The Theory and Practice of Setting the X-factor in Postal Pricing

Gregory P. Swinand and Conor O'Toole*

London Economics

11-15 Betterton Street

London EC3V9EA

gswinand-at-londecon.co.uk

Abstract:

This paper reviews the theory and practice of setting the X-factor in postal price regulation. The X-factor in general regulatory pricing is often seen as an *ex ante* exogenous productivity or efficiency factor.

Setting the X-factor and the form, theory and practice of price control in the postal sector is of general and specific interest. First, many countries are still in the process of opening their postal markets. In the EU, for example, with few exceptions postal markets will become more liberalised in 2011 under the current postal directive. While legal protection will disappear, this is not to say that vigorous competition will appear overnight. The transition to competition will likely require flexible pricing regimes and possibly rethinking current price regulation as some aspects of the market will likely remain regulated. In fact, setting price caps and X-factors was an important part of telecoms liberalisation in the US, when regulating prices paid by long distance companies to local exchange carriers.[1]

In spite of this seemingly straightforward general concept for X, different jurisdictions often use different concepts of the X-factor. While price caps date to 1982, there is still disagreement as to what X should be. We review the literature on the X-factor and what it should be at the start. Broadly, the UK and the US have taken two different approaches to X. In the UK, the X-factor is a broad efficiency factor (Littlechild 2003). The US, on the other hand, strongly influenced by groundbreaking work by Bernstein and Sappington (1999), relies on a definition of X as a productivity offset, a relative rate of total factor productivity growth and relative price changes. The UK and the US approaches led to two different schools of thought on how to design or choose X, with the UK approach eschewing a rigorous mathematical derivation and relying instead on a combined 'judgement' approach. Crew and Kleindorfer (1996) preferred the UK method.

[1] Long distance quickly became competitive while local exchange remained a monopoly.

The approach of the paper is to consider the empirical implementation of variously defined X-factors and study the results (e.g., higher or lower prices). Adopting the productivity-offset X is likely to bias prices upwards relative to alternative definitions. We propose a more direct X, where X equals the forecast of TFP growth less the difference between industry input and consumer price growth.

Finally, we review the practice of price making in the postal sector and consider the implications of our proposed definition of X in the context of some of the more important issues in postal pricing. We consider the implications of a productivity growth based X with entry, access, and a USO, by making certain assumptions about the structure of costs (e.g., quadratic average cost, Cohen et. al. 2004). Conclusions and directions for future research are suggested.

The paper builds on a number of different strands in the postal pricing literature, including Crew and Kleindorfer (1996) and Swinand and Scully (2006).

Key words: Price caps, incentive regulation, productivity; JEL codes: L43, L51, L97

1. INTRODUCTION

As deregulation of the postal sector gradually takes form in the EU and elsewhere, and with the full elimination of the reserved area for the EU in 2011 approaching, but with national incumbent's maintaining large market shares, price regulation of Postal Universal Service providers (USPs) will maintain an important place on the postal regulatory agenda for the near future.

Other factors rather specific to postal rate policy or policy choices of the liberalization and reform process will also help keep price control issues in the spotlight. For example, access arrangements and access pricing have resulted in significant losses of market share in vertically related elements of the postal pipeline (e.g., in the UK, Royal Mail has lost about 5% (main in downstream access) and the level of competition in end-to-end competition is estimated to be even lower (less than 1% loss due to liberalisation) [2]. Some postal operators, such as X, are only recently getting a more formal regulatory pricing regime. Other postal operators and jurisdictions, such as in Ireland, have a formal and developed regime, but have been slow to evolve to include such regulatory items such as a regulatory asset base and the cost of capital. In addition to the above factors, the global financial crisis has meant that certain input prices and other price indices (e.g., CPI, RPI, or HICPs) have not been rising at normal rates, and in some cases even falling. These factors can have material impact on the "correct" or economically fair allowable cost which forms the basis of either a cost of service or price cap pricing regime.

While the postal sector has perhaps been less keen on introducing price caps and performance incentives than other sectors, price caps and incentive or performance-based regulation are perhaps one of the fundamental success stories of regulatory economics over

[2] Claeys, P., "Lessons learned from recent full market openings," Presentation to the EETT Conference, March, 2009.

the last 25 years[3]. Hearn, Harman and Dhanani (2008) concluded that CPI-X type price cap regulation was the best form of price control for the postal sector going forward (they also define X as the offset X). One of the particularly important developments of this form of incentive-based regulation was the recognition by economists that regulation could potentially mimic how competitive markets would pass on the majority of industry level unit cost savings (total factor productivity growth gains) to consumers in the form of lower prices; competition would compete efficiency gains away. Thus, in trying to design regulation that mimicked competition, economists generally agreed on the need to include a means of transferring efficiency gains to consumers, while still maintaining adequate incentives in the industry for investment and innovation.

