Why Trucks Jump: Offshoring and Product Characteristics[*]

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Abstract

Despite close proximity to a low cost neighbor, prohibitive trade policies by the US and Mexico forced the big three auto producers to essentially keep all light truck production at home prior to NAFTA. In this paper, we study the first wave of light-truck offshoring to Mexico that occurred post-NAFTA due to lower trade barriers and a coincident increase in demand for light trucks in the US. This need for additional light truck capacity was accommodated by investment in both the US and Mexico. Using a new dataset that details the extent of offshoring and domestic production at the level of individual vehicle features, we ask two simple questions: Are there differences in how firms allocate production across new plants in both low and high wage locations? And given that we find differences, what characteristics distinguish the types of vehicles offshored relative to those produced domestically? To answer the first question, we evaluate the price-composition of output at new light-truck plants vis-a-vis existing plants, where we find that within-models, new capacity in the US tends to mirror the price distribution of existing capacity. In contrast, new production in Mexico is aimed at low price varieties of the same types of vehicles. In evaluating offshoring at a finer level of detail, we find that automakers offshored varieties which tend to be lower in quality, of older design vintage, are lower scale, and are less complex to produce. Finally, we find that varieties "inshored" to new or retooled capacity in the US exhibit the opposite characteristics.

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1 Introduction

A central feature of post WWII growth has been the coincident and more than proportionate increase in trade and investment flows with trade liberalization seen as a major contributor to these outcomes. However, our understanding of the relationship between these variables is mostly informed by the analysis of relatively aggregate data (at either the national or broad industry level). While aggregate data helps to substantiate the robustness of these correlations, it cannot provide insight into the mechanisms at work. This shortcoming is due to the fact that trade barriers tend to be applied to products (not industries) and investment is focused on products as well. Consequently, insight into the mechanics of this relationship requires product level variation in policies, along with product level data on trade and investment flows. In recognition of this fact, we focus on a specific liberalization episode (NAFTA) and its impact on a specific product (light-duty trucks).

Studying the light-duty truck market, which includes SUVs, pick-ups, and vans, has a number of advantages. As a starting point it is fair to say that there was essentially no trade in light trucks between the US and Mexico pre-NAFTA due to restrictive policy on both sides of the border. In the immediate post-NAFTA period there was rapid expansion in the exports of light trucks from Mexico to the US - with these exports exclusively from Mexican facilities operated by the big three US auto-makers. That is, there was a boom in light truck trade and investment in Mexico. While the removal of trade barriers due to NAFTA is coincident with this increase in trade and investment another feature of this period is also critical.[1] This relates to the pronounced growth in the demand for light trucks within the US. This rapid growth generated a need for new capacity that was installed in both Mexico and the US. Since we are able to isolate a period where there was a relatively large amount of new investment, we are able to examine how this new capacity was utilized relative to established capacity, and also whether it matters if the new capacity is in Mexico ("offshored") or domestic ("inshored").

An interesting feature of the investment strategy is that any model that was offshored was also inshored, though the converse does not hold. This means that investments intended to produce the same model (e.g. Ram 1500 pick-up truck) are occurring at the same time at locations with very different labor costs (Mexican labor costs are approximately 10% of US labor costs). This is very different from

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[1] Without the demand shock to light trucks it is not obvious that trade liberalization by itself would have generated FDI. It is quite possible that without the demand shock FDI in Mexico may have only taken place after the capital at the US plants had depreciated to a critical extent. This would have made it much more difficult to link FDI (and therefore trade) to the liberalization associated with NAFTA.

the standard view of vertical FDI which tends to predict the concentration of tasks or segments of the production process across locations. However, the standard model shouldn't be dismissed too quickly as even within a model (eg. Ram 1500) there is a large range of qualities that can be produced - with the average difference in price between the base model and the top of the range in excess of 40%. This still leaves plenty of scope for specialization within models.

To explore the issue of whether the utilization of new capacity differs from established capacity we start by examining the price distributions of vehicles produced at a plant within a model. In particular we calculate the model level weighted average for each type of plant: established, new (or retooled) domestic and new Mexican. If new capacity merely replicates the features of established capacity then there should be no systematic differences across plants producing the same model. Indeed we find that new domestic capacity, while weakly higher price, insignificantly from the price distribution of established capacity. However, this is not true for models offshored to Mexican plants. In this case, production tends to be concentrated among varieties within a model that are at the lower end of the price distribution. This suggests that even across plants with similar capabilities, the offshore plants produce systematically different vehicles.[2]

As noted above, even within a model there is pronounced variation in the price distribution that implies large variation in the features of the individual vehicles. To explore the difference in the composition of production across plants we narrow the definition of vehicle similarity from model to product-line within a model. In doing so we define a product-line based on the number of cylinders and engine displacement (liters) for a particular model. For example a model could be the Ram 1500 pick-up which is available with the following engines: 6 cylinder 3.9 liter, 8 cylinder 5.2 liter and the 8 cylinder 5.9 liter. The definition of product-line implies that the Ram 1500 has three product-lines based on engine choice. Despite this narrow definition there is still variation in the vehicles that are available to consumers. For example, after choosing the 8 cylinder 5.2 liter engine, our dataset records 6 permutations of cab type and drive train. We adopt this narrower definition to allow for a more precise matching of capabilities across locations. If a plant can produce the base model, then it is likely to be able to produce any other variety within the product-line. This may not be as true for other varieties within the model range.

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[2] One reason for this different production composition might be that it is aimed at the Mexican market. However, almost all of the production at the new Mexican plants was exported to the US.

We once again adopt the benchmark of replication of product-line output across plants: the production of any variety at a plant is just proportional to aggregate sales of the particular vehicle. To the extent that the distribution of production differs from this baseline, we relate it to a number of factors at the variety level: vehicle quality, production complexity, variety newness and variety scale. We find that different parts of the product-line are systematically allocated to capacity with different features. In particular, offshored vehicles tend to be of a lower quality, older, less complex and lower scale. This is true both in comparison to established facilities and also new domestic plants.

Overall this suggests that even at a level of disaggregation as fine as variety within product-line there is systematic variation in the characteristics of production across locations which is broadly consistent with the standard model of vertical FDI and the closely associated product cycle model (Vernon, 1966; Antràs, 2005). As suggested by this literature FDI and trade can have important interactions with the level of human capital and implications for the integrations of labor markets. The detail in our dataset suggests that the integration labor markets might be even more direct than suggested by the previous literature with plants in different locations producing exactly the same model. Taken together these results suggest that trade liberalization has a dramatic effect on both trade and investment flows. Moreover, the integration of markets (both product and factor) has important implications for the distribution of production and plant level revenue that are only clearly apparent at the product level.

Related Literature

A unique feature of our analysis is the level of detail at our disposal, offering a window onto the offshoring behavior of a major US industry at the level of detail that is of interest to consumers. Indeed, as policy parameters and characteristics (complexity, and quality) vary at finer levels of detail, cutting the data at this level is crucial. Primarily due to data limitations, the prior norm for studying the automotive industry is to evaluate pricing and other behavior at the model level.[3] Two exceptions to this are Davis and Kahn (2010), and McCalman and Spearot (2011). Davis and Kahn (2010) offer a unique analysis of used-vehicle trade with Mexico using a regression discontinuity design over prominent vehicle characteristics (primarily vehicle age). In our companion paper, McCalman and Spearot (2011), we examine a provision in US fuel economy rules that is a function of (1) detailed product characteristics and (2) the location of production.

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[3] See Berry, Levinsohn, and Pakes (1994), Goldberg (1995), Blonigen and Soderbery (2011), Sly and Soberbery (2011).

A small literature has emerged evaluating the effects of foreign production in the North American auto industry. Fox (2009) shows a positive effect of non-Asian suppliers matching with Asian automotive assemblers. Blonigen and Soderbery (2011) evaluate the gains from variety through trade and investment in the US automobile industry. They find that there were substantial gains in trade through additional variety, especially when using a market based definition of variety. In concomitant work, Sly and Soberbery (2011) evaluate the sourcing strategies of automotive firms at the model level motivated by union pressure, arguing that firms offshore their high mark-up models to Mexico to improve their standing in wage negotiations.

A larger literature exists on the motivations for offshoring. Two papers that are of particular interest are Feenstra and Hanson (1997) and Keller and Yeaple (2009). The former evaluates an increase in capital stock in the south on relative wages in the north and south. Our work is similar to theirs in that firms initially offshore varieties for which the relative benefits of offshoring are more pronounced (in our case, less complex tasks, older design vintage). Keller and Yeaple (2009) develop a three country model of sourcing behavior. In their work, offshoring a task requires the transmission of information, and hence, less-complex tasks tend to be offshored. In our empirical work, we propose a measure of complexity and find that indeed less-complex varieties are more likely to be offshored.

