Forecasting Consumer Spending

Abstract

Consumer spending accounts for roughly two-thirds of US economic output. Understanding the drivers of consumer spending is important for predicting future demand for goods & services and for policymaking. Researchers have identified many predictors of consumption including income growth, credit availability, home prices, stock market performance, and future expectations. Personal consumption expenditures (PCE) is the primary measure of consumer spending. In this Research Note, we characterize the relationship between the WAIN Street Business Default Index (BDX) and PCE, including the product and function-based subcategories of PCE. Our analysis shows that incorporating BDX data into regression models improves prediction accuracy of both small ticket and discretionary expenditures as well as the headline measure of consumer expenditures. A causality between BDX and spending can be established in several instances, providing a stronger basis for forecasting.

Data

We use the WAIN Street Business Default Index (BDX) and its business-size based sub-indices as the explanatory (independent) variable. The BDX is a monthly gauge of nationwide business defaults derived from the credit performance of nearly 18 million US businesses across all industries, geographical areas, and business size. The index is quoted as a seasonally adjusted annualized rate. The index inception date is December 2009. The monthly series is aggregated into a quarterly series and seasonally adjusted to remove residual seasonality. Preliminary exploration supports the supposition that BDX data concerning very small businesses would be the most relevant to consumer spending. Therefore, we use only the two BDX sub-indices – Solo and E20 – that concern very small businesses.

Figure 1: Quarterly BDX

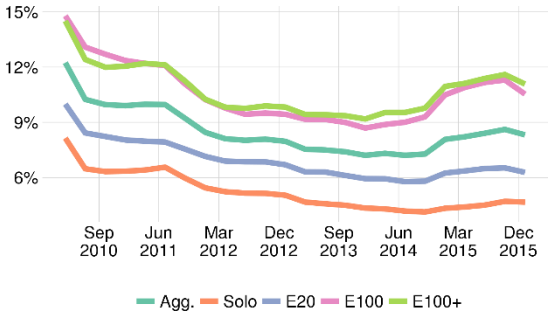
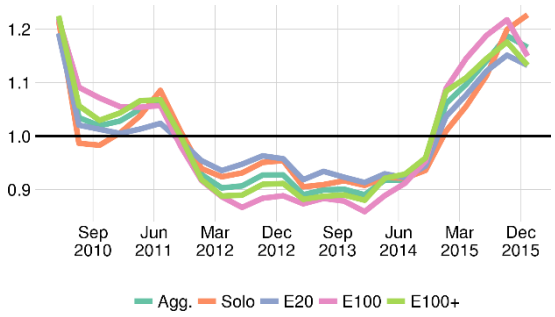


Figure 2: Ratio-detrended quarterly BDX



Business Default Index	Definition
Aggregate	All businesses
Solo	Businesses without paid employees
E20	Businesses with 1 to 19 employees
E100	Businesses with 20 to 99 employees
E100+	Businesses with 100 or more employees

We use Personal consumption expenditures (PCE) including its subcategories for the dependent variable. We obtain the seasonally adjusted, quarterly data for PCE starting in Q1 1999 from the Bureau of Economic Analysis (BEA). We use the quarterly data for PCE because they are less noisy. We also restrict the analysis to the final release data to avoid inconsistencies owing to revisions. Table 5 describes the 28 dependent series we studied. Our final data set covers twenty-three quarters from Q1 2010 to Q3 2015.

Seasonal Adjustment

We use the Census Bureau's X-13ARIMA-SEATS program for seasonal adjustment. We set the sensitivity for outlier detection to low[1] since our analysis encompasses a brief and extraordinary period.

Data Detrending

Both the BDX and PCE data exhibit a strong time trend. We use the Hodrick–Prescott filter[2] to identify the trend component. We de-trend each value by taking the ratio of the observed value and the trend. Hence, for the final series, values greater than/less than one indicate that the observed value is above/below trend. The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test confirms that all final series are trend stationary.

Methodology

As a compromise between managerial and academic perspectives, we fix the time horizon for this analysis at six quarters. Thus, our analysis incorporates at most six lags of any variable. We perform a pairwise analysis of each BDX predictor and PCE dependent variable. We identify predictors for each personal consumption expenditure category that improve prediction accuracy and Granger cause. All models that are not significant at the 0.05 level are discarded.

