Model of Building Blocks and Total Factor Productivity-based Regulatory Approaches

AEMC Workshop

29 November 2010

Denis Lawrence and John Kain

ECONOMIC INSIGHTS Pty Ltd

Spreadsheet Model

- AEMC commissioned Economic Insights to develop a spreadsheet model to test the economic properties of a TFP methodology against the current arrangements for building blocks
- The objectives of this modelling were to:
  - Provide additional support for the Commission's draft reasons
  - Improve stakeholders' understanding of the effects of a TFP methodology
  - Provide a model for stakeholders to test their own scenarios
  - Facilitate future testing of detailed design questions in applying a TFP methodology

Presentation outline

ECONOMIC INSIGHTS Pty Ltd

- Price cap approach to utility regulation
- Building blocks approach to setting price caps
- TFP - What is it?
- The use of TFP in setting price caps
- Regulatory options and scenarios modelled
- Spreadsheet model – Background and data
- Spreadsheet model – Structure and operation
- Spreadsheet model – Results

Price cap regulation

- CPI-X price caps
- A positive X factor means that prices (or revenue) have to fall in real terms
- X factor set to allow the DB the opportunity to earn its risk–adjusted rate of return
- Cap provides the DB with an incentive to outperform the assumptions used in setting the X factor
- Provides a means of sharing the benefits of efficiency improvements between the DB and its customers
- Caps can be set on the basis of weighted average prices, overall revenue or revenue yield
- Cap typically implemented using an initial price change (known as a 'P_0') and then a common X factor across the remaining years
- Under building blocks the P_0 and X are set jointly for each DB to equate the present value of the DB's forecast revenue and cost streams for the whole regulatory period.
- Under the TFP–based approach, the X factor is generally the industry (or group) productivity growth rate (for all DBs) and the P_0 aligns opening revenues with costs for each DB.

Building blocks approach

- BB calculates an annual 'revenue requirement' for each DB based on the costs it would incur if it was acting prudently
- Costs made up of opex, capital costs and a benchmark tax liability
- Capital costs made up of return of capital and return on capital
- Return of capital is opening RAB multiplied by WACC
- Use straight–line depreciation on opening RAB over its estimated remaining life plus straight–line depreciation of assets added during the period calculated over their estimated total lives
- Financial capital maintenance (FCM) is a key principle
- Need forecast of the annual revenue requirement stream over the coming regulatory period
- Opening RAB largely known so need forecasts of opex and capex
- Also need forecasts of output quantities and then P_0 and X factors set so that NPV of forecast operating revenue stream over the upcoming regulatory period is equated with NPV of forecast annual revenue requirement stream
- Adopt PTRM approach of nominal vanilla WACC & revaluation gains

Building blocks (cont'd)

- Forecasts play critical role in BB
- First calculate annual revenue requirement for each year based on the actual or realised values of all relevant variables
- Allows us to form benchmark against which we can compare BB outcomes where forecasts used and also used in TFP modelling
- 3 different forecast cases:
- 'best review time forecasts' – can still have unanticipated divergences
- 'DB favourable forecasts' – over–predict realised costs and under–predict realised output quantities producing returns in excess of WACC
- 'DB unfavourable forecasts' – under–predict realised costs and over–predict realised output quantities producing returns less than WACC
- Actual capex and depreciation for that regulatory period recognised at time of next review and incorporated in opening RAB for the next period under the AER's RFM
- Ignore differences in regulatory and taxation parameters

Total factor productivity

- TFP is total output produced per unit of total input
- Index number measure which forms the ratio of all output quantities (weighted by revenue or output cost shares) to all input quantities (weighted by cost shares)
- Commonly look at TFP growth but can also look at TFP levels across firms within an industry
- TFP growth is the ratio of the change in a weighted average of output quantities to the change in a weighted average of input quantities
- TFP is a relatively simple, transparent, robust and reproducible technique
- Requires values and quantities for all outputs and inputs and data on key operating environment characteristics

TFP and incentive regulation

- Aim of mimicking competitive markets
- Regulation by price caps (CPI-X):
  - industry average price prevails;
  - not based on own costs;
  - response to efficiency and other changes gradual
- High power but also high risk (under or over earning)
- Innovation encouraged, less scope to 'game' system
- Delinks prices and own costs, low regulatory costs
- $X \equiv [\Delta TFP - \Delta TFP_E] - [\Delta W - \Delta W_E] - \Delta M$
- TFP–based P_0s align revenue with the revenue requirement in the last year of the preceding regulatory period
- First year of the TFP–based regulatory period includes this P_0 and also the X factor (to allow for annual productivity growth)
- Subsequent years just include the X factor

TFP specification used

ECONOMIC INSIGHTS Pty Ltd

- Three billed outputs included:
  - energy throughput
  - customer numbers
  - contracted demand or contracted reserved capacity
- Four inputs included:
  - opex
  - overhead lines
  - underground cables
  - transformers and other capital
- Capital user cost measured exogenously based on ex ante FCM in analogous manner to BB approach
- Industry input price index is derived by dividing total costs by the total input quantity index