More generally our paper is related to the literature on product quality and globalization. The need for new investment to facilitate Mexican light truck exports is reminiscent of the quality upgrading mechanism emphasized by Verhoogen (2008). The emphasis on vertical differentiation by location is related to Schott (2004) and Khandelwal (2010), though both these paper conduct their analysis at the product level, rather than the firm-product level. By combining a particular trade liberalization event, with a shock that converts the potential of this new environment into observable phenomena, we are able to add to the literature by tracking and documenting exactly how firms respond and the margins on which they adjust.

2 NAFTA and Changes to Industry Structure

Without question auto trade is extremely important among NAFTA countries. For instance in 2003 it accounted for 20% of all trade between the NAFTA partners. Moreover, between 1993 and 2003 NAFTA motor vehicle trade almost doubled, accounting for 18% of the growth in NAFTA trade over this period (see Hufbauer and Schott, 2005). The light truck segment stands out as one area where the growth was especially dramatic, which is where we focus our attention. The reason for the growth is not hard to isolate; the policies in place prior to NAFTA essentially eliminated trade in light trucks between the US and Mexico (see appendix for a discussion of these policies).[4] While these policies were unfortunate more generally, their elmination presents us with a unique opporutnity to study the integration of two locations with natural complementarities.

The removal of trade barriers due to NAFTA created the potential for significant production to be relocated to Mexico - an opportunity that was exploited immediately. From a standing start at the implementation of NAFTA, the big three were able to invest in facilities south of the border to the extent that 6% of all light trucks sold in the U.S. in 2000 were produced in Mexico. While this growth is impressive, it is clear that not all light truck production was offshored over this period. Hence, the question now becomes what particular models or varieties of light-truck were offshored to Mexico? Did the firms simply use the Mexican production market as as source of flexible capacity? Or, did these firms strategically offshore different types of truck to Mexico?

3 Data

The data for this project comes from two industry sources, which are merged into a large dataset of vehicle characteristics, plant of production, and sales information for model years 1990-2000. The source for production information is a custom dataset constructed by *R.L. Polk* (Polk) based on the population of vehicle registrations in the U.S. and Canada. Specifically we acquired sales information for every observed permutation of vehicle characteristics and plant of production, both types of information available in the vehicle identification number (VIN). We complement this data with manufacturer suggested retail prices as listed at the beginning of the model year and important vehicle characteristics such as vehicle weight and maximum cargo weight. This information is obtained from the *Wards Automotive* dataset of vehicle characteristics (Wards). The Wards data provides all information that is in the Polk dataset with the exception of sales and location of production, along with more refined data on characteristics, prices, interior trim levels, and transmission options.

A critical part of our analysis is choosing an appropriate level of refinement to define varieties.

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[4] Along side large non-tariff barriers in both countries, the US imposed a 25% MFN tariff while Mexico had a 20% MFN.

Previous analyses define varieties by their basic make-model pair (eg. GMC Sierra), and if applicable, country of origin. Facilitated by our dataset, we can do so at additional levels of detail that will provide insight into the nuanced nature of offshoring decisions.

Aside from the firm and basic vehicle classes, the broadest level of aggregation will be called a *platform*. A platform embodies the basic vehicle type within a firm from which different models can be manufactured. From platforms, we define a *model* as some arrangement of a platform that may differ by within-firm brand and weight-class: for example the full size Chrysler pick-up has three models, the Ram 1500, Ram 2500 and the Ram 3500. A list of all platforms and models within each platform is presented in the Appendix (in Table 10).

The next level of detail is a *product-line*, which is defined by the types of engines that are available for a model, where variation is derived from engine size (liters), number of cylinders, and whether the engine runs on diesel fuel. The finest level of detail (for which sales information is available) is *variety*, which is based on the variation in options that are available within a product-line. These options/features include drive-type (4X4), cab style (regular, extended or crew), and whether or not there are heavy duty or long-bed (pickup) options. At this level of detail, we also introduce the concept of a *configuration*, which is a variant of each variety based on features beyond what Polk provides. These may be interior configurations, the type of heavy-duty or long-bed options, transmission options (number of gears, automatic), and work truck features. In the Appendix, we provide an example of these configurations from within the Wards database. In Section 6, we introduce a measure to evaluate the dissimilarity of configurations within a variety. To identify the number of configurations for each variety in each year, we use the number of entries in the Wards database that match with each variety in the Polk database. The number of platforms, models, product-lines, and varieties in the dataset are presented in Table 1. Further, we have also provided the average number of configurations per variety. Clearly, the level of detail in our dataset is roughly 11X more than the current frontier in terms of examining trade or FDI. Hence, the level of detail in our sample will not only allow for an analysis of which models were offshored (the current literature), but also which segments within each model based on their product characteristics were offshored.

Table 1: Sample Detail

Platforms	23
Models	76
Product-lines	279
Varieties	845
Avg. Configurations per Variety	4.08

Notes: This table presents the number of platforms, models, product-lines, and varieties available in the dataset. Further, the table also presents the average number of trim configurations per variety.

Specialization Across Plants

To complete the description of the data, we examine the nature of specialization across plants.[5] The crucial question for our paper is whether there is specialization within-models across plants, and if so, how capacity is exploited relative to existing theories of offshoring. To get a sense of the degree to which there is specialization across plants within-models, in Table 2, we tabulate descriptive measures that summarize the degree to which platforms and varieties are spread across multiple plants.

Table 2: Multiplant Varieties/Platforms

	Pre-NAFTA	Post-NAFTA
Plants per Variety	1.87	1.91
Plants per Platform	2.73	3.04

Notes: This table presents the production-weighted average number of plants that produce each variety and platform.

In Table 2, we see that the number of domestic plants that produce a given variety is just below 2. In contrast, the average number of domestic plants that produce a given platform is slightly larger than 3. This suggests that certain plants *specialize* in specific varieties, where if varieties were allocated randomly across plants that are tooled for their specific platform, these statistics should be roughly equal. Indeed, this begs a number of questions regarding which varieties were offshored to Mexico within platforms, and the subsequent effects on those plants most affected by offshoring. We now turn to examining precisely these issues.

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[5] The plant is identified by the vehicle identification number, and hence is part of the dataset.

4 Aggregate Light-truck Investment in the US and Mexico

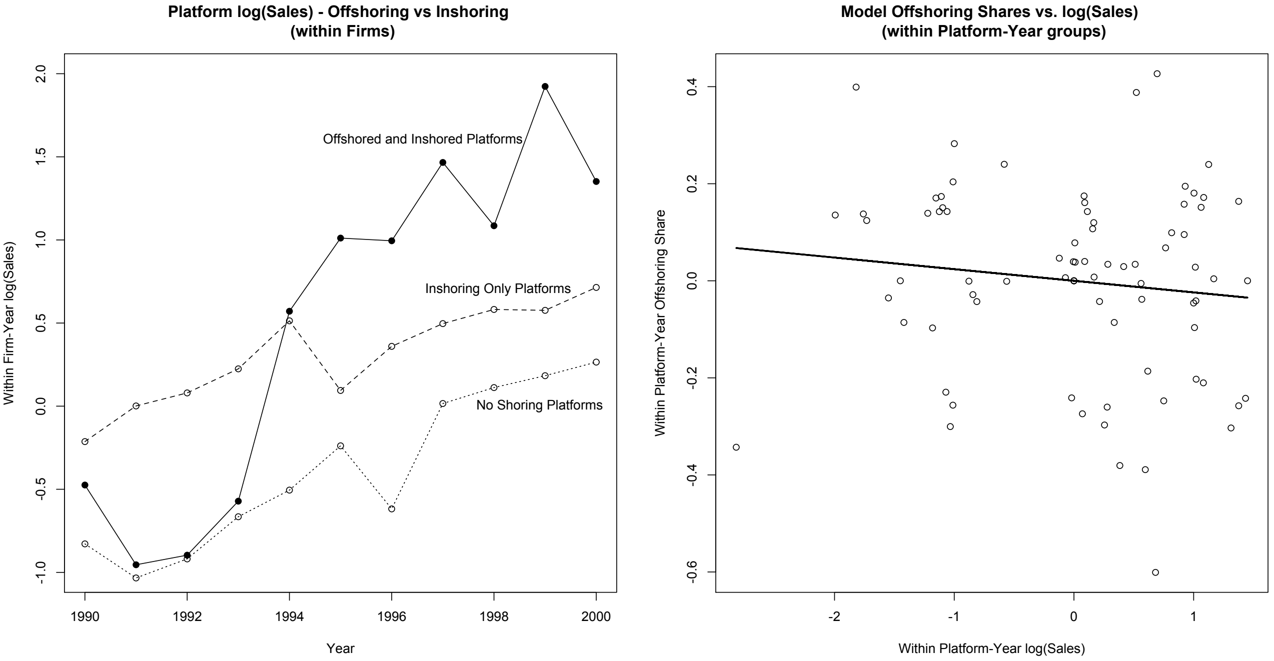
To begin our study of automotive offshoring to Mexico, we highlight the specific "platforms" that were offshored to Mexico post-NAFTA relative to those that remained domestic. A vehicle platform is essentially a basic vehicle type that requires a large scale investment to design, implement, and produce. Once this investment has taken place, platforms can be adjusted to manufacture specific vehicle models, product-lines, and finally varieties. Production decisions over the latter are assumed to be subsequent to the decisions regarding the broader vehicle platforms. Hence, the first decision is which vehicle platforms to offshore, inshore, or both.

