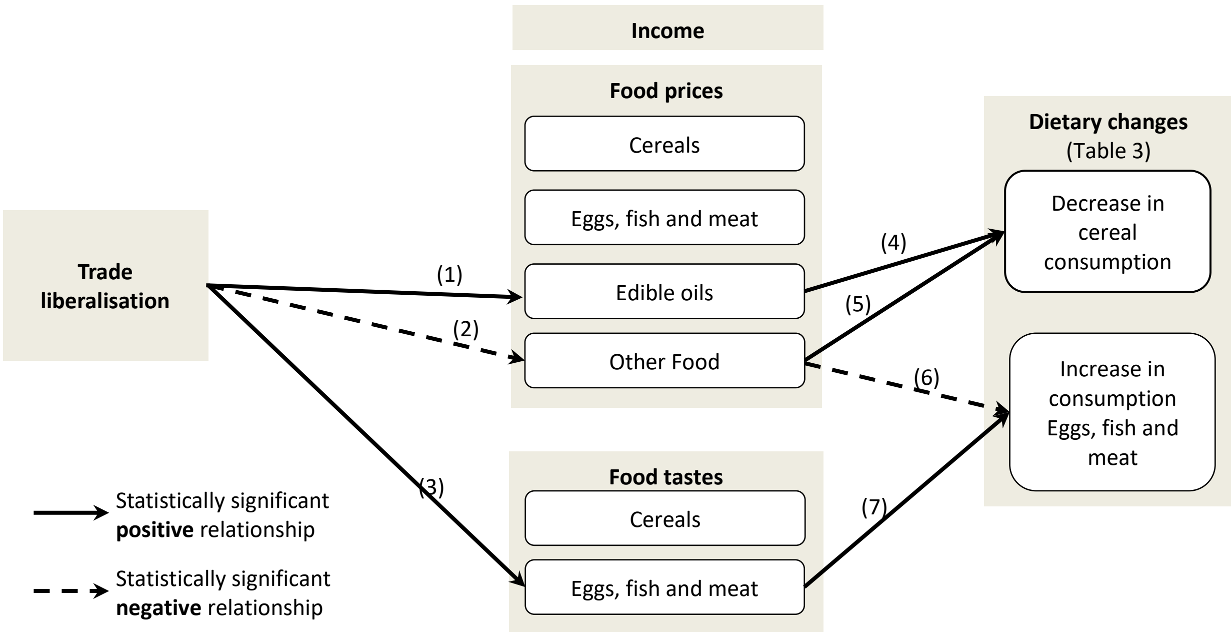


Figure 4. Mechanism behind the trade-diet link in the case of rural Indian regions



Note: Refer to tables 7-10 for the statistical results in details.

Appendix A. Data sources and summary statistics

Table A1 Data source

Variables	Disaggregation level	Data Source
Food consumption, food prices, MPCE, Socio-economic demographics	Household	National Sample Survey (43rd and 45th to 53th round)
Tariffs	Product/ industry	Topalova (2010), World Integrated Trade System, Aghion et al. (2008)
FDI reform and industrial delicensing	Industry	Aghion et al. (2008)
Industrial composition in 1991	District	Indian Census in 1991
Relative endowment of cereal cropland	District	Indian District Database (Vanneman and Barnes 2000)

Table A2. Summary statistics for selected years

	1987	1992	1997
Regional level variables			
Average share of food expenditure			
Cereals	0.44	0.43	0.39
Eggs/ Fish / Meat	0.05	0.06	0.06
Median share of food expenditure			
Cereals	0.45	0.43	0.39
Eggs/ Fish / Meat	0.03	0.04	0.04
Calorie intake (in kcal)			
Cereals	1671	1497	1364
Eggs/ Fish / Meat	25	26	25
Real income/ expenditure (in Indian rupee)			
MPCE	177	418	1057
MPCNE	83	188	545
Real food prices (Indian rupee per kilogram)			
Cereals	2.73	4.71	6.86
Eggs/ Fish / Meat	20.19	31.37	54.02
Edible oils	27.32	34.99	37.41
Other food	4.33	6.83	10.84
Food price index	6.67	15.62	33.39
Reform variables			
Tariff	0.173	0.073	0.034
Non-scaled tariff	0.881	0.361	0.163
FDI reform	0	0.097	0.097
Delicensing	0.246	0.730	0.735
Food-related tariff	0.144	0.032	0.019
Non-scaled food-related tariff	0.802	0.166	0.094
Relative endowment of cropland	0.552	0.552	0.552
Household level variables			
Age of household head	44.24	44.46	43.90
Proportion of female household head	0.100	0.108	0.098
Household size	5.451	5.334	4.939
Proportion of adult female	0.326	0.328	0.329
Proportion of adult male	0.330	0.339	0.361
Share of meals consumed outsides	0.027	0.022	0.026
No of rural regions	73	73	74