Assessing improvement in prediction accuracy

To gauge the improvement in prediction accuracy we fit two separate regression models[3]. The *restricted* model consists solely of lags of the dependent variable. The *unrestricted* model includes lags of both the dependent and independent variables. We gauge improvement in prediction accuracy by comparing model standard errors. We calculate the ratio of the standard errors of the unrestricted and restricted models and consider values less than one to be an improvement since that indicates the unrestricted model has a lower standard error. Similarly, we calculate the ratio of the adjusted R-squared values of the unrestricted and restricted models and consider values greater than one to be an improvement since that indicates increased explanatory power of the unrestricted model.

Establishing causality

Granger causality determines whether a predictor time series is useful in forecasting a dependent time series based on the presence of a statistically significant relationship between the dependent variable and lagged values of the predictor variable. In other words, a variable X Granger causes variable Y if variable Y can be better predicted using the histories of both X and Y than it can be predicted using the history of Y alone. A challenge in testing for Granger causality is identifying the amount of history to incorporate – the lag order. We take a pragmatic approach and search for the smallest lag order less than or equal to six quarters at which the BDX Granger causes consumption expenditures at the 0.05 significance level.

Identifying best predictors

Our goal is to forecast and hence, we use improvement in standard error rather than adjusted R-squared to rank order predictors and prefer predictors that Granger cause. We choose the best predictor based on

[1] We set the value to which the absolute values of the outlier t-statistics are compared to as 4.
[2] We use a smoothing parameter, lambda, value of 25,600 for the quarterly data which is higher than the "standard" 1,600 and in line with recent suggestions of using larger values for lambda.
[3] The models are selected by a simple search that eliminates variables which are not significant at the 0.05 level.

at least a 10% improvement in accuracy or Granger causality. We break ties based on Granger causality p-values and greatest improvement in accuracy.

Limitations

We evaluated 28 personal consumption data series (dependent variables) against two business default rate series (independent variables). At various points in each evaluation, we employ heuristics to automate decisions concerning model selection and other model inputs. Each technique suffers from well-known challenges. Granger causality testing is highly sensitive to the choice of lag order and tends to overfit. Lagged regression models can always benefit from additional diagnostics and tuning for outliers. We are confident of our results and acknowledge that specific models could always benefit from a more robust analysis.

Results

We report both the improvement in prediction accuracy and Granger causality results in Table 4. The E20 BDX is a good predictor of headline PCE. The Solo BDX is a good predictor of more granular expenditures. The Solo BDX is good at predicting expenditures that consumers can control with greater ease and immediacy whereas the E20 BDX is a good predictor of expenditures that require a more deliberate change.

The results are intuitive. The performance of very small businesses reflects, without much delay, general business conditions. The health of small businesses affects consumers' perceptions of economic well-being which impacts their spending behavior. Different categories of consumer spending change with varying speed and intensity. Additionally, for the business owner/operator, business performance and personal financial situation are often intricately intertwined – challenges on the business front quickly translate into personal financial challenges.

In the following sections, we report results for three categories of personal consumption expenditures:

1. Headline expenditures that provide a useful summary.
2. Expenditures by product which provides a sense of differing consumer response to their situation.
3. Household expenditures by function which shows changes in spending composition.

1. Headline expenditures

The E20 BDX decreases the standard error of prediction of headline PCE by nearly one-half and the Solo BDX decreases the standard error of prediction of Household consumption expenditures by nearly one-half.

