Frugal Consumers and the Labor Market

Nir Jaimovich∗ Sergio Rebelo† Arlene Wong‡

This Draft: September 1, 2014

Abstract

During the last few decades, and especially during the Great Recession, many U.S. households have seen their real income fall. We combine several microeconomic datasets to show that a key way in which households have adjusted to lower incomes is by trading down, i.e. reducing the quality of the goods and services consumed. As we show, the production of lower-quality consumption goods uses less labor than that of higher-quality goods. Thus, as households trade down, the demand for labor falls. We show, empirically and theoretically, that the trading-down phenomenon accounts for a substantial fraction of the fall in U.S. employment.

∗Duke University and NBER
†Northwestern University, NBER, and CEPR
‡Northwestern University
1 Introduction

Over the Great Recession, many U.S. households have seen their real income fall. For instance, between 2007 and 2012, the real median household income fell by approximately 10%.\(^1\) Such changes in income naturally resulted in the adjustment of consumption expenditures. This adjustment led various researchers to argue that lower household demand was key to explaining the significant fall in employment during the Great Recession.\(^2\) These studies have focused on the decline in total household expenditure due to: (i) a decline in quantity consumed across all expenditure categories, (ii) postponement of purchases in some categories (such as large durables), and (iii) lower prices paid as households search more intensely for the lowest possible price.

In this paper, we show that another important channel of adjustment by households is the composition of their expenditure. Moreover, we show that the consumption expenditure composition has important effects on aggregate employment. Specifically, we study (i) the substitution across categories from luxuries to necessities, and (ii) the substitution within a category towards lower quality products (a phenomenon that we refer to as “quality-trade-down”). For example, during the Great Recession, relative to the period before it, households chose to eat more at home than at restaurants (substituting across categories). Furthermore, even when households did eat away from home, they chose to eat more at lower-priced limited-service eating places, rather than full-service restaurants (substituting within categories).

Our novel contribution is to show, empirically and theoretically, that such shifts in the composition of consumption, and predominantly the quality-trade-down, had large effects on employment. That is, we show that household demand can affect employment even in the absence of changes in the total dollar spent. Thus, aggregate shocks to income can affect employment not just through changes in the total level of expenditure, but also via shifts in the composition of the expenditure, implying that there are potentially large amplifications of aggregate shocks through household demand.

Our analysis begins in Section 2 where we show that, over the Great Recession in particular, and, in the last 40 years in general, there has been a shift towards the consumption of lower-quality goods.\(^3\) We argue that this quality-trade-down can explain a significant fraction of the fall in labor during the Great Recession. This argument is based on a new fact we document showing that firms producing lower-quality products, to which we refer throughout the paper as “lower quality firms,” use fewer employees per dollar of sale, a measure to which we refer as “labor intensity.” This measure provides a direct way of examining the effect of changes in what consumers buy (in terms of product quality) on the number of employees, even in the absence of a change in total consumption expenditures.

Through simple quantitative accounting exercises, we show that each dollar spent towards low-quality goods results in fewer employees than had that same dollar been spent towards high-quality

\(^{1}\) See Sentier Research (2014), based on Census Bureau data.
\(^{2}\) See for example XXX
\(^{3}\) This phenomenon has been discussed in the popular press. For example, the Wall Street Journal (2011) discusses how “as Middle Class Shrinks, P&G aims high and low” by launching new products aimed at the low-end: e.g. P&G launching a new low-priced Gain dish soap
goods. Specifically, we establish that the combination of these two facts, (i) a shift to lower-quality products, and, (ii) the lower labor intensity associated with such products, accounts for roughly one-third of the fall in employment during the Great Recession.

We view the results of the analysis in Section 2 as indicative of the importance of studying the general equilibrium effects that quality-trade-down can have on the economy. As such, in Section 3 we incorporate a quality choice channel into popular business cycle models and show that the presence of quality choices leads, among other things, to (i) large amplification of real and monetary shocks, (ii) sectoral comovement of labor, and (iii) a new theory of labor wedge measurement.

Finally, in Section 4 we study a model in which we relate the quality-trading-down phenomenon to the job-polarization literature. Specifically, we show that the model provides a new theory of a “polarization multiplier” where technological changes with adverse effects on the labor market, such as those emphasized in the job-polarization literature (e.g. robotics and outsourcing), lead to a quality-trade-down and hence result in further negative effects on the labor market.

Our paper relates to Bils and Klenow (2001) and Bils (2009) who show that quality is related to income, but who focus on the implications for CPI measurement, not employment. More recently, our paper relates to the work on “shopping and labor” by Huo and Rios-Rull (2013) and Kaplan and Menzio (2014). These papers focus on how variations in prices paid and product market frictions generate labor market effects. Obviously and more generally, our paper relates to the long tradition in macroeconomics that analyzes the effects changes in aggregate consumption have on the labor market. In contrast to that tradition, however, we focus on a different channel: that of how changes in the composition of the bundle of goods consumed affects the labor market, given the varying labor intensity required across different quality products.

2 Quality and Labor Intensity

In this section we document the empirical findings that motivate our work. After discussing the different data sources we employ and our empirical approach we present evidence on the large differences by firms’ quality in the labor intensity measure. Importantly we show that lower quality firms are characterized by lower labor intensity. We then show that there has been a shift towards consumption of lower quality goods (quality-trade-down) over the Great Recession in particular, as well as over the last 40 years in general. We conclude this section by showing, via simple accounting exercises, that the combination of these two facts can account for roughly a third of the decline in employment during the Great Recession.

---

4e.g. Acemoglu (1999), Autor et al. (2006), Goos and Manning (2007), and Goos et al. (2009)
2.1 Data Sources and Empirical Approach

We first focus our analysis on six sectors within retail trade: Accommodation, Apparel, Grocery Stores, Restaurants, Home Furnishing, and General Merchandise. We start by examining these sectors because we have clear information about the quality distribution of firms within these sectors. Together, these six sectors account for approximately 22% of total private non-farm employment in the economy. We then extend our analysis to the rest of the economy in Section 2.5.

We use price as a proxy for quality, with the natural hypothesis that the price of goods and services is increasing in quality. This approach is consistent with the idea that the quality of a product can be represented by the product characteristics. For example, the quality of a car can be reflected in the material of the car, and extra features such as the power of the engine, security systems and so forth. These additional features tend to increase both the price and the overall quality of the car. Therefore we would expect the price of a product to be positively related to the product quality.

To understand the interaction between the quality of goods and services and the labor intensity used to produce these products, we construct a new firm-level data set using several sources: (i) the U.S. Census Retail Trade Survey, which has information on sales and number of employees; (ii) annual Compustat balance sheet data on the number of employees, sales, operating expenses, and cost of goods sold; and (iii) price information from the social website YELP. We briefly discuss these data sources (see Appendix A for more detail).

U.S. Census Data

The publicly available U.S. Census Retail Trade Survey provides a broad coverage of household expenditure and employment information (including the number of employees) across a range of sectors within retail trade. These sectors are disaggregated at a 6-digit NAICS level. In particular, for the General Merchandise sector, the Census provides a split into three clear categories that can be easily associated with the price range (and therefore quality) of the stores. These are (i) non-discount department stores (which we define as “high quality”), (ii) discount department stores (“middle quality”), and (iii) other general merchandise stores which includes warehouse clubs and family dollar stores (“low quality”).

Compustat and YELP Data

For the other sectors, the Census Retail Trade Survey does not provide a clear, disaggregated indication of the price (and quality) distribution of stores within each of the sectors. Therefore, to examine the quality of products in the other sectors, we construct a new data set by merging Compustat data with price information from the social website YELP. Relying on the YELP data limits our initial analysis to the following five sectors: Accommodation, Apparel, Grocery Stores, Restaurants, Home Furnishing. Again, we discuss how we extend our analysis to the rest of the economy in Section 2.5.

---

5The idea that the price of a product increases in quality is related to a number of studies that have focused on the ability of the BLS to account accurately net out changes in prices due to improvements in quality when computing inflation. See for example, Pakes (2003), Hausman (2003), Bils (2008), and Bils and Klenow (2013).
We obtain annual firm-level balance sheet information from Compustat on the number of employees, sales, operating expenses, and cost of goods sold. Our base Compustat sample covers the period 2007-2012 for the five retail sectors listed above, and consists of 218 number of firms that are traded on the U.S. stock exchange. In the extension of our analysis to the rest of the economy over 1980-2012, our sample includes 29,497 number of publicly-traded firms. See Table 5 in Appendix A for more detailed information on the data sample.

To assign the firms in the Compustat data set into different quality tiers, we obtain their price information from YELP. Specifically, YELP categorizes the company at an establishment level within a geographic area into four price ranges: $, $$, $$$, and $$$$$. Using price as a proxy for quality, we define the “low-quality” tier as the $ YELP price range, the “middle-quality” tier as the $$ YELP price range, and the “high-quality” tier as the $$$-$$$$ YELP price ranges. The price ranges for each of the establishments is determined by YELP based on on the average price range voted on by the reviewers on YELP.

Yelp provides price ranges at an establishment level (i.e. store-location), while the Compustat data is at a firm level (which can own multiple establishments). Therefore to classify firms within Compustat into quality tiers, we first associate the firm with the retail chain or brand that it owns. For each of these retail chains/brands, we collect the YELP price range of the first match for each of the 18 largest U.S. cities by population. We then compute the average price range over the 18 cities and retail brands/ chains, which is used to assign the Compustat firm into a quality tier. For example, a firm within the Compustat sample is “Yum! Brands Inc”, which owns Taco Bell, KFC and Pizza Hut. We collect the price of the first review of Taco Bell in Chicago IL, the first review of Taco Bell in San Francisco, and so forth. The average across the price ranges of the 18 city-Taco Bell, 18 city-KFC, and 18 city-Pizza Hut establishments is then used to assign “Yum! Brands Inc” to an appropriate quality tier. Overall, the YELP website had price ranges that were available for 86 percent of the firms that we examined within the Compustat data.

Figure 1 depicts the distribution of firms by the three quality tiers in 2007. The figure shows that around 30% of total sales within each sector are in the low quality tier, around half are in the middle, and the remaining are in the high quality tier. This distribution is consistent with marketing studies of industries, such as XXX and XXX.

---

6We combine the two YELP price ranges into a single “high-quality” tier in part because there are not many firms within the Compustat dataset in the YELP $$$-$$$$ price ranges. Moreover, classifying firms into three quality tiers allows us to compare the firms in these sectors to the General Merchandise sector, which the Census data also classifies into three quality categories.

