

Inside the Global Supply Chain

Production, Trade, Inventories and a New Demand Model for Industrial Real Estate

Overview

Readers of AMB's research reports are familiar with the long-standing and strengthening linkage of GDP and trade with the demand for industrial real estate. The purpose of this report is to take the study of trade's role as a predictor of net absorption of industrial real estate to a new level of refinement.

Our model presents a holistic view of the supply chain and its impact on industrial real estate demand. While variations in trade are the fundamental drivers of demand for industrial real estate, production and inventory levels are also highly correlated with trade and are important indicators of this demand. By studying the interaction of trade with production and inventory levels, we believe our model provides greater accuracy into the turning points and forecasts of demand for industrial space.

Three important findings are indicated by our analysis:

- Production, trade and inventories have fallen to unsustainably low levels. From their peak, they have declined by double digits, while consumption has decreased by just 1.9%. **Production and trade must rebound in order to restock inventories and to meet even baseline demand for goods.**
- **Production and trade are in fact rebounding globally.** The major economies have exhibited positive growth trends in trade and industrial production in recent months. These trends are precursors to sustained inventory growth and increased industrial real estate demand.
- **Consensus trade forecasts imply 2010 U.S. net absorption of more than 100 million square feet and 500 million square feet globally** – a complete turnaround following negative absorption of 225 million square feet through the first three quarters of 2009.

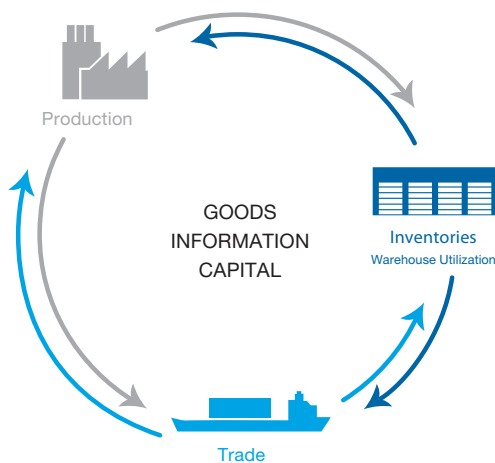
Our new demand model illustrates the movement of goods and quantifies the magnitude and direction of these key variables with the demand for industrial real estate. This report is a useful tool for those who want to examine these relationships as we emerge from an unprecedented global financial and real estate crisis relative to historic behavior and correlations.

The Model

Supply Chain Components

Exhibit 1 depicts the fundamental flows within the heart of the supply chain; where goods, information and capital flow freely between production, trade and inventories. For this research, we define **production** as the manufacturing component of U.S. industrial production; **trade** is expressed as the sum of imports and exports in real (constant) U.S. dollars; and **inventories** are private inventories in real (constant) U.S. dollars, as defined by the Bureau of Economic Analysis. Generally, once a product has been manufactured, it moves through a distribution center either to be consumed domestically or it is exported for further assembly, then end-use. Imports also flow into warehouses and/or production as well. Finally, goods flow from warehouses into production and exports. All three components are inherently interconnected globally.

Exhibit 1: Supply Chain Back End
Flow of Goods, Information and Capital¹



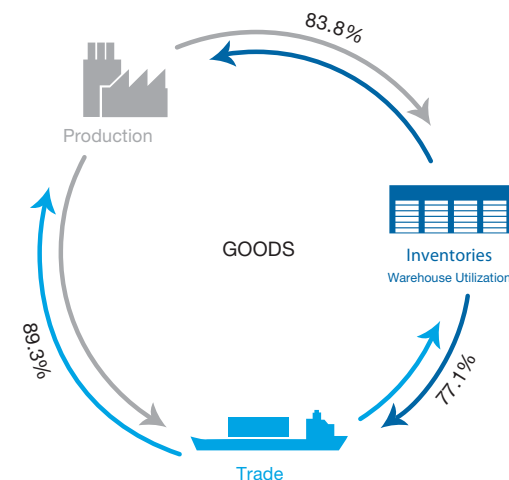
Source: AMB Property Corporation

Correlation and Causation

First, to test our hypothesis we examined the correlation of the annual flow of real goods between these supply chain

components for the period of 1990-2008. As expected, our findings indicate there is a compelling linkage of greater than 77% (Exhibit 2). Second, we studied the causation between all three indicators; the results clearly identified multidirectional causation (Appendix A). This means that these three indicators are predictive of one another, and it is apparent that changes in production and trade lead to changes in inventory levels. While inventories have had a longer-term (two-year) lead on production, longer-term cyclical draw downs or increases are eventually met with production changes. We see evidence of this today, as production and trade are in the early stages of recovery, and inventories have continued to contract in many countries, albeit at a slower pace.