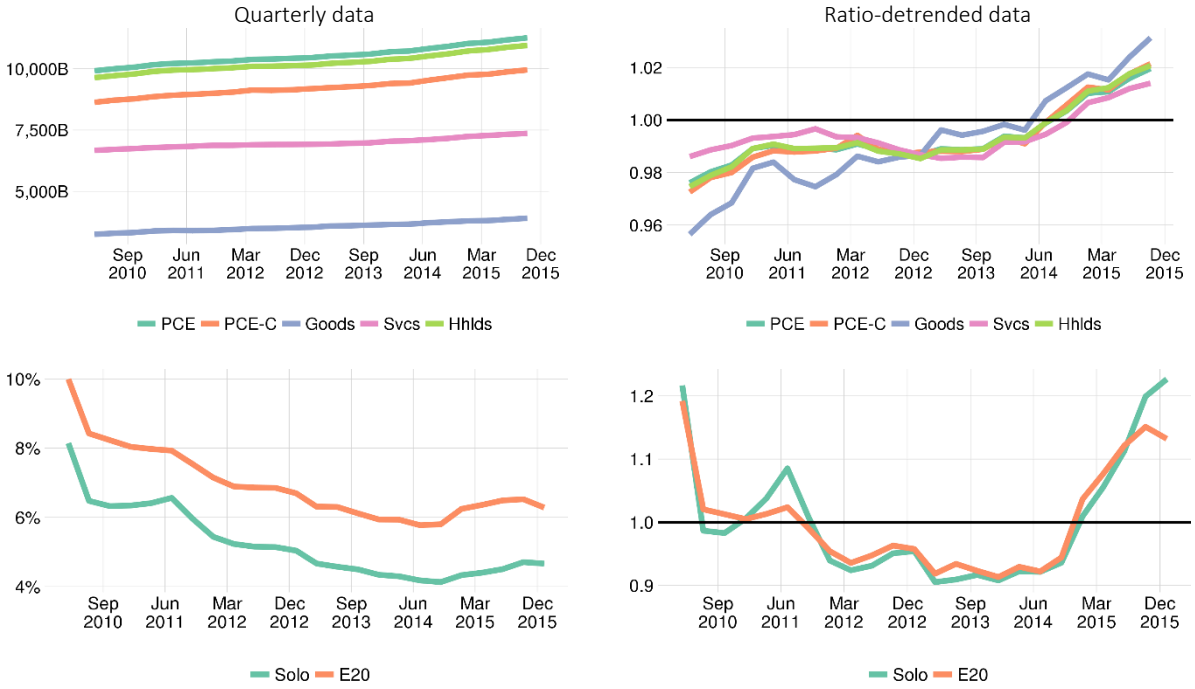


Table 1: Headline expenditures relationship with BDX

Personal consumption expenditures data[1]	BDX	Prediction accuracy[2]		Granger causality[5]	
		Standard error ratio[3]	Adj. R-squared ratio[4]	Lag order[6]	p-value[7]
Headline expenditures					
Personal consumption expenditures (PCE)	E20	0.52	1.05		
PCE excluding food and energy (PCE-C)	Solo	0.87	1.02		
Goods (Goods)	Solo	0.79	1.02		
Services (Svcs)	Solo	0.86	1.02		
Household consumption expenditures (Hhlds)	Solo	0.55	1.05		

Excerpted from Table 4. See Table 4 for footnotes.

2. Product-based expenditures

There is a strong causal relationship between spending on small ticket items ("Other durable goods") and the Solo BDX which supports the intuition that the Solo BDX reflects consumers' sense of immediate economic well-being which impacts their expenses that are easier to adjust. There is also a strong causal relationship between spending on "Financial services and insurance" and the Solo BDX.