7In general, we find that there is not much price dispersion across the different brands/ chains of the same firm, or across cities within the same retail brand/chain. This may reflect the fact that many of the firms that own multiple brands/ chains within the retail sector generally focus on one main segment of the price distribution. For example, “Yum! Brands Inc” focuses on the fast-food restaurant segment of the market, with its retail chains (Taco Bell, KFC and Pizza Hut) all falling within the $ YELP price range.
2.2 Firm Labor Intensity By Product Quality

Equipped with this categorization of firms into quality tiers we examine whether there are differences in the amount of labor that is used to sell a given amount of sales in dollar figures across different quality products. To do so, we construct a measure of labor intensity from the Census data (for the General Merchandise sector) and from the Compustat database (for the other five sectors). Specifically, we define labor intensity as the number of workers per million dollars of sales revenue of the firm within a given year (again see Appendix A for details of these calculations).

We use this labor intensity measure for a two reasons. First, as discussed in the introduction, this measure provides a direct way of examining the effect of compositional shifts in final demand across firms on employment (which is shown in more detail in Section 2.4). Secondly, we focus on the number of employees, rather than on labor cost, because of data availability. Most firms report their number of employees, while less than a quarter of firms within the Compustat dataset report labor costs. This is partly because firms are not required to report labor costs in their annual reports to the U.S. Securities and Exchange Commission (SEC).

Figures 2 - 7 depict the labor intensity by quality category in the different sectors. For example,
Figure 2 depicts the number of employees per every one-million dollars spent in 2012 in the Grocery Stores sector. Moreover, the picture depicts in a red line the average of this measure for each of the three quality bins. As is clearly visible, the measure of labor intensity is on average twice as high for the middle quality firms relative to the lower quality firms, and about 50% higher in the high quality firms relative to the middle quality firms. The positive correlation between labor intensity and quality is also evident in the other retail sectors that we examined (Figures 3 - 7).
Main U.S. Restaurants
Number of employees for every $m spent in 2012

Figure 3

Apparel Stores
Number of employees for every $m spent in 2012

Figure 4
Figure 5

Home Furnishings and Appliances
Number of employees for every $m spent in 2012

Figure 6

Main Hotel Firms
Number of employees per $m spent in 2012

Choice Hotel
Wyndham
Ibis Hotel
IHG
Marriott
Morgans Hotel
Starwood
Accor - mid to luxury
Hilton Hotels
Thus, the following pattern is clearly visible in all of the sectors: lower quality firms are characterized by a lower labor intensity. Figure 8 summarizes this pattern in one graph as it depicts number of employees per every one-million dollars spent in 2012 across all the sectors.\footnote{The figure is constructing by revenue weighting all the firms in the sample} On average, middle quality firms have a labor intensity measure that is 36\% higher than that of low quality firms. Similarly, high quality firms have a labor intensity measure that is on average 30\% higher than that of the middle quality firms.
2.3 Quality-Trade-Down

The results so far established the significant variation in the labor intensity measures across the different quality ranges. We now proceed by analyzing the changes in the market shares (based on the sales revenue of firms) in each of the sectors by quality. Specifically, in Figure 9 we compare the changes in the market shares of the different quality ranges over 2007-2012 for each of the sectors (again see Appendix A for details of these calculations). Note that within each sector the share of the middle-quality firms declined during this period, while low-quality firms increased their share. Overall, across these sectors, the low-quality firms increased their market share by almost 5%, predominately at the expense of middle-quality firms (depicted in the left-most column of Figure 9). These market share shifts imply that households lowered the quality of their expenditure at a time when income declined significantly.

Finally, as we discuss in Section 2.5.4 these changes are part of a longer trend. However, we mainly concentrate in the 2007-2012 period since, as we show in Section 2.5.4, the shifts towards lower-quality firms during the Great Recession were large in magnitude relative to the overall trend. Moreover, by focusing on the recent period we are able to use the YELP data for the firm quality categorization.

The only sector where the middle quality has increases is the accommodation. See Appendix A for a detailed discussion of this sector.
2.4 Effect of change in quality on employment

In this section, we take a first step at quantifying the effect of quality-trading-down on employment during the Great Recession. We view the simple accounting exercises conducted below as suggestive of the magnitude in change owing to the quality-trading-down considerations, and indicative of the need to pursue careful quantitative analysis. In Sections 3 and 4, we consider a quantitative theoretical approach which takes into consideration General Equilibrium channels.

We first describe our results focusing on the six retail sectors (home furnishing, accommodation, apparel, grocery stores, food away from home stores, and general merchandise stores) for which we have direct evidence on the quality distribution of firms. We then describe how we generalize the results to the rest of the U.S. economy in Section 2.5. Specifically, we compute the change in the number of employed workers between 2007 and 2012 due to observed changes in the market share of the different quality tiers, holding fixed the measured labor intensity and sales in 2012. We then compare this to the actual change in per capita employment over the same period for the six sectors that we examine. This allows us to isolate the employment changes that were due to shifts in the quality of goods and services consumed by households over this period.

We compute the total change in employment due to substitution across quality in two ways. First
we consider solely the direct effect of quality shifts on employment within the same sector. We then
discuss the potential indirect effect on employment in other sectors that provide intermediate inputs to
the sector that experienced. As we show below, the indirect effects are quantitatively small relative to
the direct effects. In Appendix B, we show that our results are robust to various sample assumptions.

**Direct effects on employment**

The direct effect of quality shifts on employment is computed as

\[
\sum_{i \in I} \text{Sales}_{i}^{2012} \cdot \text{Labor Intensity}_q^{2012} \cdot \sum_{q(i) \in Q} \Delta \text{Market share}_{q(i)}
\]

where \(\text{Sales}_{i}^{2012}\) denotes the dollar value of 2012 sales in sector \(i\); \(\text{Labor Intensity}_q^{2012}\) denotes the
revenue-weighted average labor intensity (number of employees per dollar value of sales) of firms
within quality tier \(q\); and \(\Delta \text{Market share}_{q(i)}\) denotes the percentage point change in market share
between 2007 and 2012. The market share of firms within quality tier \(q\) at time \(t\) is given by

\[
\text{Market share}_{q(i),t} = \frac{\sum_{f(i) \in q(i)} \text{Sales}_{f(i),t}}{\sum_{q(i) \in Q} \sum_{f(i) \in q(i)} \text{Sales}_{f(i),t}}
\]

where \(f(i)\) indexes the firm in sector \(i\). Equations 1 and 2 are computed using data from Compustat,
based on the YELP-implied allocation of firms in quality tiers (described in the previous section).

Table 1 reports the change in employment for each quality tier. Column (I) shows that the low-
quality tier increased in market share by 5 percentage points over 2007 to 2012, predominately at the
expense of the middle quality tier (which was also observed in Figure 9). Given the variation in labor
intensity across these quality tiers (column II), the quality-trading-down behavior implies a decline
in employment within the middle and high quality tiers, which is only partly offset by an increase
in employment in the low-quality firms (column III). Overall, the shift in the quality of household
expenditure implies a reduction of around 580 thousand jobs within these six retail sectors, which is
approximately equivalent to a 2.62% decline in employment. This compares to an actual decline of
7.87% in employment (per capita) in these six sectors. Thus, these numbers imply that trading-down in
quality can potentially account for one-third (2.62%/7.87%) of the decline in actual employment within
these retail sectors. The stylized accounting exercise implies that shifts in the quality of expenditure
can potentially have large effects on employment in the economy. This motivates the study of the
general equilibrium effects of the quality decision of households in Section 3.

**Indirect effects on employment**

We also compute the “indirect” effects on employment from quality shifts in the six retail sectors.
Indirect effects from quality shifts within a sector refer to the flow-on effects to employment outside of
that sector due to changes in demand for inputs produced by other sectors. Indirect effects can arise
from differences in the required total inputs (per output) of the firms in each quality tier. For instance,
### Table 1: Direct effect of changes in quality on employment

<table>
<thead>
<tr>
<th>Quality (q)</th>
<th>△ Market share (I)</th>
<th>Labor Intensity (II)</th>
<th>△ Emp (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>5ppt</td>
<td>5.6</td>
<td>978,738</td>
</tr>
<tr>
<td>Middle</td>
<td>-4ppt</td>
<td>9.1</td>
<td>-1,350,858</td>
</tr>
<tr>
<td>High</td>
<td>-1ppt</td>
<td>11.1</td>
<td>-210,055</td>
</tr>
</tbody>
</table>

Implied total change: -582,175
Implied percentage change: -2.63%
Actual percentage change (per capita): -7.87%

Suppose that low-quality restaurants require less inputs produced by other (non-restaurant) sectors for every dollar of output compared to higher-quality restaurants. In this case, a shift from high to low quality not only affects employment within the restaurant sector, but also reduces the amount of inputs that need to be produced by other sectors and subsequently labor in those sectors. Therefore shifts in quality within a sector can have indirect effects on other sectors in the economy.