Building Blocks versus TFP

ECONOMIC INSIGHTS Pty Ltd

- The building block approach is based on detailed analysis of each network's own projected costs and circumstances and on judgements regarding efficiency gaps
  - Advantages: can focus on specific circumstances and be more forward looking
  - Disadvantages: often subjective, 'black box', non-reproducible ('in our professional opinion ...'), resource intensive, intrusive, can distort input mix, spurious accuracy, more scope to game
- The productivity approach uses observable information on performance of all relevant networks to set parameters
  - Advantages: objective, transparent, reproducible, economical, addresses asymmetric information, less scope to game
  - Disadvantages: may not take adequate account of network-specific circumstances, still have to forecast, higher risk

Alternative ways of using TFP

- Use industry partial factor productivity (PFP) index growth rates to set efficiency targets for components of Building Block approach
- Better suited to opex than capital targets as capital PFP gives information on capital stock, not directly on capex
- Opex partial productivity can be used to roll forward opex allowance in building blocks using 'rate of change' formula:

  ΔReal Opex = ΔOpex Price – ΔOpex Partial Productivity + ΔOutput Quantity – ΔCPI
- Use industry TFP index growth rate to set overall efficiency target – then no separate targets for input components
- Very few examples of pure application of this (US railroads, NZ electricity distribution thresholds)
- Use as one of the pieces of information that 'inform' the (subjective) decision on setting the X factor – more common

Regulatory options examined

ECONOMIC INSIGHTS Pty Ltd

- Seven regulatory cases and options examined:
  - Building Blocks Case 1 – best review-time forecasts
  - Building Blocks Case 2 – DB-favourable forecasts (forecast opex and capex higher by 5% and output quantities lower by 1% than what eventuates)
  - Building Blocks Case 3 – DB-unfavourable forecasts (forecast opex and capex lower by 5% and output quantities higher by 1% than what eventuates)
  - TFP-based Option 1 – 3 fixed, 5-year periods
  - TFP-based Option 2 – 2 fixed periods (7 years, then 8 years)
  - TFP-based Option 3 – 1 fixed 15-year period
  - TFP-based Option 4 – 10-year rolling X factor

Modelling - Scenarios

- Look at base case and five scenarios to test differences in returns for the businesses:
  - unanticipated increase in output – growth rates in customers and energy throughput outputs increase by 2 percentage points in last three years of first out-period and then return to previous growth rates (growth spurt associated with sudden increase in population)
  - increase in mandated standards – anticipated increase of capex to 50% above its previous levels for first three years of second out-period only and increase in capital input quantity growth rates of 2 percentage points for same years for all DBs; and
  - 'wall of wire' – anticipated 'wall of wire' proxied by capex increasing to 3 times its previous levels for each of the five years of the first out-period only and then returning to previous levels for all DBs.
  - unanticipated opex quantity reductions for one DB – one–off of 10%, recurrent of 10% and reduced growth rate
  - unanticipated capex reductions for one DB – one–off of 10% and recurrent of 10%

Summary measures

- Have 3 main measures to assess performance of BB and TFP methods
- Primary profitability measure is the ratio of the present value of the stream of excess returns to the present value of the stream of actual annual revenue requirements
- Annual excess returns are defined to be the difference between operating revenue and the corresponding actual annual revenue requirement
- Secondary profitability measure is the average of the deviation of the annual realised rate of return from the WACC over the 15 out–years
- To assess the impact of different regulatory options on customers we present the overall index of prices paid by customers calculated as the sum of operating revenues divided by the industry output quantity index
- For unanticipated cost reductions look at retention ratio given by:

  $PV[(OR^{SS}_{ua} - RR^{SS}) - (OR^{BC} - RR^{BC})] / PV[RR^{BC} - RR^{SS}]$
- Numerator is PV of benefits going to the DB which is the difference between the savings scenario's profits and the corresponding base case profits
- Denominator is PV of total benefits available which is the difference between the base case and the relevant actual annual revenue requirement

Modelling - background and data

- Aim is to compare an accurate building blocks simulation that is consistent with the AER's Post-tax Revenue Model (PTRM) with TFP-based regulation under both fixed and rolling X factors
- TFP model is consistent with AEMC Preliminary Findings and has periodic resets to realign revenues with costs
- Model developed in Excel 2003 and contains 31 separate sheets
- Has macro to solve BB so macros need to be enabled in Security settings
- Five distribution businesses (DBs) including one mainly rural, one mainly urban and three mixed rural/urban
- Data levels and growth rates calibrated against actual Australian DBs but levels scaled to maintain anonymity
- Data covers 11 'historical' years and 15 future 'out-years'
- TFP growth rates range from 1.2% (DB1) to 1.7% (DB5) with industry average TFP growth rate of 1.4%

Modelling – data (cont'd)

- Data for each DB covers the value, quantity and price of the three outputs and the four inputs
- The initial (year 0) capital base and annual capital expenditure for each DB are also included in the database
- Industry variables are formed as the summation of the five DB variables
- A number of economy–wide productivity and price variables are included to permit formation of the relevant X factors
- Only variables for the out–years can generally be altered and only a subset of variables can be altered as a number of fundamental relationships have to be maintained (eg price times quantity must equal value)
- Cells which can be altered in the model are shaded light blue