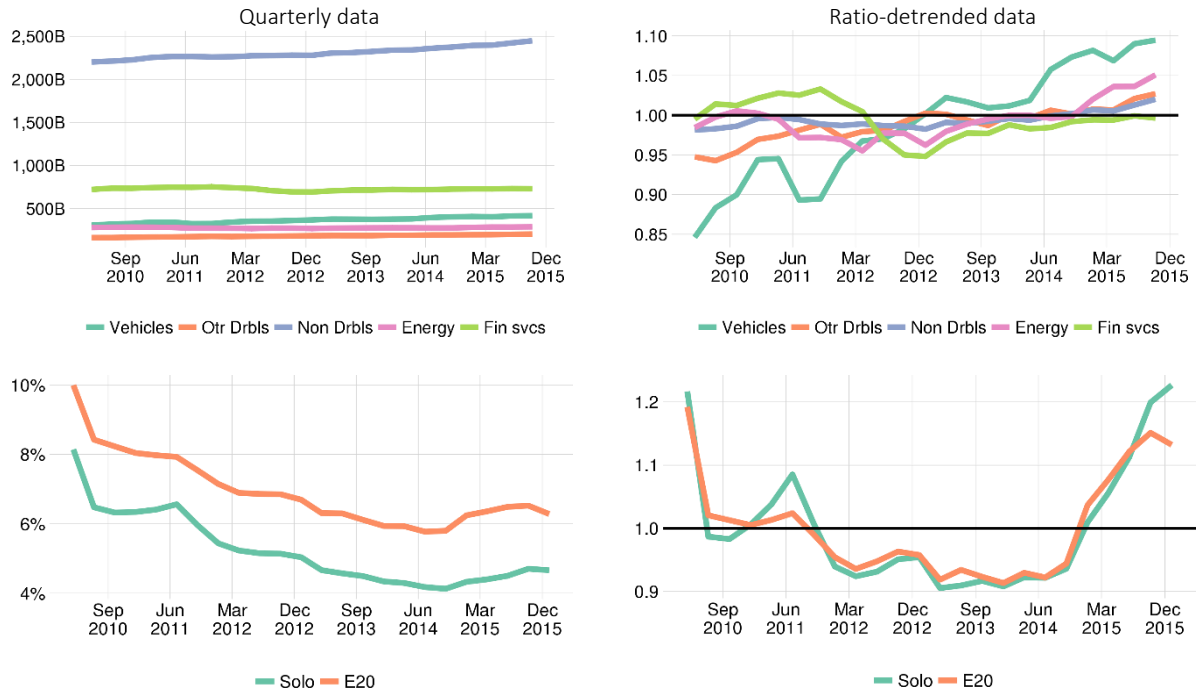


Table 2: Product-based expenditures relationship with BDX

Personal consumption expenditures data[1]	BDX	Prediction accuracy[2]		Granger causality[5]	
		Standard error ratio[3]	Adj. R-squared ratio[4]	Lag order[6]	p-value[7]
Product-based expenditures					
Motor vehicles and parts (Vehicles)	Solo	0.55	1.06		
Other durable goods (Otr Drbls)	Solo	0.42	1.32	3	0.02253
Nondurable goods (Non Drbls)	Solo	0.82	1.10		
Gasoline and other energy goods (Energy)	Solo	0.59	1.24		
Financial services and insurance (Fin svcs)	Solo	0.91	1.06	1	0.03685

Excerpted from Table 4. See Table 4 for footnotes.

3. Function-based expenditures

The Solo BDX improves forecasts of household spending on personal items, communication services, and other expenses consistent with the perspective that the Solo BDX is a proxy for consumer perceptions of immediate economic well-being. The E20 BDX improves forecasts of household expenditures on food, transportation, and education – expenses that can be varied but are less amenable to immediate change. Education expenditures is a broad category and includes expenses on nursery, commercial, and vocational schools which are more amenable to shorter-term changes. Similarly, Transportation expenditures include motor vehicle expenses as well as expenses related to air, ground, and water transportation.