We consider the indirect effects of quality shifts on employment in a manner that is comparable to how the Bureau of Economic Analysis (BEA) constructs its “Total Requirements tables”. The BEA tables describe how a change in inputs required by one sector affects the outputs of other sectors. Specifically, we calculate

\[
\sum_{i \in I} \sum_{k \in I} \left( \frac{\text{Emp}}{\text{Output}} \right)_{i, 2012} \cdot [\text{△Output in } i \text{ due to quality shifts within } k]
\]

where the term \(\frac{\text{Emp}}{\text{Output}}\), refers the number of employees per dollar value of output in sector \(i\) in 2012. The second term refers to the change over 2007-2012 in the value of output produced by sector \(i\) as inputs for sector \(k\) due to quality-related shifts in market shares within sector \(k\), and is computed as

\[
[\text{△Output in } i \text{ due to shifts in } k] = f_{ki}^{2012} \cdot \left[ \text{Output}_{k, 2012} \cdot \sum_{q(k) \in Q} \text{△Market share}_{q(k)} \cdot \left( \frac{\text{Input}}{\text{Output}} \right)_{q(k), 2012} \right]
\]

The first term, \(f_{ki}^{2012}\), denotes the change in output of sector \(i\) given a dollar change in total inputs required by sector \(k\) (from any sector). The second (bracketed) term then gives the magnitude (in dollars) of the change in total inputs required by sector \(k\) related to shifts in the market shares of the quality tiers within sector \(k\). Therefore, the product of the two gives the change in output required by sector \(i\) due to shifts in quality within sector \(k\).
We obtain data for the first term of Equation (4) directly from the BEA “Total Requirements Industry by Industry” table, and construct the empirical counterpart of the second (bracketed) term using data from Compustat, the BLS and the BEA. We use Compustat data to compute $\Delta \text{Market share}_{q(k)}$ as defined in (2). The term $(\text{Input/Output})_{q(k)}$ denotes the revenue-weighted average input-output ratio for firms in quality tier $q$ within sector $k$ in 2012. We construct the empirical counterparts of the inputs and outputs of each firm to be consistent with the definitions in the BEA Total Requirements tables. Specifically, the dollar value of output of firm $f$ in sector $k$ is computed as

$$\text{Output}_{f(k)} = \text{Operating expenses}_{f(k)} - \text{Cost of goods sold}_{f(k)}$$

and the value of the inputs is defined as

$$\text{Input}_{f(k)} = \text{Operating expenses}_{f(k)} - \text{Cost of goods sold}_{f(k)} - \text{Labor costs}_{f(k)}$$

The operating expenses and cost of goods sold are from Compustat. The labor costs of firms within the Compustat data, however, is sparsely available since firms are not required to publicly report this term on their annual reports. Therefore, we instead estimate the labor costs of each firm using the number of employees reported at a firm-level (from Compustat) multiplied by the sector-wide average annual wage (from the BLS). The change in the input-output ratio is then multiplied by the dollar value of output in sector $k$ in 2012, denoted by $\text{Output}_{k}^{2012}$, to give the change in the dollar value of output produced by sector $i$ due to quality shifts in sector $k$.

The total change in employment due to substitution across quality is then given by the sum of two components: (i) the direct effect of quality shifts on employment within the same sector, and (ii) the indirect effect on employment in other sectors that provide intermediate inputs to the sector that experienced the quality shifts. We estimate that total employment declined by approximately 2.62%, taking into account both the direct and indirect effects. This is quantitatively similar to the change in employment resulting from the direct effects of quality shifts within each sector (2.63%), which implies that the quality-trade-down effect on employment is predominately driven by the direct effects within the sectors.

### 2.5 Extension to Other Sectors of the Economy

In what follows we discuss how our results extend to the rest of the economy. First we present further evidence of the quality-trade-down using alternative data sources. We then show that the same pattern of lower quality firms being less labor intense is also present in the manufacturing sector. This is an important fact since it shows that the quality and labor intensity relation we highlight so far is not only a retail phenomenon. Armed with these results as motivating evidence for using labor intensity as a proxy for quality, we then discuss how we compute the effects of quality-trade-down for the entire economy.
2.5.1 Other Data Sources: Quality-Trade-Down

In what follows, we show that our quality-trade-down results are consistent with findings from a number of alternative data sources to Compustat: the BEA National Income and Product Accounts (NIPA) on food away from home, and the Nielsen Homescan data on household spending on food at home. Both of these alternative data sources are broader in coverage of expenditure, but have less detailed information about the quality distribution of firms. Finally, we apply the Bils and Klenow (2001) methodology that allows us to estimate the fraction of the change in consumption expenditures that is due to a reduction in the quality of goods purchased.

For instance, the NIPA data on household expenditure on food away from home has a broader coverage of spending in the U.S. economy (covering expenditure at firms that are both traded and non-traded on the U.S. stock exchange), but provides a less disaggregated split of the quality of expenditure for food away from home sector into “Full-service restaurants” and “Limited-service eating places”. Based on these two quality tiers, the NIPA data shows a 1.5 percent shift in spending from full-service to limited-service restaurants over 2007-2012, consistent with the findings based on the Compustat and YELP data. As Figure 10 depicts, the percentage fall within the expenditure on food away from home sector in the Full-service restaurants is bigger in magnitude than the percentage fall of the entire category pointing to the importance of this within-category substitution.

![Real Food Expenditures From Start of Recession](chart.png)

Figure 10
Similarly, the Nielsen Homescan data does not provide the exact store name that the household bought from, but does provide information about the type of store (for example, Big Box stores, supermarkets and drug stores), and product codes. This allows for a disaggregation of spending in two ways: (i) by store-type into two broad quality tiers: Big Box stores (which are generally lower in price) vs. all other stores; and (ii) by product-type into two broad quality tiers: generic products (which are on average lower in price) vs. non-generic products. For these two categorization of spending, Nevo and Wong (2014) find that counties with more pronounced increases in unemployment also had more intense pick-up in expenditure made at Big Box stores and purchases of generic products. Specifically, they find that a 1% increase in the unemployment rate increases expenditure on grocery generic items by 3.5% and shopping at Big Box stores by 4.1%. This is consistent with our findings of quality-trade-down behavior within the food-at-home sector during the Great Recession period.

**quantity vs. quality**  
Lastly, we apply the Bils and Klenow (2001) methodology to our period of interest (2007-2012) using micro data on household expenditure from the U.S. CEX Survey. This approach allows us to decompose the change in total consumer expenditure into those originating from a change in quantities (keeping quality fixed) vs. a change in the quality of goods purchased. Specifically, in Equation (13) of Bils and Klenow (2001) (see equation 5 below), they estimate the extent to which the official BLS consumer price index deviates from true underlying inflation due to mis-measurement of actual quality growth over time:

\[ \Delta p_i = \Delta x_i - (1 - \mu) \Delta q_i \]  

(5)

where \( \Delta p_i \) denotes the BLS inflation for good \( i \), \( \Delta x_i \) denotes the unit price of the good, and \( \Delta q_i \) denotes the growth in quality which the BLS seeks to net out from its measurement of inflation. The key parameter estimated by Bils and Klenow (2001) is \( \mu \), which denotes fraction of the quality growth that the BLS is unable to net out in it’s computation of the CPI.\(^{11}\)

Therefore Equation 5 provides a way to recover the underlying change in quality of household expenditure over 2007-2012. Rearranging Equation 5 yields:

\[ \Delta q_i = \frac{\Delta x_i - \Delta p_i}{1 - \mu} \]  

(6)

We obtain price data for \( \Delta p_i \) from the BEA on 59 durable goods, data from the U.S. CEX household survey for \( \Delta x_i \) (taking an average across households in the sample), and use the estimated \( \mu \) of 0.618 from Bils and Klenow (2001). We then compute the expenditure weighted average of the quality growth across the 59 durable goods. Based on this, we estimate that quality of household expenditure

\(^{11}\)Bils and Klenow (2001) use the slope of the quality Engel curve to instrument for the rate of quality-shifting given an change in income. In turn, the slope of the quality Engel curve is estimated from regressing the unit price paid by the household for the durable good on the household’s total spending on non-durable goods. See Bils and Klenow (2001) for more detail.
declined by 8.42 percent over 2007-2012. This decline in quality equates to approximately two-thirds of the decline in total household expenditure on these goods and the remaining one-third is due to a decline in quantity of consumption. This implies that trading-down in quality is an important channel through which households responded to lower income during the recent recession, consistent with our findings in Section 2.3 of pronounced shifts in market shares towards lower quality firms.

2.5.2 Quality and Labor Intensity in Manufacturing

The manufacturing sector is of particular interest since a plausible concern is that the quality dimension we highlight so far is more of a "retail phenomenon". To address this concern, we build upon Holmes and Stevens (2013) who show that the size of manufacturing plant is a valid proxy for the extent to which an establishment produces standardized vs. speciality products. Specifically, Holmes and Stevens (2013) use confidential Census manufacturing data to show that smaller establishments tend to produce higher quality (more specialized) products. Motivated by their finding, we use the Census dataset to construct labor intensity by the size of establishments (as measured by the number of employees, see Appendix C for details). Consistent with our previous findings, Figure 11 clearly shows that smaller establishments (who produce higher quality goods according to Holmes and Stevens (2013)) are also more labor intense.

![Figure 11](image-url)
Furthermore, we redo the analysis in Figure 11 by three-digit manufacturing industries. The goal of this exercise is to show that this aggregate manufacturing pattern is not solely driven by one industry. As Figure 12 shows, the same pattern holds for the vast majority of the manufacturing industries.

2.5.3 Calculating the effects of Quality-Trade-Down in the Aggregate Economy

The results in the Manufacturing sector give further motivation for using labor intensity as a proxy for quality. As such, we consider two approaches that allow us to calculate the effects of the quality-trade-down in the aggregate economy.
Applying the results to all sectors  In the first approach, we simply apply the results we found in Section 2.4 to the rest of the economy. We note, however, that several industries (utilities, transportation and warehousing, educational services, mining, agriculture, government) are probably less likely to have the variation in quality that we emphasize. As such, we simply assume that there is no room for quality-trade-down within these sectors, which account for 30% of aggregate employment. We assume that the rest of the sectors, which account for the remaining 70% of aggregate employment, behave in the same way as those in Section 2.4. Given that our findings in Section 2.4 suggested that the quality-trade-down accounted for 33% of the fall in aggregate employment during the Great Recession, we obtain an estimate of about a quarter when applying this estimate to the 70% of the economy.

Using Labor Intensity to Allocate Firms into Quality Ranges  In our second approach we use labor intensity to allocate other 10,885 Compustat firms in other sectors into quality categories. We first allocate firms into three quality tiers based on cut-offs in the firm labor intensity distribution within each sector in the U.S. economy. Specifically, we use the following cut-offs which were implied by the YELP categorization for the six sectors that we examined earlier: (i) low quality: Bottom 33% of labor intensity distribution, (ii) middle quality: 33% - 80% of labor intensity distribution, and (iii) high quality: Top 20% of labor intensity distribution. We then compute the revenue-weighted labor intensity for each quality tier in 2012, and the change in market share of the three quality categories over 2007-2012. The implied change in employment is then computed as in Equation 1. We find that the quality-trade-down may account for approximately a quarter of the actual observed decline in aggregate employment.

As a robustness to this approach, instead of using the categorization implied by our YELP findings, we hold fixed the entire labor intensity distribution within each sector (i.e. we do not use a cut-off rule for sorting firms into quality tiers). Specifically, we hold fixed the labor intensity in 2012 and compute the change in market share of each firm within each sector. The total change in employment is computed as:

$$\sum_{k \in K} \sum_{f(k) \in F(k)} \text{Sales}_{f(k)}^{2012} \cdot \text{Labor Intensity}_{f(k)}^{2012} \cdot \Delta \text{Market share}_{f(k)}$$

(7)

where $k$ denotes the sector, $f(k)$ is the firm within sector $k$, Sales$_{f(k)}^{2012}$ and Labor Intensity$_{f(k)}^{2012}$ denote the sales and the labor intensity of the firm in 2012, respectively, and $\Delta$Market share$_{f(k)}$ denotes the change in market share of the firm from 2007-2012.

