Spatial Effects of Import Competition: Edible Oils in India*

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August 16, 2025

*We are deeply grateful to the editor, Sangeeta Bansal and two anonymous reviewers for their invaluable and constructive feedback, which significantly improved the paper. We also thank seminar participants at Ambedkar University and the Food and Agriculture Research Discussion Group Meeting, as well as participants at the Annual Conference on Economic Growth and Development at the Indian Statistical Institute Delhi, Australasian Development Economics Workshop, International Network of Economic Research Conference, West Bengal Growth Conference, Biennial Conference on Development at Indira Gandhi Institute of Development Research, and International Conference of Agricultural Economists, for their helpful comments. The remaining errors are our own.

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Abstract

This paper examines, within a panel data setting, the spatial impacts on prices and on wages, of India's trade liberalization in edible oils. Starting from near-autarkic policies that prohibited the import of edible oils, imports surged to meet most of the domestic demand following trade liberalization in the 1990s. While the domestic oils sector provides negligible employment, it uses domestically grown non-traded oilseeds, which occupy 14% of cultivated land and are next in importance only to the cereal grains of rice and wheat. These oilseeds are grown in the dryland arid regions where farm incomes are low and precarious. To examine spatial effects , the paper constructs geographically varying exposure to trade shocks that depend on the cultivated area planted with oilseeds. Consistent with a model of spatial price competition, the paper finds greater price impacts in the high oilseed growing regions. On the other hand, spatial impacts on wages are not significant, suggesting labor reallocation. While we do find significantly greater cropping pattern and production responses in the high oilseed growing regions; however, such evidence does not extend to labor reallocation outside agriculture.

Keywords: Palm Oil, Border Price, Trade Liberalization, Wage Rate, Spatial Effects
JEL Codes: F63, F13, Q17, Q18

1 Introduction

This paper examines the spatial impacts on prices and on wages of India's trade liberalization in edible oils that began in the early 1990s. Starting from near-autarkic policies that prohibited the import of edible oils, restrictions were relaxed and tariffs reduced on edible oil imports. From the early 1990s, imports steadily increased from negligible amounts to over 15 million tons by the end of the 2020s (see Figure 1). During this period, the relative price of edible oils in India declined by nearly 30% until the Ukraine war spiked global prices in 2020 (Figure 2). Today, imports supply about 55-60 % of domestic consumption (OECD/FAO, 2023).

The effect of import competition on agriculture and on the food sector has been contentious in economic policy debates (Anderson, 2014; Smith and Glauber, 2020). In developing countries where much of the unskilled workforce works in agriculture, the potential adverse effects on their welfare are feared (e.g., (McMillan et al., 2007; Bank, 2007; Cheong et al., 2013)). These concerns have constrained global trade negotiations (Glauber and Sinha, 2021; Glauber et al., 2023; Laborde and Martin, 2012). For the sake of competitive trade, the WTO Agreement on Agriculture prohibits governments from procuring agricultural commodities (including food) at administered prices. The G33 coalition of developing countries have, however, disputed this provision and have argued for exempting price supports from WTO restrictions. Their case is that low income farmers need market support. This dispute has not been resolved yet.

The opening up of India's food sector to edible oils imports is illustrative of this dilemma. 55% of India's agricultural workforce do not own any land and depend primarily on labor income. As for the land owning cultivators, 86% of them own less than 2 hectares. They too supplement their farm income with substantial amounts of labor income (NSSO, 2021). How has the sustained import competition for over two decades affected them?

Relative to the workforce, the domestic edible oils sector provides insignificant employment. It might, therefore, seem that trade liberalization in this sector confers gains to consumers while avoiding losses to workers. However, domestic oils are produced using domestically grown oilseeds (e.g., mustard, sesame, groundnut, cottonseed). Oilseeds are not imported because of sanitary and phytosanitary barriers and is, thus, a non-traded good. At the time of opening up the sector, oilseeds were grown on 14% of India's cultivable land and were next in importance only to the cereal grains of rice and wheat. Moreover, these oilseeds are largely grown in the less productive rain-fed agricultural regions of the country (Rao et al., 2015). So while the direct wage and employment impacts of edible oil trade liberalization might be expected to be minor, the spill-over impact on the non-traded domestic oilseeds sector could well be large.

The increased consumption of imported oils and palm oils, in particular, suggests that consumers benefited from trade liberalization. Import competition may have adversely affected domestic oil processors, who are much fewer in number. Despite the possibly downward pressure on prices, the effect on oilseed producers is not so clear because they may have had the opportunity to switch to alternative crops. The effect on wages is even less clear since labor could move to the faster growing sectors within agriculture and outside agriculture.

It is widely recognized that labor might escape the adverse effects of international competition if it can shift to economic activities in which the country has a comparative advantage. But, in practice, such shifts may be muted for a variety of reasons, including the fact that labor might need substantial retraining. A literature has grown around the idea that the economic impact of trade liberalization can be identified by comparing industries or regions that are differentially exposed to trade (Goldberg and Pavcnik, 2007). The underlying premise is that labor is not mobile, and so each region (or industry) can be regarded as a local labor market. Over the long run, labor could move – in which case this approach would not find large impacts of trade liberalization.

In this paper we use the differential trade exposure approach to analyse the impact of Indian edible oils imports on edible oil prices, wages and a number of other economic variables relating to land allocation, labor allocation, and economic welfare. The analysis examines the spatial impacts across Indian districts. The share of oilseeds in the district crop area serves as a measure of differential trade exposure to edible oil imports as well as a measure of differential competitive market structure. This allows us to establish spatial differences in price pass-through as well as wage pass-through. In the agricultural trade literature, the differential trade exposure method was used by He (2020) who examined the impacts of US agricultural exports on US farm and non-farm employment. Time series econometric methods have also been used to examine the impacts of trade liberalization and tariffs on prices and wages (e.g., Lasco et al. (2008)). Model based analyses have relied on multi-market models, computable general equilibrium models, and gravity models. The trade-offs between these different approaches are well known. The model-based simulation approaches can provide comprehensive answers, while the econometric approaches are based on fewer assumptions (Goldberg and Pavcnik, 2007).

In our results, we find that that the pass-through of the border price to local edible oils prices is significantly greater in districts that grow more oilseeds. Here border price refers to the border price of imported palm oil which is the product of the world price, ad-valorem tariff rate and the exchange rate. This is supportive of the hypothesis that the extent of price pass-through depends on local competition. The finding means that workers in high oilseed producing districts face a double whammy. Firstly, their cropping pattern exposes them more to import competition. In addition, the price pass-through is also greater in these regions. Despite the double disadvantage, it turns out that there are no significant spatial differences in the wage pass-through. Neither do we see significant spatial impacts on total agricultural employment, total non-agricultural employment or the share of non-agricultural employment. We also do not find significant spatial impacts on per-capita consumption. To look for mechanisms, we turn to the evidence on reallocation of labor within agriculture. The paper finds significant evidence that cropping pattern changed in response to price shocks. The greater adjustment, however, is on the intensive margin. As a result, districts with more trade exposure also see a greater production response in oilseeds to border price changes.

The rest of the paper is structured as follows. The next section examines the institutional environment under which trade liberalization took place. We discuss the analytical challenge posed by the potential endogeneity of edible oil trade policies. Section 3 describes the data sources and descriptive statistics. The empirical strategy and the application of the differential trade exposure approach to edible oil imports are described in Section 4. Section 4 also presents the empirical model and the theoretical framework that justifies it. Estimation findings and robustness checks are discussed in Section 5 and Section 6 respectively. Concluding remarks are gathered in Section 7.

2 The Edible Oil Sector and Trade Liberalization in India

Oils obtained from mustard (rapeseed), soybean, groundnut, and cotton seed are the major edible oil varieties produced within India. India's imports of oils are primarily palm oil (and its derivatives), soya oil and sunflower oil (Figure 3). Although the tariff rate of soya oil is typically lower than on palm oil, it is the latter that is mostly imported. Palm oil is cheaper (despite the tariff) and the major palm oil exporting countries (Indonesia and Malaysia) are much closer to India than the major soya oil exporting countries (South America and the US) [1].

Since imports account for more than half of consumption, the consumption pattern has shifted towards them. In the 1970s, palm oil and soya oil were unimportant. The traditional oils of groundnut, mustard, and cotton dominated the market. By the end of the century, palm oil was the leading oil, followed by soya oil (Dohlman et al., 2003). Consistent with the liberalization of edible oils trade and the dominance of palm oils in imports, we see a close association between the palm oil border price and the edible oil retail price (see Figure 4).

[1] Table C.1 in Appendix C compares the world prices of different type of edible oils.

The retail price displayed here is the average unit value of edible oil purchases by households calculated from nationally representative consumer expenditure survey data.

Although India allows the imports of oilseeds (non-genetically modified), such imports have not been important for several reasons. Tariffs on oilseeds have generally been higher than on oils, and their imports are also governed by phytosanitary regulations. The ban on genetically modified seeds also rules out the import of soybeans since it is these varieties that are predominantly produced by the major exporting countries. Oilseeds producers have, therefore, not faced direct competition from foreign producers. However, the import of edible oils could have depressed the prices of domestically produced substitutes and thereby affected the demand and prices of domestic oilseeds.

