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Euro area: beware of the bullwhip effect

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For companies, inventory management is crucial. Too much stock increases operating costs. Too little can lead to shortages. Businesses seek to adjust their inventory levels, arbitrating between safety stocks and costs efficiency. To do so, they forecast their future customer demand. Over the last three years, customer demand forecasting has been particularly challenging. The sudden appetite surge for various goods confronted with rigid supply chains, led to shortages and inflation. Companies rushed to secure their supply of inputs, by overbuilding inventories and reassessing procurement strategies.

Today, the global economy is shifting rapidly from a sharp 2021 economic rebound towards a slowdown. With lower demand growth prospects in sight, companies with overbuilt stocks levels may face an "inventory glut". Such risk could force them to dispatch their merchandise quickly, halting new orders, limiting production, and discounting prices. A form of procyclical "bullwhip effect" — where companies under-order from their suppliers causing a further weaker demand up along the supply chain — may already be in motion in the euro area, which could intensify the economic cycle.

Rising Inventories, slowing demand

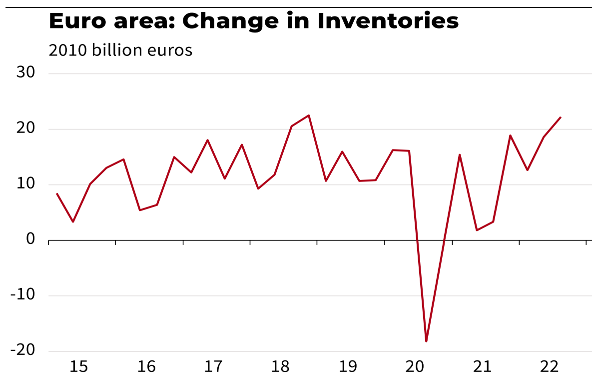
Since the pandemic, companies have stockpiled intermediate and final goods. Following an initial collapse in consumption in 2Q 2020, the fast demand rebound driven by the progressive end of the lockdowns led to supply chain "bottlenecks" and shortages. The result was price pressures, which became very apparent as early as in mid-2021. Note that the demand for manufactured goods (for instance durable goods) also benefited from a shift in consumption patterns in detriment of services, which have been hit harder by the pandemic.

These rapid, and hard to predict, shifting behavioural patterns weigh on firms' abilities to manage their inventories. With strong order backlogs and fragilities in supply chains, companies in the manufacturing sector prioritised self-insurance and over-ordered from their suppliers to stockpile vital inputs. In other words, many

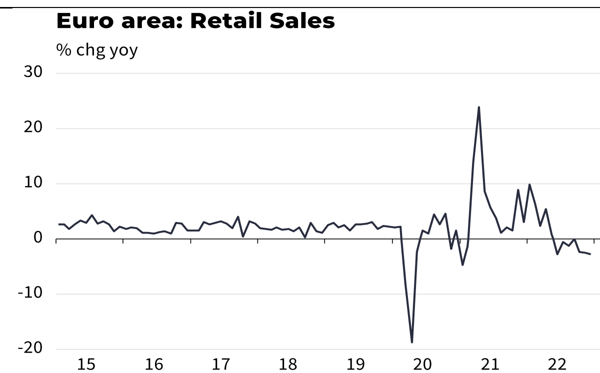
firms chose to switch from a "*just-in-time*" production model to a "*just-in-case*" strategy.

However, since mid-2022, euro area overall inventories have been rapidly improving, leaving companies today with overall relatively well-fed warehouses. As shown below, euro area manufacturing inventories are still expanding as of 3Q 2022.