The definition of offshoring for our sample is fairly straightforward. Specifically, since light-truck imports by the domestic automakers were extremely small prior to NAFTA, we define offshored platforms as those that utilized capacity in Mexico to serve the domestic market after 1994. The definition of inshoring is slightly more nuanced. Along with some new capacity, one of the interesting features of the 1990s is that idled car plants were refurbished to satisfy the increasing demand for large trucks in the US and Canada. Hence, the definition of an inshored plant that we use is a plant that is not active prior to 1994 that adds a model that continues to be produced at an older plant (hence capacity does not just switch from one plant to the next). We also require that the new plant produce the new model in a continuing manner until the last two years of the sample. A list of all offshored and inshored plants, along with the offshored and inshored models, is presented in Table 3. Clearly, the lion's share of offshoring and inshoring was concentrated in larger trucks and SUVs, though also included some minivans produced by Chrysler.

To analyze the motivations for offshoring and inshoring, we adopt a nested decision process for the firm. Specifically, we leverage the fact that firms are able to produce various models and varieties after investing in basic vehicle platforms. As we only have 21 platforms, and such large scale investments are not made in every period, we will simply highlight some of the descriptive characteristics that motivate the offshoring or inshoring of a vehicle platform. In particular, we compare those platforms that received new capacity in the US and Mexico with those that received new or retooled capacity in the US, and those platforms that did not receive any new or retooled capacity.

Focusing on offshoring for the moment, guided by Antràs and Helpman (2004), offshoring takes place only if the revenues earned from offshoring can recover the often large fixed costs of installing

Figure 1: Platform and Model Offshoring



Notes: The left-hand panel presents within-firm average revenues for platforms that were offshored relative to other groups. Precisely, we group platforms into “Offshored and Inshored”, “Inshoring only”, and ”No Shoring”, de-mean by firms, and then average within each group. The right-hand panel presents the relationship between offshoring shares and log(Sales) within platform-year groups.

Table 3: Offshored and Inshored Plants

Plant	**Firm**	**Platforms***	**Notes**
Offshoring			
Lago Alberto	Chrysler	Fullsize Pickups	Slightly Retooled
Saltillo	Chrysler	Fullsize Pickups	New Investment
Cuautitlan	Ford	Fullsize Pickups	Existing for Mexican Market
Silao	GM	Large SUV	New Investment
Inshoring			
St. Louis North, MO	Chrysler	Fullsize Pickups	Converted from Minivan
St. Louis South, MO	Chrysler	Minivans	Converted from Idle
Windsor, ON	Chrysler	Minivans	Converted from Idle
Kentucky Trucks, KY	Ford	Fullsize Pickups	Extended from Medium Duty to include Light Duty
St. Louis, MO	Ford	Fullsize Pickups	Converted from Minivan
Arlington, TX	GM	Fullsize Pickups, Fullsize SUVs	Converted from Cars
Linden, NJ	GM	Compact SUVs, Pickups	Converted from Cars
Flint, MI	GM	Fullsize Pickups	Converted from Fullsize vans
Wentzville, MO	GM	Fullsize Vans	Converted from Cars

Notes: This table presents the new or retooled plants in Mexico (Offshored) and the US and Canada (Inshored) that overlapped with existing capacity in the US and Canada. *Platform designations provided in the Appendix.

capacity in a foreign market. Further, platforms that exhibit a substantial growth in consumer demand may be a natural choice for offshoring, since otherwise costly reallocation would occur to move other platforms abroad and replace with growing platforms at home at existing facilities. To this end, the left panel of Figure 1 examines revenues earned by each offshored platform relative to the other platforms within the firm that were not offshored in each year. Clearly, offshoring is focused on high sales-growth platforms, and by the end of the sample, offshored platforms are clear bread-winners for each firm. Further, we see that inshored platforms also tend to be higher sales within the firm relative to those that are neither offshored or inshored.

However, in the right-panel of Figure 1, we find a different story, where we illustrate the within-platform prevalence of offshoring at the model level as a function of log sales in each year. Clearly, there is not a strong positive relationship between sales and offshoring as was found in the left panel of Figure 1. Indeed, if anything, the relationship is negative, which suggests that other factors may be at play in determining the price-composition of offshoring. We now examine the price composition of offshoring from the perspective of matching models and plants across North America.

5 Product Quality at New and Old Capacity

The addition of new capacity naturally leads to the question of how it is exploited. One dimension of this question relates to the composition of production at plants that are set-up not only to produce the same platforms but also the same models within a platform. If all models are the same except for some superficial difference (such as color), then the issue of allocation of production across plants is relatively unimportant. However, given the large degree of within model product differentiation, the allocation of production across plants can have very large implications for the revenues attributable to plants and therefore over the perceptions of plant performance and viability (the difference between the price of the base model and the top of the range model is greater than 40% on average for the model-years in our sample).

As a benchmark consider the possibility that any new capacity is just a replication of the old capacity in terms of the distribution of vehicles within a model-year. That is, production at any plant for each variety within a model-year is just proportional to the overall sales. In that case, the price distribution for each model year would be the same at each plant producing that model-year. In turn this implies that the sales weighted average price for each model-year at each plant producing that model-year should be the same.

To examine this benchmark case, over the period 1994-2000, we estimate the differences in the log of the sales weighted average price for each model-year across plants as follows:

$$ln(price_{m,t,p}) = \alpha_1 \cdot new\ capacity_{m,t,p} + model\_year + plant\_year + \epsilon_{m,t,p} \tag{1}$$

In (1) $New\ Capacity_{m,t,p}$ is a dummy variable that is defined as 1 when a plant (p) begins production of a model (m) in a year (t) after the model initially appears in our sample. In addition we require that this model is produced at this additional plant in an ongoing way (as described in section 3). Model-year fixed effects are included so that comparisons can be made across plants but with-in model-years. One concern is that differences in the average price in any given year may reflect extraneous factors such as model ramping up, strikes or natural disasters that limit production within a year at a plant. To account for such one-off events we also include plant-year fixed effects. The sample is defined as all model-years from 1994 that are produced at more than one plant, where at least one of those plants is

Table 4: Offshoring, Inshoring, and Plant Characteristics

VARIABLES	(1) ln_price	(2) ln_price	(3) ln_price
(New Capacity)	-0.006	0.018	0.021
	(0.010)	(0.015)	(0.015)
(New Capacity) x (Mexican Plant)		-0.047**	-0.026*
		(0.019)	(0.016)
Observations	463	463	463
R^2	0.84	0.84	0.94
Number of model_yr	182	182	182
Model-Year FE	y	y	y
Plant-Year FE	y	y	y
Truck Attributes	n	n	y

Notes: The unit of observation is plant-model-year. Attributes include length, width, curb weight and types of cylinders, liters, drive train, cab, duty rating, bed and fuel. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

new capacity.

The results of this regression are presented in Table 4. In relation to the simple model-year replication hypothesis, column (1) can't reject the hypothesis that the model-year price distribution at both old and new capacity are the same. In particular, the first row suggests that there is no significant difference in the average price at the new and old capacity. Given that the majority of additional capacity was installed within the US and Canada, it is worthwhile isolating the new Mexican capacity to see if it has the same replication feature. To examine this issue (1) has been augmented with a interaction dummy to reflect when new capacity is located in Mexico and the results are reported in column (2). While it is still the case that on average the new and old capacity are utilized in a similar manner, this is not the case for the new Mexican capacity (offshored capacity). The average price at these offshore facilities is 5% less than domestic new and old capacity - this difference is significant at the 5% level.