In 1993/94, the three major oilseeds by area were groundnut, rapeseed- mustard, and cotton, and 27 million hectares (or 14% of the total area) grew oilseeds. Since then, the area has fluctuated but without a trend. By the end of the 2010s, the area occupied by oilseeds was again around 27 million hectares. The stability, however, hides the fact that while the area under the traditionally consumed oilseeds (especially groundnut) declined substantially, the area under cotton and soybeans increased. In both these cases, the returns to their cultivation are not derived solely from oil extraction. Cottonseed oil is a secondary product; fibre is the main product of cotton. Cotton area expanded in the 2000s because profitability improved with the introduction of Bt Cotton varieties (James et al., 2015). In the case of soybeans, soymeal feed is a joint product of oil extraction. Despite competition from imported oils, soybeans enjoyed robust demand because of domestic and overseas demand for soymeal feed (Dohlman et al., 2003).

Before 1994, all imports of edible oils were on government account, as private trade was banned. Imports were contracted whenever domestic supplies fell short. The official policy at this time was self-reliance, and government programs were launched to increase productivity and production of oilseeds. Government policy also favored the traditional small scale oil crushers by disallowing large scale units in the sector (except for units that used solvent extraction methods). This policy was removed in 2015. For much of the period of this study, the traditional domestic oils of mustard and groundnut were dominated by small crushing units that lacked the capacity to retail beyond their local markets (Dohlman et al., 2003; Persaud and Landes, 2007; Jha et al., 2012; Reddy, 2009). The empirical strategy discussed in section 4.1 uses this feature to define regional variation in competitive market structure.

In 1994, the government reversed policy and allowed free imports on private account subject to tariffs. The reversal of policy was directly due to the WTO Agreement on Agriculture in 1994. It should be noted India initiated a broad program of trade liberalization starting in 1991. Tariffs were substantially reduced, and the proportion of manufacturing products subject to non-tariff barriers steadily declined. However, agriculture was left out of that initial opening up process. Subsequently, the commitments to the WTO agreement drove trade liberalization in edible oils in the mid-1990s (Reddy, 2009; Jha et al., 2012; Gulati and Narayanan, 2007; Ghosh, 2009).

Trade liberalization in edible oils can therefore be regarded as exogenous to conditions within the agricultural sector. Two caveats, however, attach to this statement. When edible oils imports were liberalized in the mid-1990s, India maintained its quantitative restrictions on other agricultural imports citing balance of payment difficulties (Gulati and Narayanan, 2007). In a dispute, the WTO ruled against India's position, and India lifted its quantitative restrictions on other agricultural imports in 2001. Thus, the government chose to liberalize the edible oils imports before it did so for other food commodities.[2]

Prior work has not addressed the question as to why this happened. However, it is well known that India has struggled with low productivity in oilseeds (Dohlman et al., 2003; Persaud and Landes, 2007; Jha et al., 2012; Srinivasan, 2005).Indeed, even the success in increasing output (prior to liberalization) was achieved from pressing more area into cultivation (at the expense of pulses and millets) rather than higher yields (Gulati et al., 1996). As a result, the protection required for edible oils was higher than for other food staples (Gulati et al., 1996). Such a strategy was not sustainable in the face of rapidly growing demand spurred by income and population growth (Jha et al., 2012; Srinivasan, 2005). On average, edible oils constitute about 7-8% of household food budgets, and inflation in its price matters to consumers. The comparative disadvantage of oilseeds, is in part because it is cultivated in dryland areas with limited access to irrigation (Dohlman et al., 2003; Jha et al., 2012). This means that the differences in cropping pattern that measure differential exposure to trade and competition are in turn because of differences in irrigation and other region specific factors that may also directly matter to the dependent variable. Hence, controlling for these region differences is necessary for identification.

The second caveat is that while the government removed quantitative restrictions on edible oils starting in 1994, palm oil tariffs have subsequently varied (Figure 5). As others have pointed out, a varying import tariff is the government's way of keeping prices within a desired band and is therefore a function of domestic and international availability and prices (Reddy, 2009; Chand et al., 2004; Dohlman et al., 2003). As a specific instance of it, Gulati and Narayanan (2007) argue that tariffs spiked during the period 1999 to 2004 because of a crash in world prices. Such government behaviour aimed at stabilizing domestic prices attempts to strike a balance between (edible oil) consumer and (oilseed) producer interests.

[2] A timeline of the evolution of policies in this sector is displayed in Appendix A

This prevents the full transmission of world prices and exchange rates to domestic prices, wages, and other variables. Indeed, if it were fully stabilizing, consumers and producers would be insulated from import competition beyond the initial shock of trade liberalization.

Figure 6 compares the border price (the product of global prices, the exchange rate and the tariff) with the zero tariff import price (the product of global prices and the exchange rate alone). The two variables are highly correlated; however, the trends are not quite parallel. The gap between the variables widens in some years and narrows in others because of varying tariffs. The correlation between the zero tariff import price and tariffs is as high as -0.74. This could arise because of the stabilizing behavior noted above.[3] Lobbying by affected interests may have mattered as well. In so far as the factors that determine the government's tariff decisions are time varying nationally (as would be if stabilization is the primary goal), they are controlled by a time fixed effect in the regressions. If the government decisions are affected by time varying factors specific to a state within India, they are controlled by state output of oilseeds and by state time trends.

Besides these controls for tariff endogeneity, we also check the robustness of our results by replacing the border price with the zero tariff import price. Since tariffs are not included in the latter, this serves to check whether our results are contaminated by the endogeneity of tariffs.

3 Data Description

Our analysis spans the period between 1993-94 and 2011-12. The paper constructs a district level panel data set. As districts have been sub-divided over time, the paper sticks to the geographic boundaries established in 1961. The district level analysis spans 257 districts that include 14 major states in the sample: Punjab, Haryana, Uttar Pradesh (includes Uttarakhand), Madhya Pradesh (includes Chhattisgarh), Bihar (includes Jharkhand), Gujarat, Rajasthan, West Bengal, Maharashtra, Andhra Pradesh, Karnataka, Orissa, Tamil Nadu and Kerala. The variables and their corresponding data sources are specified in Appendix Table C.2.

The paper uses the National Sample Survey Organization (NSSO) employment and consumer expenditure surveys from 1993-94, 1999-2000, 2004-05, 2007-08 and 2011-12. The NSSO datasets are household level surveys that are representative of India's population. In this paper, we consider the rural sample only. In rural areas, the first stratum is a district. Villages are primary sampling units (PSU) and are picked randomly in a district over an

[3] Such stabilizing behavior has been noted for other commodities in India as well. In the case of wheat, Gouel et al. (2016) estimated the elasticity of tariffs to world prices to be -0.76

entire agricultural year (July to June) over quarters to ensure equal spacing of observations across the year. The households are randomly chosen in the selected PSUs.

Wages and employment data are sourced from the NSSO employment and unemployment surveys. Total agricultural employment, total agricultural employment for men and women, total non-farm employment, and non-farm employment share are the employment variables. The variables have been calculated at the district level based on the description of the usual principal activity status of respondents within the working age group. In NSSO, the usual principal activity status refers to a person's primary activity, i.e., it essentially identifies a person's main role or occupation over the course of a year. Prices of edible oils are sourced as unit values from consumer expenditure surveys, also from NSSO. The consumer expenditure survey provides information on the household level's total expenditure and quantity consumed of edible oil. The total expenditure and quantity consumed are aggregated at the district level. Dividing the district-level total expenditure by the district-specific total quantity consumed, we obtain the unit value of edible oil (for a district) which is a measure of the price of all edible oils - whether domestically produced or imported.[4] We also use an alternative price measure for three traditionally consumed oils alone - mustard oils, groundnut oils, and coconut oils. None of these are imported. We aggregate them and derive the price of what we term traditional oils.

The consumer expenditure survey is not informative about the prices of oilseeds. We use data from farm harvest prices (source: ICRISAT database). Unfortunately, because of missing observations, the quality of data is patchy.

The consumer expenditure survey is also the source for per-capita consumption. Educational attainments and social group composition (the percentage of low caste and tribal populations) are also obtained from the NSSO survey.

The district wise cropping pattern is based on government records and is obtained from the ICRISAT database. The rainfall figures are taken from the gridded dataset of the Centre of Climatic Research at the University of Delaware, which includes monthly precipitation values on 0.5 degree intervals in longitude and latitude centered on 0.25 degree. This grid value is achieved by spatial interpolation using data from nearby weather stations and other sources of rainfall data. District level monthly rainfall estimates were arrived at by averaging the monthly precipitation value of all the grid points lying within the geographic boundaries of a district in a year.

The data on district-specific infrastructural variables, such as the percentage of villages electrified, irrigated, and connected by bus, rail, and paved roads (each as a separate vari-

[4]The consumption categories in the expenditure data do not have a separate category for palm oil, and therefore it is not possible to separate out the imported palm oil price from all the domestic oils.

able), have been obtained from the census of India. For the period 1993-94, we use the census data of 1991. For the periods 1999-2000, 2004-05 and 2007-08, the census data of 2001 is used. For 2011-12, we use the 2011 census figures. The district-level census boundaries for each of these periods are mapped to 1961 census boundaries.

Data on tariffs come from the World Integrated Trade Solution (WITS) database. The data is used to compute the trade exposure measure. It is also used to compute a composite tariff measure as an employment weighted average of tariff rates on different commodities. In our paper, the composite tariff measure is used as a control variable. In order to construct that composite tariff measure, we obtain the average employment share for each district at the three digit (NIC code) level from NSSO employment-unemployment survey data. The employment share corresponds to the initial period i.e.,1993-94. Data on ad-valorem tariff rates at the 6 digit commodity level is available from the WITS (World Integrated Trade Solution) database. We match 3 digit NIC codes with the 6 digit trade codes to calculate the tariff rate at the 3 digit NIC code level(for almost 200 commodities). Then we multiply the tariff rate (computed at the 3 digit level) with the employment share (also at the 3 digit level) and sum it up for all commodities to compute the composite tariff rate.