The rate of relative price reductions, or transfer of efficiency gains, was settled upon as the so-called X factor, but on a global scale, this was perhaps all that was settled. X was first introduced in the UK price caps introduced after the Thatcher privatisations and quickly adopted in the US. The X factor is considered the 'efficiency factor' in UK price caps for regulated services such as water, gas, electricity, and telecoms. Postcomm has proposed simply that the "X is a factor to allow for increased efficiency"[4]. Somewhat differently, in the US the X factor is often referred to as a 'productivity offset', reflecting X's somewhat different definition in the US as something more complex than just efficiency. This type of pricing methodology was introduced into the UK postal service in 2003 following the introduction of an RPI – X system by Postcomm[5]. The X factor is a feature of some Postal price controls, such as in the UK, while other controls (e.g., Ireland) might only implicitly account for efficiency directly in the control formula.

[3] WIK (2006) notes that only 5 out of 25 member states have implemented incentive.

[4] http://www.psc.gov.uk/policy-and-consultations/consultations/price-control-2001--2003/Price_Control.pdf

[5] Postcomm (2003), Review of Royal Mail Group plc's Price and Service Quality Regulation

The UK and the US approaches led to two different schools of thought on how to design or choose X, with the UK approach eschewing a rigorous mathematical derivation and relying instead on a combined 'judgement' approach. Crew and Kleindorfer (1996) preferred the UK-style method. The US, on the other hand, strongly influenced by groundbreaking work by Bernstein and Sappington (1999), relied on a solid definition of X as a productivity offset, a relative rate of total factor productivity growth and relative price changes. In spite of this, a number of commentators such as Crew and Kleindorfer (1996) expressed doubts about the productivity offset approach to X, seeing the offset approach as possibly increasing prices above what they might otherwise be.

Perhaps surprisingly, X can take on a number of definitions, often depending on the jurisdiction. It could be considered the measure of total factor productivity growth in its pure sense, or it could merely be considered a measure of how prices should change—the rate at which real consumer prices should fall; or X could be considered a relative measure of productivity; or even a relative measure of productivity relative to price changes. The various definitions leave some lingering questions. Without a more rigorous definition of X there is room for confusion or criticism from industry: first as to what kind of productivity X should include, second as to how various price effects should be included, while maintaining transparency.

In the UK, due to the more judgmental approach to X, debate over what exactly X should be has likely led to regulatory uncertainty. In the US, because the offset is derived from a more rigorous setting, less debate over X has perhaps been replaced with debate over other parameters: consumer dividends, sharing factors, and accumulated inefficiencies. Even in the US, however, the dynamics of forecasting X have not been deeply studied. The result is remaining regulatory uncertainty surrounding X in the UK, the US, and elsewhere.

Regulatory uncertainty may increase the cost of capital, which may increase the cost of service in the long run--something every regulator wishes to avoid.

The nature of this tension and the potential problems with the offset approach was recognised in relation to postal price setting in the context of deregulation by Crew and Kleindorfer (2008) who stated, "There is a continuing confusion about the nature of the X factor among many regulators. Instead of being considered nothing more than the real reduction in prices to be provided to customers, the X factor has often been coupled iwth predicted productivity growth of the company or the economy at large. Prices would then be allowed to rise not by the CPI minus the X factor but by the CPI minshe the estimated "productivity offset". .....Although the practice of setting the X factor based upon the productivity offset is rather widespread, *it is inappropriate*." [emphasis added]

The importance of resolving certain issues with X should be clear and perhaps bears greater scrutiny given the current approaching deregulation, and the need for regulatory pricing policies that correctly bridge between nascent and fully working competition.

Finally, the current financial crisis indicates need for a re-visitation of indexing price controls to input prices. In the past, CPI, and say, PPI or (other input price movements) may have been more highly correlated, and rising at at least close to target rates in most jurisdictions. This essentially meant that regulated prices might have been rising in the past by CPI less say, 2% for X. If CPI turned out to be between 2-3%, this would mean that the price control engendered a modest nominal price rise.

1.1 Critiques of the current approaches

While some have advocated for the UK approach to X (Crew and Kleindorfer 1996), the UK style has not been without its criticisms[6]. One of the major criticisms has been a lack of transparency for X. While it is generally understood that X is some measure of the scope for efficiency improvement, it is not clear for a postal services provider facing their next price control exactly what goes into X. The lack of transparency, it is argued, leads to things such as the possibility of over or double counting--for example, does X include input price changes? A more transparent X, it is argued, would address such questions. In addition, a transparent formula should be founded on sound economic theory and evidence that would allow open debate. For example, if X were defined[7] explicitly in terms of TFP growth, then how input prices would enter the price cap would become completely transparent, and debate might focus on what the proper forecast of TFP might be. Because of these concerns in the UK, regulated industry stakeholders have been calling for a more US-styled definition of X[8].

We argue in this paper, however, that the productivity-offset X, as is used in the US, is not likely to be in regulators' interests. This is because the US-style productivity offset, while grounded in theory, does not reflect the empirical evidence. More precisely, the US-style productivity offset is based on a substitution that does not generally hold empirically.