Based on this calculation, we find that shifts in market share of firms within each sector implies a 3.01% decline in employment, which is approximately 45% of the actual decline in per capita employment over 2007-2012. It is important to note that the implicit interpretation underlying Equation 7 is that shifts is market share towards firms with lower labor intensity reflects changes in the quality of expenditure in each sector. While this interpretation is supported by the evidence of the positive relationship between labor intensity and quality (as we show in previous sections) we caution that there
might be other economic forces that increases the share of low labor intensity firms that are orthogonal to quality-trade-down. As such we consider the 45% to be an upper bound to the quality-trade-down effect on employment.

To conclude, we find that the quality-trade-down within categories phenomenon is an important channel for the evolution of aggregate labor during the Great Recession.

2.5.4 Long Trend in Market Shares by Quality

The changes observed over 2007-2012 (see Figure 9) are part of a longer trend. Figure 13 plots the five-year centered moving average of the market shares of the low, middle and high quality tiers in the U.S. economy (Figure 13 is based on the entire Compustat dataset described above). The figure shows a clear shift in quality of expenditure since at least the early 1970s, before stabilizing during the late 1990s. Specifically, we observe an increase of approximately 20 percentage points in the market share of the low-quality firms, predominately at the expense of middle-quality firms. This is equivalent to an average shift of around 2.7 percentage points within a five-year period towards low-quality firms over 1973-2000.

The long-term trends help to put into context the magnitude and the interpretation of the quality trading-down behavior that occurred during the recent recession. Firstly, the long-term trends suggest that the shift towards lower-quality firms during the Great Recession were large in magnitude. Specifically, over 2007-2012, the low-quality tier increased in market share by almost 5 percentage points (shown in Figure 9), which is almost double the average 5-year shift in quality over 1973-2000 (observed in Figure 13). The second implication is that the shifts in quality over 2007-2012 is predominately cyclical, since the long-term trends appears to have stabilized from the late 1990s onwards.

12It is worth noting that the quality categorization is a relative ranking of firms within each year. Therefore, Figure 13 does not necessarily imply that overall quality of expenditure has declined, since quality improvements in products and services can occur over time (see for example, Bils and Klenow (2001) and Bils (2009) for a more detailed discussion of quality growth). Instead, the figure implies a shift in relative quality of expenditure across firms.
2.6 Category substitution

As we discuss in the introduction, another way in which households adjust the composition of their expenditure following a decline in income is by shifting their budget allocation away from luxuries towards necessities. A number of existing studies have documented declines in entertainment expenditure, travel and apparel and increases in food expenses as a share of total expenditure (see for example Banks, Blundell, and Lewbel (1997), Bils and Klenow (2001), and Aguiar and Bils (2013). For the purposes of this paper, this channel could have implications for employment if firms producing necessities are less labor intensive than those producing luxuries; in this case a budget share shift away from luxuries towards necessities can potentially reduce the aggregate demand for labor in the economy, even absent any change in total expenditure.

We proceed as follows (see Appendix D for details). We first use the U.S. Consumer Expenditure Survey (CEX) to provide evidence on the presence of "luxuries and necessities" categories. This is done by studying estimating the elasticities of the category budget shares to total household expenditure. We then construct labor intensity measures for each category of expenditure. To do so, we first match the CEX expenditure categories with the NIPA personal consumption expenditures categories (PCE). The use of Engel Curve slopes of the goods and services to classify the categories into luxuries and necessities is also used in Bils, Klenow and Malin (2012) in their tests of Keynesian Labor Demand.
We then further match the PCE categories with the relevant commodities included in the PCE. This allows us to match the commodities to the Input/Output tables. Using the "2012 Economic Census of the United States" we then construct for each commodity, and thus for each of the consumption category, a labor intensity measure.

### 2.6.1 Luxuries and Necessities

In this section we discuss the identification of those categories that are luxuries vs. necessities. We begin by presenting the budget shares of the 31 categories we consider. Figure 14 depicts the common finding of housing and health care jointly accounting for about a third of the expenditures and about three times as big as the next expenditure category (Food at Home).

---

**Figure 14**

There are the consumption budget shares on the onset of the Great Recession, during the last quarter of 2007.
Elasticities  Evidence of the presence of luxuries and necessities can be obtained from the following Engle curve estimation of the CEX,

\[ w_{ht}^k = a^k + \beta^k \ln(X_{ht}) + \sum_j \gamma_j \ln(P_{jt}) + \theta^k_{ht} \cdot Z_{ht} + \epsilon^k_{ht} \] (8)

where \( w_{ht}^k \) is the budget share allocated to category \( k \) by household \( h \) at time \( t \); \( X_{ht} \) is total household expenditure; and \( P_{jt} \) is the price index of each expenditure category \( j \) at time \( t \). The variable \( Z_{ht} \) is a vector of household demographics variables, including the age and square of the age of the head of household, dummies based on the number of earners (<2,2+), and household size (<2,3-4,5+). The error term is denoted by \( \epsilon^k_{ht} \). We estimate Equation (8) using household sample weights given in the CEX data based on the 1980-2012 waves of the CEX Surveys. The coefficient \( \beta^k \) gives the fraction change in budget share allocation to expenditure category \( k \), given a 100% point change in total household expenditure.\(^\text{15}\)

2.6.2 Luxuries, Necessities, and Labor Intensities

Equipped with the estimated elasticities, and having constructed the labor intensity measures for each of the 31 categories, Figure 15 depicts a scatterplot of the relation between these two measures.\(^\text{15}\)

\(^{15}\)Miis-measurement of individual goods may be cumulated into total expenditure, which can bias the estimated coefficients. Therefore for robustness, we also use the standard approach of instrumenting total expenditure with total income reported by the household (see for example, Aguiar and Bils (2013)). The estimated elasticities yield similar results to our base estimation without instrumenting. Thus, the discussion that follows is based on the non-instrumented results.
Figure 15 shows that there is indeed a positive relation between a category expenditure elasticity and its labor intensity measure. This positive correlation suggests that recessionary shifts from luxuries to necessities can potentially affect aggregate labor because of variations in labor intensity across categories of luxuries and necessities. To examine the effect on aggregate employment, we proceed in a similar way to that of Section 2.4. Specifically, we compute the change in the number of employed workers between 2007 and 2012 due to changes in the shares of the expenditures categories, holding fixed the measured labor intensity.

To construct these changes, we first simply apply the actual observed changes in the consumption
shares from the NIPA PCE. The potential drawback from this approach is that the reason for these changes is not only the recession but captures other trends etc. As such, we also construct new shares that rely on the estimated elasticities. By using the aggregate fall in consumption between 2007 and 2012, we can calculate the new budget shares.

Equipped with these two approaches we find that category substitution, in stark contrast to the results of changes within categories, accounts for a negligible amount of the drop in aggregate employment. Thus to summarize, our findings suggest that of the two forms of substitution, the adjustment of consumption towards low-quality products within categories is of a first-order importance for aggregate employment. Our simple accounting exercises suggest that this adjustment accounts for about a third of the fall in aggregate employment during the Great Recession. In contrast, the movements from luxury categories to necessity categories, did not contribute to the fall in aggregate employment, from the perspective of the variation in labor intensity and observed changes in consumption patterns. As such, in the following two sections we focus our analysis to General Equilibrium models which embed a quality choice.

3 Quality Choice and Business Cycle Models

The empirical findings discussed above are indicative of the need to pursue a theoretical quantitative analysis. As such, in what follows we consider two general equilibrium business cycle models that allow us to study the implications of the quality choice phenomena for the aggregate labor market.

Specifically, we proceed as follows. We first discuss the two key ingredients that are necessary in our theoretical analysis: production and utility functions that incorporates quality choices. We then incorporate these into (i) an otherwise standard real-business-cycle model (RBC), and (ii) an otherwise standard sticky-prices monetary model as in Calvo (1983). We show how the presence of a quality choice leads to a (i) large amplification of real and monetary shocks, (ii) sectoral comovement of labor, and (iii) a new theory of labor wedge measurement.

3.1 The Production Function

We are interested in a production function that is consistent with the key empirical fact we document in Section 2, i.e. that higher quality firms are characterized by higher labor intensity. A natural production function that delivers this result is a constant elasticity of substitution (CES) production function augmented with quality. Specifically, we consider the following production function,

\[ Y(q_t) = A_t \left[ \alpha \left( \frac{N_t}{q_t} \right)^\rho + (1 - \alpha) (K_t)^\rho \right]^{\frac{1}{\rho}} \]  \hspace{1cm} (9)
where \( q_t \) denotes the quality of the product, \( Y(q_t) \) denotes the output of quality \( q_t \), \( A_t \) denotes total factor productivity, and \( N_t \) and \( K_t \) denote labor and capital employed by the firm respectively. The elasticity of substitution between capital and labor equals \( \frac{1}{1-\rho} \).

Consider now the problem of a price taking firm that operates a production function as described in equation (9) and maximizes profits as follows,

\[
\max_{\{K,N\}} = P(q_t)Y(q_t) - r_t K_t - w_t N_t
\]

where \( P(q_t) \) denotes the price of a good of quality \( q_t \), and \( r_t \) and \( w_t \) denote the rental and wage rate respectively. This maximization problem has two key properties: higher quality goods have (i) an higher price, and (ii) higher labor intensity. To see these, we note that the first order condition of a price taking firm are given by,

\[
P(q_t)A_t \left[ \alpha \left( \frac{N_t}{q_t} \right)^\rho + (1 - \alpha) (K_t)^\rho \right]^{\frac{1-\rho}{\rho}} \alpha \left( \frac{1}{q_t} \right)^\rho (N_t)^{\rho-1} = w_t
\]

\[
P(q_t)A_t \left[ \alpha \left( \frac{N_t}{q_t} \right)^\rho + (1 - \alpha) (K_t)^\rho \right]^{\frac{1-\rho}{\rho}} (1 - \alpha) (K_t)^{\rho-1} = r_t
\]

These two first order conditions imply that the price of a good of quality \( q_t \) is given by

\[
P(q_t) = \frac{1}{A_t} \left[ \alpha^{-1+\rho} \left( \frac{1}{q_t} \right)^{\frac{\rho}{1-\rho}} w_t^{\frac{\rho-1}{1-\rho}} + (1 - \alpha) \right]^{\frac{1}{\rho}} \left[ w_t^{\frac{1}{1-\alpha}} \right]^{\frac{\rho}{1-\rho}}
\]

and thus \( \frac{dP(q_t)}{dq_t} > 0 \).