The border price of palm oil is computed as the world price multiplied by one plus the ad-valorem tariff rate and exchange rate. All nominal quantities (domestic prices, wages, consumption, and border price) are deflated by the consumer price index of agricultural laborers.

4 Empirical Strategy and Model Specification

4.1 Empirical Strategy

Topalova (2007) and Topalova (2010) pioneered the differential trade exposure approach and applied it to study the effects of trade liberalization in India during the 1990s. Topalova constructed a district specific measure of trade exposure as the employment weighted average of tariffs over all traded goods. Although tariffs are uniform for all districts, the employment composition is not, and hence this measure captures a district's exposure to foreign trade. This is the key independent variable, and the analysis seeks to uncover its effects on the dependent variable of interest. The differential trade exposure approach has been used to identify the impacts of trade liberalization or import competition on wages, poverty, unemployment, schooling, child labor, and gender-specific outcomes (e.g., (Hasan et al., 2007; Edmonds et al., 2010; Autor et al., 2013; Hasan et al., 2012; Kovak, 2013; Gaddis and Pieters, 2017)).

Relative to the standard case, our application of the differential trade exposure methods is noteworthy in three ways. The literature measures trade exposure by the employment weighted average of tariffs over all traded goods. By this measure, the opening up of India's food sector to edible oil imports would be inconsequential, as the domestic edible oils sector is insignificant in total employment.[5] The non-traded good (oilseeds) is an essential intermediate input to the domestic import competing sector, i.e., edible oils. Import competition in edible oils transmits price pressure to oilseeds - a crop that is next in importance only to cereals in India's agricultural economy. The spillover impacts on this non-traded sector is therefore the primary interest. This mechanism stemming from vertical linkages is different from what has been noted in the literature.[6] Our trade exposure variable for the local labor market is, therefore, proportional to the area share of oilseeds. The employment share of oilseeds would be a more direct measure of labor market exposure to trade shocks. However, data limitations preclude the use of such a variable.[7]

A second aspect that deserves mention is that edible oils is not a homogeneous category. While India primarily imports palm oil, it does not produce it. India produces many varieties of edible oils of which mustard, groundnut and soya oil are most prominent.[8] The oils differ in flavor and other cooking properties.[9] The imported varieties are, therefore, imperfect substitutes for domestic varieties.[10]. A priori, it is not clear how much of the movement in border prices would be transmitted to domestic prices. It is well known that product differentiation and local market structure affect price pass-through (Goldberg and Pavcnik, 2007; Nicita, 2009; Zimmerman and Carlson, 2010; Han et al., 2016; Bittmann et al., 2020; Genakos and Pagliero, 2022). If the extent of competition varies spatially (like trade exposure), then the extent of price pass-through can be established empirically by methods similar to the differential trade exposure literature. Theoretically, the effect of market structure on price

[5]In 1993/94 - the period immediately preceding edible oil trade liberalization - the share of edible oils in total employment was 0.03%.

[6]In a specific factor model, Kovak (2013) showed that non-traded prices would move with traded prices because of demand shifts and inter-sectoral competition for labor.The implication is that the correct employment weighted tariff should omit non-traded sector employment in the denominator.

[7]In 1993/94, the employment share of oilseeds (derived from employment surveys using a three digit classification code) was positive in 50 districts, while the area share (derived from agricultural crop data) was positive in close to 300 districts. In view of these missing observations, we chose not to use an employment weighted trade exposure variable

[8]The oilseeds that contribute most to edible oils production in India are mustard, soyabean, and groundnut. India also produces edible oils from sesame, nigerseed, safflower and sunflower. Except in negligible quantities, India does not produce palm oil. Imports are predominantly palm oil followed by soya oil and sunflower oil.

[9]https://iopepc.org/products-edible-oils.aspx

[10]Preferences for cooking oils vary by region and community; see Welch et al. (2008), chapter 5 of Jha et al. (2012).

pass-through can be positive or negative depending on relevant elasticities, the curvature of the demand curve and whether competition is modeled as Cournot or Betrand. As a result, the impact of greater competition on pass-through is an empirical issue (Genakos and Pagliero, 2022).

The imported variety faces greater competition from domestic varieties in regions that produce local oils because of greater availability and also entrenched tastes for the local variety.[11] Because of the wide prevalence of local small-scale units that retail locally, the availability of domestic varieties is correlated with local production and availability of oils.[12] As mentioned in the last section, the importance of small scale units is a legacy of a policy that disallowed large scale units in the oils that were traditionally consumed, such as mustard, groundnut, and sesame. Hence, we hypothesize that regions that produce oilseeds are not only more vulnerable to imports but are also the regions that would offer the most domestic competition to imported varieties. In other words, the local non-traded sector of oilseeds is not only a measure of trade (spillover) exposure but, because of vertical linkages, it is also a determinant of the local market structure of the traded good. The share of oilseeds in the local agricultural area serves a dual purpose – as a measure of differential trade exposure and as a measure of differential competitive market structure. We can, therefore, compare the price pass-through and the wage pass-through between regions that specialize in oilseeds and regions that do not.[13]

A third feature of our work is that our analysis covers a period of sustained and varying import competition rather than a discrete episode of trade liberalization. While the initial impetus to import competition came from trade liberalization, the extent of it has varied in subsequent years because of variation in tariffs, exchange rates, and world prices. The initial trade liberalization took the form of replacing quantitative restrictions with tariffs. Subsequently, tariffs have varied considerably with several rounds of reductions and hikes (Figure 5). With the abolition of quantitative restrictions, the border price captures the extent of import competition. Tariffs, of course, matter to import competition, but so do world prices and exchange rates.

The net changes in import competition as captured by the border price (suitably deflated) is displayed in Figure 7. We construct a panel data set of India's districts over the period

[11] For correlation of tastes with local production, see Srinivasan (2005)

[12] About the importance of local small-scale producers, see Persaud and Landes (2007),Jha et al. (2012), Reddy (2009). Dohlman et al. (2003) estimated that three-fifths of India's domestic edible oil production "comes from a vast number of often antiquated village- level crushers (ghanis) or other small expellers."

[13] It should be noted that if edible oils production is dominated by large producers (such as solvent extraction plants that were exempt from small-scale reservation policies) who sell locally and to distant markets, then that would snap the link between local edible oil production and market structure. There would be no reason to expect differential price pass-through.

1993/94 to 2011/12, where we examine the effect of the variation in the border price on a number of variables, including edible oil prices and wages. Over this period, the border price fell by 38%. Our differential exposure variable is based on local geographic variation in the share of oilseeds in cultivated area. During the early period of the study period, tariffs fell across the board, especially in the manufacturing sector. In our controls, we include a composite tariff measure that is an employment weighted average of tariffs on all traded commodities.

4.2 Model Specification

The spatial pass-through equation is estimated by running the following empirical specification:

$$Y_{dt} = \beta_0 + \beta_1\ lnBP_t * S_d\ + \beta_2\ Z_{dt} +\ f_d +\ T_t + \varepsilon_{dt} \tag{1}$$

Y_{dt} is the dependent variable. It could refer to the log of the price of edible oils, log wages, log agricultural employment, share of non-farm employment, log per-capita consumption, log of total land devoted to oilseeds cultivation or log of oilseeds production. The dependent variable varies across districts and over time. f_d and T_t stand for the district and time fixed effects, respectively. ε_{dt} is the regression error term.

BP_t is the border price of palm oil at the 't'th time period. S_d is district d's share of oilseeds in the agricultural area in 1993/94 - the initial year of our study. In the wages regression, the product of BP_t and S_d is our trade exposure variable. It is proportional to the area share of oilseeds. As mentioned earlier, even though oilseeds are not imported, it is an essential input to domestic oils, and unlike them, it is an important employer of agricultural labor. In the prices regression, the product of BP_t and S_d is a measure of competitive market structure for reasons described earlier.

A theoretical model that justifies the area share of oilseeds as an index of competitive market structures is described in the appendix (Appendix B). In this model, the imported oil variety (palm oil) is an imperfect substitute of the domestic oil varieties. We consider a duopoly where in each district there is a single seller of the imported oil and a single seller of the locally produced oil. The marginal cost for the firm selling palm oil is its border price. This is uniform throughout the country. The marginal cost for the firm selling locally produced oil is lower in regions that grow more oilseeds. Our pass-through measure is elasticity of the price of local oils to the palm oil border price - the same as in the regression specification (1). In Bertrand competition, the appendix shows that the pass-through elasticity is higher when the per unit costs of local edible oils is lower. While our result, under certain assumptions, generalizes to oligopolistic markets, it is by no means general.[14]

β_1 is the coefficient of interest. It measures the differential transmission of border price to the dependent variable of interest. When the dependent variable is in logs, we can derive from (1) the difference in the transmission elasticity (elasticity of the dependent variable to the border price) between high oilseed growing districts and low oilseed growing districts. When the dependent variable is a share, we can derive from (1), the difference in the impact from a percentage increase in border price. As is the case with all differential trade exposure literature, β_1 does not measure the impact of border price on the dependent variable for the country as a whole. Rather, it measures the relative impact of import competition across high and low oilseed growing districts.