2. PREVIOUS WORK ON X

2.1 Origins of X

[6] See for example Williamson (2002).

[7] In general, there is no explicit formula for X in the UK price caps.

[8] See for example, the water industry's advocacy site at www.water.org.uk , and Water UK report The General Efficiency Assumption: Setting X in CPI-X, 2002.

The X in RPI[9] – X type price caps is by now a UK success story in terms of government policy in general, as well as in terms of regulatory economics. The introduction of X was originated by Littlechild and collaborators (Littlechild 2003) at the time of the first UK privatisations in the 1980s. While there has evidently been some speculation as to what the expectations of the originators were, they have apparently kept detailed notes and published accounts of what was intended.

Thus, according to Littlechild, the original intentions were simple; X was to reflect how prices (for BT at the time) should fall relative to the economy as a whole, i.e., how real industry output prices should change over time. One of the more fundamental ideas of the price cap was also to avoid lengthy cost of service and rate of return regulation, which (in the view of the originators of X) had proved inefficient[10] in other jurisdictions such as the United States.

Apparently, more rigorous derivations of X were not investigated at the outset in the UK. This is not to say that the originators did not consider these things. Quite the contrary; they did. Their considerations were likely subsumed by practical matters of studying the actual effects of particular decisions for X on the companies' bottom line. What resulted was that the process of determining X in the UK was determined through consultations, both with the companies and outside experts and consultants. While this was perhaps the most reasonable way forward at the time, due in part to the lack of time series data, the process left embedded difficulties, such as the need to rely on company information for various components of potential efficiency, and a lack of transparency as to what the definition of X should be.

[9] CPI is the retail price index, the most common measure of general inflation in the UK. The corresponding fixed-weights consumer goods price index in other jurisdictions is the CPI.

[10] The main sources of the inefficiency are considered to be excess capacity, poor technology choices over time, failure to implement innovative organisational structures, and gold plating.

Part of the difficulty with setting X in this more *ad hoc* way, rather than with a more rigorous definition, is that the companies invariably have better information about the scope for efficiency improvement than the regulator. These informational asymmetry problems were some of the problems that the price cap regulation was meant to avoid. The existence of informational problems seemed to become all too apparent, when according to many observers, the companies did the best out of the first round of X factors set immediately after privatisation (Saal and Parker 2001). Subsequent efforts at estimating efficiency scope for X partially addressed some of the informational problems from relying on the companies themselves for data by turning to comparator industry techniques, such as has been done by Ofwat in their previous price reviews[11].

2.2 Work on X in other jurisdictions

The success of RPI- X type price caps was evident as the price cap form of regulatory price setting was quickly adopted in other jurisdictions. Regulators such as by the Federal Communications Commission (FCC) in 1995 in their Common Carrier Bureau's Tariff Review Plan 1995, (setting the rates which the newly broken up AT&T companies would charge each other for various types of interconnection[12]). At about the same time, similar price caps were making their way into US States' regulatory pricing, which make up the bulk of the regulatory pricing in the US, examples being NYNEX[13], the Boston Gas decisions of the Massachusetts DTE (Bodnar 1997). Similar decisions and uptake were found in

[11] See London Economics (2003), "PR04: Scope for efficiency study", Ofwat, at http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/pr04_efficiencyrep_londonecon.pdf/$FILE/pr04_efficiencyrep_londonecon.pdf.pdf.

12 It is useful to note that productivity growth in US telecoms has been higher than in any other sector of the economy over a long run period such as the post war period, and over almost any business cycle. Total factor productivity growth rates exceeded 4%, verses 0-2% for many industries. 2% TFP growth in the US economy as a whole is considered strong.

13 MA DTE, NYNEX D.P.U. 94-50.

jurisdictions, such as Canada[14] in their treatment of telecoms price regulation and Austria[15] in newly restructuring industry.

There are some interesting similarities in most of the work in jurisdictions outside the UK. First, the many of the regulators state the goal of the price cap as a "simulator" of competition, and also that it might be a bridge to a time when more competitive forces could gradually replace regulation. Second, the FCC, the Canadian telecoms experience, Boston Gas, and others all adopted a definition of X as a productivity 'offset' that was "relative" to other prices and "relative" to prices in the economy as a whole. This was the result of a well-known academic paper on the subject, and so we turn to this relative measure of X now.

2.3 Price regulation and the use of X in the Postal Sector

In the postal sector, various methods of regulatory pricing have been used worldwide including ex ante, ex post, and price cap methodologies. In a European context, despite the proposed full market liberalisation within the European postal market that is to take place by 2011, it is most probable that some level of price regulation will still be required even in a more competitive context given the market shares that incumbents will hold.

There is significant variety in the pricing mechanisms used, in Europe and elsewhere, with the majority subject to dual price control regimes. Guidelines for the regulation of universal postal services for the EU provide that "for each of the services forming part of the provision of the universal service" prices must be "geared to costs", "transparent and non-discriminatory" and "affordable" (Wik Consult, 2006). The regulatory price scope ranges

14 Bodnar, J. (1997), "Productivity input prices and price caps in telecommunications – the Canadian experience" 1997 ICFC June 24 - 27, 1997.