Model structure

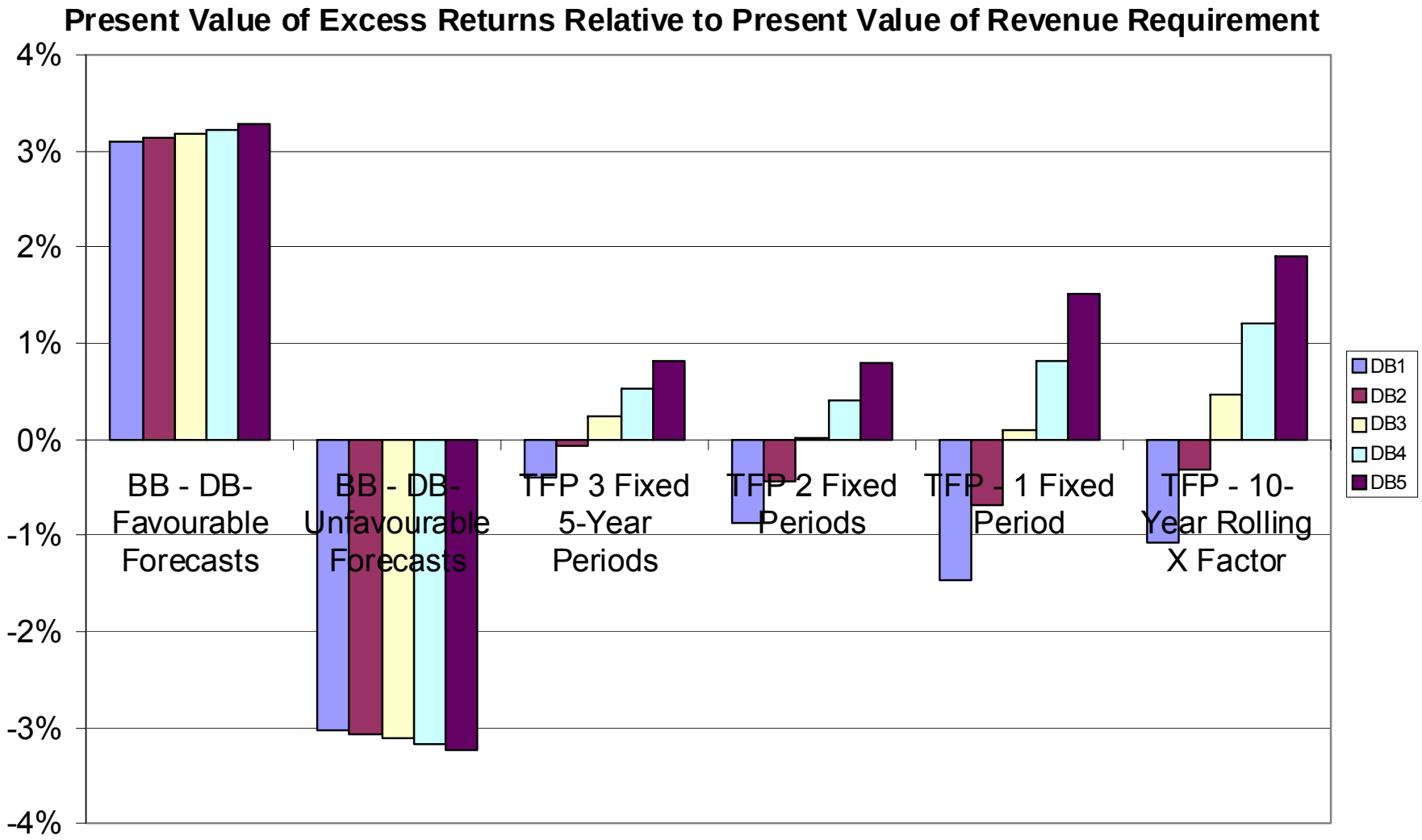
- Notes sheet provides a brief description of the model
- General data sheet contains a number of general variables including economy–wide productivity and input prices
- 6 Data sheets contain the databases for the five DBs and the industry
- WACC calculation sheet contains the key cost of capital parameters
- 5 Building blocks calculations sheets, one for each DB, calculate P_0s, X factors and revenue for each of the DBs under the three building blocks forecast cases – they also calculate actual future revenue requirements
- TFP calculations sheet calculates the TFP and related indexes
- 5 TFP–based regulation sheets, one for each DB, calculate P_0s, X factors and revenue for each of the DBs under the four TFP–based options
- 3 TFP chart sheets graph key TFP components

Model structure (cont'd)