One concern is that the "offshoring" coefficient may just reflect the lower cost of the vehicle due to the lower labor costs in Mexico, and that the models produced there will also carry a lower price. To explore this possibility we include vehicle attributes in the regression. Column (3) reports the result that the coefficient on "offshoring" is much smaller and no longer significant. This suggests that the difference in the average price across plants is not driven only by costs but also by the attributes of the vehicles produced. That is, the composition of production differs significantly across the Rio Grande. We now exploit the detail in our dataset to examine this issue more closely.

6 Offshoring, Inshoring, and Variety Characteristics

The previous section suggested that capacity in Mexico is used to produce vehicles with different characteristics than those in other North American plants. Moreover, since the average price within a model-year is lower at Mexican plants, this suggests that the vehicles produced in Mexico tend to be of lower quality than produced by their North American counterparts. However, this conclusion is pre-mature since there is still a great deal of variation within a model-year based on elements of vehicle performance and comfort. Issues of performance relate to engine characteristics with variation in cylinders (for example) that could include 6, 8 or 10 cylinder engines. It is possible that the top of the line 6 cylinder model is produced in Mexico, while the 6 cylinder base model is produced in other North American plants. Adopting this narrower focus suggests that is it possible for Mexico to produce higher quality vehicles and still have a lower average price within a model year simply because the 8 or 10 cylinder version come with a higher price. Further, engine characteristics and the location of production may be strongly influenced by the source of the engine itself. Indeed, some engines are produced by independent suppliers and/or locations that exploit significant economies of scale. That is, engines used across multiple models and platforms in some cases are the same and sourced from the same plant. Hence, it is important to acknowledge these linkages, and when identifying the composition of offshoring and inshoring, control for these inputs sourcing issues.

Given both issues, we explore the composition of offshoring by narrowing the focus from model-year to varieties within a product-line-year. This sharper focus has the advantage of matching the capabilities of two plants very exactly. This follows from the definition of a product-line which is based on engine characteristics (cylinders and liters). A variety is then constructed by adding additional features to this engine. For example a pick-up truck can have the option of adding 4X4 drive train, long-bed, extended or crew cab and a heavy duty option. By holding the engine configuration constant we essentially identify plants that have the same basic capabilities along with absorbing issues of input sourcing using product-line-year fixed effects. We then ask which plants produce which versions within the product-line?

To begin the analysis, we examine the relationship between product characteristics and the "type" of plant which produces light truck varieties. As in the previous section, we classify plants as new or retooled capacity in Mexico (offshoring), new or retooled production in the US or Canada (inshoring), or existing production in the US or Canada ("no shoring"). For a given variety v in year t, it must be the case that the share of production that occurs at each type of plant adds to 1:

$$MexShare_{v,t} + InShare_{v,t} + NoShare_{v,t} = 1 \tag{2}$$

Here, $MexShare_{v,t}$ is the share of variety v that is sourced from production in Mexico in year t, and $InShare_{v,t}$ and $NoShare_{v,t}$ are the equivalent variables for inshoring and no shoring. Via (2), if the same regressors are used in predicting $MexShare_{v,t}$, $InShare_{v,t}$, and $NoShare_{v,t}$, the OLS coefficients will add-up to zero.[6] Hence, it is the ordering of, and statistical difference between, these coefficients that is of interest in this section.

Broadly, we expect that new or retooled production in the US will be more advanced than existing production in the US, as many of the existing US and Canadian assembly plants are relatively old, and are designed in a way that reflects "Fordist" notions of scale-driven manufacturing. In contrast, many of the new and retooled facilities in the US adopt modern lean techniques that are more closely associated with the Toyota Production System, and most importantly, are conducive to flexible production. Hence, we expect that new production in the US or Canada will reflect some level of increased technical know-how and flexibility, and hence, we expect that varieties more likely to require this know-how or flexibility will be sourced from these new facilities.

In contrast, new and retooled production in Mexico has a different set of issues vis-a-vis new or existing production in the US. Indeed, while production in Mexico may be a result of new investment and is not subject to the collusive union arrangements in the US and Canada, it is in a distant location, and the workers are generally less-skilled and speak a different language than the remainder of the North American Market. Hence, via a number of channels (which are discussed below), it might be expected that relative to existing production in the US, production in Mexico is associated with vehicle characteristics that embody a lower degree of complexity and quality than those that remain in the US.

For our baseline regressions, we will focus on three characteristics: the maximum cargo weight to

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[6] Similar decomposition methodologies are used by Hummels and Klenow (2005) and Bernard, Jensen, Redding and Schott (2007).

curb weight ratio, variety dissimilarity, and variety vintage. The maximum cargo weight to weight ratio is defined as the maximum possible weight of passengers and cargo divided by the curb weight of the vehicle, where curb weight is defined as the operating weight of the vehicle (including petrol and required fluids to operate). Indeed, vehicles with a higher maximum cargo weight to weight ratio likely have structural characteristics that require additional welding, higher strength components, or additional worker care in the construction of the vehicle. In all cases we interpret greater carrying capacity as a measure of quality and expect that these varieties will be less likely to be offshored.

To measure the complexity of vehicle assembly, we adopt a novel measure of variety dissimilarity. The focus on dissimilarity is motivated by the fact that each vehicle variety may have different options available that a line worker must distinguish when putting together the most refined aspects of the vehicle. For example, while all vehicles need a steering wheel, not all vehicles need a leather-wrapped steering wheel. For varieties that exhibit variation across configurations within a variety, there is more information for the line worker to process when producing the vehicle. If this information transmission is costly, it may be less likely for a firm to offshore its most complex varieties within a product-line. Further, if new production in the US embodies a greater degree of flexibility relative to old production in the US, it is more likely that these complex varieties will be sourced from new or retooled production in the US.

To measure dissimilarity, we use the "Mahalanobis Distance" of Mahalanobis (1936), which is essentially a Euclidean distance between two points in a multi-dimensional space, but correcting for the fact that some dimensions may be correlated. Specifically, defining a vector of characteristics for configuration c of variety v as $x_{c,v}$ and the mean characteristics across all configurations within v as μ_v, and the covariance matrix of characteristics across configurations as V_v, the Mahalanobis distance from the mean for configuration c within variety v, $D_{c,v}$, is defined as:

$$D_{c,v} = \sqrt{(x_{c,v} - \mu_v) \cdot V_v^{-1} \cdot (x_{c,v} - \mu_v)^T}$$

Conveniently, $D_{c,v}$ is scale invariant, which is a nice property given that we will be using this metric across very different platforms, products, and varieties. To measure the average dissimilarity across configurations within a variety, we use a measure similar to the sample standard deviation:

$$D_v = \sqrt{\frac{1}{N_v - 1} \sum_{c \in \Omega_v} D_{c,v}^2} \tag{3}$$

In (3), N_v is the number of configurations within variety v, and Ω_v is the set that contains these configurations. When taking this measure to the data, which we label the "Mahalanobis Dissimilarity", we use the manufacturers suggested retail price, the gross vehicle weight, curb weight, length, width, and height to define configurations of a variety. The variance covariance matrix, V_v, is also defined over these characteristics within each year. Finally, if there is only one configuration within each variety, D_v is forced to zero.

The last attribute we include in the benchmark regression is a measure of variety vintage, which for each variety v in year t is defined as the current year t minus the first year the variety is observed in the sample. Indeed, many models of North-South trade based on product cycles predict that new variety introductions are more likely to be sourced from the North, and only offshored to the South after production of a variety is more "standardized" or lower in terms of human capital intensity (Vernon 1966, Antràs 2005). Given that we are using product-line-year fixed effects, we are estimating the propensity of shoring options based on the relative vintage within each product-line-year (so the effects are unrelated to overall trends). Finally, we also include a dummy variable for varieties that are in their initial year to control for a likely discrete incentive to troubleshoot a new variety closer to the engineers that designed it.

To examine the relationship between shoring options and characteristics, we estimate the following:

$$Share_{v,t}^r = \alpha_r \cdot Characteristics_{v,t} + ProductLine\_Year + \epsilon_{v,t}^r, \tag{4}$$

where $Share_{v,t}^r$ is the share of variety v in year t that is sourced from plant-type r, and α_r is the vector of coefficients that is associated with the regression for plant-type r. Again, since we are using the same characteristics, $\sum_{r \in R} \alpha_r = \mathbf{0}$, where $\mathbf{0}$ is a vector of zeros of the same dimension as α_r, and R is the set of plant types. The null associated with a hypothesis that production within a product-line at a plant is just proportional to aggregate sales would then result in any element in this vector also equally zero. This provides a clear benchmark for the analysis.