15 E-Control, (2003) "Incentive Regulation for the Austrian Electricity Transmission and Distribution Companies", Discussion paper. Vienna, 5th March, www.e-control.at.

from covering the complete universal service to reserved series and other product categories. Various benchmarks are used to regulate costs update pricing mechanisms. These range from various price indices, past costs, future costs, and efficient costs while various national regulatory authorities determine product costs, product volumes and regulate productivity. Within this context, a number of countries have used pricing regimes that include an estimation of an "X" factor. These include the UK, which uses an RPI -1% adjustment factor, and Belgium which uses a value for X of 2.5% (Wik Consult, 2006).

2.4 Bernstein and Sappington

The predominant view outside the UK on the proper derivation of X in an CPI-X type price cap come[16] from a particularly important study, Bernstein and Sappington (1999) (B&S). B&S posit a regulator who must regulate an industry via an CPI – X type price cap. The regulator's goal is to keep prices in the industry as low as possible to ensure zero economic profits. Therefore, with the zero economic profits condition as the goal, the starting point for their analysis is an accounting identity--output price times quantity must equal input price times quantity. One can write price as an index of all output prices, *P*, and an output quantity index *Y*, along with input price and quantity indices, *W* and *Q*, (superscript *i* to index the industry), giving:

$$P^i Y^i = W^i Q^i \tag{1}$$

[16] Prior work, such as the working paper by B&S, notably predated the publication in the Journal of Regulatory Economics by a number of years.

Taking logarithmic time derivatives (1) can be converted into growth rates. Writing lowercase letters to indicate the natural log and a dot over a variable to denote the time derivative, gives the dynamic zero profits[17] condition:

$$\dot{p}_t^i + \dot{y}_t^i = \dot{w}_t^i + \dot{q}_t^i \tag{2}$$

Defining TFP as the ratio of total output to total input, Y/Q, the dynamic industry zero profits condition can be rearranged to yield two theoretically equivalent measures of TFP growth.

$$\dot{y}_t^i - \dot{q}_t^i = \dot{w}_t^i - \dot{p}_t^i \equiv T\dot{F}P_t^i \tag{3}$$

The first measure above is the quantity measure of TFP growth. The second is the dual, or price measure.

The regulator is interested in setting the rate of growth in output prices for the industry, so the dual dynamic zero profits condition can be rearranged in terms of TFP growth to solve for the rate of change in industry output prices:

$$\dot{p}_t^i = \dot{w}_t^i - T\dot{F}P_t^i \tag{4}$$

This equation says that if zero profits are to be maintained, then the rate of growth of industry output should equal industry input price growth less TFP growth. Realise now that the rate of growth in output prices at the industry level is precisely the CPI – X type price cap. Therefore, we can write a general price cap definition as:

$$\dot{p}_t^i \equiv C\dot{P}I_t - \dot{X}_t^i \tag{5}$$

[17] Bernstein and Sappington (1999) show how to adjust the measure to allow for profits.

B&S then go on to derive what their view of what X should be. They start by defining (2) for the whole economy. Using e-superscript to signify the economy-wide variable, we can write the dynamic zero profits equation for the economy as a whole and derive economy TFP as:

$$\dot{y}_t^e - \dot{q}_t^e = \dot{w}_t^e - \dot{p}_t^e \equiv T\dot{F}P_t^e \tag{6}$$

Or, in terms of prices and TFP:

$$\dot{p}_t^e = \dot{w}_t^e - T\dot{F}P_t^e \tag{7}$$

Next, B&S recognise that CPI is, by definition, an estimate of the rate of growth in output prices in the economy on the whole; $\dot{p}_t^e \cong C\dot{P}I_t$. Therefore they posit:

$$C\dot{P}I_t = \dot{w}_t^e - T\dot{F}P_t^e \tag{8}$$

Making the appropriate substitutions and rearranging gives their X:

$$X_t = \left(T\dot{F}P_t^i - T\dot{F}P_t^e\right) - \left(\dot{w}_t^i - \dot{w}_t^e\right) \tag{9}$$

From here on, we will refer to (9) as the 'productivity-offset' X. What (9) says is the following. Given an CPI-X type price cap, then the X factor that will ensure industry zero profits will be a function of two things: first, the rate by which TFP growth in the industry *exceeds* TFP growth for the economy as a whole, minus, the rate by which input price growth *exceeds* input price growth for the economy as a whole. Thus, according to B & S, the proper definition of the X factor is a differential of a differential.