Second, for \( \rho < 0 \) (i.e. labor and capital are "more complements" than the Cobb-Douglas case which corresponds to \( \rho = 0 \)) the labor/capital ratio, \( N/K \), increases with quality,

\[
\frac{N_t}{K_t} = \left[ \frac{w_t}{r_t} \left( 1 - \frac{(1-\alpha)}{\alpha} \right) \right]^{\frac{1}{\rho}} \left( q_t \right)^{\frac{\rho}{1-\rho}}
\]

implying that the measure of labor intensity, \( \frac{N}{P(q_t)} \frac{1}{Y(q_t)} \), increases with quality. To see this we note that this measure can be written as

\[
\frac{w_t q (1-\alpha)}{r_t} \left[ \frac{w_t}{r_t} \left( 1 - \frac{(1-\alpha)}{\alpha} \right) \right]^{\frac{\rho}{1-\rho}} \left( q_t \right)^{\frac{\rho}{1-\rho}} + (1 - \alpha) \left[ w_t^{\frac{1}{1-\alpha}} \right]^{\frac{\rho}{1-\rho}} \]

and substituting the expression for the price (Equation 13) the labor intensity measure is given by

\[
r \left( \frac{1}{1-\alpha} \right) \left[ \alpha \left( \frac{w_t}{r_t} \left( 1 - \frac{(1-\alpha)}{\alpha} \right) \right) \right]^{\frac{\rho}{1-\rho}} \left( q_t \right)^{-1} + (1 - \alpha) \left[ \frac{w_t}{(q_t)} \frac{1}{\alpha} \right]^{\frac{1}{\rho}}
\]
Note that as quality goes up, the expression \((1 - \alpha)\frac{1}{(q_t)^{\rho}}\) decreases (since \(\rho < 0\)) and thus overall the expression for the labor intensity increases with quality.

### 3.2 The Utility Function

Naturally, in order for consumers to choose an higher product’s quality, and paying for it an higher price (as equation 13 shows), there has to be a benefit. In what follows we assume that this benefit is reflected in an higher utility from a given consumption quantity (e.g. given a constant quantity of driving one car, consumers derive an higher utility from driving a luxury car versus an old non-operational one).

We are interested in a simple formulation that satisfied the following three conditions: (i) utility is increasing in a product’s quality, (ii) the marginal benefit of increase in quality is decreasing (i.e. utility is strictly concave in quality), and (iii), quality is a normal good.

We first consider a static example. The simple extension of the common log preferences in consumption satisfies these three properties

\[
U = \max_{q,C(q)} q^{1-\theta} \frac{1}{1-\theta} \log [C(q)]
\]

subject to

\[
C(q) = \frac{Y}{P(q)}
\]

Naturally this formulation satisfies the first two requirements. To see that it also satisfies the third, note that the optimal choice of quality is given by,

\[
\log \left[ \frac{Y}{P(q)} \right] = \frac{1}{1-\theta} \frac{qP'(q)}{P(q)}
\]

It is easy to show that the elasticity of the price function with respect to quality is positive. Given this property and the fact that \(\frac{dP(q)}{dq} > 0\) it immediately follows that quality is a normal good.

As we discuss below, when we incorporate an endogenous labor decision we simply extend the popular separable preferences between consumption and labor to be

\[
U = \max_{q,C(q),N} q^{1-\theta} \frac{1}{1-\theta} \log [C(q)] - \phi N^{1+\nu} \frac{1}{1+\nu}
\]

This separable formulation preserves the three “quality requirements” discussed above.
3.3 Embedding Quality into Business Cycle Models: A real model

In what follows we incorporate the production and utility functions discussed into an otherwise standard business cycle model. As we show below, the introduction of quality choice into this model has important implications for several long standing puzzles in the business cycle literature such as: (i) the volatility of labor, (ii) sectoral comovement in labor, and (iii) the fluctuations in the labor wedge.

The structure of the economy is as follows. Since our empirical work centered solely on the quality margin of consumption we consider a two sector model of consumption and investment. This formulation allows us to be consistent with quality being solely consumption characteristic improving the mapping to the empirical work. Moreover, we assume that both the consumption and investment final goods are produced by perfectly competitive firms and that there is one market clearing price for the rental and wage rate with perfect capital and labor mobility across sectors.

Households The economy is populated by a large number of identical, infinitely-lived households. Each household is composed of a unit mass of family members. Family members derive instantaneous utility from consumption of quality \( q_t \), \( C(q_t) \), and disutility from hours spent working, \( N_t \). The representative household’s date \( t \) problem is to maximize the discounted sum of utility function given by equation (16), i.e.

\[
U = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ q_t^{1-\theta} \log [C(q_t)] - \phi N_t^{1+\nu} \right\} 
\]

subject to

\[
C(q_t)P(q_t) + P_l I_t = w_t N_t + r_t K_t 
\]

\[
K_t = K_t^C + K_t^I 
\]

\[
N_t = N_t^C + N_t^I 
\]

where, \( C(q_t), I_t, N_t, K_t \) denote the aggregate quantities of consumption of quality \( q \), investment, hours, and capital respectively, \( K_t^C, K_t^I, N_t^C, N_t^I \) denote the sectoral quantities of capital and hours in the consumption and investment sector respectively, and \( P(q_t), P_l^I, w_t, r_t \) denote the prices in the economy of consumption of quality \( q \), investment, the wage rate, and the rental rate of capital respectively.

The household takes all prices as given. Denoting by \( \lambda \) the Lagrange multiplier associated with the budget constraint above, the first order condition for consumption, optimal quality, hours worked,
and investment are given by

\[
\frac{q_1^{1-\theta}}{1-\theta} \frac{1}{C(q_t)} = \lambda_t P(q_t) \tag{21}
\]

\[
\log(C(q_t)) = \frac{1}{1-\theta} \frac{q_t}{1-\theta} P(q_t) \tag{22}
\]

\[
\phi N_t = \frac{q_1^{1-\theta}}{1-\theta} \left[ \frac{w_t}{1} \frac{1}{P(q_t) C(q_t)} \right] \tag{23}
\]

\[
P_{t,t+1} = \beta \lambda_{t+1} (r_{t+1} + (1-\delta) P_{t,t+1}) \tag{24}
\]

**Firms in the Consumption Sector** To study the role of quality choice over the business cycle, we relax the common assumption of a Cobb-Douglas assumption of unit elasticity of substitution across capital and labor and consider a CES functional form as in equation 9,

\[
C(q_t) = A_t \left[ \alpha \left( \frac{N_C^t}{q_t} \right)^\rho + (1-\alpha) \left( K_C^t \right)^\rho \right]^{\frac{1}{\rho}} \tag{25}
\]

**Firms in the Investment Sector** We assume that production function of investment goods is identical as as the one in the consumption sector. The only modification is that the investment sector does not embed a quality choice. Thus, the production of investment goods is given by,

\[
I_t = A_t \left[ \alpha \left( N_I^t \right)^\rho + (1-\alpha) \left( K_I^t \right)^\rho \right]^{\frac{1}{\rho}} \tag{26}
\]

Given that firms in both sectors face the same aggregate prices of the wage and rental rate, it follows that the economy is characterized by

\[
\frac{w_t}{r_t} = \alpha \left( \frac{A_t}{q_t} \right)^\rho \left( N_C^t \right)^{\rho-1} = \frac{\alpha (A_t)^\rho}{(1-\alpha) (K_C^t)^{\rho-1}} \left( \frac{N_I^t}{K_I^t} \right)^{\rho-1} \tag{27}
\]

implying that the ratio of the production factors int he two sectors is given by,

\[
\left( \frac{K_I^t}{K_C^t} \right)^{\rho-1} = \left( \frac{N_I^t}{N_C^t} \right)^{\rho-1} \left( \frac{1}{q_t} \right)^{-\rho} \tag{28}
\]

**Equilibrium** The equilibrium is defined as follows. Given \( K_0 > 0 \) and the stochastic process for technology, a competitive equilibrium is an allocation, \([C(q_t), I_t, N_t, K_t, K_C^t, K_I^t, N_C^t, N_I^t]\), and price system \([P(q_t), P_I^t, w_t, r_t]\) such that: given prices, the allocation solves both the representative household’s problem and the representative firm’s problem for all \( t \); the capital rental market clears for all \( t \); and labor markets clear for all \( t \). Walras’ law ensures clearing in the final goods market for all \( t \).
Quantitative Specification To maintain comparability with the RBC literature, we perform a standard calibration when possible and they are presented in Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Moment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount rate</td>
<td>0.985</td>
</tr>
<tr>
<td>$\nu$</td>
<td>Inverse of Frisch elasticity</td>
<td>0.001</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Match $N^{SS}$</td>
<td>5.31</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Elasticity of utility to quality</td>
<td>0.5</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
<td>0.025</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Elasticity of substitution: $K$ and $N$: $\frac{1}{1-\rho}$</td>
<td>-1</td>
</tr>
<tr>
<td>$\xi$</td>
<td>AR(1) coefficient of TFP</td>
<td>0.95</td>
</tr>
</tbody>
</table>

The only parameter for which there is no guidance in the literature is $\theta$. We thus proceed as follows. Our empirical results discussed above suggest that around 25%-33% of the change in aggregate labor during the Great Recession were due to the quality-trade-down. We then calibrate $\theta$ such that we match the same moment. Specifically, in the data we calculated this share as

$$\Delta\text{Emp}_{\text{quality-trade-down}} = \sum_q \Delta\text{Market share}_q \cdot (LI_{q}^{2012} \cdot \text{Sales}_{2012})$$

The equivalent moment in the model is given by

$$\Delta\text{Emp}_{\text{model, quality-trade-down}} = \sum_q \Delta\text{Market share}_q \cdot (\text{Labor Intensity}(q)^{ss} \cdot P(q)^{ss}C(q)^{ss})$$

where the labor intensity in the steady state is pinned down in the model as given by,

$$\text{Labor Intensity}(q)^{ss} = \frac{NC}{P(q)C(q)} = \frac{1}{w} \left[ 1 + \left( \frac{1-\alpha}{\alpha} \right) \frac{1}{\rho} \left[ \frac{Ar}{qw} \right]^{\rho-1} \right]^{-1}$$

We find that for a value of $\theta = 0.5$ the mean of the Impulse Response Function in the model of the share of the change in employment that is due to the quality-trade-down is 25%, i.e.,

$$\frac{\Delta\text{Emp}_{\text{model, quality-trade-down}}}{\Delta\text{Total Emp}_{\text{model}}} = \frac{\Delta\text{Emp}_{\text{data, quality-trade-down}}}{\Delta\text{Total Emp}_{\text{data}}} = 0.25$$

Figure 16 depicts the impulse response function of hours worked and output in the model. As a
comparison the figure plots the response of the same two variables to the same shock in the same model without quality choice. The behavior of these two variables in the latter model is consistent with the common findings in the literature: there is a lack of magnification of the exogenous shock and unlike the US data, hours worked are not as volatile as output. In contrast, as Figure 16 shows, on impact, the response of aggregate output is about three times as high in the model with quality relative to a model without quality. Second, the model with quality choice generates movement in hours worked that almost mimics that of output.