Table 5: Offshoring, Inshoring, and Variety Characteristics

VARIABLES	(1) MexShare	(2) NoShare	(3) InShare	(4) InShare
$\frac{WeightCapacity}{CurbWeight}$	-0.568***	0.424***	0.144	0.276***
	(0.211)	(0.139)	(0.176)	(0.075)
Mahalanobis Dissimilarity	-0.308***	0.034	0.274***	0.173***
	(0.079)	(0.051)	(0.062)	(0.061)
First Year of Variety?	-0.507***	0.058	0.449***	-0.029
	(0.110)	(0.053)	(0.104)	(0.056)
Variety Vintage	0.013	0.017***	-0.030***	-0.033***
	(0.009)	(0.006)	(0.009)	(0.009)
R^2	0.18	0.09	0.30	0.29
Platforms	Offshored	Offshored	Offshored	Inshored
Observations	483	483	483	453
# Product-line-year	134	134	134	134

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results from estimating (4) for all three share variables are presented in columns one through three of Table 5 (using the sample of platforms that report a positive level of offshoring). Here, we find a pronounced differences between the characteristics associated with offshoring and those associated with production in the US. In particular, the results suggest that products with a higher maximum cargo weight to curb weight ratio are positively associated with domestic production relative to production in Mexico. Further, varieties that have a greater level of dissimilarity in configurations are more likely to remain in the domestic market, and within the domestic market, at new or retooled plants. Finally, varieties in their first year of production are highly associated with remaining in the US, and within the US, are more likely to be sourced from new or retooled plants.

To reinforce this pattern of sourcing, in column four of Table 5, we estimate the model on the set of platforms that report inshoring but no offshoring. Since there are two sourcing options for these varieties, we only report results for regressing $InShare_{v,t}$ on characteristics. In column four, we find evidence that is consistent with the same effects presented in columns one through three. That is, newer varieties and those with more dissimilar configurations are more likely to be sourced from new/retooled capacity in the US.

6.1 Robustness

To test the robustness of the results in Table 5, and to explore alternate hypotheses, we now offer a few extensions. While our data offers a number of advantages in terms of detail, it is constructed by registrations in the US or Canada which do not include sales in the domestic Mexico or another third market. For example, perhaps a variety of truck is a large seller in the Mexican market but not in the US or Canadian markets, and as such, any US or Canadian production is naturally sourced from Mexico. To investigate this issue we compared our sales information with alternative sources for plant production data. This comparison revealed that the majority of Mexican light truck production at the plants in our sample was shipped to the US. Nevertheless as a robustness check, we adopt a strategy to absorb as much of this variation as possible. In particular, we will absorb any time-invariant variety-specific propensities to offshore or inshore by estimating the regression in (4) using first differences:

$$\Delta Share^{r}_{v,t} = \alpha_r \cdot \Delta Characteristics_{v,t} + ProductLine\_Year + \Delta\epsilon^{r}_{v,t} \quad (5)$$

Table 6: Offshoring, Inshoring, and Variety Characteristics - First Difference

	(1)	(2)	(3)	(4)
VARIABLES	ΔMexShare	ΔNoShare	ΔInShare	ΔInShare
$\Delta\frac{WeightCapacity}{CurbWeight}$	-0.136***	0.144***	-0.009	0.179
	(0.021)	(0.016)	(0.016)	(0.120)
ΔMahalanobis	-0.147***	0.050	0.097***	0.050
	(0.048)	(0.036)	(0.029)	(0.044)
ΔFirst Year?	-0.111*	-0.050**	0.161***	0.004
	(0.060)	(0.025)	(0.058)	(0.009)
R^2	0.18	0.14	0.17	0.07
Platforms	Offshored	Offshored	Offshored	Inshored
Observations	397	397	397	356
# Product-line-year	120	120	120	119

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The idea is the following - by adding an additional heavy-duty package that contains additional features, this will change the production incentives of the firm in the US in terms of configurations (and perhaps quality). This won't be marked as a new variety in our data, but will change the other attributes of the vehicle. However, adding this new configuration should not have a large effect on the incentives for consumers in Mexico to purchase those varieties that are important to them. Hence, by evaluating changes to the attributes of a variety *over time* we provide for an additional test of the model that is not identified by time-invariant consumer preferences in any market. The results from this first-differenced regression are presented in Table 6. The results in Table 6 are broadly consistent with those in Table 5. In this case, when a variety changes it's configuration portfolio such that it has more dissimilar configuration, that increases the variety's propensity to be sourced from the US, and with the US, from new plants. Further, when a variety moves from it's first to second year of production, it is more likely to be source from old plants in the US and even more so from Mexico. Next, consider the dominant attribute model which was discussed in section 3, where if fixed costs are incurred in the process of investment in a new or retooled plant, those products which earn the highest revenues are the most likely to warrant such an investment. However, once investment cost are sunk, the question then becomes how capacity is utilized if indeed the firm has a choice over the composition of production at multiple locations that are tooled for the same product type. To examine whether the dominant attribute model is supported via investment at the variety level, we expand on the definition of new varieties that is used in Table 5. Specifically, we classify products into three groups - new varieties, old varieties that are above their product-line median production level in the previous year, and old varieties that are below their product-line median in the previous year. Excluding the last group in the estimating equation, we estimate the model with an additional dummy variable that identifies old varieties that are relatively high-selling varieties within their product-line in the previous year. These results are reported in Table 7, where we find another sharp difference between production that is offshored and existing and new production in the domestic market. In particular, we find that relative to the group of old varieties that is below their within-product-line median of sales, above-median varieties are less likely to be offshored. In contrast, relatively large selling varieties are more likely to be inshored. When evaluating the sample of inshored platforms, while insignificant, the sign is consistent with the previous result that varieties of above-median scale are more likely to be sourced from new facilities in the domestic market. As a final extension, we evaluate the lag dependance of sourcing certain varieties from existing plants. Specifically, an unobserved variable that is likely of significant importance is the location of input suppliers that make components that are specific to certain varieties. For example, while we do absorb variation in engine suppliers via our fixed effect strategy, we are unable to control for the identity and location of input suppliers that make components that define varieties (such as a heavy-duty frame). This is of particular interest for pick-up trucks, for which models received both new investment within the domestic market and outside the domestic market, but also require many specialty components that may be produced by single-plant manufacturers. Further, certain components may not be of sufficient scale to warrant a new plant post-NAFTA. Hence, if these input suppliers are located around existing plants (as theories of just-in-time manufacturing suggest), then the location of these plants may provide an anchor that prevents varieties from being sourced from new and distant capacity at home or abroad. Econometrically, the potential omitted variables issue arises when noting that some of these components may be correlated with our existing measures that predict whether a variety will be offshored or inshored. For example, perhaps pick-up trucks with a crew cab require a specialty component that is located in Detroit, but that crew cab pick-ups also have a large level of dissimilarity in configurations that, as our results currently suggest, make it more likely that variety with dissimilar configurations is sourced from the domestic market.

Table 7: Offshoring, Inshoring, and Variety Characteristics - Variety Scale

VARIABLES	(1) MexShare	(2) NoShare	(3) InShare	(4) InShare
$\frac{WeightCapacity}{CurbWeight}$	-0.765***	0.453***	0.312*	0.287***
	(0.206)	(0.137)	(0.176)	(0.081)
Mahalanobis Dissimilarity	-0.294***	0.032	0.263***	0.167***
	(0.080)	(0.051)	(0.063)	(0.063)
First Year of Variety?	-0.567***	0.067	0.500***	-0.025
	(0.109)	(0.055)	(0.099)	(0.057)
Variety Vintage	0.012	0.017**	-0.029***	-0.033***
	(0.008)	(0.007)	(0.008)	(0.009)
Above-median Scale?	-0.128***	0.019	0.109***	0.018
	(0.038)	(0.029)	(0.026)	(0.024)
R^2	0.22	0.10	0.34	0.29
Platforms	Offshored	Offshored	Offshored	Inshored
Observations	483	483	483	453
# Product-line-year	134	134	134	134

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Offshoring, Inshoring, and Variety Characteristics - Existing Plant-Variety Relationships

VARIABLES	(1) mshare	(2) noshare	(3) inshare	(4) inshare
$\frac{WeightCapacity}{CurbWeight}$	-0.367*	0.160**	0.207	0.259***
	(0.214)	(0.074)	(0.196)	(0.083)
Mahalanobis Dissimilarity	-0.292***	0.007	0.285***	0.220***
	(0.071)	(0.029)	(0.063)	(0.077)
First Year of Variety?	-0.508***	0.073	0.435***	0.051
	(0.123)	(0.053)	(0.093)	(0.055)
Variety Vintage	0.057***	0.004	-0.061***	-0.001
	(0.014)	(0.005)	(0.011)	(0.014)
Above-median Scale?	-0.135***	0.049***	0.087***	0.004
	(0.033)	(0.017)	(0.023)	(0.025)
R^2	0.35	0.62	0.46	0.36
Platforms	Offshored	Offshored	Offshored	Inshored
Observations	483	483	483	453
# Product-line-year	134	134	134	134

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The issue of course is that we do not have detailed information regarding the location of input suppliers or linkages to varieties. Instead, we control for this issue by utilizing plant-level dummy variables that identify if a given variety is sourced from a particular plant pre-NAFTA. These dummies control for existing relationships between varieties and old plants that may persist post-NAFTA. The results from estimating the model with these old plant-variety linkages are presented in Table 8, where we find that the results are robust to the inclusion of these "lagged" plant-variety linkages. One coefficient that changes magnitudes somewhat is the coefficient on the maximum cargo weight to curb weight ratio, which suggests that heavy-duty varieties are more likely to be sourced from plants that are specifically tooled for them, and have produced them in the past.

