Online Appendix for US Trade and Inventory Dynamics

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Below, we discuss the robustness of our findings as well as the data sources and calculations.

A. Robustness

Here we discuss the robustness of our findings. First, we show that the finding of a relatively high volatility of trade is robust across alternate filters of the data. Next, we show that controlling for the different composition of trade from production or sales does not alter our findings of a high trade elasticity. Finally, we show that including inventory adjustment improves the fit of standard import demand regressions.

Filtering: To evaluate the role of filtering on our finding that the declines in trade in 2008-09 are not unusual, in Table A1 we report the elasticity of trade under alternative filtering methods. In particular, we 1) HP filter with a smoothing parameter of 10^5 and 2) remove a linear trend from each data series. These detrending methods remove very low frequency trends from each data series and generate quite similar results. In the final two columns, we report the results on the raw, unfiltered data. Here, we find that the decline in trade in the current recession is indeed unusual, particularly for imports with respect to GDP (an elasticity of 7.6 vs 3.2). The fall in exports also appears unusual. Given that the rising importance of trade is often attributed to factors outside of growth in income or production, say falling trade barriers, we believe the appropriate way to analyze the data is to detrend them. Moreover, this detrending allows us to compare mild and severe recessions.

Composition I: Trade is substantially less volatile when compared to industrial production rather than GDP. Obviously, this reflects in large part the fact that the industry composition of trade is more similar to industrial production than GDP. One might still be concerned that the relatively high volatility of trade relative to industrial production may also reflect compositional differences. The potential for composition to explain the high volatility of trade is evident in Table A2, which reports business cycle statistics of a variety of macroeconomic aggregates. Here we see that consumer durables and investment are more volatile than measures of consumer non-durables or GDP. However, we still find that consumer durables and investment are less volatile than imports or exports. Thus, it appears unlikely that the relatively high volatility of trade is purely due to it being more intensive in durables and investment goods.

An alternative way to account for compositional concerns is to construct a trade-weighted measure of industrial production that more closely matches the composition of trade. In particular, we construct a measure of trade-weighted industrial production as

$$IP_t^{TW} = \alpha_{D\_exMV} IP_t^{D\_exMV} + \alpha_{autos} IP_t^{MV} + \left(1 - \alpha_{D\_exMV} - \alpha_{MV}\right) IP_t^{ND}$$

The data for these series are available from 1972M1 to 2010M10 and aggregated to a quarterly basis. Based on the 2003-07 shares of each good in non-petroleum imports we set $\alpha_{D\_exMV} = 0.55$, $\alpha_{MV} = 0.15$, $\alpha_{ND} = 0.30$. These shares overstate the importance of durables and motor vehicles in trade since they are based on trade shares excluding petroleum for imports. Panel A of Table A3 shows that this trade-weighted measure of industrial production that places a larger weight on durables and motor vehicles is approximately 10 percent more volatile than U.S. manufacturing production, suggesting that only a small part of the high volatility of trade can be attributed to the different composition of industrial production from trade.

Composition II: One might still be concerned that our trade-weighted measure of industrial production is not disaggregated enough. To consider this, we examine the cyclical properties at the industry level, focusing on motor vehicles. Due to data limits (we would like a real series of motor vehicle trade and shipments), we consider monthly data from 1997:01 to 2010:10. Panel B of Table A3 shows that imports and exports are about 25 to 30 percent more volatile than production, about 40 percent more volatile than manufacturers' shipments, and two and a half times as volatile as retail sales. Thus, it appears clear that trade is more volatile than production and domestic shipments even once we control for industry composition.

Import Demand Regressions: It is common to estimate the import demand equation we derived. These regressions are typically run in differences for reasons of stationarity (see Gallaway, McDaniel, and Rivera, 2003, for example). For this reason, we estimate an equation of the form:

$$(1) \qquad \Delta m_t = -\gamma \Delta p_t + \alpha \Delta c_t + \beta \Delta x_t,$$

where $\Delta x_t = (i_t - i_{t-1}) - (i_{t-1} - i_{t-2})$ denotes the change in inventory investment.