Appendix B. Robustness checks

Table A3. Robustness checks using scaled tariff and thick round samples

	Scaled tariff (without IV)		Thick round samples	
	Cereals	Eggs. Fish and Meat	Cereals	Eggs. Fish and Meat
	(1)	(2)	(5)	(6)
Tariff	0.218*	-0.175***	0.425***	0.061*
	(0.118)	(0.049)	(0.157)	(0.037)
Tariff*Endowment	-0.374**	0.182***	-0.415*	-0.083*
	(0.162)	(0.069)	(0.228)	(0.049)
Observations	810	810	294	294

Note: All regressions are estimated with constant, region and time dummies. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table A4. Robustness checks using alternative samples

Year excluded in the sample	1987	1988	1989	1990	1991	1992
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Regional consumption of ***cereals***						
Tariff	0.437***	0.508***	0.408***	0.351***	0.431***	0.467***
	(0.144)	(0.147)	(0.135)	(0.135)	(0.136)	(0.126)
Tariff*Endowment	-0.593***	-0.739***	-0.541***	-0.534***	-0.490***	-0.573***
	(0.185)	(0.190)	(0.174)	(0.170)	(0.173)	(0.166)
Observation	737	737	736	736	736	737
Panel B: Regional consumption of ***eggs, fish and meat***						
Tariff	-0.176***	-0.156***	-0.099**	-0.090*	-0.105**	-0.123**
	(0.056)	(0.059)	(0.050)	(0.051)	(0.048)	(0.048)
Tariff*Endowment	0.214***	0.202***	0.115*	0.111*	0.118*	0.147**
	(0.075)	(0.078)	(0.067)	(0.066)	(0.065)	(0.066)
Observation	737	737	736	736	736	737

Note: All regressions are estimated with constant, region and time dummies and controls for other reforms. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table A5. Robustness checks using alternative samples

Year excluded in the sample	1993	1994	1995	1996	1997
	(1)	(2)	(3)	(4)	(5)
			*Panel A: Regional consumption of **cereals***		
Tariff	0.411***	0.427***	0.450***	0.335***	0.427***
	(0.131)	(0.134)	(0.137)	(0.123)	(0.135)
Tariff*Endowment	-0.511***	-0.532***	-0.582***	-0.387**	-0.489***
	(0.173)	(0.179)	(0.183)	(0.164)	(0.186)
Observation	736	736	736	737	736
			*Panel B: Regional consumption of **eggs, fish and meat***		
Tariff	-0.120**	-0.120**	-0.089	-0.102**	-0.090*
	(0.050)	(0.052)	(0.055)	(0.052)	(0.050)
Tariff*Endowment	0.144**	0.145**	0.095	0.103	0.112
	(0.069)	(0.071)	(0.075)	(0.068)	(0.069)
Observation	736	736	736	737	736

Note: All regressions are estimated with constant, region and time dummies and controls for other reforms. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table A6: The mechanism between trade-diet link using food related tariff

	Income		Food prices				Food taste	
	lnMPCE	lnMPCNE	Cereals	Eggs. Fish and Meat	Edible Oils	Other food	Cereals	Eggs. Fish and Meat
FoodTariff	-0.077	-0.396	-0.059	-0.491	0.943***	-0.676***	0.318**	-0.121***
	(0.169)	(0.273)	(0.188)	(0.376)	(0.354)	(0.242)	(0.157)	(0.032)
Observation	810	810	810	810	810	810	810	810