Exhibit 2: Correlation
Real Annual Flows 1990-2008



Source: Moody's Economy.com and AMB Property Corporation

Correlation with Industrial Real Estate Demand

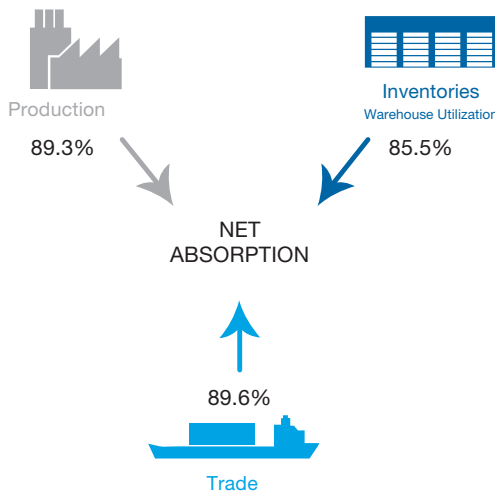
Exhibit 3 illustrates the correlation of production, trade and inventory growth with demand for industrial real estate (net absorption as a percent of stock). The correlation between these indicators is significant, with correlation ranging between 85% and 89%; the causation analysis suggests that trade and production are the primary drivers of net absorption. The

¹ The earliest stages of the supply chain are often the extraction and transportation of raw materials and commodities that drive the initial phase of production; this first stage has very little impact on the demand for industrial real estate, and as such we begin our analysis further downstream. However, the theoretical flow between trade and production in these early stages is the same as in the later stages depicted in Exhibit 1.

relationship between inventories and net absorption is also highly correlated, but the existence of causation is difficult to imply; possibly because utilization levels and inventory flows vary throughout both sides of an economic cycle.

The next step in this analysis entailed using linear regression models to equate historical changes in production, trade and inventory levels with changes in industrial real estate demand. With R²s ranging between .73 and .79 (Appendix B), each of the three factors individually explain between 73% and 79% of the historical variation in net absorption (1990-2008), and as such, each should be considered a solid indicator of industrial real estate demand.

Exhibit 3: Correlation with Industrial Real Estate Demand
Real Annual Flows 1990-2008



Source: Moody's Economy.com, CBRE Econometric Advisors and AMB Property Corporation

While production, trade and inventory levels have a strong linear relationship with each other and with demand for industrial real estate, much has changed in the past year and a half. Exhibit 4 shows the change in each component from peak levels through 2Q09 and their subsequent recovery in the third quarter.

Interpreting the Results

While U.S. consumption and net absorption have decreased by about 2% from their peaks, production and trade have declined

Exhibit 4: Peak-to-Recovery (as of 3Q09)

	Peak Quarter	% Change Peak-to-2Q09	% Change 2Q09/3Q09
Real Consumption	2007 Q4	-1.9%	0.8%
Real Production	2007 Q4	-16.0%	2.0%
Real Trade	2008 Q2	-17.0%	3.7%
Real Inventories	2008 Q1	-6.9%	-1.9%
Absorption (% of Stock)	2007 Q4	-2.0%	-0.4%

Source: Moody's Economy.com, CBRE Econometric Advisors and AMB Property Corporation

by more than 16%. Real inventories are down a more modest 6.9%; however, nominal or current inventories have fallen by 13.7% from their peak in 2Q08. It is apparent that trade, production and inventories have fallen much farther than would be warranted by consumption (demand). **However, production and trade are beginning to recover as indicated in Exhibit 4.**

We believe these variables will continue to rebound, as there is no evidence that the structural relationship between these variables has changed. They are the foundation of the global supply chain, and the relationship between production, trade and inventories is a long-standing one and has evolved over many decades. Goods will continue to be produced and will need to be stored and distributed. Trade continues to serve as a means of raising productivity and lowering overall costs, and in our previous paper we demonstrated that it will continue to grow at a multiple to GDP of more than 3 times.

While improving by 33% over the prior quarter, net absorption was negative 50 million square feet, bringing the year-to-date total to a negative 225 million square feet, the biggest annual decline on record. We expect the fourth quarter to show greater improvement though absorption may still be negative.

Furthermore, we believe the rebound in production and trade is occurring globally. In fact, it is now readily apparent that they have turned the corner, and after nearly a year and a half of deep decline, production and trade are showing consistent positive gains around the world (Exhibit 5).