In Table A4 we present the results of this regression on the data used in our wedge analysis. Columns I and II present the results of the specification above. Column I presents the results of the standard import equation that omits the inventory term. Column II is the unrestricted equation. As the table indicates, adding inventories raises the R^2 measure from 60 percent to 70 percent.

Columns III and IV of Table A4 report estimates of an error-correction model in which we also include lagged values of all variables. The idea here is to capture the gradual response of imports, maybe due to adjustment costs or lags between orders and deliveries of goods. Specifically, we estimate the following equation

$$(2) \qquad \Delta m_t = -\gamma_0 \Delta p_t + \alpha_0 \Delta c_t + \beta_0 \Delta x_t + \delta m_{t-1} - \gamma_1 p_{t-1} + \alpha_1 c_{t-1} + \beta_1 x_{t-1},$$

Notice here that in this specification the role of inventories is much more pronounced. The R^2 increases from 66 percent to 82 percent. In this sense inventory dynamics account for a sizable fraction of the dynamics of imports in the data. Clearly, these results understate the role of inventories, since we have used aggregate inventories to proxy for the stock of imported goods inventories, an admittedly imperfect proxy.[1]

B. Data Sources and Calculations

This specific data series used in the paper U.S. Trade and Inventory Dynamics are described below. The numbers in the opening paragraph were based on the following four data series

- IP: Durable Goods [NAICS] (SA, 2002=100) Federal Reserve, IPMDG@USECON
- IP: Nondurable Manufacturing (SA, 2002=100), IPMND@USECON
- Exports: Nonpetroleum Products (SA, Mil.Chn.2005$) Census, TMXENPH@USINT
- Imports: Nonpetroleum Products (SA, Mil.Chn.2005$), TMMENPH@USINT

Figure 1, Table 1, and Tables A1-A2: Most data are downloaded through Haver. The data series are

[1] We have also run these regression on a longer time series (1972q2 to 2010q3) and find that the R^2 increases from 23 to 46 percent in differences. With the error correction terms, the R^2 increases from 44 to 66 percent.

- IP: Mfr [SIC] (SA, 2002=100), IPMFG@USECON ;
- Real GDP (SAAR, Bil.Chn. 2005$), GDPH@USECON;
- Real PCE: Goods (SA, Bil.Chn. 2005.$), CTGH@USECON;
- Real PCE: Durable Goods (SAAR, Bil.Chn. 2005$), CDH@USECON;
- Real PCE: Nondurable Goods (SAAR, Bil.Chn. 2005$), CNH@USECON;
- Real Private Nonres. Invest: Equip. & Software (SAAR, Bil.Chn. 2005$), FNEH@USECON;
- Real Private Investment: Software (SAAR,Bil.Chn. 2005$), FNENSH@USECON;
- Real Change in Private Farm Inventories (SAAR, Bil.Chn. 2005$), VFH@USECON;
- Real Exports of Goods (SAAR, Bil.Chn. 2005$), XMH@USECON;
- Real Imports of Goods (SAAR, Bil.Chn. 2005$), MMH@USECON;
- Real Mfr & Trade Inventories: All Industries (EOP, SA, 2005$), TITH@USECON;
- Real Mfr & Trade Sales: All Industries (SA, 2005$), TSTH@USECON;

We measure final expenditures, $Y_t^T = \alpha\left(I_{EQ,t} + C_{D,t}\right) + (1-\alpha)\, C_{ND,t}$ where $I_{EQ,t} = I_{EQS,t} - I_S$ and I_{EQ} =Investment in Equipment, I_{EQS} =Investment in Equipment and Software, I_{EQ} =Investment in Software, C_D =Consumption of Durables, C_{ND} =Consumption of Non-durables and α is share of durables in total nonpetroleum imports and is measured as the average share from 2003 to 07, or

$$\alpha = \frac{1}{5}\sum_{t=2003}^{2007} M_t^D / M_t = 0.70,$$

where M^D is annual real imports of durables and M_t is annual real non-petroleum imports (from the BEA table 4.2.6, \$2005). Note, relative to all imports (including petroleum), the durable share is approximately 0.60.