To control for the change in tariffs of commodities other than edible oils, the control variables in Z_{dt} include a composite district specific tariff measure as the employment weighted average of tariffs over all traded goods. In addition, to capture the impact of the removal of quantitative restrictions, we include a dummy variable for the period since 2001.

The district specific non-agricultural control variables in Z_{dt} include infrastructure variables (percentage of villages electrified, connected by bus, rail, and paved roads), educational attainments (literacy rate), and social group composition (the percentage of scheduled caste and scheduled tribe populations). Agricultural variables include the percentage of villages irrigated in a district and district-wise average annual rainfall. If Indian tariffs adjust to domestic production, then the domestic oilseeds production may affect the palm oil border price via tariffs. To control for such feedback effects, we include aggregate (state level) oilseeds production.

In addition, the regressions also control for the state specific time trend and initial district wise composition of farm and non-farm employment and the initial composition of area share belonging to cereals and non-cereals cultivation. A full description of the variables and their descriptive statistics are contained in Table 1.

[14] The difficulty of obtaining general results is illustrated by Zimmerman and Carlson (2010). In theoretical models, market structure depends on the number of firms as well as the degree of product differentiation. When products are relatively homogeneous, a firm i facing a lot of rivals is unlikely to pass-through a rise in its costs. But when there is product differentiation, the firm acquires some market power and is more likely to pass- through an increase in their costs. Other firms will also increase their prices (in response to higher costs of firm i) but the pass-through will be lower when there is more competition in terms of the number of firms and will be higher when there is greater product differentiation. The net effect on price (averaged across firm i and its competitors) is qualitatively ambiguous.

5 Findings

5.1 Price and Wage Regression

The benchmark price and wage regression results are shown in Table 2 and Table 3, respectively. The dependent variable is measured in logs. The dependent variable in Table 2 is the district average price for all edible oils. In each of these tables, we have four columns that correspond to four specifications that vary with respect to the controls that are used. The set of controls expands as we move from column 1 to column 4. In the first column, the controls are district and time fixed effects. The second column adds the district specific time varying variables in the vector Z_{dt}. These include the agricultural and non-agricultural variables discussed above. They also include a composite tariff measure. To address differential trends, column three adds a state time trend.[15] To make sure the results are robust to differential trends owing to different initial conditions, the fourth column adds time trends interacted with district initial conditions (employment share of farm employment, land share of cereals).

The price regression in Table 2 confirms the hypothesis that border price transmission is greater in districts with larger area shares devoted to oilseeds cultivation. The spatial effect is significant at the 1% level across all specifications. This finding is consistent with the higher degree of price competition (and hence lower marginal cost) in high oilseeds producing regions. The difference in price elasticity between a region with a 50% oilseeds share and a region that does not grow oilseeds is about 0.17 (using column 4 estimates). The regression is graphically represented in Figure 8, which plots the partial correlation between the log of the local edible oil price and the trade exposure variable. Figure 8 illustrates the positive association between the local edible oil price and the trade exposure variable.

With regard to the wage regression, the point estimates suggest sizeable spatial differences with greater agricultural wage impacts in districts that are more exposed to trade (please see Table 3). However, statistically, the evidence of a spatial wage impact is weak. The wage impacts are significant at the 10% level in specifications (2) and (3) but fall below this level of significance in column 4.

[15] During this period some states offered subsidies on edible oils (Jumrani and Meenakshi, 2023). These are controlled by the state-time interactions.

5.2 Impact of Border Price on Other Variables

The lack of significant impacts on agricultural wages led us to look at the impacts of border price on employment variables. In the first five columns of Table 4, we present the results of specification (4) (corresponding to Table 2 and Table 3) for five different dependent variables: male, female and total agricultural employment; total non-farm employment; and its share in total employment. The lack of statistical significance in these results is consistent with the statistically weak wage impacts. As a final check, we also looked at the impact on the per-capita consumption expenditures of agricultural laborers. These are agricultural workers who do not own any land and work on other people's farms. Households that depend on unskilled labor (agricultural and other labor) are known to be over-represented among the poor. Not only are the impacts not significant, but they are of the wrong sign as well (column 6 of Table 4). Therefore, Table 4 shows that border price changes have no significant effect on employment or consumption.

When faced with import competition, oilseeds producers may have the option of muting the impacts by shifting land, labor and other resources to other crops. Tables 5 and 6 present the results from all four specifications for oilseeds area and production (both in logs). Spatial differences in response are significant for both the area and production. The respective elasticities are greater in areas more exposed to import competition. The magnitude of the impact and its statistical significance are both larger when the dependent variable is production rather than area, indicating that responses on the intensive margin (production) are greater than responses on the extensive margin (area).

During the period of analysis, border prices fell by almost 38%.A one-standard-deviation increase in trade exposure (0.13) is associated with a reduction in the area under oilseeds cultivation by approximately 1.9% and a larger reduction in oilseeds production of about 6.6%, based on the estimates reported in the fourth columns of Tables 5 and 6.

The direct impact of import competition on farmers would be felt through oilseeds prices. However, as mentioned in the data section, the data on this variable is incomplete and patchy. Appendix Tables C.3-C.5 (in Appendix C) report the transmission of border price to the prices of three oilseeds: rapeseed-mustard, sesame and groundnut. For the first two, the estimates show a strong spatial impact - price transmission is greater in areas that specialize in oilseeds. Using the estimates from column 4 of Appendix Tables C.4 and C.5, we calculate that a one-standard deviation increase in the trade exposure variable is linked to a 4.2% decrease in the price of rapeseed–mustard and a 2.1% decrease in the price of sesame, considering that the border price fell by nearly 38% during our study period. However, this is not true for groundnut. For groundnuts, the coefficient on the trade exposure variable is not statistically significant, indicating no evidence of an effect on groundnut prices (Appendix Table C.5).

6 Robustness

In this section, we consider the robustness of our price transmission results (Table 2) to (a) endogeneity of tariffs, (b) omitted variables and (c) alternative measures of the dependent variable and the border price.

To address the issue of endogeneity of tariffs (discussed in section 2) we replace the border price with the zero tariff import price, which is the product of the world price and the exchange rate. The results continue to be highly significant. Relative to Table 2, the spatial transmission in transmission elasticity is smaller, as would be the case when tariffs are chosen to stabilize domestic prices (Table 7).

To check for omitted variables, Table 8 reports the outcome of a falsification test. Ideally, we would like to construct a placebo trade exposure variable based on the area share of an alternative crop. Oilseeds are typically grown during the monsoon growing season. As other crops grown during this time compete with oilseeds, their production shares could be correlated negatively with oilseeds. For this reason, we picked the share of wheat - the principal crop grown during the winter season - as the placebo trade exposure variable. Table 8 shows that the placebo effect is not different from zero.

India imports palm oil in both refined and crude (unrefined) forms. Crude oils are imported by domestic processors who refine them and sell them in the domestic market. The tariffs on crude oils are typically lower. Table 2 employs the border price of refined oils. Table 9 examines the transmission of crude oil border prices. The results indicate smaller (relative to refined oils) and highly significant (at 1% level) spatial price effects. Based on the column (4) regression estimates, the implied difference in price elasticity between a region with a 50 percent oilseeds production share and a region with no oilseeds production is approximately 0.09.

Besides palm oil, India also imports soya oil, although in much smaller quantities. Table 10 replicates the price transmission regression of Table 2 with one difference. The border price of palm oil is replaced by a weighted average of the border prices of palm oil and soya oil, where the weights are their respective shares in total oils imports in 1993/94. The results closely resemble the findings in Table 2.

The dependent variable in Table 2 is the average retail price for all edible oils (including imported oils). While the data does not allow us to compute a retail price for all domestically produced oils, we can obtain the price of some domestically produced oils - rapeseed-mustard, groundnut and coconut). Table 11 replicates all the price regressions when the dependent variable is recast as the price of the traditional oils alone (rapeseed-mustard, groundnut and coconut) rather than the price of all edible oils. These regressions capture the spatial transmission of the palm oil border price on the prices of traditional oils. The table displays the benchmark regression corresponding to Table 2 (the specification in column 4) and the outcomes of all the robustness checks discussed above. The results in the first three columns of Table 11 show that the trade exposure variable has a statistically significant effect on the traditional oil price, regardless of whether the area share is interacted with the border price of refined palm oil, the border price of crude palm oil, or the world palm oil price. Column 4 presents the coefficient for the placebo trade exposure variable, obtained by interacting the border price with the share of area under wheat cultivation. The coefficient is statistically insignificant, suggesting that the placebo effect is not statistically different from zero.

It was noted earlier that, besides oils, soybeans and cotton generate other products as well. Hence, their acreage may be driven by the prices of their joint products (soymeal and cotton fibre, respectively). The question is whether these variables contaminate the area and production responses of oilseeds to import competition presented in Tables 5 and 6. The oilseeds considered there already exclude cotton, but they do include soybeans. Appendix Tables C.6 and C.7 replicate the regressions in Tables 5 and 6 with the only difference that the dependent variable (area and production, respectively) excludes soybeans. The results show that omitting soybean amplifies the influence of the border price of palm oil on oilseed production and area under cultivation. A one-standard deviation increase in trade exposure (0.13) results in a loss of oilseeds production by 8.9% when total oilseeds exclude soyabean production (significantly greater than the 6.6% reduction in oilseeds output with soybeans). When the total area under oilseeds cultivation does not include soybeans, a one-standard deviation rise in trade exposure leads to a loss of oilseeds area of about 4.4% (far larger than the 1.9% decline in oilseeds area with soybeans). The opportunities afforded by soymeal sales have, to some extent, countered the adverse effects of import competition in edible oils.