3. PROBLEM WITH OFFSET X

However, we contend that this view of X can lead to upward bias in the price cap[18]. This is because of the substitution of (8) into the price cap; (7) is not likely to hold empirically. The

[18] As was foreseen by Crew and Kleindorfer (1996) but not substantially investigated.

rate of consumer price inflation is not likely to equal input price inflation less TFP growth for the economy. It is also not clear why, if the price control is properly indexed for input prices, CPI needs to enter the equation, as inflation in input prices will be accounted for. We continue with the details of why this is likely to upward bias the measure. Next, write the price cap as a function of the productivity offset X; this gives:

$$\dot{p}_t^i = C\dot{P}I_t - \left(T\dot{F}P_t^i - T\dot{F}P_t^e\right) - \left(\dot{w}_t^i - \dot{w}_t^e\right) \tag{10}$$

Notice that, if input prices grow at a rate that is similar between the industry and the economy as a whole, and if TFP in the economy is similar to the TFP growth in the industry, then prices in the industry under the price cap rise at exactly the rate of CPI. In other words, real prices remain constant. Notice that, under (10), TFP growth in the industry could be quite robust, input price growth could be nil (the two of which would imply strong unit cost reductions in a competitive industry), and the price cap could still require real prices to rise, if CPI was not falling. This seems counterintuitive if regulation is meant to mimic competition.

We thus assert that productivity-offset X is biased. To see the nature of the direction of bias, collect the economy and industry terms.

$$\dot{p}_t^i = C\dot{P}I_t + \left(T\dot{F}P_t^e - \dot{w}_t^e\right) - \left(T\dot{F}P_t^i - \dot{w}_t^i\right) \tag{11}$$

Next, define two CPIs: true CPI as measured by the National Statistical agency estimates; call this *CPI**, and the CPI that would result from the whole economy TFP input price differential (Equation (8)); call this CPI^e. Making these substitutions, we can write:

$$\dot{p}_t^i = C\dot{P}I_t^* - \left(C\dot{P}I_t^e\right) - \left(T\dot{F}P_t^i - \dot{w}_t^i\right) \tag{12}$$

Notice that the true CPI, *CPI**, stays in the equation of the price cap and enters positively, while CPI^e, CPI as estimated by the substitution, enters the price cap negatively. Thus if *CPI** exceed CPI^e, then the price cap will be biased upwards. In other words, if true CPI exceeds the theoretical CPI actual economic profits will be expected to be positive under the price cap. Thus, the validity of the productivity-offset view of X depends on the validity of the substitution.

The correctness of this substitution is something that therefore should be empirically tested. Fortunately, (12) contains variables that are regularly estimated by national statistics agencies, and recent work by the EU KLEMS project has meant that economy-wide and industry TFP measures are now available. It is therefore possible to readily test the validity of the productivity-offset X.

4. ALTERNATIVE DEFINITION OF X

According to Littlechild (2003) and Crew and Kleindorfer (2008), the X factor is simply the rate at which real consumer prices should fall. But what should that rate be?

Proposition: We propose that X, the rate at which real consumer prices *should* fall, should be the rate of industry TFP growth less the rate of growth in real input price increases for the industry.

Non-technical Proof: Competition ensures zero economic profits, while still allowing a fair return on capital. The X-factor as proposed is the simplest form of the zero profits condition.

In the simplest terms, X should be based on the zero economic profits condition. For practical purposes this is closely approximated by expected industry TFP growth (plus an

input price differential or real input price changes). To see this, using the same notation as previously: Start with $\dot{p}_t^i = \dot{w}_t^i - T\dot{F}P_t^i$ and $\dot{p}_t^i \equiv C\dot{P}I_t - \dot{X}_t^i$. Recall that the former is derived from the zero profits condition and the definition of TFP growth, while the latter is the definition of the price cap. Setting them equal and solving for X, gives:

$$\dot{X}_t^i = T\dot{F}P_t^i + \left(C\dot{P}I_t - \dot{w}_t^i\right) \tag{13}$$

Under this derivation, X is TFP growth for the industry over the period, plus the differential between CPI and input price growth. Rewriting the price cap under our alternative definition gives:

$$\dot{p}_t^i = C\dot{P}I_t - \left(T\dot{F}P_t^i - \left(\dot{w}_t^i - C\dot{P}I_t\right)\right) \tag{14}$$

Thus, the price cap says the X factor should be just TFP less real input price growth.

There are a number of benefits to this definition relative to productivity-offset X. First, it is simpler. It requires fewer estimates of underlying data series as well. Second, it is more likely to return a price cap that limits the industry to zero economic profits, since it does not rely on a substitution that evidently does not hold empirically. Also, since when TFP growth is properly measured, TFP growth maps directly into unit cost savings, *ceteris paribus,* the formula for X as proposed is easily seen to map into cost savings for the consumer that would be in-line with what a competitive industry would have generated. The formula, as proposed, does not wash out the impact of expected TFP growth in the industry with a differential between it and economy-wide TFP growth.

The proposed X is superior to the 'judgemental' approach to X. Regulatory uncertainty is reduced and the accounting for input price changes is explicit. This is perhaps more important in the current financial climate where some input prices may be falling, but

where, in the postal sector, key input prices such as labour costs are likely to be rising in real terms in some cases[19].