7 Conclusion

The process of globalization associated with the dramatic increases in trade and investment is commonly said to be driven by trade liberalization. However, aggregate data can only confirm this association, it can't provide insight into the mechanics that underlie these dynamic forces. To provide greater understanding of this process we exploit the liberalization of the US light truck market in the wake of NAFTA. This period of liberalization also coincided with a boom in US light truck demand that required a pronounced increase in capacity. Critically we have access to product and plant level data in both the US and Mexico that allows us to map out the detailed characteristics and implications of this liberalization episode and the associated expansion of capacity.

We answer the question of which products are offshored at various levels of aggregation. At the most aggregate level, that of the platform, we find that the fastest growing and the best selling platforms tend to be offshored. This is consistent with theoretical models that emphasize scale as a key component of FDI. However, at more disaggregate levels scale operates in the opposite direction and other factors become particularly important. Indeed, at the variety level the products offshored tend to be lower in quality, of older design vintage, are lower scale, and are less complex to produce. In contrast, we find that varieties "inshored" to new or retooled capacity in the US exhibit the opposite characteristics.

Taken together these results suggest that trade liberalization has a dramatic effect on both trade and investment flows. Moreover, the integration of markets (both product and factor) has important implications for the distribution of production and plant level revenue that are only clearly apparent at the product level.

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A Appendix

A.1 Trade policies on light trucks

Prior to NAFTA, there were three policies that made offshoring of light-truck production essentially prohibitive. The first, and likely most restrictive, was the MFN tariff on light-trucks. In stark contrast with passenger cars, where the tariff has long held steady at 2.5%, the MFN tariff on light trucks was 25%, a relic of the 1964 "chicken war" with the European community. The second restrictive policy was one of import-substitution in the Mexican automobile sector. In particular, any imported inputs for finished trucks, or the finished trucks themselves, must be balanced by exports from production facilities in Mexico. While this was meant to foster growth in their own auto sector, the lack of demand for US made vehicles in Mexico made very difficult the balancing required for successful offshoring. Further complicating matters were restrictions that foreign owned input producers may not serve the domestic Mexican market without using sufficient Mexican content in their production process.[7] The third policy was a little-known non-tariff barrier to trade within US fuel economy rules. While we direct the reader to our companion paper (McCalman and Spearot, 2011) for a detailed analysis of this program, we find that this policy resulted in 10% higher prices for varieties subject to US fuel economy standards.

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[7] For an extended discussion of substitution and input requirements, see Chapter 4 of *Assessing NAFTA: A Tri-National Analysis*, Fraser Institute, 1993.

A.2 An Example of Configurations

One of the novel contributions of the paper is using the Mahalanobis Distance as a metric for measuring the dissimilarity of configurations within a variety. While we do not have sales information for each configuration, we leverage the dissimilarity of configurations as a proxy for the "complexity" in producing a particular variety. Below, we provide and example of these configurations for a variety, the FORD F150 8CYL 5.4L 4X4 LONGBED for the year 1997.

Table 9: FORD 150 8CYL 5.4L 4X4 LONGBED Configurations

TRIM	BOX	WHEELBASE	LENGTH	WIDTH	HEIGHT	CURB	GVW	TRANS	PRICE
-	6.5	120.2	203.7	79.5	75.3	4235	6000	M5(A4)	18380
-	8	138.8	222.3	79.5	75	4339	6000	M5(A4)	18575
-	6.5	120.2	203.7	79.5	75.3	4235	6000	M5	18585
-	8	138.8	222.3	79.5	75	4339	6000	M5	18900
XL	6.5	120.2	203.7	79.5	75.3	4235	6000	M5(A4)	19385
XL	6.5	120.2	203.7	79.5	75.3	4235	6000	M5	19575
XL	8	138.8	222.3	79.5	75	4339	6000	M5(A4)	19585
XL	8	138.8	222.3	79.5	75	4339	6000	M5	19775
XL FLAIRSIDE	6.5	120.2	207.4	79.5	75.3	4308	6000	M5(A4)	20050
XL FLAIRSIDE	6.5	120.2	207.4	79.5	75.3	4308	6000	M5	20255
XLT	6.5	120.2	203.7	79.5	75.3	4235	6000	M5(A4)	21245
XLT	8	138.8	222.3	79.5	75	4339	6000	M5(A4)	21445
XLT	6.5	120.2	203.7	79.5	75.3	4235	6000	M5	21710
XLT FLAIRSIDE	6.5	120.2	207.4	79.5	75.3	4308	6000	M5(A4)	21910
XLT	8	138.8	222.3	79.5	75	4339	6000	M5	21910
XLT FLAIRSIDE	6.5	120.2	207.4	79.5	75.3	4308	6000	M5	22385

While there isn't much variation in the height of each configuration, and zero variation in width, there is variation in length depending on whether there is a long bed in the configuration (box length, "BOX", equals 8). Further, there is variation in prices that can be used to provide an estimate of the heterogeneity across configurations within a variety.

Sales and Vehicle Characteristics

Table 10: Firms, Platforms, and Models: 1990-2000

Chrysler		**General Motors**	
Platform	*Model*	*Platform*	*Model*
Compact Pickup	DODGE DAKOTA	Compact Pickup	CHEVROLET S10
Compact SUV	JEEP CHEROKEE		GMC SONOMA
	JEEP GRAND CHEROKEE		GMC SYCLONE
Jeep	JEEP WRANGLER	Compact SUV	CHEVROLET BLAZER
Large Pick-up	DODGE RAM1500		GMC ENVOY
	DODGE RAM2500		GMC JIMMY
	DODGE RAM3500		GMC TYPHOON
Large Van	DODGE RAMVAN1500		OLDSMOBILE BRAVADA
	DODGE RAMVAN2500	Large Pickup	CHEVROLET CK1500
	DODGE RAMVAN3500		CHEVROLET CK2500
Medium SUV	DODGE DURANGO		CHEVROLET CK3500
	JEEP WAGONEER		GMC CK1500
Minivan	CHRYSLER GRAND VOYAGER		GMC CK2500
	CHRYSLER TOWNCOUNTRY		GMC CK3500
	CHRYSLER VOYAGER	Large SUV	CHEVROLET SUBURBAN1500
	DODGE CARAVAN		CHEVROLET SUBURBAN2500
	DODGE GRAND CARAVAN		CHEVROLET TAHOE
	PLYMOUTH GRAND VOYAGER		GMC SUBURBAN1500
	PLYMOUTH VOYAGER		GMC SUBURBAN2500
			GMC YUKON
Ford		Large Van	CHEVROLET EXPRESS1500
Platform	*Model*		CHEVROLET EXPRESS2500
Compact Pickup	FORD RANGER		CHEVROLET EXPRESS3500
Compact SUV	FORD EXPLORER		GMC RALLY1500
	MERCURY MOUNTAINEER		GMC RALLY2500
Crossover SUV	FORD ESCAPE		GMC RALLY3500
Large Pick-up	FORD F150		GMC SAVANA1500
	FORD F250		GMC SAVANA2500
	FORD F350		GMC SAVANA3500
Large SUV	FORD BRONCO	Medium Van	CHEVROLET ASTRO
	FORD EXCURSION		GMC SAFARI
	FORD EXPEDITION	Minivan	CHEVROLET LUMINA
	LINCOLN NAVIGATOR		CHEVROLET VENTURE
Large Van	FORD ECONOLINE150		OLDSMOBILE SILHOUETTE
	FORD ECONOLINE250		PONTIAC MONTANA
	FORD ECONOLINE350		PONTIAC TRANSSPORT
Minivan	FORD AEROSTAR		
	FORD WINDSTAR		
	MERCURY VILLAGER		

Notes: This table presents a list of platforms and models that are available in our combined dataset. The platform information is self-compiled from industry information regarding firm and vehicle-type.