Figure 2 and Table A5.

Here we plot dynamics of imports, sales, and inventory of imported autos.

- Sales = from Ward's automotive: U.S.: Imported Car Sales ex Canada & Mexico (NSA, Units) + U.S.: Imported Light Truck Sales ex Canada & Mexico (NSA, Units). The Sales series is seasonally adjusted using the Board of Governors' Combined Seasonal, Trading-day Factor for Imported Auto Sales.
- Imports = downloaded from the USITC based on selected Harmonized codes for passenger cars and light trucks from the Census. Measured as total imports minus imports from Mexico and Canada. Seasonally adjusted using the X-12.

- Inventory = from Ward's automotive: U.S.: Imported Light Vehicle Inventory ex Canada & Mexico (NSA, Units). Seasonally adjusted using the X-12.

Figure 3, Table 2, and Table A4.

Here we plot wedges

- Final Expenditure is the same as in Figure 1.
- Real Imports of Nonpetroleum Goods (SAAR, Bil.Chn.2005$) MMXPH@USNA
- PCE Excluding Energy Goods & Services: Chain Price Index (SA, 2005=100) JCXEG@USECON
- Personal Consumption Expenditures: Durable Goods: Chain Price Index(SA,2005=100) JCD@USECON
- Private Nonres Investment: Equipment & Software: Chain Price Index(SA, 2005=100) JFNE@USECON
- Imports: Nonpetroleum Goods: Chain Price Index (SA, 2005=100) JMMXP@USNA
- Real Manufacturing & Trade Inventories: All Industries (EOP, SA, Mil.Chn.2005$) TITH@USECON
- We define the relative price of imports to absorption as the case in which each term is in logs and the weights are chosen so that durables, non-durables, and capital have equal weights.

$$p = JMMXP - (JCXEG + 3xJCD + 2xJFNE)$$

Table A3, Panel A: The data for these calculations are:

- IP: Durable Goods Mfg Ex. Motor Vehicles/Parts (SA, 2002=100), IPMDXMV@USECON;
- IP: Motor Vehicles and Parts (SA, 2002=100), IPG61T3@USECON;
- IP: Nondurable Mfr (SA, 2002=100), IPMND@USECON.

Table A3, Panel B: The data for these calculations are:

- IP: Motor Vehicles and Parts (SA, 2002=100), IPG61T3@USECON;
- Exports: Autos, Parts and Engines (SA, Mil.Chn.2005$), TMXEAVH@USECON;
- Imports: Autos, Parts, and Engines (SA, Mil.Chn.2005$), TMMEAVH@USECON;
- Real Sales: Mfg: Motor Vehicles & Parts (SA, Mil.Chn.2005$), TSMG6MH@USECON.
- Real Sales: Retail Trade: Motor Vehicle & Parts Dlrs (SA, Mil.Chn.2005$), TSRI1H@USECON

Table A1: Elasticity of Trade in Previous Recessions

	A. HP = 1600		B. Linear		C. HP = 10^5		D. Raw data	
Imports	Median	2009Q2	Median	2009Q2	Median	2009Q2	Median	2009Q2
GDP	4.7	5.3	4.6	4.6	4.3	4.3	3.2	7.6
Industrial Production	1.6	1.6	1.6	1.6	1.6	1.6	1.4	1.4
Expenditure on tradeables	2.4	1.7	2.3	1.6	2.1	1.7	1.7	1.7
Exports								
GDP	3.3	5.2	2.8	3.3	2.6	3.0	5.7	5.7
Industrial Production	1.5	1.5	1.0	1.2	1.0	1.1	0.9	1.1

Notes: Imports are measured from start of recession based on the NBER dates. Exports are measured as the change from the peak, which may be after the recession has started. Median denotes the median (across all recessions) response of the variable in question and 2009Q2 denotes the dynamics in the current recession. Three seperate detrending methods were used. HP=1600 denotes applying an HP filter with a smoothing parameter of 1600; Linear stands for removing a linear trend; and HP=10^5 stands for HP filtered with a smoothing paramter of 100000. Thus, all drops are measured relative to the trend. Raw data are the unfiltered data.