5. Testing the productivity-offset view of X versus the alternative

5.1 DATA and Empirical Results

There are two ways we propose to test the validity of the offset-X versus the real unit cost reductions view. First, it would be interesting to see which sort of X factor, if plugged into a standard CPI-X type pricing formula would have given higher prices. In other words, one should compare the historical outcome of Equation 10, and Equation 18. In addition, it would be useful to calculate equation (8) and see if it holds empirically—in other words, does CPI really tend to be equal the difference between economy input prices and economy-wide TFP.

In order to perform the first test, we must obtain data on TFP and prices and volume indices for both the aggregate economy and industry for a sample of countries. Fortunately, due to efforts which have come to fruition over the last (approximately) 4-5 years, the EU KLEMs project now has consistent accounts for NACE 2-digit industry levels which enable industry specific productivity growth accounting. Unfortunately, the data at this level is aggregated in the "Post and Telecommunications Services." Nonetheless, since the purpose of our paper is to demonstrate the issues with the X-factor, we do not think this presents too much of a problem. Of course, if implementing a pricing policy for a particular country and a particular Post, one would want an actual estimate of the forecasted and achievable productivity growth for the industry or the company in question. The OECD produces

[19] This may be less true for the UK, where inflation has continued above 3% recently, mostly due to the devaluation of sterling. In the USA and Ireland for example, the growth rate in PPI less CPI has been close to zero or negative.

probably the best set of aggregate economy TFP or multifactor productivity[20] (MFP) estimates for the majority of OECD countries. We also obtained data on nominal GDP growth, GDP output volume indices, and GDP price-deflator growth from the OECD. The method was then to create the price deflator from the difference between the log-growth in nominal GDP and the growth in the OECD GDP output volume index. For the industry-specific data, the EU KLEMS database was used and the March 2008 release[21]. Country files were downloaded for all OECD countries plus other EU 25 Countries. Many countries had incomplete data or data on CPI, for example from Hungary and the Czech Republic, showed very high rates of inflation, which might have made the growth accounting and dichotomy between prices and quantities less reliable. In addition, we calculated our own factor input price index from the KLEMS data, by dividing nominal total compensation of labour and capital by the respective input volume indices of each, and then taking the torquist index[22] of growth in these implicit price series.

We then calculated an industry output price series using both the productivity offset X and the alternative consumer real prices reductions view. Using the available data resulted in numbers from 1996 -2005 for a sample of 16 OECD countries. The results of this exercise can be found in Table 1 below.

[20] Technically, many economist prefer "multifactor" productivity, as there are possibly unpaid factors of production or weakness in the accounts that are not measured. For example, environmental resources might be considered an "unpriced" factor of production, but output growth is typically not attributed to environmental degradation or use. To account for environmental use, Gollop and Swinand (1999) proposed total resource productivity or TRP.

[21] Available at http://www.euklems.net/.

[22] The tornquist index is the cost-share weighted average of the log-growth in the implicit input prices, where the average share of labour or capital between the last two years is used as the weight. It is the well-known discrete approximation to the Divisia index.

Table 1: Comparison of Price Rises using different definitions of X

Price and TFP Changes aagr 1996-2005									
Country	Industry Prices Offset-X formula	Industry Prices TFP less real input prices formula	Difference Industry prices: Offset versus TFP X	TFP industry (KLEMS)	TFP economy (OECD)	Input prices industry KLEMS Growth Accounting	Input prices economy OECD GDP	CPI	Output Industry Price Index EU KLEMS
Australia	0.73%	-1.76%	2.48%	1.20%	1.3%	-0.55%	1.31%	2.5%	-1.76%
Austria	-0.18%	-1.90%	1.72%	1.28%	1.1%	-0.62%	1.09%	1.7%	-1.92%
Belgium	2.77%	0.88%	1.89%	-0.08%	1.0%	0.79%	1.00%	1.9%	0.88%
Denmark	0.73%	-1.41%	2.14%	1.98%	0.3%	0.57%	0.31%	2.1%	-1.40%
Finland	0.17%	-1.16%	1.33%	4.64%	2.1%	3.48%	2.10%	1.3%	-1.16%
France	-1.28%	-2.83%	1.56%	4.00%	1.1%	1.17%	1.10%	1.6%	-2.84%
Germany	-0.79%	-2.19%	1.40%	3.08%	1.1%	0.90%	1.07%	1.4%	-2.19%
Ireland	1.27%	-1.77%	3.04%	3.74%	3.6%	1.97%	3.60%	3.0%	-1.76%
Italy	1.44%	-0.99%	2.43%	3.43%	-0.1%	2.44%	-0.09%	2.4%	-0.99%
Japan	-3.93%	-3.86%	-0.07%	1.91%	1.2%	-1.95%	1.21%	-0.1%	-3.86%
Netherlands	-0.49%	-2.81%	2.32%	3.29%	0.9%	0.48%	0.86%	2.3%	-2.81%
Portugal	2.89%	-0.03%	2.92%	0.40%	1.2%	0.37%	1.20%	2.9%	-0.03%
Spain	3.45%	0.53%	2.92%	-0.68%	-0.1%	-0.15%	-0.06%	2.9%	0.53%
Sweden	-0.35%	-1.31%	0.96%	1.38%	1.8%	0.08%	1.78%	1.0%	-1.31%
UK	-0.82%	-2.34%	1.52%	2.81%	1.2%	0.47%	1.23%	1.5%	-2.35%
USA	2.59%	0.31%	2.28%	1.49%	1.2%	1.80%	1.45%	2.5%	0.29%
Avg	0.51%	-1.42%	1.93%	2.12%	1.18%	0.70%	1.20%	1.9%	-1.42%