These results are further illustrated in Table 3 where we present the empirical second moment properties observed in the U.S. data and those generated by these two models a. As Table 3 shows, the ratio of the volatility of hours worked to that of output is the model with quality choice is almost unity and about double the one in the model without quality choice. This unit value is very close to the one observed in the data.

![Figure 16](image-url)
Table 3: Second Moments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
<th>Model: Quality</th>
<th>Model: No Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\frac{\sigma_X}{\sigma_{GDP}}$</td>
<td>$Cor^{X,GDP}$</td>
<td>$\frac{\sigma_X}{\sigma_{GDP}}$</td>
</tr>
<tr>
<td>Total Hours</td>
<td>1.1</td>
<td>0.78</td>
<td>0.98</td>
</tr>
<tr>
<td>Hours in C</td>
<td>0.80</td>
<td>0.48</td>
<td>0.37</td>
</tr>
<tr>
<td>Hours in I</td>
<td>2.48</td>
<td>0.86</td>
<td>3.29</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.80</td>
<td>0.85</td>
<td>0.49</td>
</tr>
<tr>
<td>Investment</td>
<td>3.16</td>
<td>0.87</td>
<td>3.47</td>
</tr>
<tr>
<td>Q</td>
<td>NA</td>
<td>NA</td>
<td>0.56</td>
</tr>
<tr>
<td>$P^I$</td>
<td>1.07</td>
<td>-0.39</td>
<td>0.42</td>
</tr>
<tr>
<td>Labor Wedge</td>
<td>1.1</td>
<td>-0.69</td>
<td>0.37</td>
</tr>
</tbody>
</table>

The table presents the second moments of different variables of interest or the U.S. data, the model with quality choice, and the model without a quality choice. For each of these, we report the standard deviation of the variables relative to output, and the correlation with output. The former is titled by $\frac{\sigma_X}{\sigma_{GDP}}$, while the latter is titled by $Cor^{X,GDP}$. The U.S. data and the model are quarterly and are HP-filtered with a smoothing parameter of 1600.

3.3.1 Why is there Magnification?

The results presented so far show that the presence of quality choice generates a time series of hours workers that is as volatile as output. We begin the discussion of this result with a simplified example of the model presented above. We then discuss the role of the utility function in this result, and conclude the discussion with the role of the production function.

Example  We abstract from capital and investment and consider the following static problem where the output of quality $q$ be produced by a perfectly competitive firm that operates the following production function

$$Y(q_t) = \frac{A_t}{q_t} N_t$$

This production function implies that the price of a good of quality $q$ is given by

$$P(q_t) = \frac{w_t}{A_t} q_t$$
We further specify the instantaneous utility function to be of the form presented in equation 17 and maximize it subject to the static budget constraint of

\[ C(q_t)P(q_t) = w_t N_t. \]

We thus get that the first order condition for labor is given by

\[ \phi N_t = \frac{q_t^{1-\theta}}{1-\theta} \left[ \frac{w_t}{P(q_t) C(q_t)} \right] \]

Using the budget constraint, this first order condition can be written as

\[ q_t = \left[ (1-\theta)\phi N_t^{1+\nu} \right]^{\frac{1}{1-\theta}} \]

Similarly, the household’s first order condition for consumption is given by

\[ \log(C(q_t)) = \frac{1}{1-\theta} \frac{P'(q_t)q_t}{P(q_t)}. \]

We note that given the pricing equation in this simplified model, \( P(q_t) = \frac{w_t}{A_t} q_t \), consumption is constant and equals \( C = \exp(\frac{1}{1-\theta}) \). We can then combine the two first order conditions into one equation in \( A_t \) and \( N_t \). Log-linearizing the resulting equation we obtain the following relation between these two variables,

\[ \tilde{N}_t = \frac{1-\theta}{\theta+\nu} \tilde{A}_t, \]

where a circumflex denotes the percentage deviations of a variable from its steady state.

It is useful to compare this model to a model without quality: thus, the utility function has no choice of quality in it (i.e. it is the common separable utility function between consumption and hours), and the production function is simply given by \( Y_t = A_t N_t \). In this case, following the same steps as above one can show that there are no fluctuations in labor at all. Thus, it is the presence of the quality choice that induces fluctuations in labor.

**The role of the utility function** To highlight the general impact that quality choice has on the optimal allocations of the consumer we consider the following general separable utility function,

\[ U = G(q_t)V(C(q_t)) - D(N_t) \] (29)

where \( G(q) \) is an increasing and strictly concave function of quality, \( V(C(q)) \) is an increasing and strictly concave function of consumption, and \( D(N) \) is an increasing and strictly convex function in hours worked. To simplify the discussion, assume without loss of generality that the consumer maximizes a the utility function given in Equation (29) subject to a static budget constraint

\[ C(q_t)P(q_t) = w_t N_t \] (30)
Note that the first-order-condition for hours worked with quality as a choice is given by

$$G(q) V' \left[ \frac{W N}{P(q)} \right] \frac{W}{P(q)} = D'(N)$$

In contrast, the first-order-condition for hours worked in a model without quality is given by,

$$V' \left[ \frac{W N}{P} \right] \frac{W}{P} = D'(N)$$

Consider the case where there is a shock that induces the consumer to increase the optimal amount of hours worked. Without a quality choice the marginal benefit of an extra hour of work declines with consumption, limiting the increase in hours since the cost of providing hours is convex. However, with quality as a choice, an increase in optimal $q$ (relative to no quality) has two effects. First, it "shifts up" the marginal utility of consumption, leading to an increase in the marginal benefit of working. Second, the reduction in the actual units of consumption mitigates the fall in the marginal utility of consumption, leading again to an increase in the marginal benefit of working.

**The role of rho** Next we address the role of the $\rho$ (the parameter governing the elasticity of substitution between labor and capital), and having quality in the production function in general. We begin the discussion of this result with a simplified example of the model presented above.

Let the utility function be given by Equation 17 subject to

$$P(q)C = rK + wN.$$  

Note that we assume for the purpose of this example that $K$ is a factor of production that cannot be accumulated. This simplification allows us to derive the analytical results that follow. Combining the first order condition of this problem we get

$$(1 - \theta)log(C) = \frac{qP'(q)}{P(q)}$$

$$\frac{q^{1-\theta}}{1-\theta} \frac{w}{C P(q)} = N^\nu$$

We assume that the production function continues to be a CES, i.e.

$$C(q) = A \left[ \alpha \left( \frac{N}{q} \right)^\rho + (1 - \alpha) (K)^\rho \right]^{\frac{1}{\rho}}$$

34
This implies that the price elasticity with respect to quality is given by

\[ \frac{P'(q)q}{P} = \frac{1}{1 + \frac{(1-\alpha)^{\frac{1}{1-\rho}}}{\alpha(\frac{N}{q})^\rho(1-\alpha)^{\frac{1}{1-\rho}}}} \]

Then, given the optimality condition for labor we can summarize the behavior of this economy with the following two equations,

\[
(1-\theta)\log \left( A \left[ \alpha \left( \frac{N}{q} \right)^\rho + (1-\alpha) (K)^\rho \right]^{\frac{1}{1-\rho}} \right) = \frac{1}{1 + \frac{(1-\alpha)^{\frac{1}{1-\rho}}}{\alpha(\frac{N}{q})^\rho(1-\alpha)^{\frac{1}{1-\rho}}}}
\]

\[
q^{1-\theta-\rho} \frac{1}{1-\theta} \left[ \alpha \left( \frac{N}{q} \right)^\rho + (1-\alpha) (K)^\rho \right]^{\frac{1}{\rho}} = N^{1+\nu-\rho}
\]

Figure 17 plots the values of labor and quality choice as we change the "TFP" value of A. As Figure 17 depicts, the lower \( \rho \) is (the X axis) the higher is the volatility of N and q. Furthermore, it is instructive to compare this economy to an economy featuring no quality. In this case, naturally, there is no first-order-condition for quality choice. Thus, the equation summarizing the equilibrium in this economy is given by

\[ \frac{1}{w} \frac{N}{P} = \phi N^\nu \]

In this economy there is only one level of labor no matter what the level of TFP is.

Thus to summarize, this simple example shows that the presence of a quality in the model allows N to be more volatile and that the lower \( \rho \) is the higher is the volatility of labor.
within our full General Equilibrium model. Specifically, we simulate the model for various level of $\rho$. Table 4 presents the second moments properties of the model with and without quality choice. The main take aways from this exercise are as follows. (i) Without a quality choice, the hours in the consumption sector cannot commove with output if they exhibit any volatility. (ii) When $\rho < 0$ (which is a necessary condition in the CES production for having labor intensity to be increasing with quality) having a quality choice magnifies the overall volatility of the economy and the volatility of labor relative to output. (iii) For the model with quality, $\rho$ has important implications on the economy. For example, as $\rho$ increases the model generates second moment properties that are inconsistent with the U.S. data: the correlation of consumption with output (and even investment with output) become negative, and the relative volatility of consumption to output can be larger than unity.