A sharp increase in inventories change amid an unusual period of sales volatility



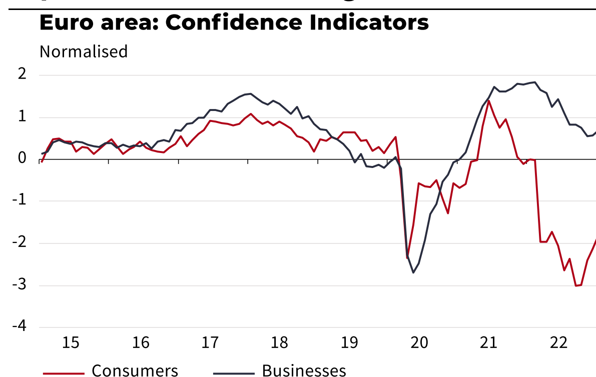
Source: Eurostat, SG Economic and Sector Studies



Source: Eurostat, SG Economic and Sector Studies

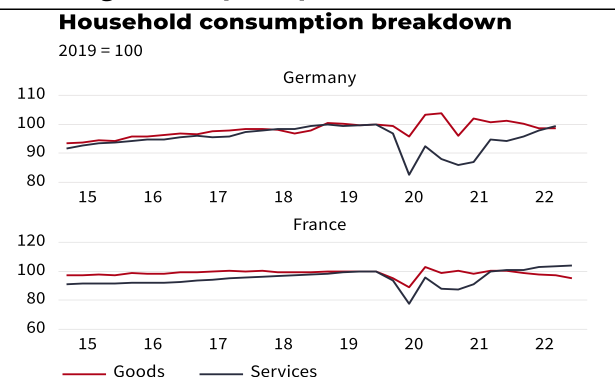
In additon, consumption trends are now weakening, as inflation and policy tightening cripple purchasing power. Since early 2022, inflation, and geopolitical uncertainty have been the centre of interest. To counter inflation, central banks are tightening their financing conditions, while household and business confidence is deteriorating. In such climate, consumption is likely to remain sluggish over the medium term, particularly if unemployment starts to rise over the coming months.

Expectations of decreasing demand



Source: DG ECFIN, SG Economic and Sector Studies

Shifting consumption patterns

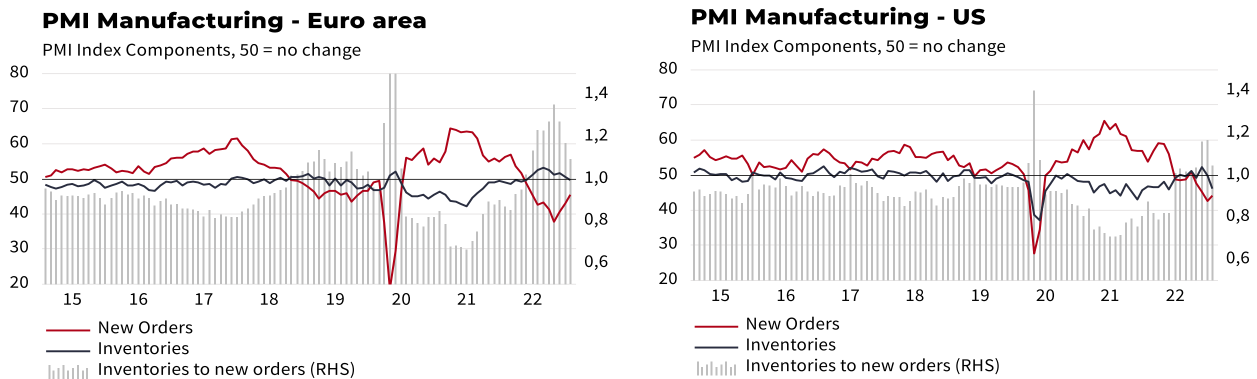


Source: Refinitiv, SG Economic and Sector Studies

The below PMI data indicates that this phenomenon is, so far, quite specific to the euro area and that it has not yet been observed on a macro level in US data. This could be due to different dynamics between the EA and the US in terms of consumption and investment. Both appeared to be more resilient in the US, despite

elevated inflation and rising rates, leading to shorter storage time for many categories of goods.

Dispatching overbuilt inventories: a potential challenge for European corporates



Source: S&P Global, SG Economic and Sector Studies

CORPORATE INVENTORY GLUT IN SIGHT

As inventories stand high and demand weakens, corporates may soon face an inventory glut. Companies left with warehouses full of products they struggle to sell will likely:

- Reduce their respective new orders, as inventories are well-fed.
- Attempt to discount prices to improve sales and dispatch stocks. This, alongside high storage costs and logistical inefficiencies, could also weigh on a firm's profitability.
- The aggregation of this behaviour may also induce a negative shock on economic growth and disinflationary effects.