Observing the table, the first column is the hypothetical prices in the industry and offset-X would have produced and the second column is the hypothetical historical industry prices that alternative-X would have produced. The next column is the difference between the two. One notices that Offset-X would have led to higher prices in the industry in almost every case (save Japan). Further, the average difference would have been about 1.93%

higher. On average, over a 10-year period, Offset-X would have led to prices about 21% higher in the industry than under the alternative X.

One of the more interesting cases above is Japan, where there is virtually no apparent difference between offset-X and alternative-X. Apparently, it is the negative CPI growth, and the fact that industry input prices fell, while economy-wide input prices did not, which is driving this result.

This brings out the next point of empirical testing; equation 8. Does CPI growth tend to equal the growth in the GDP price deflator?[23] The answer is it doesn't. On average the GDP price index growth is about 2.5% lower than CPI growth. In addition, a regression using OLS of GDPPI on CPI showed a low correlation.

As a final look at our empirical results, we compared the output price growth from the hypothetical price caps with the actual output price index growth from the EU KLEMS database. The alternative-X matched the actual output price growth closely while offset-X would have led to higher prices. Of course, this is not to say that prices might not have been lower had a more stringent X-factor been in place. But to the extent that the industry (in this case telecoms and post combined) was facing stringent pressures, either from competition, from alternative communications sources, or from price controls, one would expect the resulting historical output prices to be reflective of the "correct" prices.

6. Implications for postal pricing policy

Taking the alternative-X definition as the 'rate at which consumer prices in the industry *should* fall' view of X also opens up an economically sound and researched framework

[23] As defined by taking the difference between growth in OECD nominal GDP less growth int eh OECD GDP volume index.

for adjusting price caps for a range of issues that are important for the postal industry: incorporating quality into X, consideration of the impact of scale economies and market share loss, access, and others. Consider for example the issue of scale economies. One of the sources of TFP growth is scale economies (and vice versa). Scale economies in the postal sector have been researched explicitly by Cohen et. al. (2004). They take the conclusions of Panzaar (1991), that the delivery function is the main source of scale economies, and extend this to posit an empirically tractable estimate of a generalised postal service cost function. They conclude that a quadratic average cost function, shifted up or down for local prices/wages, approximates well the postal cost function for a surprising number of posts. Given this (or other) estimates of an appropriate estimate of scale economies[24] can be found. It is then reasonably straight forward to estimate the change in scale economies due to a change in market share, either via an index number approach that explicitly accounts for scale economies, or using an appropriate econometric technique such as specifying a translog cost function with the appropriate explanatory variables. This is in fact what Cohen et. al. did in a number of papers (2003, 2005); they essentially argue that posts which are on the 'steep' part of their average cost curve might have trouble if they lose significant market share, whereas say, the USPS, which they argue was on a relatively flat portion of its curve, should be able to lose market share without much impact on unit cost. How this fits into price control was discussed by Hearn, Harman and Dhanani (2008).

[24] Their functional form implies scale economies across all output. They do not test this in a fully rigorous manner, but present regression results with intuitive appeal. Also appealing to their method is that they posit that the relative size of fixed costs for the post can be estimated based on the percentage of cost in the delivery function.

7. CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

This paper has discussed alternative definitions of X in standard price caps and how they would apply in the postal setting. While price caps are not new, some issues in the actual implementation of price caps remain unresolved. The paper compared and contrasted the UK style efficiency judgement X with the productivity-offset X often found in the US. The UK approach to X has been criticised for lack of transparency, while the US-style productivity offset X is more transparent, we presented evidence that a critical substitution in the derivation of the productivity-offset X in general does not hold empirically. We also showed how this 'differential of a differential' X might lead to growth in postal industry output prices that exceeded the dynamic zero profits condition. We proposed a simpler X that is more likely to ensure the zero profits condition, that is transparent, and that maps TFP growth less real input price increases directly into the final output prices of the industry under the price cap.

This research raises some important directions for the future. For example, regulators in some cases have adjusted industry price controls with additional "consumer dividend" factors, perhaps in response to the upward bias in the X factor? Does a rigorous but upward biased productivity offset X, adjusted downward with a consumer dividend factor, reduce or increase regulatory uncertainty relative to a 'judgemental' approach? If so, is there evidence that one approach has been superior to the other? Another area of further interest is the time-series properties of X.

