From constant prices to chain-linked prices: what consequences?

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Divisions

- Quarterly National Accounts
- Business Survey
- Short-Term Economic Analysis

Until the start of 2007, the volume series of the quarterly national accounts were published in constant base-year prices (in this case, the base year was 2000). To measure economic reality more accurately and meet European Union (EU) requirements, the series will henceforth be calculated at chain-linked prices. The first publication concerned was the set of initial results for Q1 2007, released on May 15, 2007. From now on, "Conjoncture in France" *will therefore be based on these new series.*

Our article reviews the implications of this important change for the reinterpretation of growth and its determinants, and for tools used in short-term forecasting. The study is divided into three parts: (I) description of different concepts used to determine volumes; (II) analysis of the impact of the switch to chain-linked prices on the interpretation of the recent past; (III) examination of implications for econometric forecasting tools.

The transition to chain-linked prices gives a slightly different image of France's recent past: the external-trade contribution to GDP growth is less negative because the new approach allows for the relative decrease in prices of imported capital goods. By contrast, household consumption explains a smaller share of growth. Investment is practically unaffected by the change of concept. For short-term analysis, the adoption of chain-linked prices has an occasional—but marginal—impact on the econometric tools in current use.

I - Chain-linked prices provide a better description of economic reality

There are two ways of measuring economic aggregates: in "nominal" or "value" terms, i.e. at current prices, or in "volume" or "real" terms, i.e., excluding inflation effects. While it is relatively easy to measure volume for a specific product (number of kilograms of peaches, number of units of the same car model, number of visits to the hairdresser, and so on), the procedure is more complex if we are examining an aggregate of different products: how do we add kilograms of peaches and visits to the hairdresser?[1]

Volumes at constant prices are based on data in value terms for a base year (e.g., value of peach consumption), updated by the volume growth rate for each product (e.g., increase in consumption of kilograms of peaches). The resulting volumes are simply summed to obtain an aggregate. The measure called "volume" is thus a variable obtained by applying an earlier-period price to "elementary" volumes.

Until the results published on May 15, 2007, this was the system used in the French quarterly national accounts, 2000 being the reference year. The method made it easy to compute sums or differences between aggregates and preserve accounting identities at all aggregation levels. Here are two examples: (I) if we know the consumption volumes for all goods and services, we can directly calculate total consumption volume by summing the two quantities; (II) in volume terms, the method directly preserves the accounting identity between the sum of supply components (production + imports) and demand components (consumption + investment + exports + changes in inventories).

However, the estimation of aggregates in volume terms at constant prices has a disadvantage: it yields figures that may give an imperfect image of economic reality when we are looking at a year some distance away from the base year. The reason is that the relative weight of each product in a volume aggregate depends on the structure of product prices observed in the base year. But the price structure can change considerably over time. As a result, the greater the distance from the base year, the less each product's relative weight in an aggregate is relevant to describing current economic reality.

For example, "in 2000, household consumption" of sound and image receiving, recording, and reproduction equipment ("HiFi-TV" for short here) accounted for 0.8% of total consumption expenditures on goods and services, in both volume and value terms. Six years later, consumption of these products more than tripled in volume terms.[2] By 2006, given the changes in other products, household consumption of HiFi-TV equipment accounted for 1.7% of their total consumption volume in constant prices. But as the prices of these devices had fallen by half since 2000, their consumption represented only 0.9% of the total in value terms (if we rebased the accounts to 2006, 0.9% is thus the weight we would assign to consumption of HiFi-TV equipment when determining consumption volume for 2007).

An alternative solution, therefore, is to replace volume weights by the value weights observed in the previous quarter or year. We adopted the second approach—based on volumes calculated at chain-linked prices—for French quarterly national accounts starting with the results published on May 15, 2007. There are different well-known techniques for chain-linking quarterly data. We have chosen the annual-overlap method, recommended by Eurostat and used by most EU Member States.

The new method provides a truer description of economic changes. It involves aggregating the "elementary" volumes on the basis of the most recent price structure available—in our case, the previous year's. Chain-linking consists in choosing a reference year (essential for defining levels) and annually updating the structure of relative prices of elementary series (number of kilograms of peaches, of cars, of visits to the hairdresser, and so on). By constructing volume series at chain-linked prices, we can therefore incorporate changes in the aggregates' relative prices over time. But chain-linking deprives us of the additivity property of the elementary series. Similarly, unlike historical series at constant prices, chain-linked prices do not preserve the classic identity, mentioned earlier, between the sum of the economy's sources (GDP + imports) and the sum of final uses (final consumption + investment + exports + changes in inventories). We need to shift to an interpretation in terms of contributions of demand components to GDP growth.

The advantages and drawbacks of the alternative methods for determining aggregates in volume terms are summarized in Table 1.

The transition to chain-linked prices is thus an invitation to analyze the changes in the interpretation of macroeconomic series and in the tools used for short-term analysis.

1. For some sophisticated products with fast-changing technical specifications, such as computers and automobiles, we need to adjust volume for the change in product quality—not always a simple task.
2. In the elementary series, volumes at constant prices are equal, whichever of the two concepts is used.

Table 1
Advantages and drawbacks of switch to chain-linked prices

Advantages		Drawbacks
Additivity of elementary series, allowing easy construction of aggregates and preservation of accounting identities at the aggregate level, particularly suitable for macroeconomic modeling	**Volumes at constant base-year prices**	Growth in aggregates economically less relevant, as it may be disrupted by sharp swings in relative prices of certain elementary products
Growth in aggregates economically more relevant, being based on a price structure by product revised annually	**Volumes at previous-year chain-linked prices**	Loss of additivity property of elementary series

Source: INSEE

II - The switch to chain-linked prices slightly modifies the analysis of the recent past

GDP growth differentials concentrated in the initial quarters

In Q1 2007, French GDP rose 0.5% at chain-linked prices but 0.6% at constant prices, a difference of 0.1 points. The contribution of household consumption expenditures to growth is 0.17 points smaller at chain-linked prices than at constant prices. It is exactly offset by a 0.17-point increase in the contribution of external trade. Changes in inventories contributed 0.1 points to the GDP growth differential.