Nonetheless, this possible inventory glut will not be felt the same way across companies as their ability to forecast future consumer demand depends on several factors, from their position in the supply chain to their degree of vertical integration.

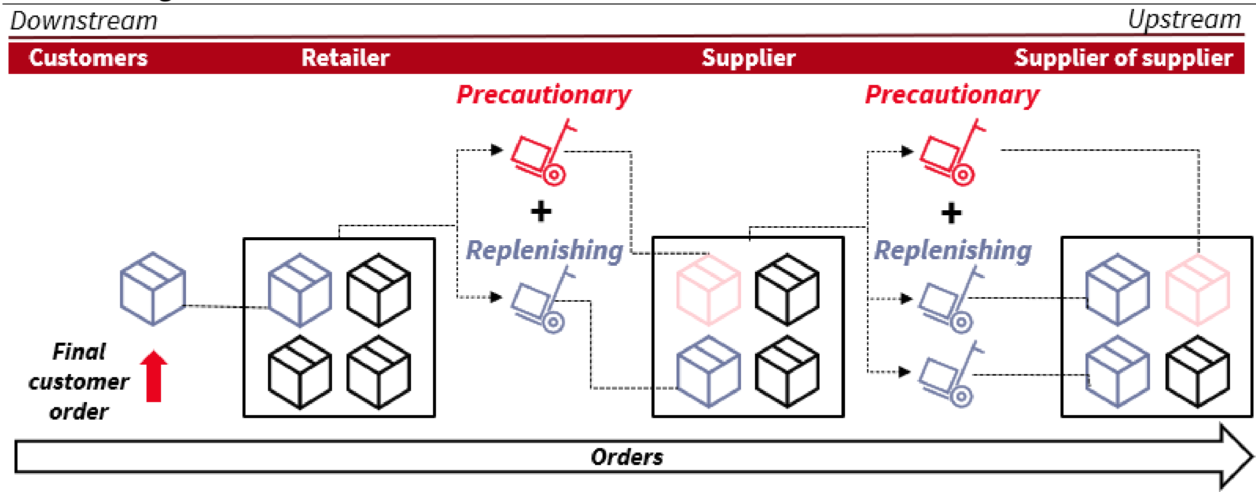
Blurry consumer demand leads to volatile upstream demand

Businesses optimise their inventory levels based on a trade-off between safety stocks and cost efficiency. At the core of this process is customer demand forecasting. Except that, in a supply chain, only some businesses correctly perceive the actual demand. The rest sees distorted derivatives of it, leading to wrong expectations and inventory mismanagement. The result is the so-called "bullwhip" effect.

In supply chain, the "bullwhip" effect refers to a situation where, due to demand anticipation error and precautionary behaviour, a variation in final consumer demand can lead to higher variation in the demand of input-supplying firms. The

variability of demand then amplifies gradually at each stage of the supply chain, making upstream companies and sectors most vulnerable to inventory mismanagements.