There are also other issues with respect that we have not discussed. For example, Crew and Kleindorfer mention the possibility of including in X accumulated and/or company specific inefficiencies, and the need to forecast X. These issues have been considered in a number of contexts, but remain unresolved. For example, in a competitive market, the rate of TFP

growth for the industry would drive an industry-wide competitive price downward. For companies where a single and former monopoly dominates the industry, past rates of industry productivity growth may not give good predictions for the future. Further, regulators are often keen to set company-specific targets so as not to be seen to giving a benefit to companies with low productivity levels, and companies are keen on company-specific targets so that exogenous company-specific cost drivers are not seen as inefficiency.

Finally, additional questions perhaps still remain about quality of service and X and how quality of service should enter a price cap, although this area was studied in some detail by Swinand and Scully (2006) and Crew and Kleindorfer (2008, 2009)[25], more precision about how the X factor should be adjusted for quality still needs further research.

We have also not explored the relative incentive properties of X factors under various definitions, although, at the outset, as long as the X factor is seen to be exogenous, then it might not impact incentives[26].

We have proposed that X is properly based on the rate of TFP growth less real input price growth. Once X is derived more rigorously and this definition is accepted, it is then an empirical question as to how to best forecast X. It is not clear that the judgemental approach advocated by Crew and Kleindorfer (2008) would lead to better forecasts. Research on forecasting differentials between input price indices for industry and the economy might also prove fruitful.

[25] Crew and Kleindorfer concluded that the way to incorporate quality into the X factor, thus the difficult-to-regulate quality-cost trade-off would at least in part be internalised by the firm. Of course, how this enters X is another issue.

[26] For a general discussion see (Laffont and Tirole 2000). They do not get into the details of X factors though.

REFERENCES

Bodnar, J. (1997), "Productivity input prices and price caps in telecommunications – the Canadian experience" 1997 ICFC June 24 - 27, 1997.

V. Ball, F. Gollop, A. Kelly, and G. Swinand (1999), "Patterns of state productivity growth in the US farm sector: Linking the state and aggregate models," *American Journal of Agricultural Economics*, 81, 164-179.

Bernstein, Jeffrey I., and David E. M. Sappington (1999), "Setting the X Factor in Price- Cap Regulation Plans," *Journal of Regulatory Economics,* 16, no. 1 (July): 5-25.

Bernstein and Sappington (1998), "Setting the X Factor in Price Cap Regulation Plans," NBER Working Paper, 6622.

Cohen, R., Robinson, M., Scarfiglieri, G., Sheehy, R., Comandini, V.V., Waller, J. and Xenakis, S., "The Role of Scale Economies in the Cost Behaviour of Posts", Proceedings of the Wissenschaftliches Institut für Kommunikationsdienste (WIK), 8th Köenigswinter Seminar on "Regulating Postal Markets – Harmonised Versus Country Specific Approaches," February 16-18, 2004.

Crew, M.A., and P.R. Kleindorfer (1996) "Price Caps and Revenue Caps: Incentives and Disincentives for Efficiency", in M.A. Crew, ed., Pricing and Regulatory Innovations under Increasing Competition, Boston/Dordrecht/London, Kluwer Academic Publishers.

Crew, M.A., and P.R. Kleindorfer (2008) "Regulation and the USO Under Entry", in M.A. Crew, ed., Competition and Regulation in the Postal and Delivery Sector, Edward Elgar, Cheltenham, UK.

Laffont, J-J. and J. Tirole, 2000. A Theory of Incentives in Procurement and Regulation, MSA: MIT Press.

Littlechild, S. (2003), "The birth of RPI-X and other observations", Draft June 2003 Conference on The UK Model of Utility Regulation London, 9 April.

London Economics, (2003), "Scope for efficiency improvement in the UK water industry: PR4," Ofwat, available at www.ofwat.gov.uk.

Postcomm (2003), "Review of Royal Mail Group plc's Price and Service Quality Regulation: Second Price Control, Quality Service Targets and Compensation", Licence Modification and Decision Document, available at www.pse.gov.uk

Saal, D., and D. Parker (2001), "Productivity and Price Performance in the Privatised Water and Sewerage Companies in England and Wales," *Journal of Regulatory Economics*, 20, (1), pp61-69.

Swinand, Gregory and Derek Scully (2006), "Incorporating Quality of Service Measures Into Price-caps for Post," Presentation to the CRRI Conference on Postal and Delivery Economics, Bern, Switzerland.

Water UK report, (2002), "The General Efficiency Assumption: Setting X in RPI-X.

Williamson, B. (2002), "Towards Objective Methods of Setting X in RPI-X Price Controls", 25th July, presentation.

Wik Consult (2006), "Main Developments in the Postal Sector (2004-2006)" EC DG Internal Markets, available at http://ec.europa.eu/internal_market/post/doc/studies/2006-wik-final_en.pdf