The overall 0.1-point gap in GDP growth is not negligible, particularly viewed against the differences calculated for the recent period: the quarterly differential over the past seven years (2000-2006) is a modest 0.03 points of growth on average. In the 1980s and 1990s, by contrast, the gaps are wider—in some exceptional cases, as high as 0.3-0.5 points *(Chart 1)*.

A larger contribution from external trade, a smaller one from domestic demand

While the differentials for GDP growth are rather small, demand components are significantly affected by the switch to chain-linked prices, as shown in Chart 2. The gap between chain-linked prices and constant prices represents the contributions of the main GDP components to its growth at chain-linked prices, net of contributions computed in constant prices.

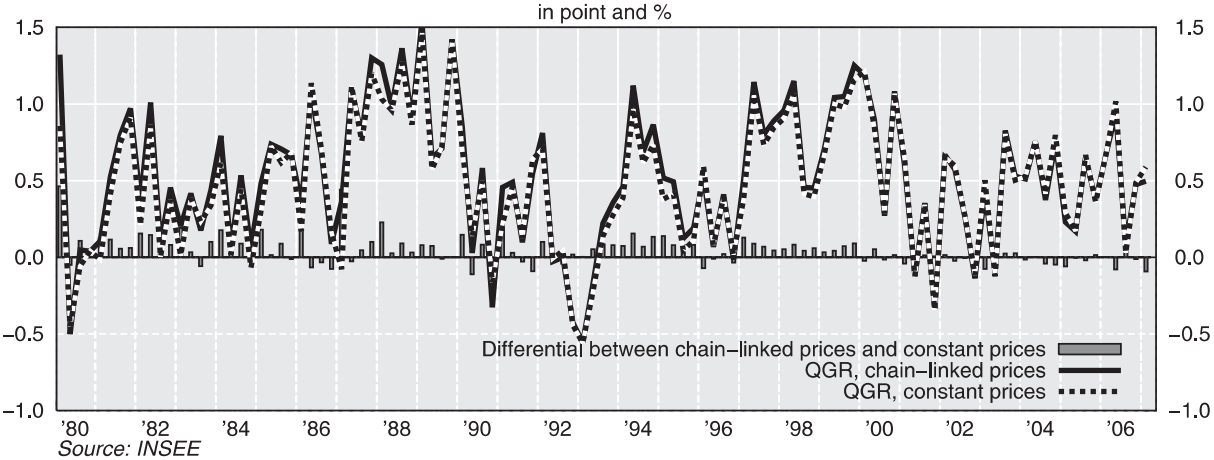
We find substantial differences in the contributions of household consumption and external trade in the recent period: household consumption expenditures contribute less to GDP growth at chain-linked prices than at constant prices. By contrast, external trade explains a larger share of GDP growth. For the other components, notably investment, the impact of the transition to chain-linked prices is virtually negligible.

There is a sizable shift in the breakdown between domestic demand and external trade in the recent past. The switch to chain-linked prices therefore significantly modifies the analysis of the breakdown

1

COMPARISON OF QUARTERLY GROWTH RATES (QGRs) OF GDP in chain–linked prices and constant prices

in point and %



Source: INSEE

of GDP growth: consumption expenditures still drive growth, but to a lesser degree, and France's external trade also has a less negative effect than the analysis at constant prices led one to assume *(Chart 3)*.

Capital goods and consumer goods chiefly explain the differentials in household consumption expenditures

The differentials between quarterly national-accounts estimates at chain-linked prices and at constant prices stem from two factors: (I) in the estimation at chain-linked prices, the price structure changes in the initial quarters of each year; (II) the estimation at chain-linked prices yields a better description of the distortion in the price structure of goods and services that compose the aggregate. Among the set of products consumed by households, the ones that exhibit strong price fluctuations over time create a significant differential between consumption at constant prices and consumption at chain-linked prices. The impact on household consumption was substantial in 2006: the aggregate's average annual growth (i.e., measured against 2005) was 2.3% at chain-linked-prices versus 2.8% in constant prices.

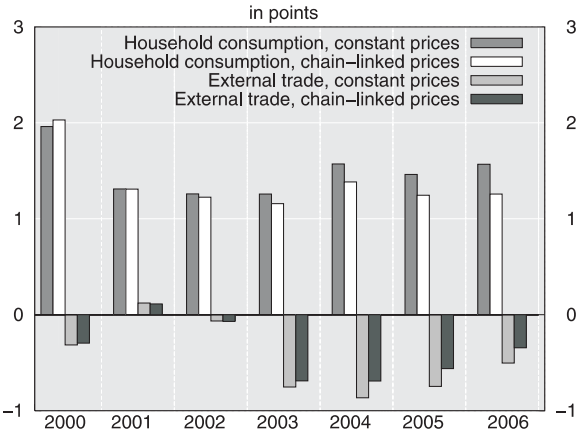
Prices of food products, transportation, construction, and services display fairly weak variance, and the consumption estimates in volume terms for these products are virtually insensitive to the method used. By contrast, for products with strongly cyclical price changes (such as capital goods) or products with volatile prices (such as energy), there can be sizable differences between estimates in chain-linked prices and in constant prices.

Table 2 reports these differences for the period 2000-2007. Capital-goods consumption exhibits the widest gap between chain-linked prices and constant prices, with quarterly growth estimated at 2.9% and 3.3% respectively. The reason is that capital-goods consumption notably comprises electrical and electronic products, whose prices are falling steadily thanks to technological progress. The decline in prices of these goods lessens the weight of capital-goods consumption in the estimation at chain-linked prices.

The same mechanism also applies to consumer goods, which notably include consumer durables. The weaker growth in consumption of these two items at chain-linked prices affects the estimate for manufactured-goods consumption, which posts average quarterly growth of 0.7% in chain-linked prices versus 0.9% in constant prices for 2000-2007.