Note: All regressions are estimated with constant, region and time dummies, and controls for FDI reform and industrial delicensing. Regressions are weighed with the number of people in the region. Food related Tariff is instrumented by non-scaled food related tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Appendix C. Food availability and the dietary impact of trade

Apart from agro-climatic characteristics, the dietary effects of trade may also depend on the availability of food within the regions. Considering that two regions which experienced the same degree of tariff cuts, households living in one region may find it easier to adjust their food consumption than the ones in another region if food is widely available and therefore could be obtained at lower economic costs. In table A7, we interact regional tariff with regional food price index (FPI), which is a proxy for the overall food availability. An increase in FPI indicates that the supply of food decreases relative to the demand for food in the region, in other words, food becomes relatively scarce and expensive, which makes it harder for Indian household to alter their diet in response to the trade. As shown in table A7, the estimated tariff effects are consistent with our main findings.

The results in table A7 would, however, be biased if FPI is endogenous with the tariff measure as the interaction term will capture the trade impact on food availability. In column 1 of table A8, we regress FPI with instrumented regional tariff and show that the coefficient of tariff measure is not statistically significant. This confirms the exogeneity of FPI empirically. This insignificant trade effect is likely to be the results of the heterogeneous price effect of trade reforms on food groups shown in table 8. With no tariff effects from prices of cereals and animal products, the negative price effect of trade on edible oils may have cancelled out the positive price effect of trade on other food, leaving no significant effect on FPI.

As a further check, we interact regional tariff with the lagged FPI in columns 2 and 3 and find no real changes in the tariff and interaction term estimates, suggesting that the estimates are not biased by the potential tariff effect on current food prices. Lastly, we estimate a specification in which FPI is not interacted with regional tariff. The results are given in columns 4 and 5 of table A8, in which the coefficients of FPI have the same sign and are in similar magnitude to the ones with interaction term in table A7. This suggests that the interaction term does not capture the trade impact on food availability. On the other hand, the coefficients of tariff variables are close to zero and not statistically significant when FPI enters in the specification linearly (table A7). This suggest that the trade impact on regional diet is dependent on the level of regional food availability as the tariff variables become statistically significant when interacting FPI. These results provide further evidence that FPI and thus food availability is not endogenous to changes in regional tariff.

Table A7. Food availability and the dietary effect of trade

	Cereals	Egg, Fish and Meat
Tariff	0.506**	-0.226***
	(0.214)	(0.066)
Tariff*lnFPI	-0.203**	0.095***
	(0.086)	(0.026)
lnFPI	-0.065***	0.029***
	(0.025)	(0.007)
Observations	810	810
R-squared	0.951	0.969

Note: All regressions are estimated with constant, region and time dummies and controls for other reforms. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table A8 Trade liberalisation and food price index

	Food price index	Budget share			
		Cereals	Eggs. Fish and Meat	Cereals	Eggs. Fish and Meat
	(1)	(2)	(3)	(4)	(5)
Tariff	0.124	0.524**	-0.219***	-0.032	-0.011
	(0.342)	(0.229)	(0.068)	(0.059)	(0.023)
Tariff*ln FPI_{t-1}		-0.259***	0.101***		
		(0.099)	(0.030)		
ln FPI_{t-1}		0.028	-0.003		
		(0.024)	(0.005)		
Ln FPI				-0.141***	0.064***
				(0.020)	(0.014)
Observations	810	734	734	810	810

Note: All regressions are estimated with constant, region and time dummies. Tariff is instrumented by non-scaled tariff. Regressions are weighed with the number of people in the region. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Unintended consequence of trade on regional dietary patterns in rural India
Supplementary Materials
(Not for publication)

A. Additional robustness checks for the main specification

Considering that the budget shares spent on cereals and animal products are a fraction and their distribution are skewed, we test whether our findings are sensitive to the use of a non-linear estimator. Columns 1 and 2 of table S1 report the Tobit estimates of the main specification with instrumented regional tariff. The coefficients of tariff variable remain the same for both cereal and animal product consumption.