To evaluate the robustness of the trade exposure variable, we examine an alternative trade exposure metric that is an index of a region's net exporting status (within the country). We replace the area share variable by the difference between the area share of oilseeds and the share of edible oils in consumption in 1993/94. Appendix Table C.8 reports the results of the price regression using the alternative trade exposure metric. The results remain consistent with previous findings. The coefficients exhibit similar magnitudes and statistical significance to those in Table 2, indicating consistent results.

7 Concluding Remarks

Like many other countries, India's embrace of trade liberalization in food and agriculture has been cautious because of concerns about how it may affect the interests of cultivators and agricultural workers. The WTO agreements on agriculture opened up India's food markets to external competition. The change was dramatic for edible oils. Relative to the consumer price index for agricultural labor, the border price of palm oil declined by 38% during the period of this study (1993/94 – 2011/12). Palm oil was cheap and was produced and exported by countries that were nearby. During the period of this study, per-capita supply doubled. Much of the increase in supply came from imports, which is why imports supply more than half of consumption today.

In this paper, we used the differential trade exposure approach to examine the impacts of increased import competition on prices and wages. While the proportion of workers employed in producing edible oils is very small, the number of workers growing oilseeds that are processed by the edible oils industry is not negligible. That's the basis for expecting spatial wage impacts.

We used the district proportion of agricultural areas growing oilseeds as the trade exposure variable. Because of government regulations, the industry structure contained small scale oilseed crushers that only sold in local markets. Hence, we conjectured that the trade exposure variable also measured the extent of competition. Our empirical findings confirmed the theoretical supposition that border price pass-through was greater in areas that specialized in oilseeds. On the other hand, the results failed to uncover significant differences in pass-through to wages. This was also the case for the consumption of landless agricultural workers and various measures of employment.

The findings also showed that producers adjusted their cropping pattern. Relative to areas that do not grow much oilseeds, the oilseeds area in regions that grow it came down in response to the decline in border price. These adjustments may have resulted in muting the wage impact. Overall, these results indicate that, on average, that import competition had a significant impact on edible oil prices but did not leave a statistically significant impact on wages or agricultural employment. Our data is too coarse to allow us to directly examine employment shifts within agriculture; however, we do observe strong production impacts especially on the intensive margin.

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Tables and Figures

Figures

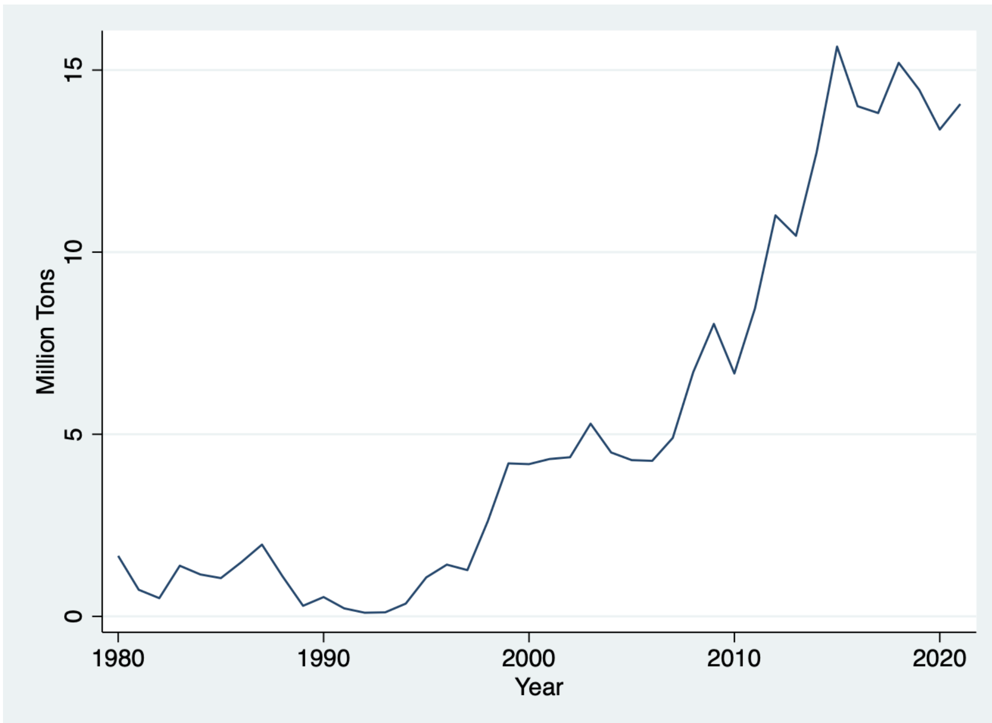

Figure 1: Edible oils imports in Million Tonnes. Drawn by the authors using official government of India data

Figure 2: Domestic Price of Edible Oils.The graph plots the annual average wholesale price index of edible oils deflated by the wholesale price index of all commodities. Source: Economic Survey, Government of India

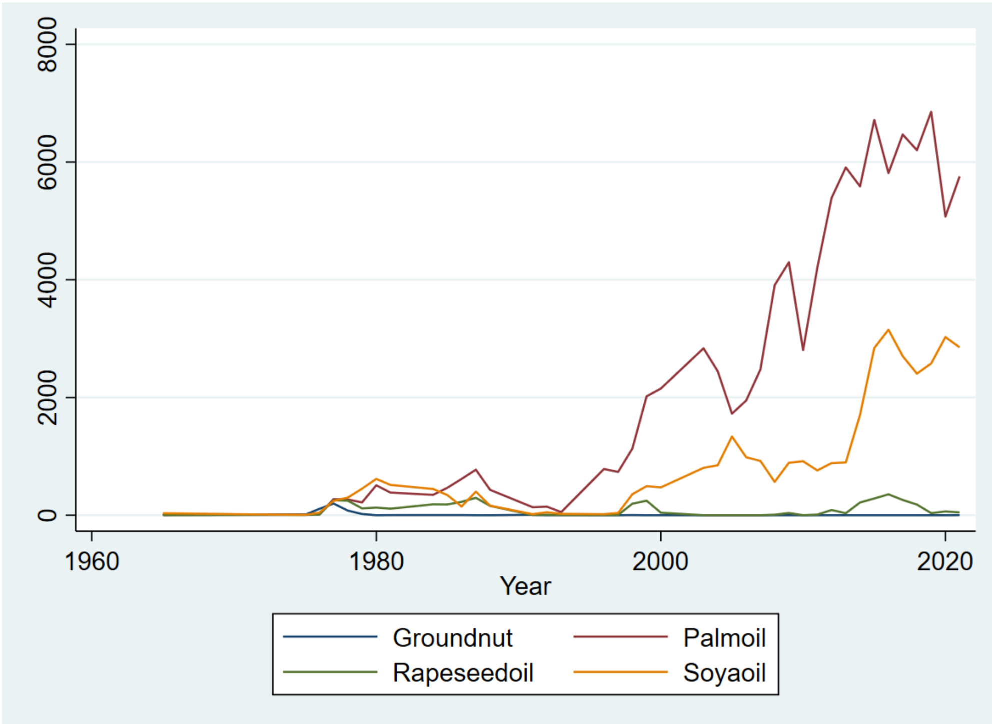

Figure 3: Import of Edible Oils of Various Types.The import values are measured in millions of dollars. Drawn by the authors from FAOSTAT data

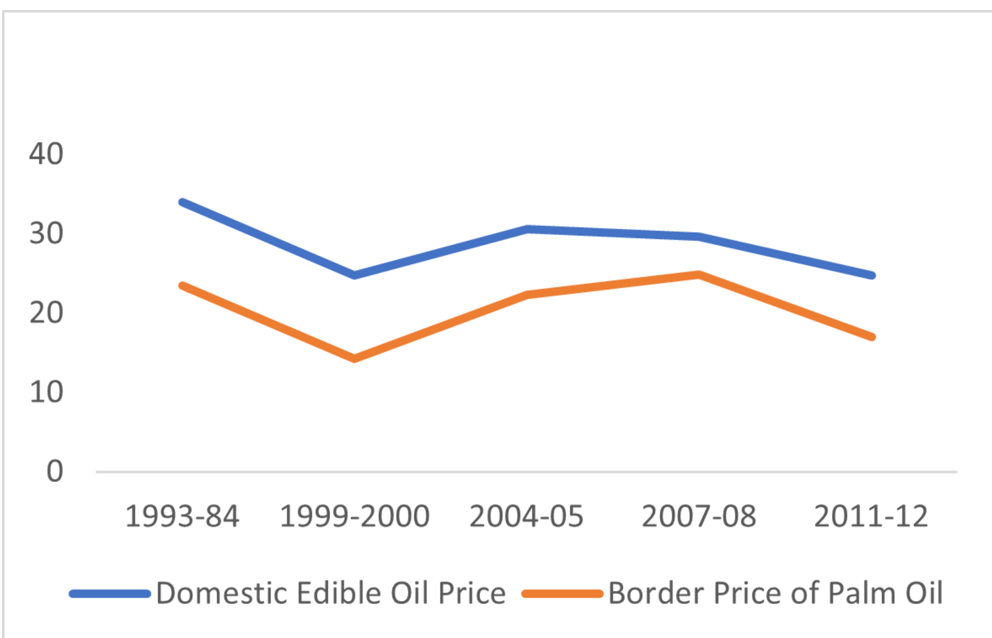

Figure 4: Domestic Edible Oil Price and Border Price of Palm Oil. Drawn by the authors.