Table A2: Summary Statistics on U.S. Business Cycles

	Standard Deviation (relative to IP)	Correlation with IP	Autocorrelation
Industrial Production (%)	3.6%	1.00	0.89
Exports	1.5	0.52	0.74
Imports	1.6	0.81	0.75
GDP	0.4	0.90	0.87
Expenditures onTradeables	0.9	0.87	0.87
Consumption on Goods	0.6	0.75	0.84
Consumption Durables	1.2	0.71	0.77
Consumption Non-durables	0.3	0.71	0.84
Investment on Equipment	1.5	0.89	0.90

Notes: Based on quarterly NIPA data from 67:1 to 10:3. Data are HP filtered with a smoothing parameter of 1600.

Table A3: Alternate Measures of Trade Volatility

A. Adjusting Trade Weights for Durables and Motor Vehicles (Quarterly)*

		Correlation with				
	SD (rel to IP)	IP	IP TW	Exports	Imports	Autocorrelation
Industrial Production	3.6%	1.00	0.98	0.58	0.86	0.89
Industrial Production (TW)	1.10	0.98	1.00	0.48	0.90	0.87
Exports	1.46	0.58	0.48	1.00	0.34	0.85
Imports	1.63	0.86	0.90	0.34	1.00	0.84

B. Industry Analysis of Motor Vehicles and Parts (Monthly, 94M1 to 10M10)**

		Correlation with				
	SD (rel to IP)	IP	Exports	Imports	Shipments	Autocorrelation
Industrial Production (IP)	8.2%	1.00	0.82	0.86	0.88	0.82
Exports	1.20	0.82	1.00	0.91	0.69	0.88
Imports	1.27	0.86	0.91	1.00	0.76	0.90
Mfr Shipments	0.83	0.88	0.69	0.76	1.00	0.75
Retail Sales	0.51	0.55	0.48	0.58	0.52	0.64

Notes: * Based on quarterly data from 72Q1 to 10Q3. HP-filtered with a smoothing paramter of 1600. IPTW uses 2003 to 2007 trade weights on durables excluding motor vehicles, motor vehicles, and nondurables.

** Based on monthly data from 97M1 to 10M10. HP filtered with a smoothing paramter of 14400. Industrial Production: Motor Vehicles and Parts (SA, 2002=100); Exports: Automotive Vehicles, Parts and Engines (SA, Mil.Chn.2005$); Imports: Automotive Vehicles, Parts, and Engines (SA, Mil.Chn.2005$) Real Sales: Mfg: Motor Vehicles & Parts (SA, Mil.Chn.2005$). Real Sales: Retail Trade: Motor Vehicle & Parts Dlrs (SA, Mil.Chn.2005$)

Table A4: Import Demand Regressions
(1997q1 to 2010q3)

	I	II	III	IV
$\Delta c(t)$	1.04	1.11	1.01	0.74
	6.25	7.52	5.45	4.88
$\Delta p(t)$	1.44	1.13	1.54	0.70
	4.10	3.50	4.37	2.46
$\Delta x(t)$		1.28		1.39
		3.76		4.74
m(t-1)			-0.33	-0.66
			-3.04	-5.66
c(t-1)			0.39	0.86
			2.84	5.62
p(t-1)			0.38	0.18
			1.46	0.89
x(t-1)				2.20
				5.42
# obs.	54	53	54	53
R^2	0.60	0.70	0.66	0.82

Note: t-stats below point estimates