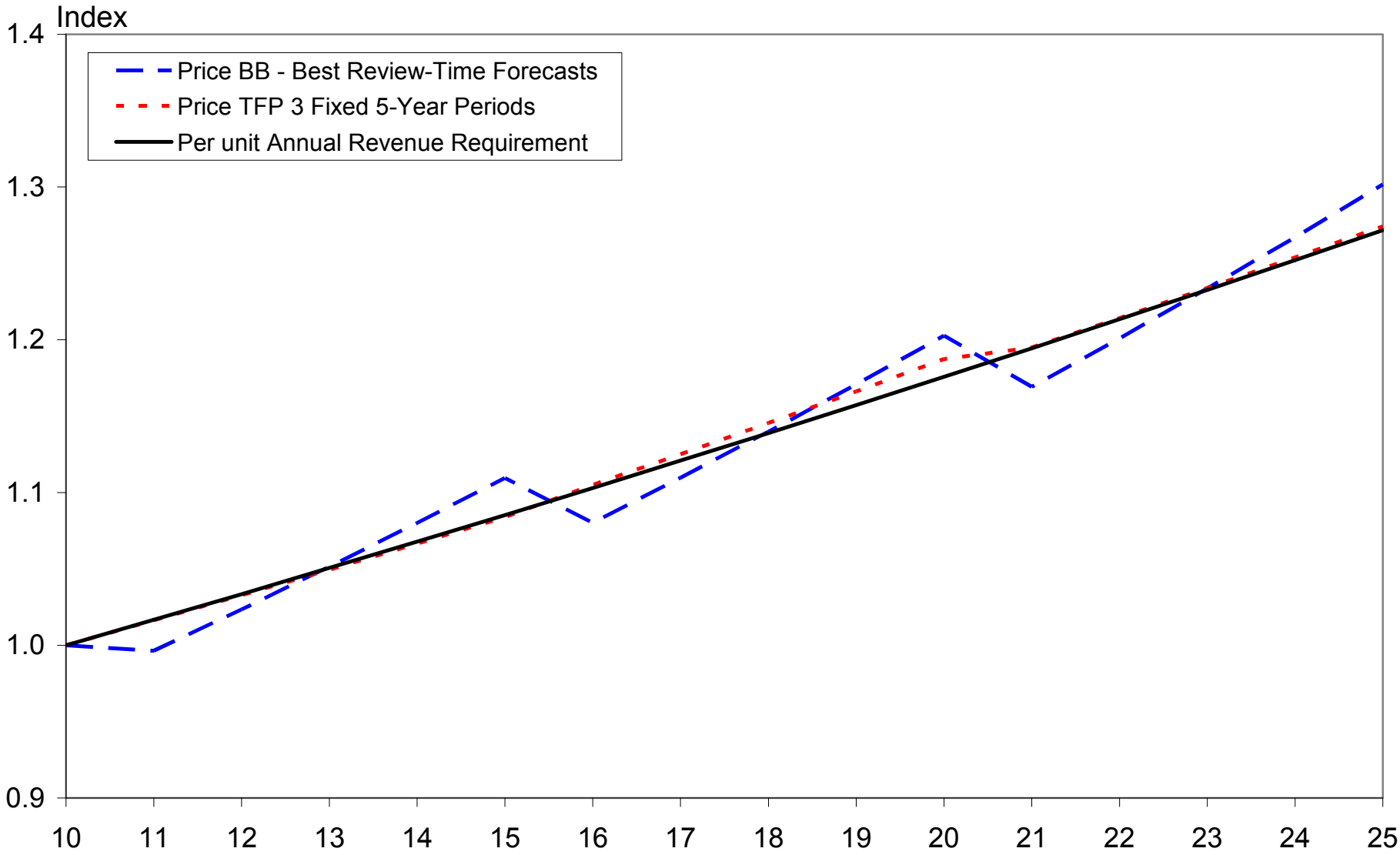
- 5 Comparisons sheets, one for each DB, construct key summary measures for each regulatory option;
- Summary sheet presents the key summary indicators for all DBs
- 2 Summary chart sheets graph the key profitability and customer indicators

- Users can test the impact of a range of future scenarios by changing data in the cells shaded light blue in the General data, Data, WACC calculation and Building blocks calculation sheets
- Note that after any data has been changed users will need to run the macro by clicking on the box near cell H172 in any of the DB Building blocks sheets
- Clicking the macro box on any of the building blocks sheets will undertake all relevant building block calculations for all five DBs