Table 11: Dodge Ram Varieties: 1990-2000

RAM1500 6CYL 3.9L
RAM1500 6CYL 3.9L 4X4
RAM1500 8CYL 5.2L
RAM1500 8CYL 5.2L 4X4
RAM1500 8CYL 5.2L CREWCAB
RAM1500 8CYL 5.2L CREWCAB 4X4
RAM1500 8CYL 5.2L EXTENDEDCAB
RAM1500 8CYL 5.2L EXTENDEDCAB 4X4
RAM1500 8CYL 5.9L
RAM1500 8CYL 5.9L 4X4
RAM1500 8CYL 5.9L CREWCAB
RAM1500 8CYL 5.9L CREWCAB 4X4
RAM1500 8CYL 5.9L EXTENDEDCAB
RAM1500 8CYL 5.9L EXTENDEDCAB 4X4
RAM2500 10CYL 8.0L
RAM2500 10CYL 8.0L 4X4
RAM2500 10CYL 8.0L 4X4 HD LONGBED
RAM2500 10CYL 8.0L 4X4 LONGBED
RAM2500 10CYL 8.0L CREWCAB
RAM2500 10CYL 8.0L CREWCAB 4X4
RAM2500 10CYL 8.0L EXTENDEDCAB
RAM2500 10CYL 8.0L EXTENDEDCAB 4X4
RAM2500 10CYL 8.0L HD LONGBED
RAM2500 10CYL 8.0L LONGBED
RAM2500 6CYL 3.9L
RAM2500 6CYL 5.9L CREWCAB DIESEL
RAM2500 6CYL 5.9L CREWCAB DIESEL 4X4
RAM2500 6CYL 5.9L DIESEL
RAM2500 6CYL 5.9L DIESEL 4X4
RAM2500 6CYL 5.9L DIESEL 4X4 HD
RAM2500 6CYL 5.9L DIESEL 4X4 HD LONGBED
RAM2500 6CYL 5.9L DIESEL 4X4 LONGBED
RAM2500 6CYL 5.9L DIESEL HD
RAM2500 6CYL 5.9L DIESEL HD LONGBED
RAM2500 6CYL 5.9L DIESEL LONGBED
RAM2500 6CYL 5.9L EXTENDEDCAB DIESEL
RAM2500 6CYL 5.9L EXTENDEDCAB DIESEL 4X4
RAM2500 8CYL 5.2L
RAM2500 8CYL 5.2L 4X4
RAM2500 8CYL 5.2L 4X4 HD LONGBED
RAM2500 8CYL 5.2L EXTENDEDCAB
RAM2500 8CYL 5.2L EXTENDEDCAB 4X4
RAM2500 8CYL 5.2L HD LONGBED
RAM2500 8CYL 5.9L
RAM2500 8CYL 5.9L 4X4
RAM2500 8CYL 5.9L 4X4 HD LONGBED
RAM2500 8CYL 5.9L 4X4 LONGBED
RAM2500 8CYL 5.9L CREWCAB
RAM2500 8CYL 5.9L CREWCAB 4X4
RAM2500 8CYL 5.9L EXTENDEDCAB
RAM2500 8CYL 5.9L EXTENDEDCAB 4X4
RAM2500 8CYL 5.9L HD LONGBED
RAM2500 8CYL 5.9L LONGBED
RAM3500 10CYL 8.0L
RAM3500 10CYL 8.0L 4X4
RAM3500 10CYL 8.0L 4X4 LONGBED
RAM3500 10CYL 8.0L CREWCAB 4X4 LONGBED
RAM3500 10CYL 8.0L CREWCAB LONGBED
RAM3500 10CYL 8.0L EXTENDEDCAB
RAM3500 10CYL 8.0L EXTENDEDCAB 4X4
RAM3500 10CYL 8.0L EXTENDEDCAB 4X4 LONGBED
RAM3500 10CYL 8.0L EXTENDEDCAB LONGBED
RAM3500 10CYL 8.0L LONGBED
RAM3500 6CYL 5.9L CREWCAB DIESEL 4X4 LONGBED
RAM3500 6CYL 5.9L CREWCAB DIESEL LONGBED
RAM3500 6CYL 5.9L DIESEL
RAM3500 6CYL 5.9L DIESEL 4X4
RAM3500 6CYL 5.9L DIESEL 4X4 LONGBED
RAM3500 6CYL 5.9L DIESEL HD
RAM3500 6CYL 5.9L DIESEL LONGBED
RAM3500 6CYL 5.9L EXTENDEDCAB DIESEL
RAM3500 6CYL 5.9L EXTENDEDCAB DIESEL 4X4
RAM3500 6CYL 5.9L EXTENDEDCAB DIESEL 4X4 LONGBED
RAM3500 6CYL 5.9L EXTENDEDCAB DIESEL LONGBED
RAM3500 8CYL 5.9L
RAM3500 8CYL 5.9L 4X4
RAM3500 8CYL 5.9L 4X4 LONGBED
RAM3500 8CYL 5.9L CREWCAB 4X4 LONGBED
RAM3500 8CYL 5.9L CREWCAB LONGBED
RAM3500 8CYL 5.9L EXTENDEDCAB 4X4 LONGBED
RAM3500 8CYL 5.9L EXTENDEDCAB LONGBED
RAM3500 8CYL 5.9L HD
RAM3500 8CYL 5.9L LONGBED