3

ANNUAL CONTRIBUTIONS OF HOUSEHOLD CONSUMPTION AND EXTERNAL TRADE TO GDP GROWTH (chain–linked prices)



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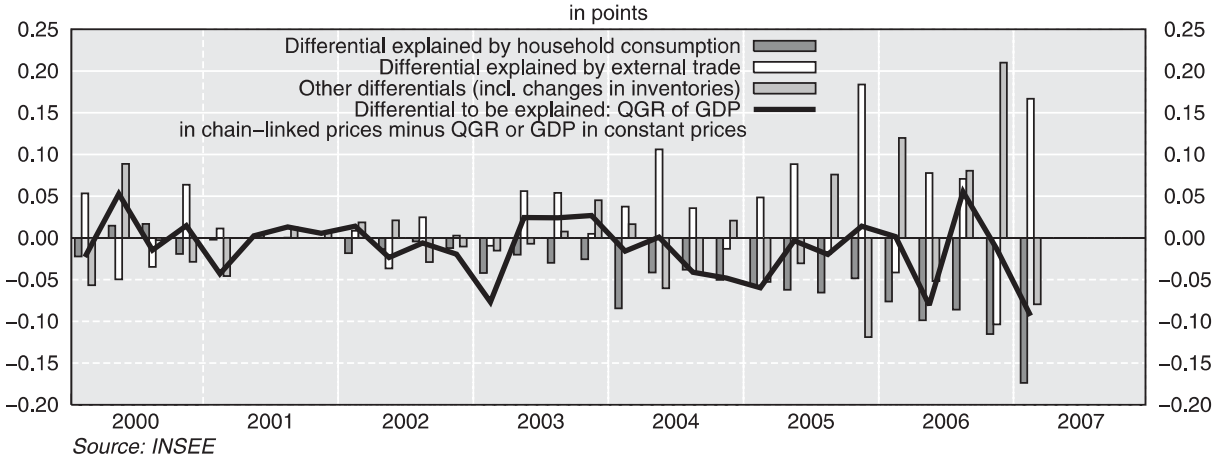
2

BREAKDOWN OF GDP GROWTH: DIFFERENTIALS IN CONTRIBUTIONS (chain–linked prices minus constant prices)



Source: INSEE

*Purchasing Manufacturers' Index

Energy prices do not move in the same patterns as prices of consumer goods and equipment, but their short-term fluctuations, combined with changes in price structure, generate differentials that can be significant in certain quarters. For 2000-2007, we find a total difference of 0.6 points in absolute value. All the other consumption items published at this level of aggregation display very similar movements in chain-linked and constant prices.

Another distinction between chain-linked-prices and constant-prices methodologies is well illustrated by household consumption of manufactured goods: the differentials widen as the distance from the base year increases *(Chart 4)*. For goods and services, the household-consumption growth differential between chain-linked prices and constant prices moved from positive before 2000 to zero in 2001 (by construction) to increasingly negative thereafter. The gaps are typically somewhat wider in the early quarters, as the price structures are changed every year at that time.

Investment differentials are negligible

The switch to chain-linked prices barely modifies the measure of quarterly volume in the total economy's gross fixed capital formation (GFCF). In the recent period, the average differentials between the two measures are negligible and display no specific trend *(Chart 5)*.

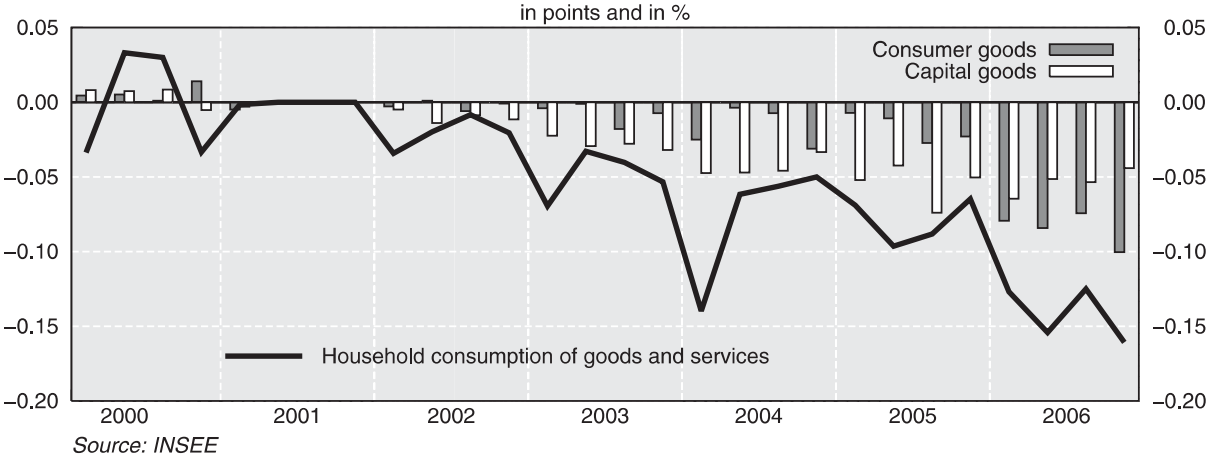
The breakdown of these minimal gaps by broad institutional sector fails to reveal any notable changes. At most, the contribution of total GFCF by non-financial enterprises (NFEs) to GDP growth has been mildly understated since 2005 when measured in chain-linked prices. This reflects a decreased contribution of NFE investment in capital goods. However, the phenomenon is very

Table 2
Main differences between chain-linked prices and constant prices for household consumption items

For the period 2000-2007		Quarterly trend at chain-linked prices (percentage)	Quarterly trend at constant prices (percentage)	Average differential (percentage)	Maximum differential (percentage)
Manufactured goods		0.7	0.9	-0.2	-0.5
of which	Consumer goods	0.8	0.9	-0.1	-0.6
	Automobiles	0.3	0.3	0.0	0.0
	Capital goods	2.9	3.3	-0.4	-1.3
	Intermediate goods	0.2	0.2	0.0	-0.1
Energy		0.0	0.0	0.0	-0.6

How to read this table: Between Q1 2000 and Q1 2007, household consumption of manufactured goods grew at an average quarterly pace of 0.7% in chain-linked prices and 0.9% in constant prices—a negative gap of 0.2 points for the new method. The quarterly growth rate of manufactured-goods consumption in chain-linked prices was up to 0.5 points (in absolute value) below the figure estimated at constant prices.
Source: INSEE

4
DIFFERENTIAL BETWEEN CHAIN–LINKED PRICES AND CONSTANT PRICES: contributions of diffentials in consumer goods and capital goods to total consumption differential
in points and in %



Source: INSEE

modest, besides being partly offset by an increase in the estimated contribution of NFE building and civil-engineering investment.