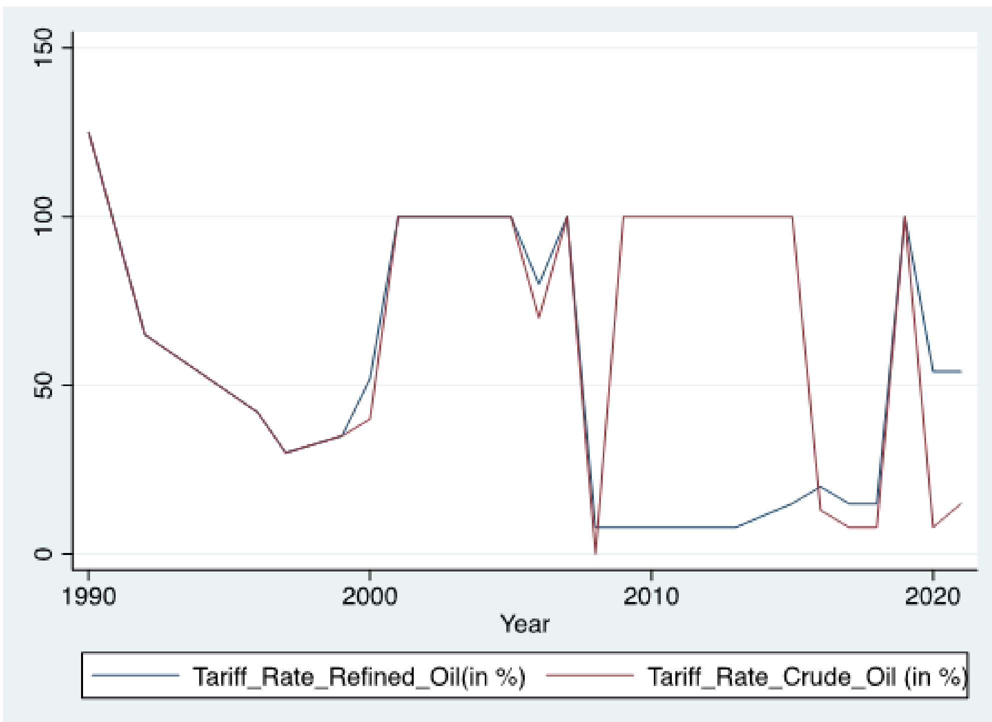

Figure 5: Tariff Rate of Refined and Crude Palm Oil. Source: WITS (World Integrated Trade Solution) Database

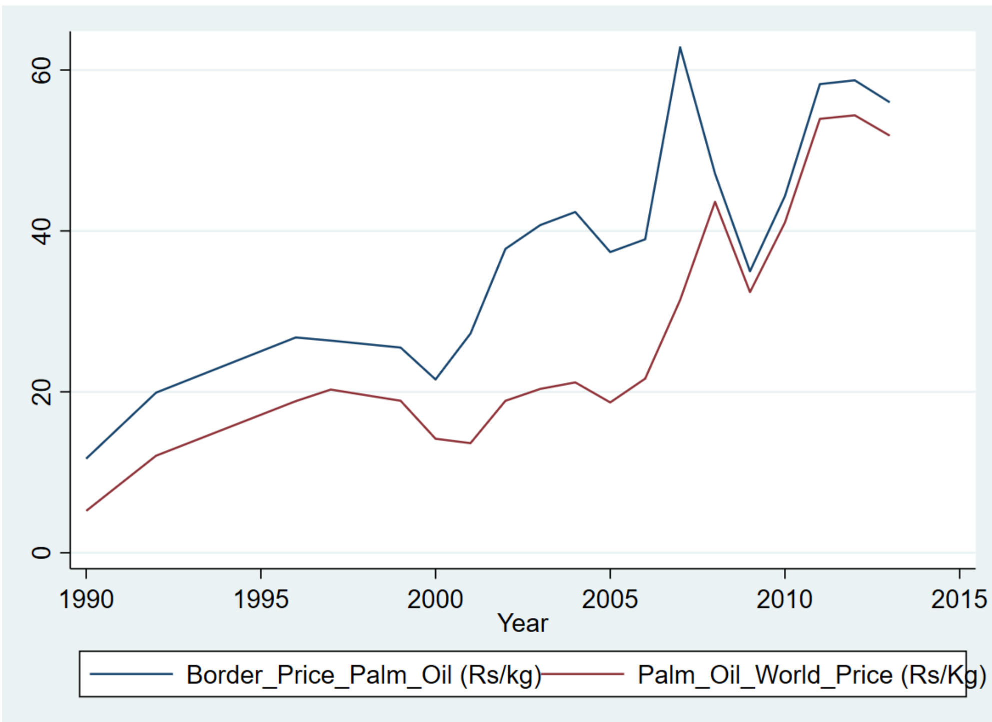

Figure 6: Border Price and the Zero Import Tariff Price (World Price/Border Price Excluding the Tariff Rate) of Palm Oil. Drawn by the authors

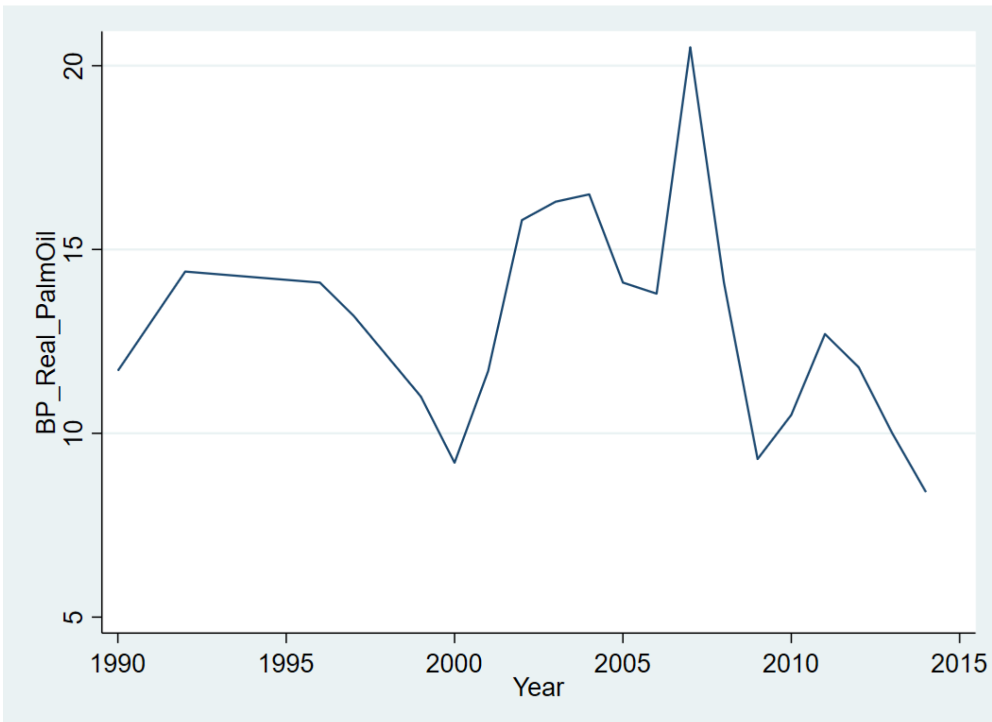

Figure 7: Border Price Deflated by Consumer Price Index

Figure 8: Partial correlation of (log) district edible oil price with district trade exposure (log palm oil border price * district oilseeds share). Drawn by the authors

Tables

Table 1: Summary Statistics

Variables	Description	Mean	SD
All edible oil price, nominal	The nominal unit value of all edible oils. This is calculated by dividing the district's total edible oil expenditure by total quantity.	3.92	0.32
All edible oil price (real)	The nominal unit value of all edible oils at the district level divided by All India CPI.	3.32	0.16
Traditional edible oil price (nominal)	The nominal unit value of traditional oils. This is calculated by dividing the district's total traditional oil expenditure by total quantity. The traditional edibles oils are rapeseed-mustard oil, groundnut oil and coconut oil.	3.96	0.35
Traditional edible oil price (real)	The nominal unit value of traditional edible oil at the district level divided by all India CPI.	3.36	0.15
Groundnut price (nominal)	The nominal farm harvest price of groundnut at the district level obtained from the ICRISAT Data.	2.87	0.46
Groundnut price (real)	The nominal groundnut price divided by all India CPI.	2.26	0.20
Rapeseed-Mustard price (nominal)	The nominal farm harvest price of rapeseed-mustard at the district level obtained from the ICRISAT Data.	2.83	0.43
Rapeseed-Mustard price (real)	The nominal rapeseed-mustard price divided by all India CPI.	2.24	0.18
Sesame price (nominal)	The nominal farm harvest price of sesame at the district level obtained from the ICRISAT Data.	3.24	0.59
Sesame price (real)	The nominal sesame price divided by all India CPI.	2.64	0.41