Table 4: Second Moments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model without Quality</th>
<th>Model with Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.01 0.01 0.01 0.01 0.01 0.00 0.03 0.02 0.02 2.56 2.94 0.22</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0.12 0.11 0.07 0.06 0.06 0.04 0.19 0.18 0.18 5.49 6.06 0.02</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>0.01 0.01 0.02 0.02 0.02 0.02 0.05 0.05 0.04 0.48 0.55 0.34</td>
<td></td>
</tr>
<tr>
<td>GDP</td>
<td>0.02 0.02 0.02 0.02 0.02 0.02 0.05 0.05 0.04 0.48 0.54 0.11</td>
<td></td>
</tr>
<tr>
<td>$N^C$</td>
<td>0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.02 0.02 2.55 2.95 0.44</td>
<td></td>
</tr>
<tr>
<td>$N^I$</td>
<td>0.11 0.10 0.07 0.05 0.05 0.04 0.18 0.17 0.18 5.50 6.05 0.29</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>NA NA NA NA NA NA 0.03 0.03 0.04 5.10 5.90 0.98</td>
<td></td>
</tr>
<tr>
<td>PQ</td>
<td>NA NA NA NA NA NA 0.02 0.02 0.02 2.55 2.94 0.23</td>
<td></td>
</tr>
<tr>
<td>N vs. GDP</td>
<td>0.42 0.53 0.70 0.78 0.78 0.91 0.98 0.96 1.04 1.00 1.00 3.18</td>
<td></td>
</tr>
<tr>
<td>C vs. GDP</td>
<td>0.61 0.48 0.33 0.28 0.28 0.21 0.49 0.45 0.61 5.29 5.40 2.00</td>
<td></td>
</tr>
<tr>
<td>I vs. GDP</td>
<td>5.92 4.81 3.21 2.72 2.72 2.20 3.47 3.57 4.53 11.36 11.14 0.14</td>
<td></td>
</tr>
</tbody>
</table>

Correlation with output

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model without Quality</th>
<th>Model with Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.94 0.91 0.87 0.84 0.84 0.76 0.86 0.79 -0.21 0.26 0.38 1.00</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0.93 0.96 0.99 0.99 0.99 1.00 0.96 0.96 0.93 0.01 -0.12 -0.99</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>0.95 0.96 0.98 0.98 0.98 0.98 1.00 1.00 1.00 1.00 1.00 1.00</td>
<td></td>
</tr>
<tr>
<td>$N^C$</td>
<td>-0.45 -0.65 -0.85 -0.96 -0.99 0.93 0.66 0.60 -0.25 0.26 0.38 1.00</td>
<td></td>
</tr>
<tr>
<td>$N^I$</td>
<td>0.90 0.95 0.98 0.98 0.98 0.99 0.95 0.95 0.92 0.01 -0.12 1.00</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>NA NA NA NA NA NA 0.86 0.79 -0.19 0.26 0.38 1.00</td>
<td></td>
</tr>
<tr>
<td>PQ</td>
<td>NA NA NA NA NA NA 0.98 0.79 -0.15 0.26 0.38 1.00</td>
<td></td>
</tr>
</tbody>
</table>

Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model without Quality</th>
<th>Model with Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>-1 -0.5 -0.1 -0.001 0.001 0.1 -1 -0.5 -0.1 -0.001 0.001 0.1</td>
<td></td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5</td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5</td>
<td></td>
</tr>
</tbody>
</table>

The models’ time series are HP-filtered with a smoothing parameter of 1600
3.3.2 Comovement

As Table 3 suggests, an interesting implication of the model is that it generates sectoral comovement in the hours worked in the two sectors. This is one of the long standing puzzles in the RBC literature (see e.g. Fitzgerlad and Christiano (1999)). To see this consider the following example based on the analysis in Fitzgerlad and Christiano (1999). Let the representative consumer maximize the same separable utility function as discussed above (however without quality) in a two-sector model of consumption and investment,

\[ U = \log(C_t) - \phi \frac{N_t^{1+\nu}}{1+\nu} \]

The first order condition for hours worked is then given by FOC for hours worked:

\[ \phi N_t^\nu = \lambda_t w_t = \frac{w_t}{P_t^C C_t} \]

Assuming that the production functions in both sectors are given by Cobb-Douglas production functions leads to

\[ \phi (N_t^C + N_t^I)^\nu = \frac{(1-\alpha)}{N_t^C} \]

As this equation makes it clear, \( N_t^I \) and \( N_t^C \) must move in opposite ways.

The model we study differs in two ways from this example. First, the production function we consider is a CES. This assumption by itself alters first order condition. However as Fitzgerlad and Christiano (1999) show, this modification does not generate comovement. The second change, the introduction of quality, is the key to the success in generating comovement. To see this, we note that the first order condition for hours worked when there is a quality choice is given by,

\[ \phi (N_t^C + N_t^I)^\nu = q^1 - \theta \frac{1}{N_t^C} \left[ \alpha \left( \frac{A}{C} \right)^\rho \right] \]

First note that the "impossibility" of \( N_t^C \) and \( N_t^I \) to comove is no longer observed in this equation. Since quality is procyclical and labor intensity is increasing with quality, the increase in quality has a direct impact on the hours worked in the consumption sector inducing them to increase and comove with the rest of the economy.\(^\text{16}\).

3.3.3 Labor Wedge

Finally, we note that the quality choice model offers a new theory of the measurement of labor wedge. Specifically, consider the Intra-temporal condition in the model

\[ \frac{C(q_t)P(q_t)}{W_t} \phi N_t^\nu = \frac{q_t^{1-\theta}}{1-\theta} = (1-\tau_t) \]

\(^\text{16}\)In the basic two sector model without quality \( N_t^C \) is negatively correlated with the rest of the economy
Note that the presence of a procyclical quality choice suggests that at least some of the movement in the labor wedge can be attributed to it. That is, the empirical observation of a counter-cyclical labor wedge could be an artifact of a lack of measurement of a procyclical $q$.

### 3.4 Embedding Quality into Business Cycle Models: Monetary Model

In this section we study the implications of a quality choice in an otherwise standard monetary model. Specifically, we introduce a quality choice margin into a sticky-price model as in Calvo (1983) model and show that it magnifies monetary shocks. As in the Calvo (1983) model, and as is common in the monetary literature, we abstract from capital accumulation in this section. This allows us to highlight the role of quality choice in the most parsimonious way.

**Households** As in equation (17), the economy is populated by a large number of identical, infinitely-lived households who maximize

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{q_{t}^{1-\theta}}{1-\theta} \log [C(q_t)] - \phi \frac{N_{t+1}^{1+\nu}}{1+\nu} \right\}$$

(31)

Since this is an economy without capital, it is a one-sector model where the household’s budget constraint is given by:

$$P(q_t)C_t + B_{t+1} = B_t (1 + R_t) + w_t N_t + T_t.$$  

(32)

In this economy, $T_t$ denotes lump-sum taxes paid to the government. $B_{t+1}$ denotes the quantity of one-period bonds purchased by the household at time $t$. $P_t$ denotes the price level and $w_t$ denotes the nominal wage rate. Finally, $r_t$ denotes the one-period nominal rate of interest that pays off in period $t$. The household’s problem is to maximize utility given by equation (31) subject to the budget constraint given by equation (32) and the condition $E_0 \lim_{t \to \infty} B_{t+1}/(1 + r_0)(1 + r_1)\ldots(1 + r_t) \geq 0$.

**First order conditions** The first order condition of the household for hours worked, consumption, optimal quality, and bonds accumulation are given by

$$\phi N_{y}^{\nu} = \lambda_t w_t$$  

(33)

$$\frac{q_{t}^{1-\theta}}{1-\theta} \frac{1}{C_t} = \lambda_t P(q_t)$$  

(34)

$$q_{t}^{-\theta} \log [C(q_t)] = \lambda_t C_t P'(q_t)$$  

(35)

$$\lambda_t = E_t \beta \lambda_{t+1} (1 + r_{t+1})$$  

(36)

where $\lambda_t$ denotes the Lagrange multiplier associated with the household’s budget constraint.
Final Good Firms  The final good is produced by competitive firms using the technology,

\[ Y(q_t) = \left( \int_0^1 \left[ Y_t^i(q_t) \right]^{\frac{\varepsilon-1}{\varepsilon}} \, di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \varepsilon > 1, \quad (37) \]

where \( Y_t^i(q_t), i \in [0,1] \) denotes intermediate good \( i \). The problem of the final good firm is given by:

\[ \max P(q_t) Y(q_t) - \int_0^1 P_t^i(q_t) Y_t^i(q_t) \, di \]

Profit maximization implies the following standard first-order condition for \( Y_t^i(i) \):

\[ P_t^i(q_t) = P(q_t) \left[ \frac{Y(q_t)}{Y_t^i(q_t)} \right]^{\frac{\varepsilon}{\varepsilon-1}}, \quad (38) \]

where \( P_t^i(\cdot) \) denotes the price of intermediate good \( i \) and \( P_t \) is the price of the homogeneous final good. Standard techniques in the Calvo model lead the final good price to be given by

\[ P(q_t) = \left( \int_0^1 P_t^i(q_t)^{1-\varepsilon} \, di \right)^{\frac{1}{\varepsilon-1}} \]

Intermediate Good Firms  The intermediate good, \( Y_t^i(q_t) \), is produced by a monopolist using the following linear technology:

\[ Y_t^i(q_t) = \frac{A_t^i}{q_t} N_t^i(q_t), \]

where \( N_t^i(\cdot) \) denotes employment by the \( i^{th} \) monopolist. We assume there is no entry or exit into the production of the \( i^{th} \) intermediate good. Before deriving the "Calvo pricing" it is useful to derive the frictionless price in this economy,

\[ P_t^i(q_t) = \frac{\varepsilon}{\varepsilon-1} \frac{w_t}{A_t^i} q_t \]

To facilitate the comparison with the benchmark without quality we assume that firms post a schedule that is linear in \( q_t \).

\[ P_t^i(q_t) = \mu_t^i q_t \]

The monopolist is subject to Calvo-style price-setting frictions and can optimize its price, \( P_t(i) \), with probability \( 1 - \xi \). With probability \( \xi \) the firm sets:

\[ P_t^i(q_t) = \mu_{t-1}^i q_t \]

Let \( \tilde{\mu}_t^i \) be the price-quality schedule chosen by a firm that can optimize at time \( t \). It then follows that the aggregate price level is given by

\[ P(q_t) = \left[ (1 - \xi) \int_0^1 (\tilde{\mu}_t^i q_t)^{1-\varepsilon} \, di + \xi \int_0^1 (\mu_{t-1}^i q_t)^{1-\varepsilon} \, di \right]^{\frac{1}{1-\varepsilon}} = \mu_t q_t \]
where

$$\mu_t = \left[ (1 - \theta) \left( \hat{\mu}_t \right)^{1-\varepsilon} + \theta \mu_t^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}$$