The decline in capital-goods prices explains external trade's smaller contribution in the recent past

For imports and exports, the average absolute differential in real growth rates at constant prices and chain-linked prices has been running at 0.3 points per quarter since 1978—a relatively mild impact *(Charts 6 and 7)*. The gap has narrowed in recent years, reaching 0.1 points since 2000. For the annual series, the average absolute differentials are 0.4 points for exports and 0.6 points for imports.

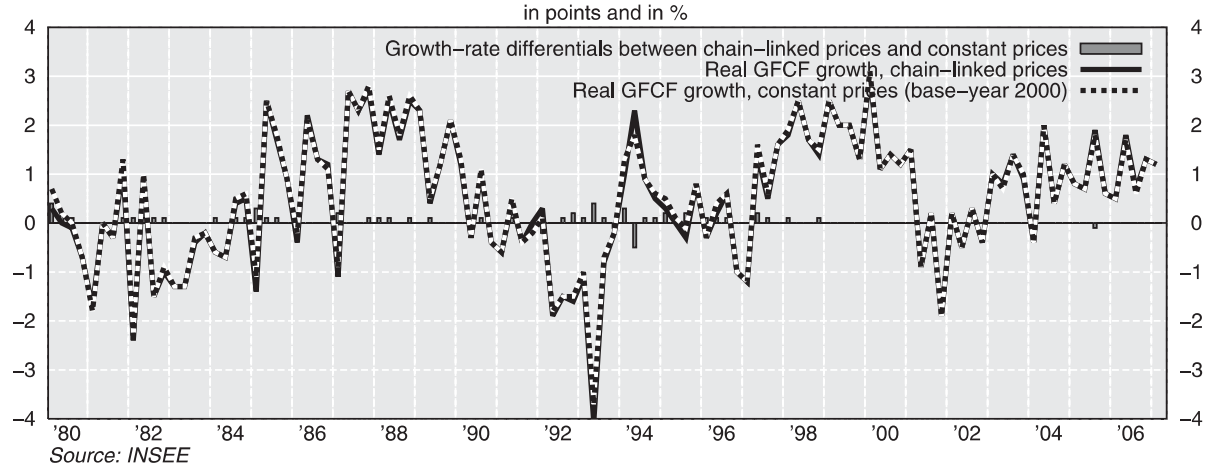
In the recent period, the external-trade contribution to GDP growth has been less negative in chain-linked prices than in constant prices *(see p. 12)* . For example, real export growth in 2006 came to 6.0% in chain-linked prices compared with 6.5% in constant prices, but the reduction in import growth was even greater, at 7.0% versus 7.9%.

As with consumption, the differentials are partly due to the sharp fall in prices of capital goods. Since early 2005, the contribution of capital goods to the growth in merchandise exports has been smaller in chain-linked prices than in constant prices *(Chart 8)*. Given the sizable decline in capital-goods export prices in recent years (2.5% a year on average since 2000), the share of these products in total exports is smaller at chain-linked prices.

Exports of energy products are significantly different in the two measurement systems, but no clear trend emerges. For other exports of goods (and services), we find no major difference in contributions at chain-linked prices and at constant prices.

5

REAL QUARTERLY GROWTH ALL–SECTOR GFCF AT CONSTANT PRICES (base–year 2000) AND CHAIN–LINKED PRICES



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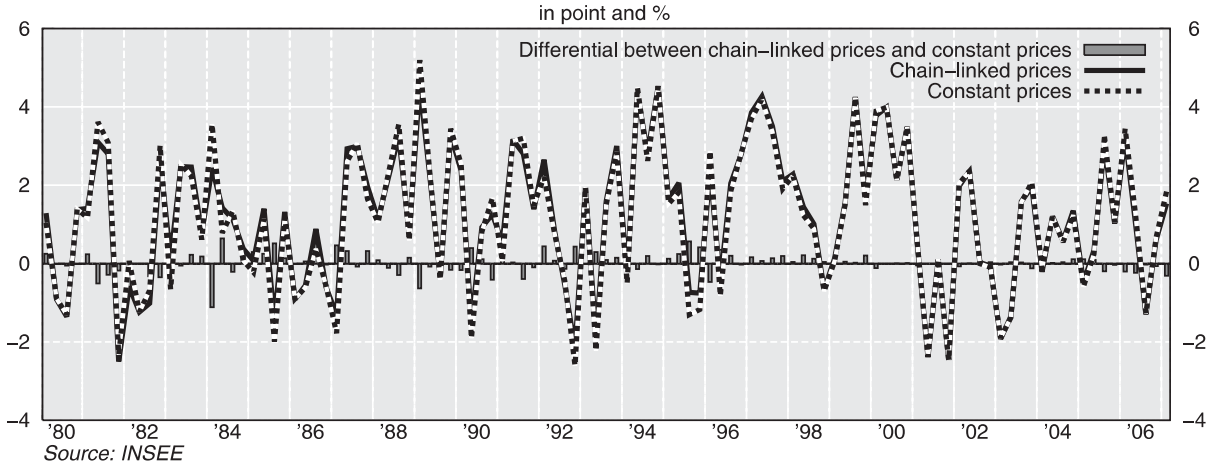
6

COMPARISON OF QUARTERLY GROWTH RATES OF EXPORTS IN CONSTANT PRICES AND CHAIN–LINKED PRICES



Source: INSEE

As with exports, the lesser growth of imports in chain-linked prices is largely due to the weaker contribution of capital goods. Indeed, the contribution differential is even more negative for imports than for exports *(Chart 9)*. This gap reflects the downtrend in prices of imported high-technology products such as computers and cellphones.