The global turn of these variables is indicative of global

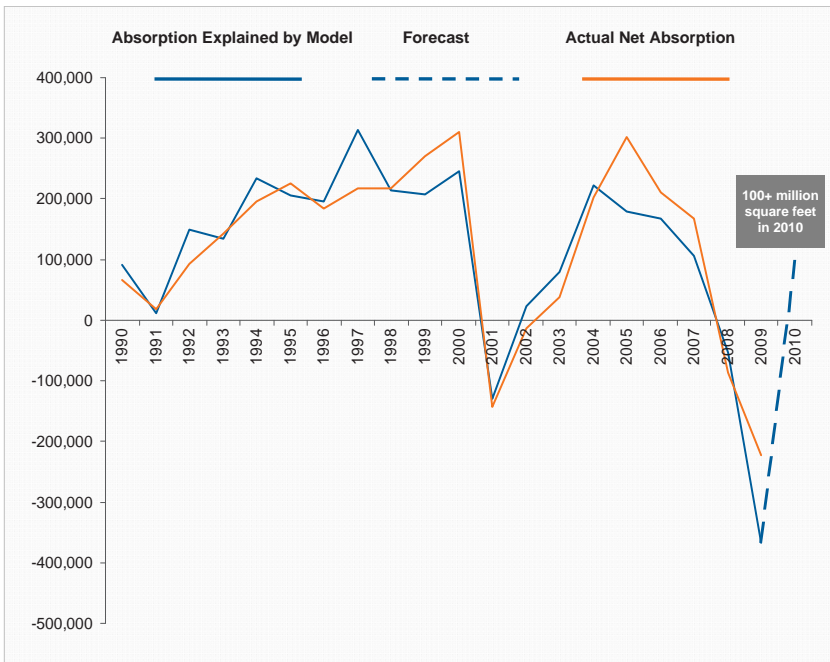
Exhibit 5: Trade and Production Are Rebounding

Data is seasonally adjusted and reflects most recent data available.
Trade data is reported in the nominal respective local currency.

	Trade		Production	
	Period	Increase	Period	Increase
U.S.	Apr-Aug	6.2%	Jul-Sep	2.8%
Canada	May-Aug	4.5%	May-Aug	6.2%
Mexico	May-Sep	11.2%	Jun-Aug	2.6%
China	Feb-Sep	27.3%	Nov-Aug	23.0%
Japan	Feb-Sep	25.4%	Feb-Aug	20.7%
Korea	May-Sep	21.4%	Dec-Aug	26.6%
Singapore	Jun-Sep	11.3%	Mar-Sep	21.0%
France	Jun-Aug	5.1%	Apr-Aug	5.3%
Germany	May-Aug	5.5%	Apr-Aug	6.3%
UK	May-Aug	2.9%	Aug	n/a

Source: Moody's Economy.com, Haver Analytics and AMB Property Corporation

Exhibit 6: Production and Trade Imply Positive Net Absorption in 2010



Source: Moody's Economy.com, Macroeconomic Advisors, CBRE Econometric Advisors and AMB Property Corporation

stabilization in consumption and GDP, and of the large cuts in production, trade and inventories at the height of uncertain times. The turn suggests that production and trade are now in recovery and need to make up some lost ground. Growth in production and trade will result in restocking and positive net absorption. The first wave of restocking goes into filling existing space that is currently underutilized. It is only after buildings fill up – and we have some time to go before that occurs – that we will see demand for incremental new space.

2010 Forecast

The 2010 U.S. consensus estimate for industrial production is currently 3.5%, and the leading independent forecasts² call for trade growth of 5.4% to 7.7%. **Ignoring inventory levels, as they are difficult to forecast, but are on the verge of rebuilding, our model indicates net absorption of more than 100 million square feet as shown in Exhibit 6.**

If the rebound outlined in Exhibit 5 continues with momentum, there will most certainly be further revisions to the consensus and forecasts, as there have been for the last four consecutive months in the case of production and trade. This would indicate an upside variance to the model, which we will update with fourth-quarter actual production, trade, inventory and net absorption data when it becomes available.

² There are a limited number of companies that forecast real U.S. trade flows. For this paper we utilized the forecasts of Moody's economy.com and Macroeconomic Advisors. Moody's has been a long-time economic data provider to AMB, however Moody's does only nominal forecasts of future U.S. trade, and the model was built with real trade flows. Macroeconomic Advisors is one of the only companies we know that offers real trade forecasts, and therefore we implemented their data as well. Interestingly, the real trade forecasts are higher and result in a larger absorption forecast.

Appendix A

The Granger causality test is a regression between time-lagged values of one variable on non-lagged values of another variable. If the regression coefficients are statistically different than zero, it implies the lagged variables are in effect, predictors of the un-lagged variable at a given level of significance (5-10%). We ran annual and quarterly lagged tests, over varying one two and three quarter and year lags. Presented below are the results for quarterly data with two quarters of lag.