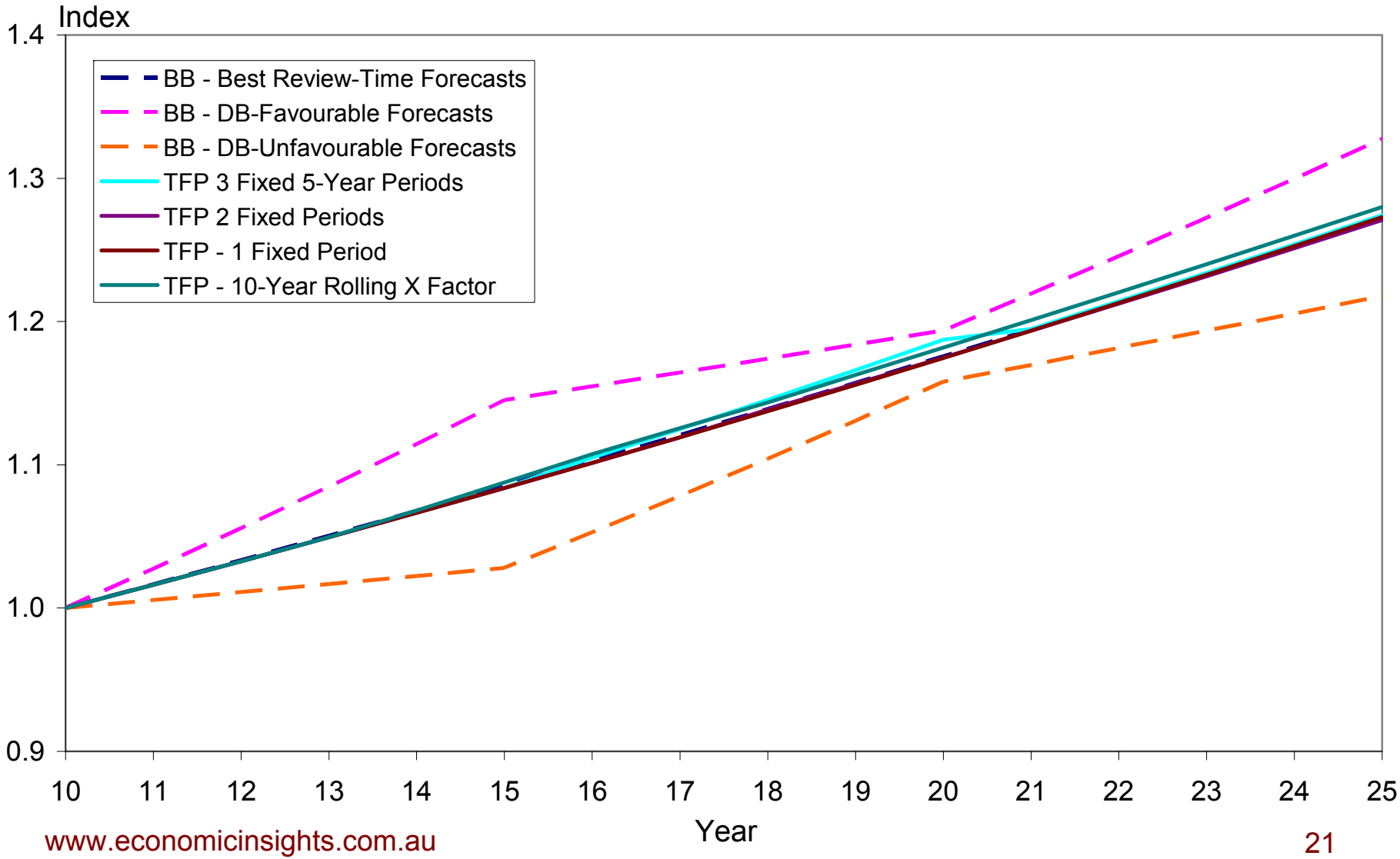
Results – base case



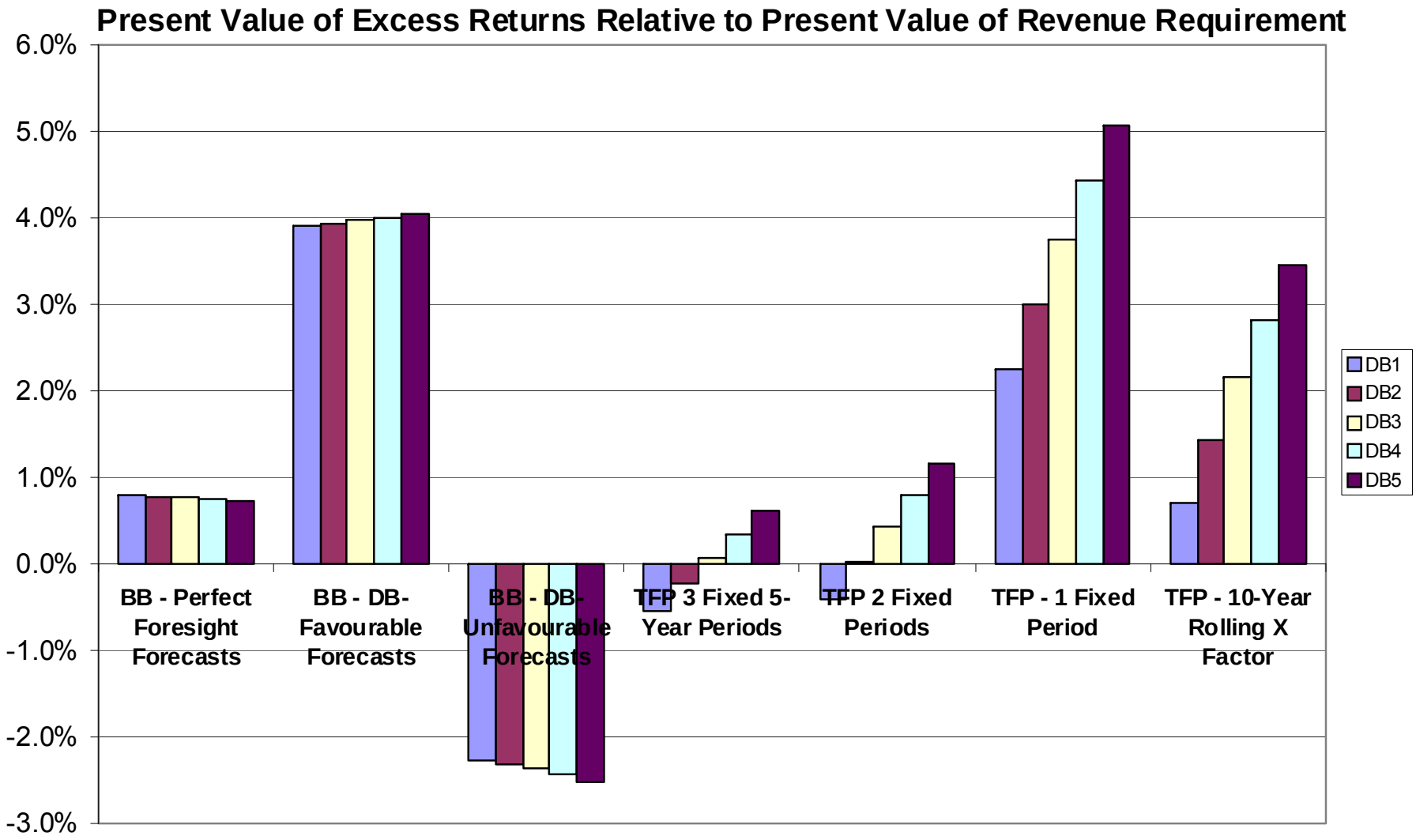
Results – base case price paths & unit annual revenue requirements