The differential in energy-product contributions is significant in the period 1978-2006—averaging 0.3 points in absolute value—but has fallen substantially in the recent period. For other imports, the contribution differentials are negligible, ranging between 0.01 and 0.04 points.

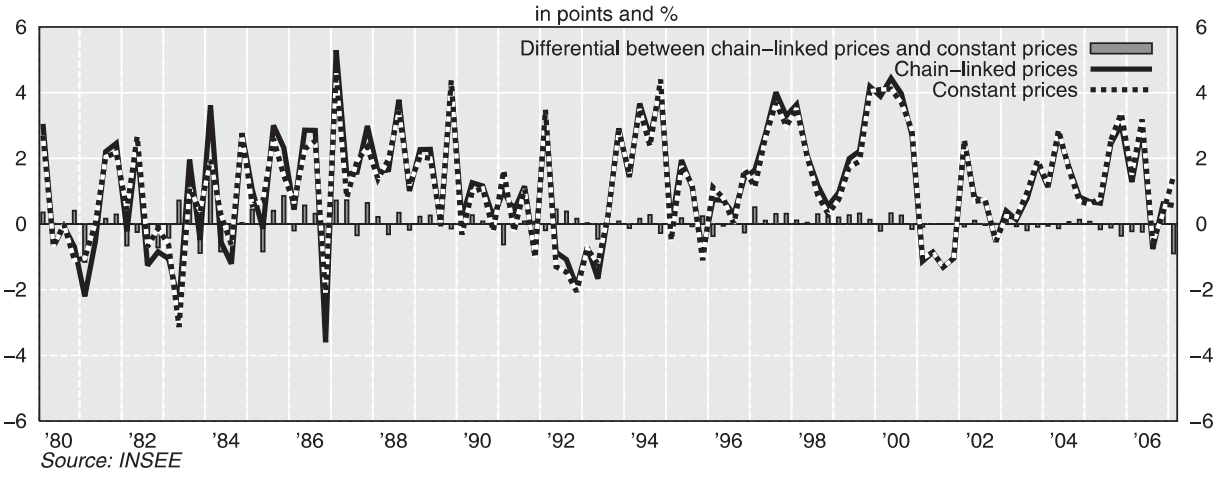
III - Consequences of the switch to chain-linked prices on forecasting tools

The conversion of the quarterly national accounts and "*Conjoncture* in France" to chain-linked prices requires us to re-estimate our forecasting tools on the chain-linked series. One of the main tools is econometric estimation using short-term indicators. For this, we construct equations based on business-trend and household-confidence surveys. The aim is to extract the maximum amount of "leading information" so that we can forecast quarterly aggregates such as GDP and household consumption.

The following analysis assesses the impact of the switch to chain-linked prices on estimation quality. The main results are set out in Table 3. To make them easier to read, we begin by presenting the overall results, indicating whether the conversion to chain-linked prices has had an influence or not.

7

COMPARISON OF QUARTERLY GROWTH RATES OF IMPORTS in constant prices and chain–linked prices



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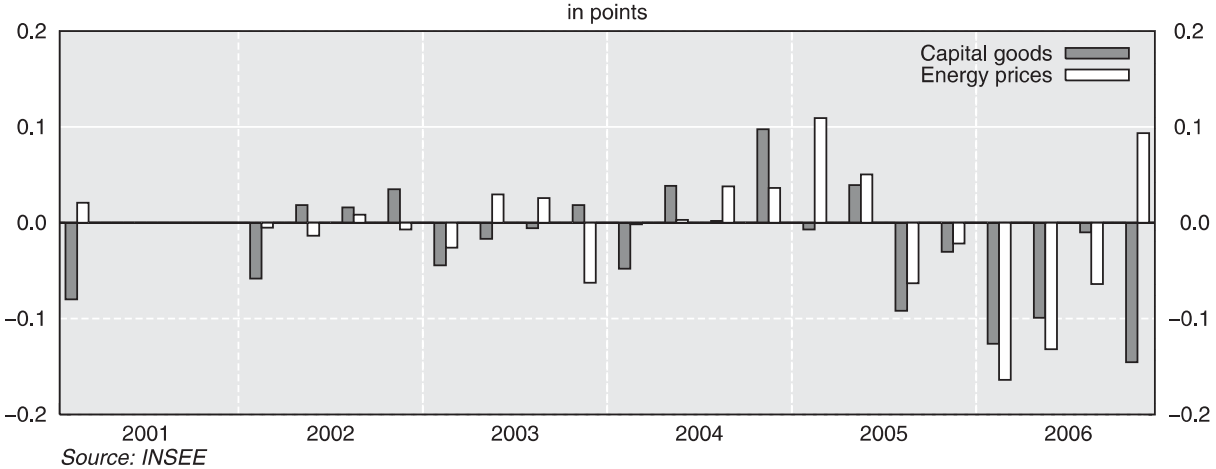
8

DIFFERENTIAL IN QUARTERLY CONTRIBUTIONS OF MERCHANDISE EXPORTS TO GDP GROWTH (chain–linked prices minus constant prices)



Source: INSEE

We then give a fuller description of the models exhibiting differences between chain-linked prices and constant prices.

There is a wide choice of criteria for assessing estimation quality. We have selected RMSE (Root Mean Square Error), which—as its name implies—measures the mean forecasting error. A low RMSE, particularly with respect to the standard deviation of the variable to be explained, denotes that the model possesses a good explanatory quality.

$$RMSE = \left[\frac{1}{N} * (Actual - Estimated)^2\right]^{1/2},$$

where N is the number of data points in the estimation period

Most of the estimates in constant prices remain valid in chain-linked prices: with some exceptions, there is no need to rewrite the model specification or introduce new determinants or remove existing ones. The coefficients associated with the determinants are very close or even, in some cases, identical. The residuals—that is, the differences between the modeled variable and its estimate—display nearly identical profiles. In sum, the switch to chain-linked prices has not had a very significant impact on the tools currently used at INSEE.