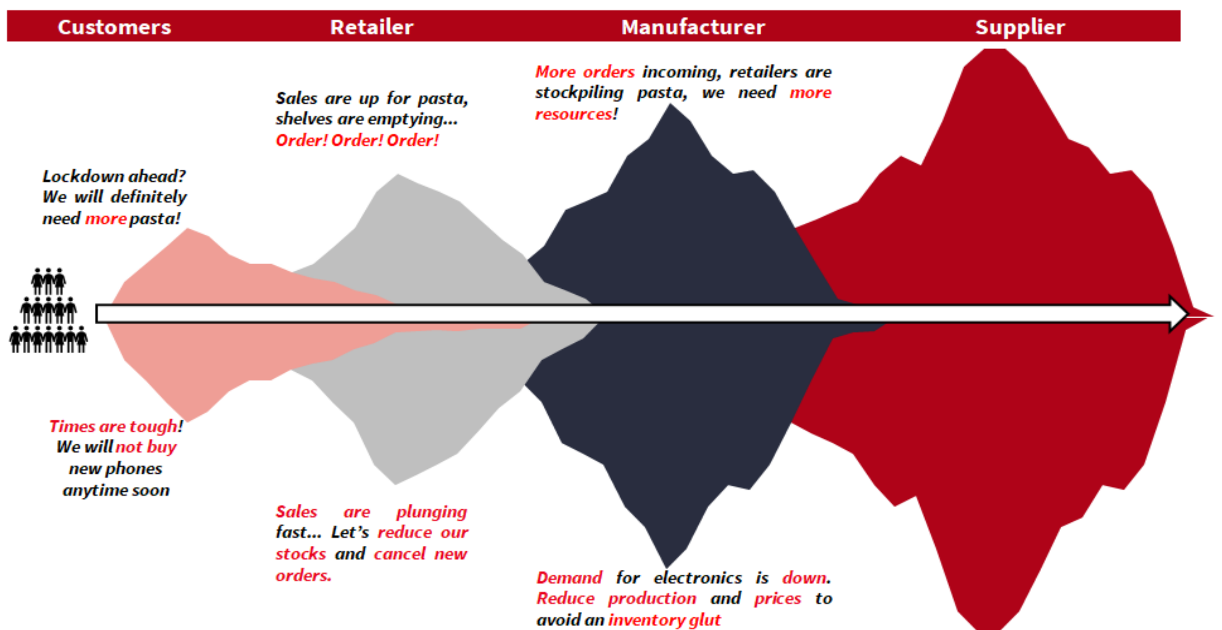
In a demand rush, companies replenish stocks and precautionary stockpile, leading to overordering



Source: SG Economic and Sector Studies

Indeed, when downstream companies –typically retailers– see a spike in demand for specific products, they boost their wholesale orders, trying to avoid empty shelves. Wholesalers then increase their supply orders by more than the perceived demand, as they also hedge against potential unfilled orders. Due to information asymmetry on the actual observed demand, companies over-order along the supply chain, resulting in higher swings in the demand of upstream sectors, as orders are amplified at each step of the supply chain.

Bullwhip effect: a demand amplification phenomenon



Source: SG Economic and Sector Studies

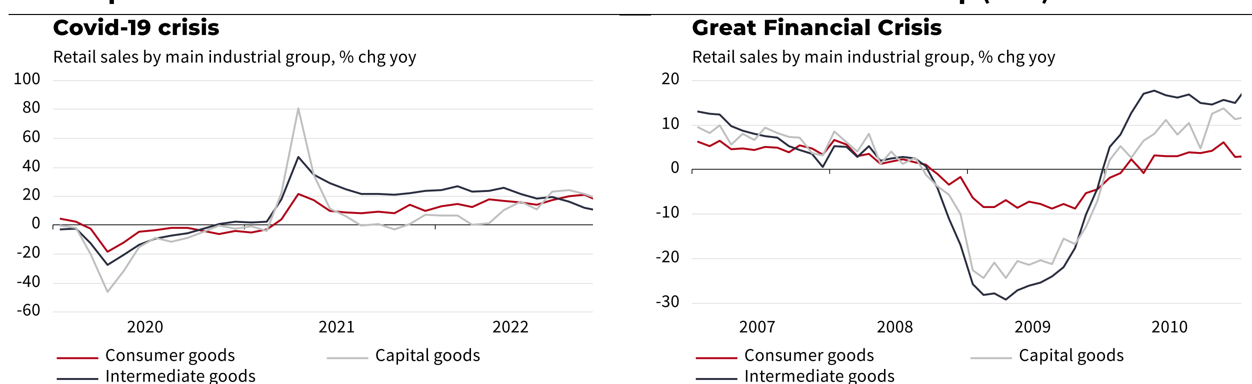
Because of this effect, upstream industries, from manufacturing industries to raw materials suppliers, observe a higher demand and production volatility. Factors such as the degree of vertical integration and the duration of the production process, can further limit order and production smoothing, enhancing this demand variability effect.