Quarters Lagged	Null Hypothesis	Observations	F-Statistic	Probability Reject
2	Net Absorption/Stock does not Granger Cause Production	56	0.3	75.8%
2	Net Absorption/Stock does not Granger Cause Real Exports	56	5.9	0.5%
2	Net Absorption/Stock does not Granger Cause Real Imports	56	1.5	24.2%
2	Net Absorption/Stock does not Granger Cause Real Inventories	45	5.4	0.8%
2	Net Absorption/Stock does not Granger Cause Real Trade	56	5.8	0.5%
2	Production does not Granger Cause Net Absorption/Stock	56	8.4	0.1%
2	Production does not Granger Cause Real Exports	56	6.2	0.4%
2	Production does not Granger Cause Real Imports	56	6.2	0.4%
2	Production does not Granger Cause Real Inventories	45	14.0	0.0%
2	Production does not Granger Cause Real Trade	56	11.8	0.0%
2	Real Exports does not Granger Cause Net Absorption/Stock	56	3.7	3.3%
2	Real Exports does not Granger Cause Production	56	5.8	0.5%
2	Real Exports does not Granger Cause Real Imports	56	5.6	0.7%
2	Real Exports does not Granger Cause Real Inventories	45	11.8	0.0%
2	Real Exports does not Granger Cause Real Trade	56	2.2	12.3%
2	Real Imports does not Granger Cause Net Absorption/Stock	56	7.2	0.2%
2	Real Imports does not Granger Cause Production	56	1.3	27.4%
2	Real Imports does not Granger Cause Real Exports	56	2.6	8.7%
2	Real Imports does not Granger Cause Real Inventories	45	36.5	0.0%
2	Real Imports does not Granger Cause Real Trade	56	2.2	11.8%
2	Real Inventories does not Granger Cause Net Absorption/Stock	45	0.9	42.1%
2	Real Inventories does not Granger Cause Production	45	3.1	5.7%
2	Real Inventories does not Granger Cause Real Exports	45	1.2	32.2%
2	Real Inventories does not Granger Cause Real Imports	45	0.7	48.2%
2	Real Inventories does not Granger Cause Real Trade	45	4.6	1.5%
2	Real Trade does not Granger Cause Net Absorption/Stock	56	6.0	0.5%
2	Real Trade does not Granger Cause Production	56	4.6	1.5%
2	Real Trade does not Granger Cause Real Exports	56	2.3	11.6%
2	Real Trade does not Granger Cause Real Imports	56	5.0	1.0%
2	Real Trade does not Granger Cause Real Inventories	45	26.2	0.0%

Appendix B

Dependent Variable: Absorption as a Percent of Stock				
Method: Least Squares				
Date: 09/02/09 Time: 10:57				
Sample: 1990 2008				
Included observations: 19				
	Coefficient	Std. Error	t-Statistic	Prob.
Real Trade Growth	0.209124	0.015931	13.12672	0
R-squared	0.779992	Mean dependent var	0.012346	
Adjusted R-squared	0.779992	S.D. dependent var	0.011015	
S.E. of regression	0.005167	Akaike info criterion	-7.642041	
Sum squared resid	0.00048	Schwarz criterion	-7.592333	
Log likelihood	73.59939	Hannan-Quinn criter.	-7.633628	
Durbin-Watson stat	1.678329			
Dependent Variable: Absorption as a Percent of Stock				
Method: Least Squares				
Date: 09/02/09 Time: 10:58				
Sample: 1990 2008				
Included observations: 19				
	Coefficient	Std. Error	t-Statistic	Prob.
Real Inventory Growth	0.522078	0.043662	11.95717	0
R-squared	0.739897	Mean dependent var	0.012346	
Adjusted R-squared	0.739897	S.D. dependent var	0.011015	
S.E. of regression	0.005618	Akaike info criterion	-7.474624	
Sum squared resid	0.000568	Schwarz criterion	-7.424917	
Log likelihood	72.00893	Hannan-Quinn criter.	-7.466212	
Durbin-Watson stat	2.577027			
Dependent Variable: Absorption as a Percent of Stock				
Method: Least Squares				
Date: 09/02/09 Time: 10:58				
Sample: 1990 2008				
Included observations: 19				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.003929	0.001617	2.429539	0.0265
Industrial Production Manufacturing Growth	0.292108	0.037236	7.844734	0
R-squared	0.783549	Mean dependent var	0.012346	
Adjusted R-squared	0.770817	S.D. dependent var	0.011015	
S.E. of regression	0.005273	Akaike info criterion	-7.553078	
Sum squared resid	0.000473	Schwarz criterion	-7.453663	
Log likelihood	73.75424	Hannan-Quinn criter.	-7.536253	
F-statistic	61.53985	Durbin-Watson stat	1.451505	
Prob(F-statistic)	0			



About the Author

David C. Twist is vice president, Research for AMB Property Corporation, responsible for the company's global research initiatives. Twist has been in real estate related research since 1990. He is a member of the National Association of Industrial & Office Properties (NAIOP) and the CFA Institute. Twist received a Bachelor's degree in Quantitative Economics from the University of California, San Diego.

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AMB Property Corporation®

Pier 1, Bay 1
San Francisco, CA 94111
United States
Main: +1 415 394 9000
www.amb.com