There is nothing surprising about this conclusion, given the great similarity in growth rates at chain-linked prices and constant prices for most of the variables studied. In fact, the example of household consumption shows that survey variables and quantitative short-term indicators are more in sync with chain-linked price series than with constant-price series.

In the following section, we comment on the estimations that have been slightly altered by the switch to chain-linked prices.

Few changes in the estimation of household consumption of manufactured goods

The estimation used to forecast quarterly growth in household consumption of manufactured goods (written QGR consump) relies on (1) data from the monthly survey of the situation and outlook in the retail trade (balance of opinion on expected workforce, written EXPWF) and (2) the statistical overhang for growth in household consumption expenditures on manufactured goods in the first month of the quarter (written OVHNG).

For each estimate, the corresponding coefficients in constant prices are shown in parentheses under the coefficients at chain-linked prices. The estimation of the equation in chain-linked prices *(in parentheses: in constant prices)* gives the following results:

QGR consump in quarter q = 0.95
(0.94)

- 0.25 * QGR consump in quarter q-1
(- 0.26)

- 0.15 * QGR consump in quarter q-3
(0.15)

- 0.26 * QGR consump in quarter q-4
(- 0.25)

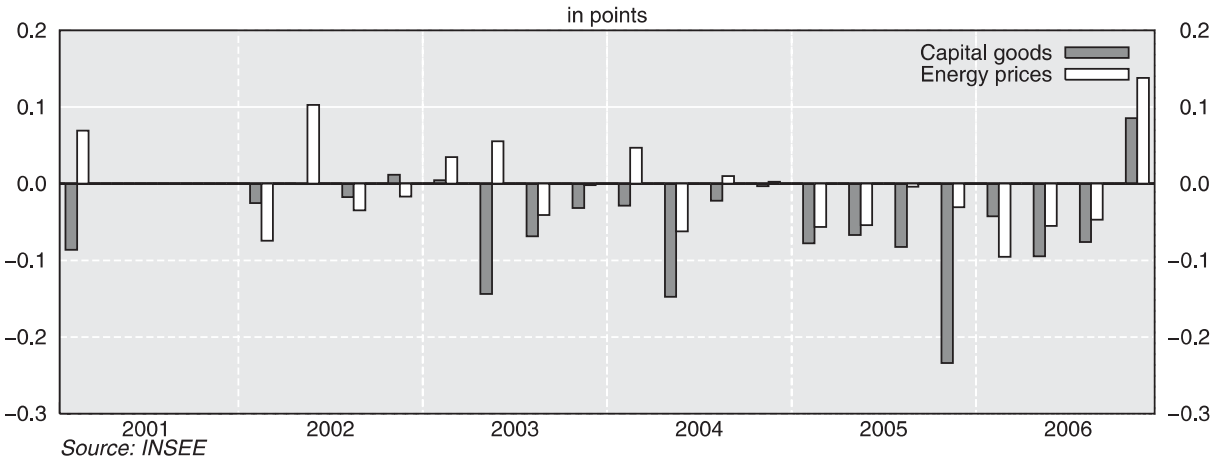
+ 0.67 * OVHNG
(0.66)

+ 0.11 * EXPWF
(0.12)

RMSE = 0.77 (*0.73*)

9

DIFFERENTIAL IN QUARTERLY CONTRIBUTIONS OF MERCHANDISE IMPORTS TO GDP GROWTH
(chain–linked prices minus constant prices)



Source: INSEE

Table 3
Impact of switch to chain-linked prices on quality of econometric-equation estimate

Variable to be explained	Standard deviation		RMSE (root mean squared error)		Impact of switch to chain-linked prices
	Constant prices	Chain-linked prices	Constant prices	Chain-linked prices	
Gross domestic product	0.42	0.43	0.22	0.23	No impact
Manufacturing output	1.37	1.38	0.80	0.81	No impact
Household consumption expenditures on manufactured goods	1.54	1.56	0.73	0.77	**Estimation of chain-linked prices better in recent period**
Total gross fixed capital formation by NFEs	1.62	1.60	0.96	0.96	No impact
Gross fixed capital formation by NFEs in manufactured goods	2.00	2.05	1.20	1.33	**Estimation of chain-linked prices slightly inferior**
Manufactured exports	2.49	2.39	1.87	1.79	**Change of specification needed**
Manufactured imports	2.27	2.28	1.52	1.50	No impact

Source: INSEE

Judging from the RMSE, the model in chain-linked prices seems slightly inferior in quality. However, if we look at the end-of-period residuals, it displays a better forecasting performance in the recent period *(Chart 10)*. This is shown by the residuals of the constant-prices model, which have been consistently positive since 2006. In the recent period, the model provides a better fit with household consumption when chain-linked prices are used. This is hardly surprising, as household consumption is lower at chain-linked prices than in constant prices at the end of the period owing to the fuller inclusion of the fall in prices of ICTs (information and communications technologies).

The estimation of total GFCF is less sensitive to interest-rate movements

The estimated quarterly growth rate of total GFCF by NFEs is explained by the following three factors:

- The quarterly-revisions indicator (REVISION) drawn from INSEE's Industrial Investment Survey. This supplies a robust estimate of the revision in investment projects for all manufacturing industries between two successive surveys.
- The capacity utilization rate (CUR) obtained from the Bank of France's monthly business survey. A rise in this indicator denotes tension in the production system.
- The nominal 10-year interest rate, deflated by the year-on-year change in producer prices for all goods and services.