Due to the endogeneity issue in the assignment of zero tariff, this paper uses the non-scaled tariff as an instrument for the scaled regional tariff. In the last two columns, we perform a robustness check for this IV strategy. The reduced form of the main specification is modified by adding the endogenous scaled tariff as regressor. While the significance of the instrument variable (Non-scaled tariff) does not vanish, the magnitudes of its effect on the regional consumption of cereals and animal products is reduced.

Table S1: Tobit and OLS estimations of the main specification

	Tobit with IV		OLS without IV	
	Cereals (1)	Eggs. Fish and Meat (2)	Cereals (3)	Eggs. Fish and Meat (4)
Tariff	0.173**	-0.114***	-0.371	-0.372***
	(0.088)	(0.042)	(0.280)	(0.101)
Tariff*Endowment	-0.218*	0.109**	0.420	0.455***
	(0.121)	(0.057)	(0.376)	(0.149)
Non-scaled Tariff (IV)			0.164**	0.054***
			(0.071)	(0.020)
Non-scaled Tariff (IV)*Endowment			-0.210**	-0.072**
			(0.095)	(0.030)
Observations	810	810	810	810

Note: All regressions are estimated with constant, region and time dummies, and controls for FDI reform and industrial delicensing. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff in columns 1 and 2. Other reform controls are FDI reform and industrial delicensing. Robust standard errors clustered at state-year level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

Table S2 provides the results of the main specification using difference before and after the first wave of Indian trade liberalisation (changes between 1991 to 1997). Following Topalova (2010), we control for initial conditions through a vector of regional variables, which include the percentage of workers in a region employed in agriculture, employed in manufacturing, employed in services, the share of district's population that is schedule caste/tribe and the percentage of literate population. To account for the influence of simultaneous reforms, controls for FDI reform and industrial delicensing are added. The trade impacts on consumption of cereals and animal products are of the same sign as the ones estimated with the full sample. Considering with the small sample size, it is unsurprising that the coefficients of tariff variable are not statistically significant.

Table S2: Difference in trade liberalisation and regional diet between 1997 and 1991

	Changes in budget share between 1997 and 1991	
	Cereals	Eggs. Fish and Meat
$\Delta Tariff_{1997-1991}$	3.139	0.497
	(2.194)	(0.426)
$\Delta Tariff_{1997-1991}$*Endowment	-7.013***	-1.115**
	(1.672)	(0.507)
Observation	74	74

Note: All regressions are estimated with constant and controls for initial regional characteristics used in Topalova (2010) and the reforms in FDI and industrial delicensing. Regressions are weighed with the number of people in the region. Tariff is instrumented by non-scaled tariff. Robust standard errors clustered at state level are given in parenthesis. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

B. Additional robustness check for the mechanism analysis

In this section, we present the results of the mechanism analysis in an alternative way to highlight the importance of different channels in explaining the dietary impact of trade. In table S3, we add demand determinant variables (i.e. MPCE, food prices) progressively to the main specification. While the inclusion of MPCE does not lead to any real changes in the coefficients, the trade protection estimates are reduced for both food groups when regional food prices are added to the specification. These results are consistent with our discussion in section 6.4 of the main text[27].

Table S3. Determinants of dietary patterns of Indian rural households

	Cereals		Eggs, Fish and Meat	
	(1)	(2)	(3)	(4)
Tariff	0.421***	0.263**	-0.113**	-0.080*
	(0.117)	(0.121)	(0.048)	(0.045)
*Tariff*Endowment*	-0.530***	-0.363**	0.134**	0.108*
	(0.150)	(0.161)	(0.067)	(0.062)
Log real MPCE	-0.075***	-0.071***	0.020***	0.019***
	(0.012)	(0.012)	(0.004)	(0.004)
Log real price				
Cereals		0.105***		-0.009**
		(0.017)		(0.004)
Eggs/ Fish / Meat		-0.021**		0.009***
		(0.010)		(0.002)
Edible oils		0.024		-0.003
		(0.021)		(0.006)
Other food		-0.010		0.000
		(0.014)		(0.003)
Observations	810	810	810	810

Note: Robust standard errors clustered at state-year level are given in parenthesis. Regressions are weighed with the number of people in the region. All regressions are estimated with constant, region and time dummies, and controls for FDI reform and industrial delicensing. ***Denotes significant at the 1% level, **at 5% level, *at 10 % level.

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