Table 1 – continued from previous page

Variables	Description	Mean	SD
Palm Oil border price	Palm Oil World Price*(1+Ad-Valorem Tariff Rate)*Exchange Rate	10.5	0.38
Palm oil border price(real)	Nominal border price deflated by All India CPI	9.9	0.21
Nominal agricultural wage rate	District specific nominal average daily wage rate for the agricultural laborers.	2.46	1.04
Real agricultural wage rate	District specific nominal average daily wage rate for the agricultural laborers deflated by All India CPI	1.86	0.9
Total area under oilseeds cultivation	Total area under oilseeds cultivation (in thousand hectares) at the district level	3.43	1.9
Total oilseeds production	Total oilseeds production (in thousand tonnes) at the district level	3.3	1.9
Total agri emp	Total number of people employed in agricultural activities	13.31	0.72
Male agri emp	Number of males employed in agricultural activities	12.96	0.71
Female agri emp	Number of females employed in agricultural activities	11.79	1.31
Non-farm emp	Number of people employed in non-farm activities	12.27	0.84
Share of non-farm employment	Share of non-farm sector in total employment	0.28	0.15
Initial oilseeds share	Share of cultivable land belongs to oilseeds production in total agricultural production for each district in 1993-94.	0.13	0.15

Table 1 – continued from previous page

Variables	**Description**	**Mean**	**SD**
Average annual rainfall	District specific average annual rainfall.	7.04	0.59
Total agricultural production	Total production of all crops (in thousand tonnes) at the state level	9.81	0.87
Irrigated	Proportion of villages in a district under irrigation.	0.44	0.3
MPCE	Monthly real per-capita expenditure of the agricultural laborers	5.9	0.35
Literate	Fraction of people in a district who have completed secondary education	0.11	0.07
St/Sc	Fraction of population in a district belongs to scheduled caste, scheduled tribe and other backward classes	0.33	0.17
Bus	Proportion of villages in a district connected by bus	0.48	0.32
Train	Proportion of villages in a district connected by train	0.02	0.02
Paved roads	Proportion of villages in a district connected by paved roads	0.61	0.28
Electrified	Proportion of electrified villages in a district.	0.87	0.19
Composite trade exposure measure	District specific composite tariff measure (employment share weighted average of tariff rates)	0.24	0.15
Cereals	Share of cereals in total cultivable lands for each district in 1993-94.	0.57	0.21
Non-farm 93-94	Share of non-farm sector in total employment in 1993-94	0.22	0.13

Note:-Authors' calculation
Apart from the variables representing shares/proportions and composite trade exposure measure, the summary figures of the remaining variables are expressed in natural logarithm.

Table 2: Price Regression

Variables	**ln All Edible Oil Price**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.364***	0.322***	0.338***	0.337***
	(0.0731)	(0.0751)	(0.0755)	(0.0763)
Observations	1,285	1,285	1,285	1,285
R-squared	0.786	0.811	0.836	0.836
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of all edible oils expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
The time varying controls include composite tariff measure, percentage of villages electrified, irrigated, connected by bus, rail, and paved roads, literacy rate, percentage of SC/STs, average annual rainfall, aggregate(state) level oilseeds production, dummy of quantitative restriction and its interaction with the composite tariff measure.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 3: Wage Regression

Variables	**ln Real Agricultural Wage Rate**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.253	0.544*	0.541*	0.486
	(0.287)	(0.319)	(0.326)	(0.325)
Observations	1,285	1,285	1,285	1,285
R-squared	0.158	0.189	0.222	0.235
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is real agricultural wage rate expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 4: Other Dependent Variables

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Male Agri Emp	Female Agri Emp	Total Agri Emp	Total Non-farm Emp	Non-farm Emp Share	Per-capita Consumption
$lnBP_t * S_d$	0.0324	-0.667	0.0623	-0.136	-0.019	-0.129
	(0.136)	(0.464)	(0.171)	(0.312)	(0.0583)	(0.167)
Observations	1,285	1,267	1,285	1,284	1,285	1,285
R-squared	0.811	0.355	0.776	0.490	0.486	0.489
Number of districts	257	256	257	257	257	257
District fixed effects	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes
State time trends	yes	yes	yes	yes	yes	yes
Initial conditions*Time trend	yes	yes	yes	yes	yes	yes

Note:-The six dependent variables are male agricultural employment, female agricultural employment, total agricultural employment, total non-farm employment, real per-capita consumption of agricultural laborers (all of them expressed in natural logarithm) and share of non-farm employment in total employment.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 5: Area Under Oilseeds Cultivation

Variables	**ln Area Under Oilseeds Cultivation**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.538**	0.374*	0.367*	0.378*
	(0.216)	(0.225)	(0.216)	(0.213)
Observations	1,271	1,271	1,271	1,271
R-squared	0.115	0.522	0.578	0.589
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is area under oilseeds cultivation (in thousand hectares) expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 6: Oilseeds Production

Variables	**ln Oilseeds Production**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	1.548***	1.335***	1.353***	1.337***
	(0.399)	(0.379)	(0.392)	(0.394)
Observations	1,265	1,265	1,265	1,265
R-squared	0.048	0.462	0.485	0.489
Number of districts	256	256	256	256
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is oilseeds production (in thousand tonnes) expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 7: Price Regression:Border Price Replaced With the Zero Tariff Import Price

Variables	**ln All Edible Oil Price**			
	(1)	(2)	(3)	(4)
$lnWP_t * S_d$	0.323***	0.342***	0.257***	0.258***
	(0.0601)	(0.068)	(0.0602)	(0.0605)
Observations	1,285	1,285	1,285	1,285
R-squared	0.787	0.813	0.835	0.836
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is the domestic edible oil price expressed in natural logarithm. Instead of the border price, the share of oilseeds is interacted with the zero import tariff price (world price/border price excluding the tariff rate).
WP_t stands for the world price/zero tariff import price
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 8: Price Regression:Falsification Test

Variables	**ln All Edible Oil Price**			
	(1)	(2)	(3)	(4)
$lnBP_t * Swheat_d$	-0.0818	0.0117	-0.0148	-0.0130
	(0.0758)	(0.0789)	(0.0752)	(0.0755)
Observations	1,285	1,285	1,285	1,285
R-squared	0.781	0.806	0.832	0.832
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of all edible oils expressed in natural logarithm.
Border price is interacted with the share of cultivable land belongs to wheat cultivation in 1993-94
BP_t stands for the border price of palm oil.
$Swheat_d$ represents share of cultivable land belongs to wheat production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 9: Price Regression:Border Price of Crude Palm Oil

Variables	**ln All Edible Oil Price**			
	(1)	(2)	(3)	(4)
$lnBPCrude_t * S_d$	0.0168	0.104*	0.177***	0.183***
	(0.0615)	(0.0598)	(0.0655)	(0.0666)
Observations	1,285	1,285	1,285	1,285
R-squared	0.780	0.807	0.833	0.834
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial Conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of all edible oils expressed in natural logarithm.
Instead of the border price of refined palm oil, the share of oilseeds is interacted with the border price of crude palm oil.
$BPCrude_t$ stands for the border price of crude palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 10: Price Regression:Average of the Border Price of Palm Oil and Soya Oil

Variables	**ln All Edible Oil Price**			
	(1)	(2)	(3)	(4)
$lnBPAvg_t * S_d$	0.361***	0.339***	0.356***	0.354***
	(0.0752)	(0.0775)	(0.0784)	(0.0787)
Observations	1,285	1,285	1,285	1,285
R-squared	0.786	0.811	0.836	0.837
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial Conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of all edible oils expressed in natural logarithm.
The share of oilseeds is interacted with the weighted average of the logarithm of border price of refined palm oil and refined soya oil.
The weights represent the share of palm oil and soya oil in total import value for the initial period i.e., 1993-1994.
$BPAvg_t$ stands for the average of the border price of refined palm oil and soya oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table 11: Regression: Price of Traditional Edible Oils

Variables	**ln Traditional Edible Oil Price**			
	(1)	(2)	(3)	(4)
$lnBP_t * S_d$	0.175**			
	(0.0715)			
$lnBPCrude_t * S_d$		0.260***		
		(0.0579)		
$lnWP_t * S_d$			0.322***	
			(0.0639)	
$lnBP_t * Swheat_d$				0.0919
				(0.0776)
Observations	1,255	1,255	1,255	1,255
R-squared	0.756	0.759	0.762	0.755
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	yes	yes	yes	yes
State time trends	yes	yes	yes	yes
Initial conditions*Time trend	yes	yes	yes	yes

Note:-The dependent variable is the price of traditional/locally produced edible oils.
The traditional edibles oils used in our analysis are rapeseed-mustard oil, groundnut oil and coconut oil.
BP_t and $BPCrude_t$ stands for the border price refined and crude of palm oil respectively. WP_t represents world price.
S_d and $Swheat_d$ represent share of cultivable land belongs to oilseeds and wheat production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Appendices

Appendix A

Timeline of Edible Oils and Oilseeds Policies in India

- 1977: Policy of allowing only small units to crush oilseeds. The policy restricted processing (except solvent extraction of oilcake) of traditional oilseeds (groundnut, mustard-rapeseed, sesame and safflower) to units with a capacity of less than 10 tonnes per day (Landes).

- 1986: Technology Mission for Oilseeds to make the country self-sufficient. Program supported by strict quantitative restrictions on edible oil imports. Only state agencies were given authorizations to import.

- 1994: Quantitative restrictions (QRs) removed on the import of palm oils (QRs removed on other edible oils in 1995). Private traders could import edible oils freely subject to tariffs. Import of oilseeds continue to be restricted because of quarantine and other safety measures.