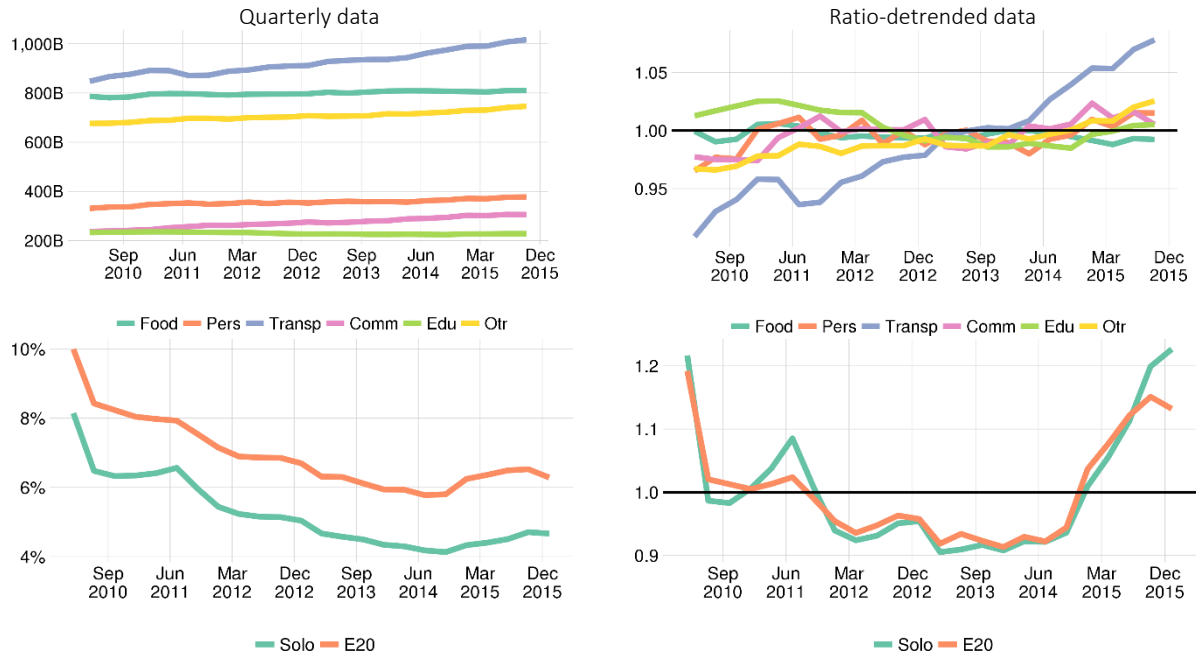


Table 3: Function-based expenditures relationship with BDX

Personal consumption expenditures data[1]	BDX	Prediction accuracy[2]		Granger causality[5]	
		Standard error ratio[3]	Adj. R-squared ratio[4]	Lag order[6]	p-value[7]
Function-based expenditures					
Food and beverages -- off-premises consumption (Food)	E20	0.65	1.39		
Clothing, footwear, and related services (Pers)	Solo	0.76	1.66		
Transportation (Transp)	E20	0.79	1.01		
Communication (Comm)	Solo	0.49	1.66		
Education (Edu)	E20	1.00	1.03	1	0.03089
Other goods and services (Otr)	Solo	1.01	0.98	3	0.03897

Excerpted from Table 4. See Table 4 for footnotes.

Conclusion

This Research Note establishes that the WAIN Street Business Default Index (BDX) concerning very small businesses has explanatory power for consumer expenditures. We find a strong causal relationship between credit performance of very small businesses as gauged by the Solo and E20 BDX sub-indices and expenditures on Education, "Financial services and insurance", and small ticket items. A methodology incorporating BDX data improves market surveillance capabilities and by leveraging monthly, sub-national BDX data, early warning of forthcoming quarterly results can be obtained. Finally, this Research Note paves the way for additional research on the association between business defaults and consumer perceptions of economic well-being.

Table 4: Relationship between BDX and personal consumption expenditures data

Personal consumption expenditures data[1]	BDX	Prediction accuracy[2]		Granger causality[5]	
		Standard error ratio[3]	Adj. R-squared ratio[4]	Lag order[6]	p-value[7]
Headline expenditures					
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1. Table 5 describes the data.
2. Prediction accuracy is evaluated by comparing two models. The restricted model consists solely of lags of the dependent variable. The unrestricted model includes lags of both the dependent and independent variables. When blank, only an unrestricted model could be fitted and hence, the improvement is unbounded.
3. The ratio of the standard error of unrestricted model and restricted model. Values less than one indicate unrestricted model has a lower standard error.
4. The ratio of adjusted R-squared of the unrestricted model and restricted model. Values greater than one indicate unrestricted model has greater explanatory power.
5. The results are for Granger causality from the BDX to expenditures. When blank, there was no Granger causality at the 0.05 significance level.
6. Lag order at which Granger causality was tested.
7. The significance level of the Granger causality test.

Table 5: Personal consumption expenditures data

Series Name	Series ID[1]	Description
PCE	DPCERX	Personal consumption expenditures
PCE-C	DPCCRX	PCE excluding food and energy
Goods	DGDSRX	Goods
Drbls	DDURRX	Durable goods
Vehicles	DMOTRX	Motor vehicles and parts
DrblsxVeh	DURxMOT[2]	Durable Goods excluding Motor vehicles and parts
Hhld equip	DFDHRX	Furnishings and durable household equipment
Rec Gds	DREQRX	Recreational goods and vehicles
Otr Drbls	DODGRX	Other durable goods
Non Drbls	DNDGRX	Nondurable goods
Food	DFXARX	Food and beverages -- off-premises consumption[3]
Clothing	DCLORX	Clothing and footwear
Energy	DGOERX	Gasoline and other energy goods
Otr Nondrbls	DONGRX	Other nondurable goods
Svcs	DSERRX	Services
Transp svcs	DTRSRX	Transportation services
Rec svcs	DRCARX	Recreation services
Food svcs	DFSARX	Food services and accommodations
Fin svcs	DIFSRX	Financial services and insurance
Otr svcs	DOTSRX	Other services
Hhlds	DPHCRX	Household consumption expenditures
Food	DFXARX	Food and beverages -- off-premises consumption[3]
Pers	DCAFRX	Clothing, footwear, and related services
Rtn hhld	DFHHRX	Furnishings, household equipment, and routine household maintenance
Transp	DTRNRX	Transportation
Comm	DCMCRX	Communication
Rec	DRRLRX	Recreation
Edu	DEDURX	Education
Otr	DOISRX	Other goods and services

1. BEA data series name.
2. Created as DDURRX - DMOTRX.
3. "Food and beverages -- off-premises consumption" is a subcategory of both Nondurable goods and Household consumption expenditures.

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