Parameters estimated for the period 1992Q2-2005Q4 at chain-linked prices ***(in parentheses: at constant prices)***:

Total GFCF in quarter q-1 =

0.89 REVISION in quarter q
(0.85)

+ 0.39 REVISION in q-1
(0.41)

+ 0.26 acceleration of CUR in q-1
(0.25)

- 0.36 first difference in real interest rate in q-3
(-0.45)

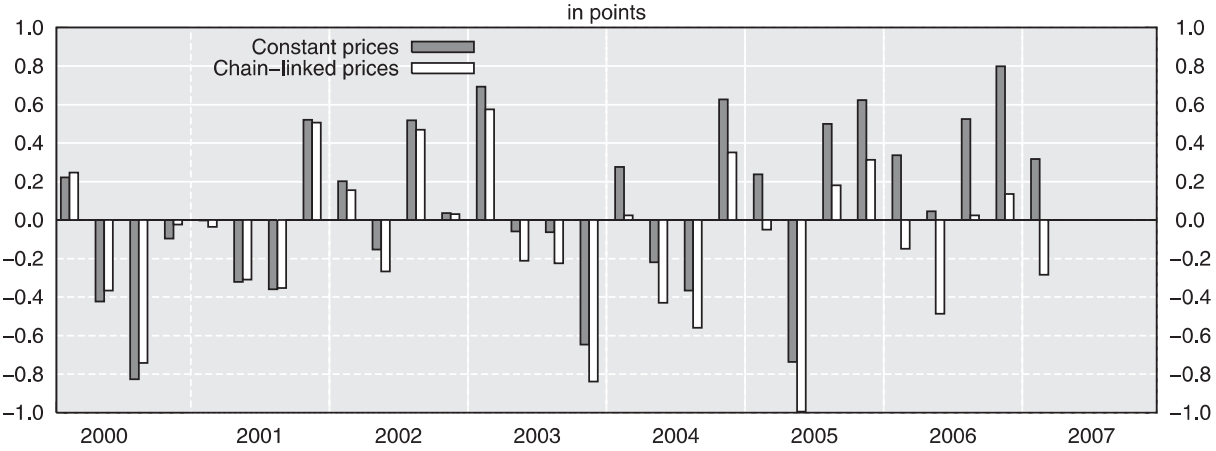
RMSE = 0.96 *(0.96)*

The model's overall estimation quality is not affected by the transition to chain-linked prices. The RMSE remains identical *(Table 3)*. In the period outside the estimation —that is, since Q1 2006— the residuals sequence does not indicate a major change either *(Chart 11)*.

10

COMPARISON OF RESIDUALS IN CHAIN–LINKED PRICES AND CONSTANT PRICES

in points



Source: INSEE

All the estimated parameters remain significant and the values taken are very similar, except for that of the interest rate. Estimated investment now seems slightly less sensitive to interest rates in chain-linked prices.

The estimation of GFCF in manufactured goods shows a slight quality loss and is also less sensitive to the interest rate

To explain quarterly growth of GFCF in manufactured goods (GFCFMFG), we use the same type of regressors as in the estimation of total GFCF, plus actual growth of GFCF in manufactured goods two quarters previously.

Parameters estimated for the period 1992Q1-2005Q4 at chain-linked prices *(in parentheses: at constant prices)*:

GFCFMFG in quarter q =

0.38 GFCFMFG in q-2
(0.41)

+ 0.62 REVISION in q
(0.57)

+ 0.68 first difference of CUR in q
(0.69)

- 0.43 first difference of real interest rate in q-2
(- 0.54)

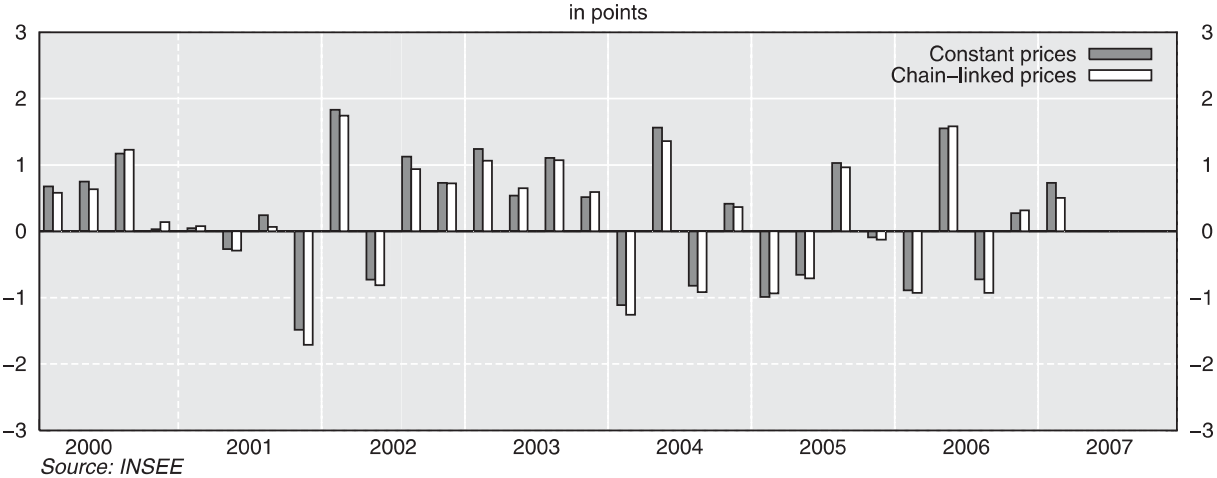
RMSE = 1.33 (*1.20*)