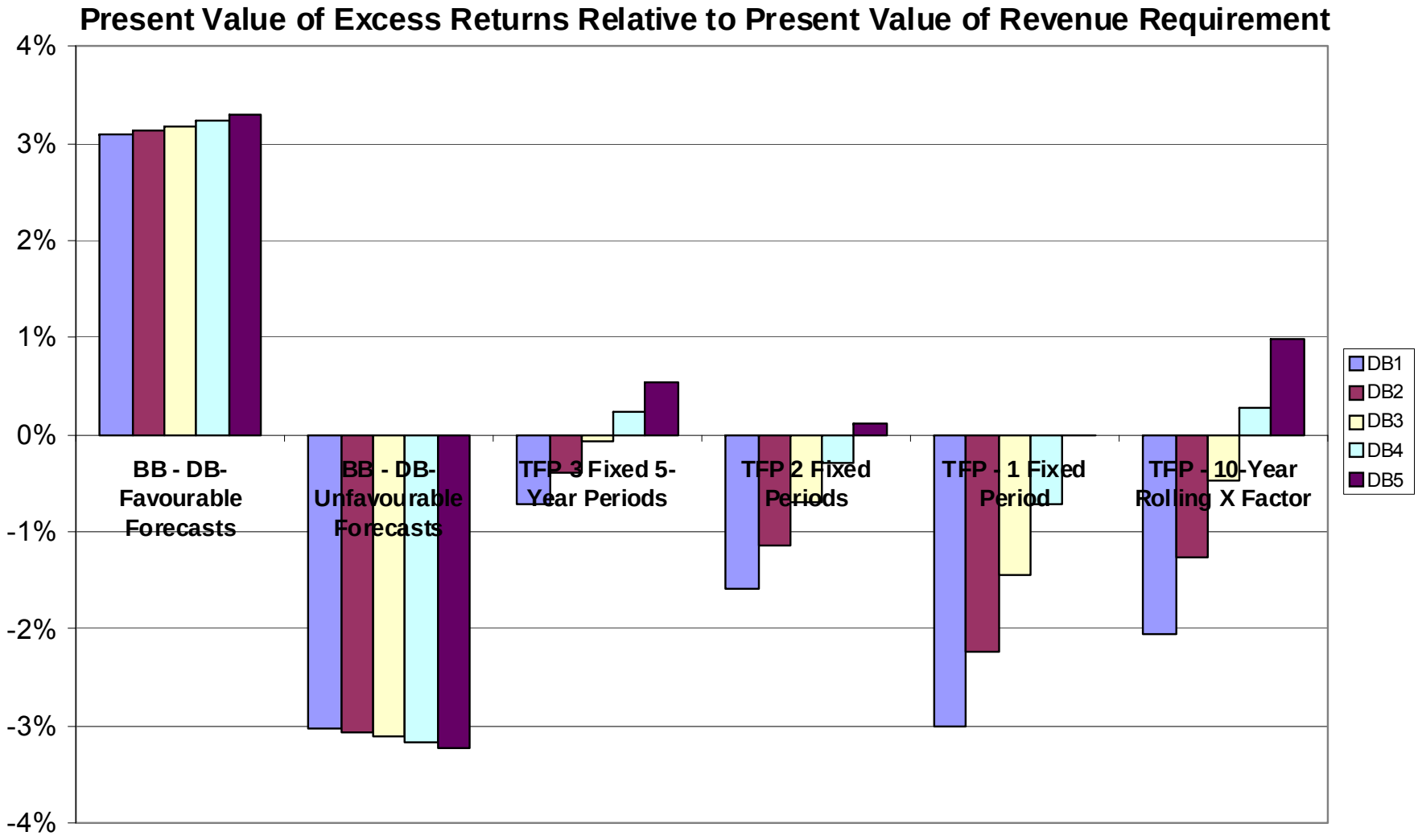
Results – base case $X=P_0$ price paths



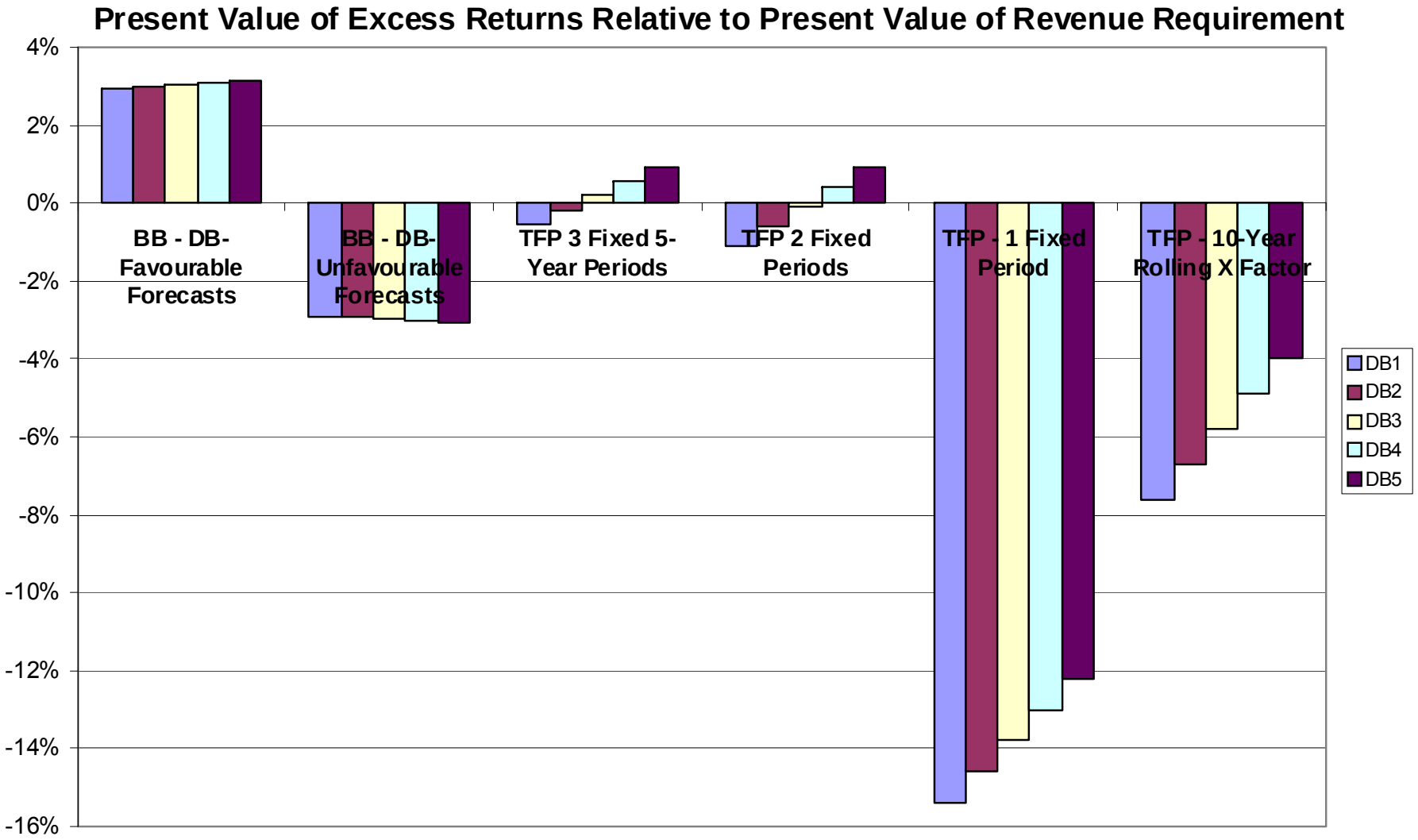
Results – Unanticipated Increase in Output



Results – Anticipated Increase in Standards



Results – 'Wall of wire'