It is important to note that upstream reaction to downstream demand can be realised at each supply stage of the chain with a lag, the latter varying depending on the industry. **In this context, it is very possible that production sometimes peaks when the actual observed demand is already in a slowdown, leading to inventory gluts.** On the opposite, in the case of an initial weakening of consumer demand, production may remain sluggish even after the demand has already rebounded (e.g., post-covid 2021).

Although well-documented since the 1960s[1] in the supply chain management literature, the “bullwhip effect” remains quite under-appreciated in economic and financial analyses.

To measure the bullwhip effect with economic data, the variation in sales is observed for three categories of goods: capital goods, intermediate goods, and consumption goods. Capital goods (e.g., machinery) are the products of upstream industries. They are durable goods acquired by downstream sectors for the manufacturing process. Intermediate goods (e.g., plastic) are inputs transformed during the production process, using capital goods, to produce consumer goods. The latter are the products (e.g., wearing apparels) sold to the final customer, at the bottom of the supply chain. Hence, and **following the above definition of the bullwhip effect, the variability of the demand (proxied by real sales) should be the highest for capital goods, and the lowest for consumer goods, because of their respective position on the supply chain.**

Bullwhip effect in times of crisis across the euro area Main Industrial Group (MIG)



Source: Source: Eurostat Short Term Business Statistics, SG Economic and Sector Studies

Overall, during the period ranging from 2002 to 2022, the standard deviation of capital goods sales variation was equal to 9.5% compared with 6.8% for intermediate goods and 3.4% for consumer goods.

[1] *Forrester, J. W. (1961). Industrial Dynamics, MIT Press, Cambridge, Massachusetts.*

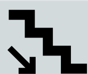
Indeed, following the 2020 shock, a form of severe "bullwhip effect" has been observed in the euro area. Sales for consumer goods fell by 18%, resulting in a 25% fall in sales of intermediate goods. Capital goods, up along the supply chain, fell by 46%. A similar effect occurred symmetrically during the rebound of 2021. While consumer goods sales increased by 21% in March 2021, intermediate goods sales and capital goods sales jumped by, respectively, 37% and 82%. During the Great Financial crisis, a similar pattern has been observed, where reductions in sales for intermediate and capital goods outsized the decrease in sales of consumer goods.
In the current context of rising inventories and lower demand prospects, a worrying destocking for European corporates may be ahead, with data suggesting a higher vulnerability for upstream companies. However, as no sudden economic crash is expected, demand swings should remain manageable.

Risk mitigation factors

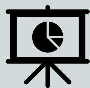
Understanding the roots of the bullwhip effect also helps figuring out elements that can mitigate it. First, as previously mentioned, upstream positioning in a supply chain often limits the visibility of firms on the final consumer demand. One can therefore expect that companies and sectors with better data-sharing capacities between retailers and manufacturers are better armed against the bullwhip effect[2] (e.g., vertically integrated firms).

Second, companies with a diverse range of products and/or clients are less likely to be severely impacted by higher demand variability from a particular segment of the economy (e.g., a diversified international trade exposure can help reduce demand variability). Finally, companies with substantial lead time between order reception and delivery (e.g., semiconductor manufacturers) are more likely to be subject to the bullwhip effect. This is particularly true when customers attempt to anticipate future shortages in production by alternating between periods of over-ordering and order cancellations ("*shortage gaming*[3]").

Factors to consider when analyzing the vulnerability of companies to "bullwhip effect"



Position on the supply chain: Companies that operate upstream in the supply chain or in upstream sectors can face a higher the demand variability.



Portfolio diversification: Companies having concentrated client's portfolio (e.g., in terms of geography/sector) or offering only a narrow range of products are more vulnerable to their clients demand variability.

Manufacturing/lead time: Companies whose products require long manufacturing time need to smooth their orders and production.

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[2] *Altomonte, C., Di Mauro, F., Ottaviano, G., Rungi, A., Vicard, V. (2013). Global Value Chains during the Great Trade Collapse: A Bullwhip Effect? in: Sjoerd Beugelsdijk, Steven Brakman, Hans van Ees and Harry Garretsen (eds.), Firms in the International Economy, MIT Pres s, Cambridge MA.*

[3] *An activity whereby people and companies order more than they need when there is a perceived or real shortage of stock.*

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