- 2001: Quantitative restrictions on all agricultural imports removed.

- 2015: Restriction that only small units can crush groundnut and mustard oil removed.

Appendix B

Spatial Model of Pass-Through

In this section, we consider a simple model of spatial pass-through in the presence of domestic substitutes. The model is a variant of a differentiated product model with linear demand and asymmetric costs (e.g., Shubik and Levitan (1980), Wang and Zhao (2007), Zimmerman and Carlson (2010)). In every district, we assume that there is a single seller of palm oil who receives supplies at the port at a border price of c_1. The border price is the product of the world price, the ad-valorem tariff and the exchange rate. Every district also contains a seller of the locally produced edible oil. The per unit cost of local oil production is denoted as c_2. Due to the cheaper availability of oilseeds as inputs, we expect c_2 to be lower in high oilseeds producing regions relative to the cost in low oilseeds producing regions.

In notation, the seller of palm oil is denoted as firm 1 and the producer of local edible oil as firm 2. Similarly, the prices and quantities of palm oil and the local oil are subscripted by 1 and 2, respectively. Demand functions for the two oils are

$$q_1 = a_1 - b_{11}P_1 + b_{12}P_2 \tag{B-1}$$

$$q_2 = a_2 + b_{21}P_1 - b_{22}P_2 \tag{B-2}$$

where P_1 and P_2 are the respective prices. These are linear demand functions with the following parameter restrictions:

$$a_i \geq 0 \ \forall i = 1, 2 \ \ and \ b_{ij} \geq 0 \ \forall i, j = 1, 2$$

Using demand functions (B-1) and (B-2), we can write down the profit functions for firm 1 and firm 2 as

$$\pi_1 = (P_1 - c_1)(a_1 - b_{11}P_1 + b_{12}P_2) \tag{B-3}$$

$$\pi_2 = (P_2 - c_2)(a_2 + b_{21}P_1 - b_{22}P_2) \tag{B-4}$$

In Bertrand equilibrium, the first order conditions for profit maximization are

$$\frac{\partial \pi_1}{\partial P_1} = 0 \ and \ \frac{\partial \pi_2}{\partial P_2} = 0$$

Solving for these first order conditions, we get the equilibrium prices as follows.

$$P_1^* = \frac{2a_1b_{22} + a_2b_{12} + b_{12}c_2b_{22} + 2b_{22}c_1b_{11}}{4b_{11}b_{22} - b_{12}b_{21}} \tag{B-5}$$

$$P_2^* = \frac{2a_2b_{11} + a_1b_{21} + b_{11}c_1b_{21} + 2b_{11}c_2b_{22}}{4b_{11}b_{22} - b_{12}b_{21}} \tag{B-6}$$

For equilibrium to exist with positive prices, the denominator must be positive (i.e. $4b_{11}b_{22} - b_{12}b_{21} > 0$). This condition is satisfied whenever own price effects are greater than cross-price effects. The pass-through of palm oil border price c_1 to the price of local oil P_2 is given by

$$\frac{\partial lnP_2^*}{\partial lnc_1} = \frac{b_{11}b_{21}}{4b_{22}b_{11} - b_{12}b_{21}} \frac{c_1}{P_2^*}$$

The pass-through elasticity is positive. Furthermore, we can consider how this elasticity varies with the marginal cost of producing edible oil, i.e., c_2. This is given by

$$\frac{\partial^2 lnP_2^*}{\partial lnc_1 \partial c_2} = -\frac{b_{11}b_{21}}{4b_{22}b_{11} - b_{12}b_{21}} \frac{c_1}{(P_2^*)^2} \frac{\partial P_2^*}{\partial c_2} \tag{B-7}$$

(B-7) is negative as $\frac{\partial P_2^*}{\partial c_2} \geq 0$ (this follows from (B-6). Hence the prediction that the pass-through elasticity of the local edible oil is greater in regions with lower costs. If we suppose that the marginal costs of producing edible oil are lower in areas that produce more edible oilseeds - the principal input - then we obtain the corollary that the pass-through of the palm oil border price to locally produced oils is greater in regions that produce more oilseeds. The reason is quite straightforward. The price of both palm oil and local edible oil increases with c_2. Therefore more price elastic/price sensitive consumers are located where c_2 is higher, and naturally that reduces the pass-through rate.

It can also be shown that

$$\frac{\partial^2 lnP_1^*}{\partial lnc_1 \partial c_2} = -\frac{2b_{22}b_{11}}{4b_{22}b_{11} - b_{12}b_{21}} \frac{c_1}{(P_1^*)^2} \frac{\partial P_1^*}{\partial c_2} \tag{B-8}$$

(B-8) is also negative. The pass-through of the palm oil border price to its own local price is also greater where the competing domestically produced oil has lower costs.

Appendix C

Table C.1: World Prices of Different Types of Edible Oils(US $/Metric Ton)

Year	Groundnut Oil	Palm Oil	Soybean Oil
1993-94	881	453	548
1999-2000	751	373	383
2004-05	1111	447	580
2007-08	1742	864	1070
2011-12	2212	1062	1263

Source:-World Bank Commodity Price Data

Table C.2: Data Sources and Variables

Data Source	Variables Constructed from the Data Source
NSS Consumer Expenditure Data	local edible oil price (nominal and real), all edible oil price (nominal and real), monthly per-capita consumption expenditure (for agricultural laboreres), share of literate, share of st/sc population
NSS Employment and Unemployment Data	nominal and real agricultural wage rate, total/male/female agricultural employment, total non-farm employment, share of non-farm employment
ICRISAT District Level Data for India	total area under oilseeds cultivation, total oilseeds production, share of oilseeds in total cultivable lands in 1993-94, share of cereals and wheat in total cultivable lands in 1993-94, price of groundnut, rapeseed-mustard and sesame (nominal and real)
Census	share of all villages in a district connected by bus, railways, paved roads, share of villages electrified and irrigated
WITS Database	provides tariff data that is used to construct variables like border price of palm oil (nominal and real) and composite trade exposure measure
World Bank Commodity Price Data (provides data for palm oil world price)	border price of palm oil (nominal and real)
Centre of Climatic Research, University of Delaware	average annual rainfall
labor Bureau, Ministry of labor and Employment	All India CPI Data
RBI Database	Exchange Rate

Table C.3: Oilseeds Price Regression:Rapeseed-Mustard

Variables	**ln Rapeseed-Mustard Price**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.776***	0.822***	0.873***	0.859***
	(0.193)	(0.209)	(0.225)	(0.220)
Observations	557	557	557	557
R-squared	0.599	0.618	0.639	0.640
Number of districts	157	157	157	157
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
Sate time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of rapeseed-mustard expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table C.4: Oilseeds Price Regression:Sesame

Variables	**ln Sesame Price**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.611***	0.588**	0.435**	0.434**
	(0.207)	(0.240)	(0.208)	(0.209)
Observations	739	739	739	739
R-squared	0.241	0.284	0.805	0.805
Number of districts	198	198	198	198
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
Sate time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of sesame expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table C.5: Oilseeds Price Regression:Groundnut

Variables	**ln Groundnut Price**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	0.0238	0.0689	0.103	0.112
	(0.111)	(0.123)	(0.122)	(0.122)
Observations	685	685	685	685
R-squared	0.473	0.534	0.605	0.609
Number of districts	179	179	179	179
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
Sate time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of groundnut expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table C.6: Area Under Oilseeds Cultivation(Excluding Soybean)

Variables	**ln Area Under Oilseeds Cultivation**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	1.087***	0.924***	0.905***	0.882***
	(0.298)	(0.334)	(0.307)	(0.310)
Observations	1,271	1,271	1,271	1,271
R-squared	0.228	0.607	0.481	0.608
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is area under oilseeds cultivation (in thousand hectares) expressed in natural logarithm.
Soybean is excluded from the computation of area under oilseeds cultivation.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table C.7: Oilseeds Production (Excluding Soybean)

Variables	**ln Oilseeds Production**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * S_d$	2.041***	1.830***	1.838***	1.808***
	(0.411)	(0.409)	(0.420)	(0.423)
Observations	1,265	1,265	1,265	1,265
R-squared	0.079	0.377	0.507	0.511
Number of districts	256	256	256	256
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
State time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is oilseeds production (in thousand tonnes) expressed in natural logarithm.
Soybean is excluded from the computation of oilseeds production.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population

Table C.8: Price Regression With an Alternative Trade Exposure Measure

Variables	**ln All Edible Oil Price**			
	(1)	**(2)**	**(3)**	**(4)**
$lnBP_t * (S_d - C_d)$	0.349***	0.310***	0.337***	0.336***
	(0.0733)	(0.0751)	(0.0762)	(0.0771)
Observations	1,285	1,285	1,285	1,285
R-squared	0.785	0.810	0.836	0.836
Number of districts	257	257	257	257
District fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Controls	no	yes	yes	yes
Sate time trends	no	no	yes	yes
Initial conditions*Time trend	no	no	no	yes

Note:-The dependent variable is domestic price of all edible oils expressed in natural logarithm.
BP_t stands for the border price of palm oil.
S_d represents share of cultivable land belongs to oilseeds production at the district level in 1993-94..
C_d represents share of edible oil in total consumption at the district level in 1993-94.
S_d-C_d represents an index of the net exporting status at the district level in 1993-94.
We use the same set of time-varying control variables as outlined in the note to Table 2.
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Standard errors are clustered by district; regressions are weighted by district' 1991 population