Table 12: Ford F-Series Varieties: 1990-2000

FORD F150 6CYL 4.9L
FORD F150 6CYL 4.9L 4X4
FORD F150 6CYL 4.9L EXTENDEDCAB
FORD F150 6CYL 4.9L EXTENDEDCAB 4X4
FORD F150 8CYL 5.0L
FORD F150 8CYL 5.0L 4X4
FORD F150 8CYL 5.0L CREWCAB
FORD F150 8CYL 5.0L CREWCAB 4X4
FORD F150 8CYL 5.0L EXTENDEDCAB
FORD F150 8CYL 5.0L EXTENDEDCAB 4X4
FORD F150 8CYL 5.8L
FORD F150 8CYL 5.8L 4X4
FORD F150 8CYL 5.8L CREWCAB
FORD F150 8CYL 5.8L CREWCAB 4X4
FORD F150 8CYL 5.8L EXTENDEDCAB
FORD F150 8CYL 5.8L EXTENDEDCAB 4X4
FORD F150 8CYL 7.5L
FORD F150 8CYL 7.5L 4X4
FORD F150 8CYL 7.5L EXTENDEDCAB
FORD F150 8CYL 7.5L EXTENDEDCAB 4X4
FORD F250 10CYL 6.8L 4X4 HD
FORD F250 10CYL 6.8L CREWCAB 4X4 HD
FORD F250 10CYL 6.8L CREWCAB HD
FORD F250 10CYL 6.8L EXTENDEDCAB 4X4 HD
FORD F250 10CYL 6.8L EXTENDEDCAB HD
FORD F250 10CYL 6.8L HD
FORD F250 6CYL 4.9L
FORD F250 6CYL 4.9L 4X4
FORD F250 6CYL 4.9L 4X4 HD
FORD F250 6CYL 4.9L EXTENDEDCAB
FORD F250 6CYL 4.9L EXTENDEDCAB 4X4
FORD F250 6CYL 4.9L EXTENDEDCAB HD
FORD F250 6CYL 4.9L HD
FORD F250 8CYL 5.0L
FORD F250 8CYL 5.0L 4X4
FORD F250 8CYL 5.0L EXTENDEDCAB
FORD F250 8CYL 5.0L EXTENDEDCAB 4X4
FORD F250 8CYL 5.0L HD
FORD F250 8CYL 5.8L
FORD F250 8CYL 5.8L 4X4
FORD F250 8CYL 5.8L 4X4 HD
FORD F250 8CYL 5.8L CREWCAB 4X4 HD
FORD F250 8CYL 5.8L CREWCAB HD
FORD F250 8CYL 5.8L EXTENDEDCAB
FORD F250 8CYL 5.8L EXTENDEDCAB 4X4
FORD F250 8CYL 5.8L EXTENDEDCAB 4X4 HD
FORD F250 8CYL 5.8L EXTENDEDCAB HD
FORD F250 8CYL 5.8L HD
FORD F250 8CYL 7.3L CREWCAB DIESEL
FORD F250 8CYL 7.3L CREWCAB DIESEL 4X4
FORD F250 8CYL 7.3L CREWCAB DIESEL 4X4 HD
FORD F250 8CYL 7.3L CREWCAB DIESEL HD
FORD F250 8CYL 7.3L DIESEL
FORD F250 8CYL 7.3L DIESEL 4X4
FORD F250 8CYL 7.3L DIESEL 4X4 HD
FORD F250 8CYL 7.3L DIESEL HD
FORD F250 8CYL 7.3L EXTENDEDCAB DIESEL
FORD F250 8CYL 7.3L EXTENDEDCAB DIESEL 4X4
FORD F250 8CYL 7.3L EXTENDEDCAB DIESEL 4X4 HD
FORD F250 8CYL 7.3L EXTENDEDCAB DIESEL HD
FORD F250 8CYL 7.5L
FORD F250 8CYL 7.5L 4X4
FORD F250 8CYL 7.5L 4X4 HD
FORD F250 8CYL 7.5L CREWCAB
FORD F250 8CYL 7.5L CREWCAB 4X4
FORD F250 8CYL 7.5L CREWCAB 4X4 HD
FORD F250 8CYL 7.5L CREWCAB HD
FORD F250 8CYL 7.5L EXTENDEDCAB
FORD F250 8CYL 7.5L EXTENDEDCAB 4X4
FORD F250 8CYL 7.5L EXTENDEDCAB 4X4 HD
FORD F250 8CYL 7.5L EXTENDEDCAB HD
FORD F250 8CYL 7.5L HD
FORD F350 10CYL 6.8L 4X4 HD
FORD F350 10CYL 6.8L CREWCAB 4X4 HD
FORD F350 10CYL 6.8L CREWCAB HD
FORD F350 10CYL 6.8L EXTENDEDCAB 4X4 HD
FORD F350 10CYL 6.8L EXTENDEDCAB HD
FORD F350 10CYL 6.8L HD
FORD F350 6CYL 4.9L
FORD F350 8CYL 5.8L
FORD F350 8CYL 5.8L 4X4
FORD F350 8CYL 5.8L 4X4 HD
FORD F350 8CYL 5.8L 4X4 HD LONGBED
FORD F350 8CYL 5.8L CREWCAB
FORD F350 8CYL 5.8L CREWCAB 4X4
FORD F350 8CYL 5.8L CREWCAB 4X4 HD
FORD F350 8CYL 5.8L CREWCAB 4X4 HD LONGBED
FORD F350 8CYL 5.8L CREWCAB 4X4 LONGBED
FORD F350 8CYL 5.8L CREWCAB HD
FORD F350 8CYL 5.8L CREWCAB HD LONGBED
FORD F350 8CYL 5.8L CREWCAB LONGBED
FORD F350 8CYL 5.8L EXTENDEDCAB
FORD F350 8CYL 5.8L EXTENDEDCAB 4X4 HD
FORD F350 8CYL 5.8L EXTENDEDCAB HD
FORD F350 8CYL 5.8L HD
FORD F350 8CYL 5.8L HD LONGBED
FORD F350 8CYL 7.3L CREWCAB DIESEL
FORD F350 8CYL 7.3L CREWCAB DIESEL 4X4
FORD F350 8CYL 7.3L CREWCAB DIESEL 4X4 HD
FORD F350 8CYL 7.3L CREWCAB DIESEL 4X4 LONGBED
FORD F350 8CYL 7.3L CREWCAB DIESEL HD
FORD F350 8CYL 7.3L CREWCAB DIESEL LONGBED
FORD F350 8CYL 7.3L DIESEL
FORD F350 8CYL 7.3L DIESEL 4X4
FORD F350 8CYL 7.3L DIESEL 4X4 HD
FORD F350 8CYL 7.3L DIESEL HD
FORD F350 8CYL 7.3L DIESEL HD LONGBED
FORD F350 8CYL 7.3L EXTENDEDCAB DIESEL
FORD F350 8CYL 7.3L EXTENDEDCAB DIESEL 4X4 HD
FORD F350 8CYL 7.3L EXTENDEDCAB DIESEL HD
FORD F350 8CYL 7.5L
FORD F350 8CYL 7.5L 4X4
FORD F350 8CYL 7.5L 4X4 HD
FORD F350 8CYL 7.5L 4X4 HD LONGBED
FORD F350 8CYL 7.5L CREWCAB
FORD F350 8CYL 7.5L CREWCAB 4X4
FORD F350 8CYL 7.5L CREWCAB 4X4 HD
FORD F350 8CYL 7.5L CREWCAB 4X4 HD LONGBED
FORD F350 8CYL 7.5L CREWCAB 4X4 LONGBED
FORD F350 8CYL 7.5L CREWCAB HD
FORD F350 8CYL 7.5L CREWCAB HD LONGBED
FORD F350 8CYL 7.5L CREWCAB LONGBED
FORD F350 8CYL 7.5L EXTENDEDCAB
FORD F350 8CYL 7.5L EXTENDEDCAB HD
FORD F350 8CYL 7.5L EXTENDEDCAB HD LONGBED
FORD F350 8CYL 7.5L HD
FORD F350 8CYL 7.5L HD LONGBED

Table 13: GM Large SUV Varieties: 1990-2000

CHEVROLET SUBURBAN1500 8CYL 5.7L
CHEVROLET SUBURBAN1500 8CYL 5.7L 4X4
CHEVROLET SUBURBAN1500 8CYL 6.2L DIESEL
CHEVROLET SUBURBAN1500 8CYL 6.2L DIESEL 4X4
CHEVROLET SUBURBAN1500 8CYL 6.5L 4X4
CHEVROLET SUBURBAN1500 8CYL 6.5L DIESEL
CHEVROLET SUBURBAN1500 8CYL 6.5L DIESEL 4X4
CHEVROLET SUBURBAN2500 8CYL 5.7L
CHEVROLET SUBURBAN2500 8CYL 5.7L 4X4
CHEVROLET SUBURBAN2500 8CYL 5.7L 4X4 HD
CHEVROLET SUBURBAN2500 8CYL 5.7L HD
CHEVROLET SUBURBAN2500 8CYL 6.2L DIESEL 4X4 HD
CHEVROLET SUBURBAN2500 8CYL 6.2L DIESEL HD
CHEVROLET SUBURBAN2500 8CYL 6.5L DIESEL
CHEVROLET SUBURBAN2500 8CYL 6.5L DIESEL 4X4
CHEVROLET SUBURBAN2500 8CYL 7.4L
CHEVROLET SUBURBAN2500 8CYL 7.4L 4X4
CHEVROLET SUBURBAN2500 8CYL 7.4L HD
CHEVROLET TAHOE 8CYL 4.8L
CHEVROLET TAHOE 8CYL 4.8L 4X4
CHEVROLET TAHOE 8CYL 5.7L
CHEVROLET TAHOE 8CYL 5.7L 4X4
CHEVROLET TAHOE 8CYL 6.5L DIESEL 4X4
GMC SUBURBAN1500 8CYL 5.7L
GMC SUBURBAN1500 8CYL 5.7L 4X4
GMC SUBURBAN1500 8CYL 6.2L DIESEL
GMC SUBURBAN1500 8CYL 6.2L DIESEL 4X4
GMC SUBURBAN1500 8CYL 6.5L DIESEL
GMC SUBURBAN1500 8CYL 6.5L DIESEL 4X4
GMC SUBURBAN2500 8CYL 5.7L
GMC SUBURBAN2500 8CYL 5.7L 4X4
GMC SUBURBAN2500 8CYL 5.7L 4X4 HD
GMC SUBURBAN2500 8CYL 5.7L HD
GMC SUBURBAN2500 8CYL 6.2L DIESEL
GMC SUBURBAN2500 8CYL 6.2L DIESEL 4X4
GMC SUBURBAN2500 8CYL 6.2L DIESEL 4X4 HD
GMC SUBURBAN2500 8CYL 6.2L DIESEL HD
GMC SUBURBAN2500 8CYL 6.5L DIESEL
GMC SUBURBAN2500 8CYL 6.5L DIESEL 4X4
GMC SUBURBAN2500 8CYL 7.4L
GMC SUBURBAN2500 8CYL 7.4L 4X4
GMC SUBURBAN2500 8CYL 7.4L HD
GMC YUKON 8CYL 4.8L
GMC YUKON 8CYL 4.8L 4X4
GMC YUKON 8CYL 5.7L
GMC YUKON 8CYL 5.7L 4X4
GMC YUKON 8CYL 6.5L DIESEL 4X4
GMC YUKON 8CYL 7.4L
GMC YUKON 8CYL 7.4L 4X4