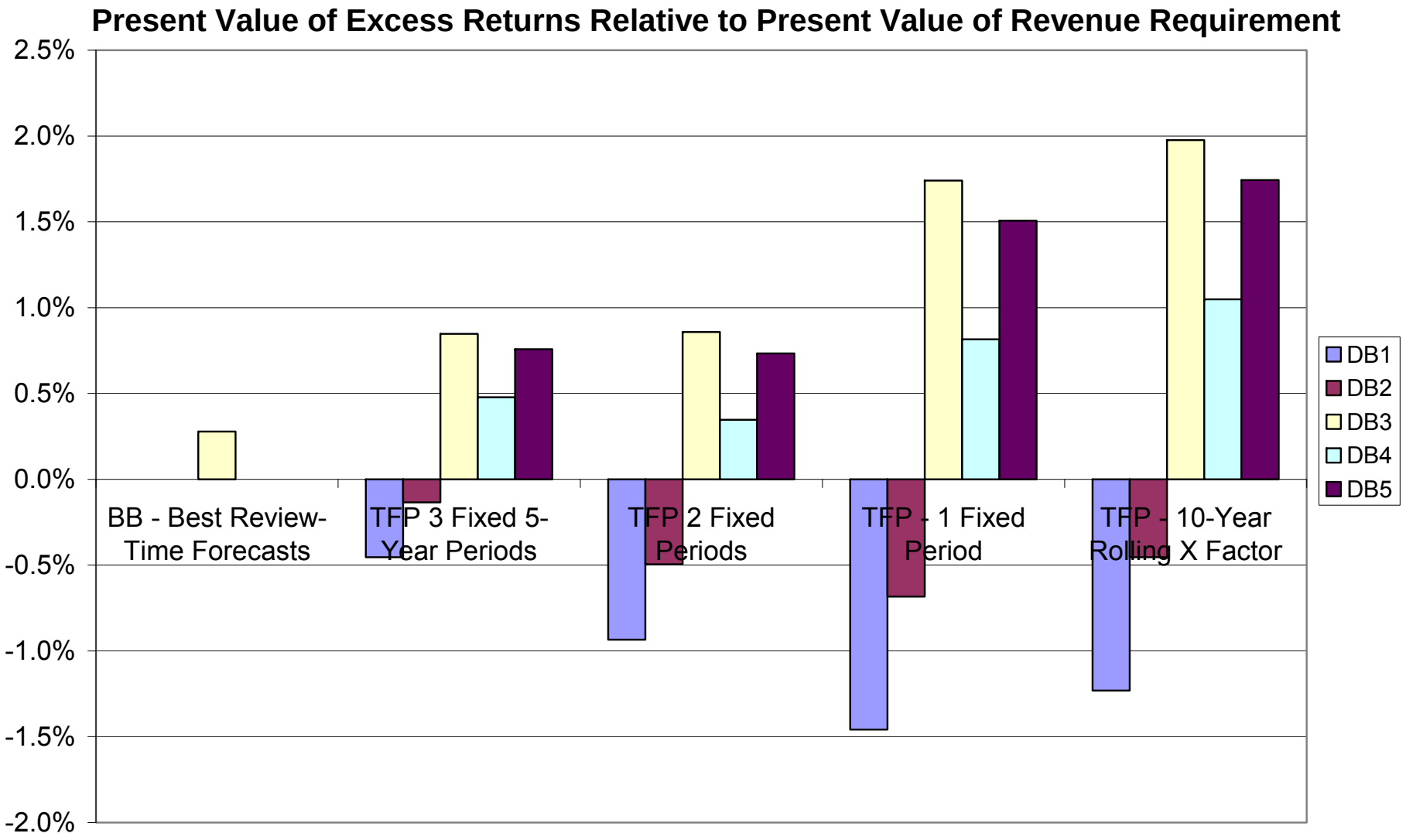


Results – Unanticipated Opex Reduction for DB3

Table 1: **Retention ratios for unanticipated opex reductions for DB3, years 11–25**

Retention Ratios	*One–off opex reduction in year 12 only*	*Recurrent opex reduction starting in year 11*	*Reduced opex growth rate starting in year 11*
BB Case 1 – Unanticipated	100%	41%	17%
TFP Option 1 – 3 fixed periods	100%	39%	36%
TFP Option 2 – 2 fixed periods	100%	51%	52%
TFP Option 3 – 1 fixed period	100%	100%	100%
TFP Option 4 – Rolling X	84%	88%	91%

Results – Unanticipated Reduced Opex Growth for DB3



Results – Unanticipated Capex Reduction for DB3

Table 2: **Retention ratios for unanticipated capex reductions for DB3, years 11–25**

Retention Ratios	*One–off capex reduction in year 12 only*	*Recurrent capex reduction starting in year 11*
BB Case 1 – Unanticipated	37%	12%
TFP Option 1 – 3 fixed periods	31%	37%
TFP Option 2 – 2 fixed periods	43%	50%
TFP Option 3 – 1 fixed period	100%	100%
TFP Option 4 – Rolling X	88%	91%

Modelling - Summary

ECONOMIC INSIGHTS Pty Ltd

- TFP-based regulation gives DBs achieving industry average productivity growth the opportunity to recover their revenue requirement and those achieving above average productivity growth to exceed their revenue requirement
- TFP-based regulation will be less attractive to DBs that do not achieve average productivity growth rates
- Small errors in forecasts in building blocks regulation can lead to significant divergences of realised revenue from revenue requirements making TFP-based regulation a somewhat safer alternative under normal circumstances
- TFP-based regulation can handle significant changes provided there are regular price resets (or, alternatively, reasonable off-ramps in place)
- Rolling X factors can build in some ongoing adjustment to changing circumstances but regular price resets are more important