The quality of the estimate of GFCF in

11

RESIDUALS OF ESTIMATION OF TOTAL GFCF

in points



Source: INSEE

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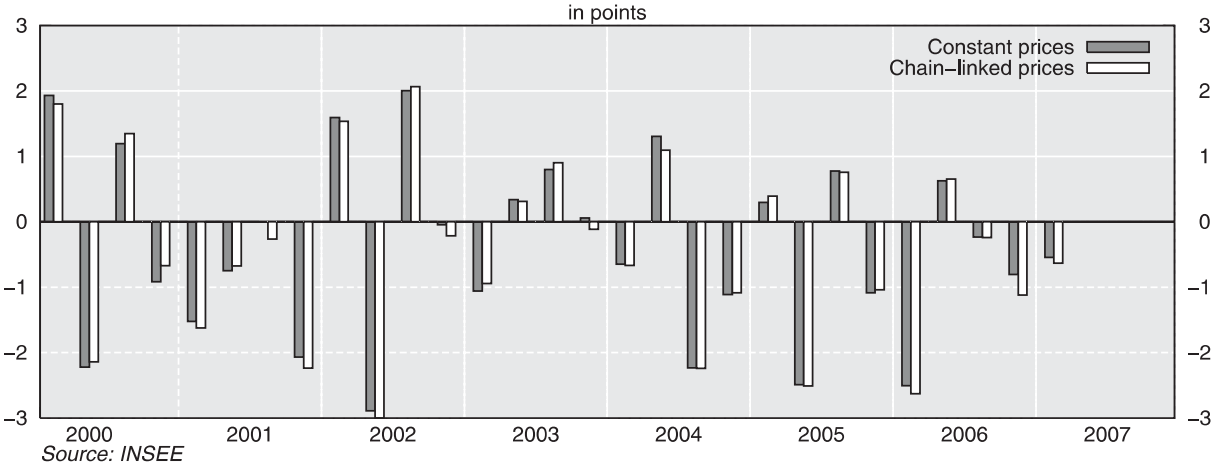
RESIDUALS OF ESTIMATION OF GFCF IN MANUFACTURED GOODS

in points



Source: INSEE

manufactured goods has deteriorated slightly with the switch to chain-linked prices. Admittedly, the variance of GFCF in manufactured goods is also somewhat greater in the estimation period, rising from 2.00 to 2.05. This worsening of the estimation is reflected in the slightly higher residuals for chain-linked prices *(Chart 12)*. The model's tendency to mildly overstate actual values in constant prices in the recent period is thus somewhat aggravated.

However, all the estimated parameters remain significant and their values are close. The sole exception is interest rates. The response of GFCF in manufactured goods to interest rates diminishes with chain-linked prices, as does that of total GFCF.

No meaningful impact on the estimation of manufactured exports

The estimation of the quarterly growth in manufactured exports uses data from the monthly business survey in industry (i.e., essentially manufacturing), monthly customs data (nominal), and the real effective exchange rate.

The estimation of the equation in chain-linked prices (*in parentheses: at constant prices*) for the period 1992Q3-2005Q4 yields the following results:

EXP(q) = 0.013 + 0.25* EXP_CUSTOMS (q-1)
(0.015) (0.56)

+ 0.001* OPFO _1(q-1)
(0.001)

+ 0.001* OPFO _2(q-1)
(0.001)

- 0.64*REER _1(q)

- 0.54*REER _1(q-1)
(0.61)

- 0.61*REER _3(q-1)
(0.79)

RMSE = 1.79 (*1.87*)

Notations:

EXP(q): real quarterly growth of manufactured exports at chain-linked prices (quarter q)

EXP_CUSTOMS (q): nominal quarterly growth of manufactured exports goods, from customs sources (quarter q)

OPFO_i (q): monthly first difference of foreign orders (balance of opinion from INSEE Industry Survey) in month i of quarter q

REER_i(q): monthly growth in France's real effective exchange rate in month i of quarter q.

The shift to chain-linked prices does not seem to have affected the quality of the estimation of manufactured exports *(Table 3)*. The slight decline in RMSE should be viewed in conjunction with the decrease in the standard deviation of the series at chain-linked prices (2.4 versus 2.5 for the series in constant prices).

By contrast, the switch to chain-linked prices has significantly impacted the model's determinants as well as their coefficients: for example, EXP(q-1), which was present in the constant-prices model, is absent from the model in chain-linked prices. Conversely, the current exchange rate REER_1(q) appears in the equation in chain-linked prices. At the same time, the growth in manufactured exports is less sensitive to the lagged variables REER_1(q-1) and REER_3(q-1). On balance, however, the real effective exchange rate has a similar influence on manufactured exports in both models. ■

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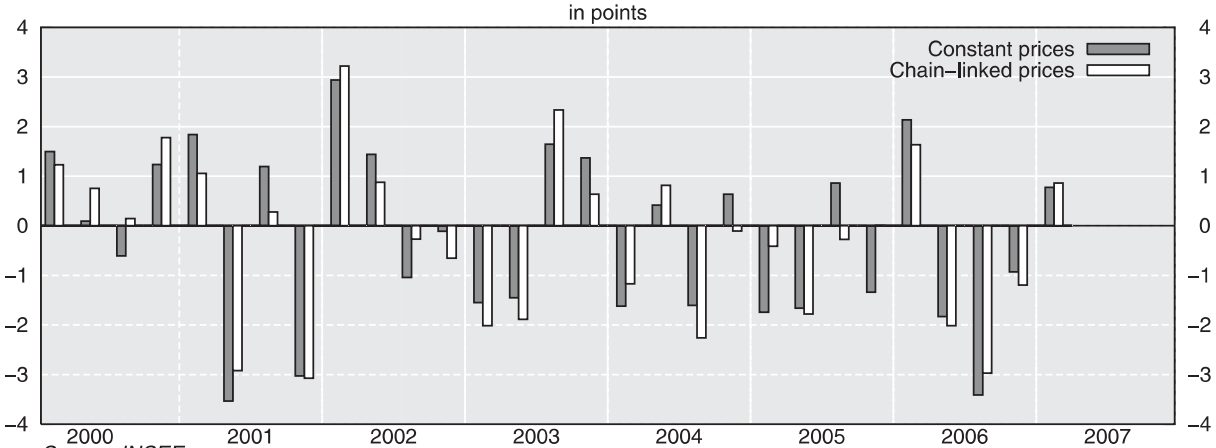
RESIDUALS OF ESTIMATION OF EXPORTS

in points



Source: INSEE