Firm $i$ maximizes its discounted profits, given by

$$E_t \sum_{j=0}^{\infty} \beta^j \lambda_{t+j} \left[ P_t^i(q_{t+j}) Y_t^i(q_{t+j}) - w_{t+j} N_t^i(q_{t+j}) \right], \quad (39)$$

subject to the Calvo price-setting friction, the production function, and the demand function for $Y_t(i)$. Note that given the linearity of the price schedule in quality the demand function for $Y_t(i)$ can be written as

$$\hat{\mu}_t^i = \frac{P(q_t)}{q_t} \left[ \frac{Y(q_t)}{Y_t^i(q_t)} \right]^{\frac{1}{\varepsilon}}$$

where we remind the reader that $\hat{\mu}_t^i$ is the price-quality schedule chosen by a firm at time $t$. As common in the Calvo model, the price that is chosen at period $t$ is only relevant along paths in which the firm could not optimize, resulting in the following optimization

$$E_t \sum_{j=0}^{\infty} \beta^j \lambda_{t+j} \left[ P_t^i(q_{t+j}) Y_t^i(q_{t+j}) - w_{t+j} N_t^i(q_{t+j}) \right]$$

Standard steps in the Calvo model (see Appendix F) lead to the following "quality-choice-modified" New-Keynsian Phillips Curve

$$\hat{\pi}_t = \frac{(1 - \beta) (1 - \xi)}{\xi} [\nu + \theta] \hat{N}_t + \beta \hat{\pi}_{t+1}$$

and the following Inter-Euler condition

$$\left( \hat{N}_{t+1} - \hat{N}_t \right) = \frac{-rr + r_{t+1} - \hat{\pi}_{t+1}}{\theta}$$

It is useful to compare these two equations to the Calvo model without quality choice,

$$\hat{\pi}_t = \frac{(1 - \beta) (1 - \xi)}{\xi} [\nu + 1] \hat{N}_t + \beta \hat{\pi}_{t+1}$$

$$\left( \hat{N}_{t+1} - \hat{N}_t \right) = -rr + r_{t+1} - \hat{\pi}_{t+1}$$

Since in the quality choice model $\theta < 1$ the above equations show the difference in the reaction of the two economies to a monetary shock. This can be observed in Figure 18.\textsuperscript{17}

\textsuperscript{17}The remaining two equations in the model are standard in the literature: A definition of the natural rate to be equal to $\log(\beta)$ and a Taylor Policy Rule where the central bank reacts to inflation, the output gap and unemployment. The calibration of $\theta$ is the same as in Section 3.3. The remaining of the parameters are calibrated as in Christiano (2014)
In this Section 4 we relate the quality-trading-down phenomenon to the job-polarization literature. As is well known, the polarization literature has shown how during the last three decades middle-wage jobs have been disappearing from the economy. In the model in this section we show how as the "middle class" is adjusting consumption to its lower income prospects it exhibits a quality-trade-down behavior and hence resulting in further negative impact on the labor market. The model in this section allows us to calculate a "polarization multiplier": i.e. we decompose the changes in the labor market into those originating from technological factors, such as those emphasized in the polarization literature (e.g. automation and outsourcing), and those that are a result of the quality-trade-down

\footnote{e.g. Acemoglu (1999), Autor et al. (2006), Goos and Manning (2007), and Goos et al. (2009)}
demand channel.

To be written

5 Conclusions

To be written
6 References

To be written
Appendices

A Data Sources

In this section, we detail our data sources and variables.

Table 5 presents some description of the data used to analyze quality shifts in expenditure in six retail sectors. It describes the data source (column I), the number of firms covered in the sample in 2007 (II), the average annual firm sales revenue (III), and the percent of the overall sector sales that our sample covers (IV).

Table 5: Data Sample Description

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Data Source</th>
<th>Number of Firms</th>
<th>2007 Annual Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(I)</td>
<td>(II)</td>
<td>(III)</td>
</tr>
<tr>
<td>Accomodation</td>
<td>Compustat and company reports</td>
<td>11</td>
<td>3,088</td>
</tr>
<tr>
<td>Apparel</td>
<td>Compustat and company reports</td>
<td>54</td>
<td>1,648</td>
</tr>
<tr>
<td>Grocery stores</td>
<td>Compustat and company reports</td>
<td>9</td>
<td>34,348</td>
</tr>
<tr>
<td>Restaurants</td>
<td>Compustat and company reports</td>
<td>74</td>
<td>1,012</td>
</tr>
<tr>
<td>Home furnishing</td>
<td>Compustat</td>
<td>41</td>
<td>4,750</td>
</tr>
<tr>
<td>General Merchandise</td>
<td>U.S. Census</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Annual balance sheet data for all sectors (other than General Merchandise) is obtained from the firms’ annual 10K reports and Standard and Poor’s Compustat database. Within the Compustat database, each firm is identified by the company’s legal name (Compustat item CONML). For each firm, we obtain the following variables: the NAICS sector that the firm belongs to (Compustat item NAICS), annual total sales revenue (in millions of U.S. dollars, given by Compustat item SALE), number of employees (in thousands, given by Compustat item EMP), operating expenses (in millions of U.S. dollars, given by Compustat item XOPR), and cost of goods sold (in millions of U.S. dollars, given by Compustat item COGS). We compute the market shares of firms based on their annual U.S. sales, which we obtain using the Compustat item SALE within the U.S. geographic area and filtering by geographic segment (using the Compustat item SNMS). Therefore our computed shifts in market share reflect changes in domestic household demand.

In addition, we obtain data directly from firms’ 10K reports (from their firms’ website) for the grocery store sector, restaurant sector, apparel sector, and the accommodation sector:
**Grocery store sector:** We split out the sales and employees for Sam’s Club separately from Walmart to focus on the segment of the firm that predominately sells products related to food-at-home. For all other firms within the sector, the data is obtained from Compustat.

**Restaurant sector:** We obtain each firm’s annual U.S. sales based on same-store sales growth rates rather than using the Compustat SALE item. We do this to abstract from significant changes in revenues from year-to-year due to mergers and acquisitions, and refranchising activities (i.e. the restructuring of existing establishments within a firm into a franchise, which results in large declines in sales that are largely unrelated to household spending). These activities are particularly prevalent in this sector.

**Accommodation sector:** In addition to the Compustat data, we also obtain data directly for Accor Hotels as it provides a split of its sales and employment numbers for each of its main hotel chains within the firm, which we can then allocate separately to a quality tier. These include: low-quality (the Ibis chain and Hotel F1), and high-quality (including Sofitel, Mgallery, Grand Mercure, Pullman, Novotel, and Mercure). For all other firms within the sector, the data is obtained from Compustat.

**Apparel sector:** For our robustness calculation, we also obtained data for apparel firms that are amongst the constituents of the Standard and Poors’ Global Luxury Index and are traded on stock-exchanges outside of the U.S. To do so, we manually obtain the sales and employees for the U.S. from the firms’ investor reports (obtained from the firm websites). Using these variables, we define the labor intensity of each firm as the number of employees per million dollar of sales. The labor intensity of each quality-tier within the sector is then computed based on a U.S. sales-weighted average of the individual firm labor intensities.\(^{19}\)

For the General Merchandise sector, as discussed in the paper, we obtain data from the U.S. Retail Trade Survey produced by the Census. The publicly available data is sufficiently disaggregated into clear quality tiers for this sector. Specifically, we define the high-quality tier as “Department stores (except discount dept. stores)” (Census NAICS code 45211), the middle-quality tier as “Discount dept. stores” (Census NAICS code 452112), and the low-quality tier as “Other general merchandise stores” (Census NAICS code 4529). For each of these quality-tiers, we therefore obtain the total sales and number of employees from the Census. The publicly available data does not provide individual firm-level information.

\(^{19}\)The labor intensity measure is based on the firm’s global sales and employment numbers. We define labor intensity using the global measure as most firms do not disaggregate their employment numbers by geographic region.
B Robustness results to Section 2

In this section, we examine the robustness of our results to a number of sample assumptions and restrictions. First, we consider the sensitivity of our results to the inclusion of firms that provide goods and services in the U.S. but are listed on stock exchanges outside of the U.S. These firms are not captured in our base sample which includes only firms that are traded on the U.S. stock exchange. This may be particularly relevant for the high-end of the apparel sector where a number of these firms are traded on stock exchanges outside of the U.S (for example, LVMH-Moet Vuitton and Christian Dior are traded on the Paris stock exchange). Therefore, we recompute the calculations based on a broader sample for the apparel sector that includes firms that form the S&P Global Luxury Index. We find that our results do not change significantly with the inclusion of these firms, with the shift in quality accounting for 34 percent of the overall decline in employment during the Great Recession (as opposed to 33 percent based on the narrower sample).

Secondly, we consider the sensitivity of our results to the use of an unbalanced sample of publicly traded firms. The sample of firms traded on the U.S. stock exchange can vary over time for a number of reasons. For example, firms can exit the sample when they close down and exit the industry (and vice-versa for newly established firms). In this case, our unbalanced sample would appropriately capture shifts in market shares of the different firms in the economy since the Compustat data would reflect entry/exit firm dynamics. However, it may also be the case that firms exit the Compustat sample because they become privatized but are still in fact operating and making sales in the economy (and vice-versa for firms that already operated in the industry prior to becoming publicly traded on the stock exchange). In this case, our calculations of market share shifts based on the Compustat sample of firms may fully reflect shifts in overall household spending. To explore this issue further, we recompute our calculations based on a balanced sample of firms over 2007-2012. The use of a balanced sample can avoid the biases associated with the listing/delisting issue, but has the disadvantage that it would not fully capture the actual entry/exit dynamics in the industry. We find that based on the balanced sample, the shift in quality can account for approximately 20% of the overall decline in employment during the Great Recession. This suggests that changes in the economy from trading down in quality can potentially explain between one-fifth to one-third percent of the total employment decline (the latter comes from the original calculations based on the unbalanced sample).

---

20For a list of the constituents on the S&P Global Luxury Index, see http://us.spindices.com/indices/equity/sp-global-luxury-index.
C Appendix for Manufacturing Sector

To be written

D Appendix for Category Substitution

To be written

E Appendix for CEX calculations

To be written

F Appendix for the Calvo Model: Not for Publication

To be written