Lens prices -- like airline prices?

Certain lenses perform beyond what their price would indicate (70-200L F4)and others not (16-35L). Some low priced lenses have IS (28-135) while other lenses increase substantially in price with IS. Some cheap lenses have poor build quality but great optics (50mm 1.8), while more expensive lenses still have relatively poor build quality (50mm 1.4). Is there any sense in lens prices?

Distance from normal

Some lenses are easier to design than others.

"Normal" focal length is easiest of all. This corresponds to a focal length about as long as the diameter of the image circle. 50 mm is pretty close to it. The further away you get from 50, the more difficult things get: towards the shorter end, it gets progressively more difficult to keep the lines straight and aberrations under control, and towards the longer end, it gets simply trickier to manufacture the things to the tolerances where great magnification *and* sharpness are combined.

So, you should expect to find the best optics for the least amount of money somewhere between, say, 28 and 135 mm. Under 28, and either quality will go down, or price will go up. Over 135, the same thing.

Then, consider brightness. Again, a normal lens is the easiest to make bright. Moving away in either direction, it becomes progressively more difficult to maintain brightness and optical quality.

You might say that for primes, a "normal" brightness series might go something like this:

20/2.8 -- 35/2 -- 50/1.4 -- 85/1.8 -- 100/2 -- 200/2.8 -- 300/4 -- 400/5.6

By jumping through design hoops, you can get an extra stop, sometimes even more, on each of these lengths, but not easily -- you'll wind up with a good lens that's bulky and expensive, or a poor lens that's smaller and cheaper. Compare, for example, the 85/1.2L and the 85/1.8, or the 35/2 and 35/1.4L. Both pairs of lenses are optically roughly equal in quality, but the extra stop on the brighter ones has required a major addition in weight, exotic design elements, and price. Or, consider the 50/1.4 and the 50/1.0L. The latter is a stop brighter, but much bigger, hideously expensive, and optically nowhere near as good as the 1.4 at any aperture. There are exceptions, especially at the wide end, where things get generally weirder -- a good WA lens is very difficult to design and build, because aberrations become harder to keep under control. You won't find a 20 mm that's as sharp at the corners as a decent 50 mm.

When you compare the prices on these primes, you'll find that they have a roughly constant price per unit of weight. It naturally costs more to put together a big lens to the same tolerances as a small one.

If we'll take the "prime series" as our baseline, and keeping in mind that we can add a stop of brightness by going for exotic, expensive technologies, we can start doing variations. If we want to add a particular feature to a lens, it'll costs us brightness. For example, adding good macro capability costs about a stop: compare the 100/2 and the 100/2.8 Macro, or the 50/1.8 Mk I and the 50/2.5 Macro. Each pair is very similar in optical quality, but the macro version is a stop slower.

Of course, there are things like build quality and features: the 50/1.8 Mk II would cost about as much as, say, the 35/2, if it were built like the 35/2. Generally, but not always, build quality and optical quality go hand in hand: it doesn't make much sense to put expensive and exotic glass into a cheap body that'll fall to bits easily... and it doesn't make much sense to "over-build" an optically mediocre lens either. (Somebody should let Tokina know -- their AT-X Pro zooms are built like brick outhouses, but most of them are damp squibs optically.) There are exceptions -- usually near the normal range, where good optics aren't necessarily expensive: therefore the 50/1.8.

Then, there are the standards to which a lens is built. A "consumer" lens is generally designed to make good 4x6's, but at 8x10's, the problems will start to show up. By compromising on optical quality, it's possible to bring price and weight down.

Zooms

With zooms, it's easy to be misled into staring at the zoom ratio -- how many times difference there is between the wide setting and the tele setting. This does matter, of course, but it's not the whole story. Again, the further you depart from "normal," the more optical trade-offs you need to make -- or the bigger, more exotic, and more expensive the lens. It's especially tricky to make a lens that combines wide-angle performance (keeping distortion and aberrations under control) with tele performance (maintaining sharpness while increasing magnification). There's a reason the Sigma 50-500 is a great lens, while the Canon 35-350 L is a pretty mediocre one (for an L, and for the price, anyway): it's because 35 is below normal focal length, while 50 isn't.

For example, a 28-90 is a fairly easy lens to make. A 24-70 is more difficult, because a 24 is significantly trickier than a 28. A 28-200 is even trickier to do well, and generally involves big trade-offs in brightness, at least. Ultra wide-angle zooms are the trickiest of all: that's why the likes of the 16-35/2.8L and the 17-40/4L have very narrow zoom ratios -- little over 2x in both cases. That's also why we're not likely to see a 16-105 zoom any time soon... not unless someone manages to pull a rabbit out of a hat with exotic new technologies like diffractive optics, anyway.

So, "zoom range" (i.e., what's the difference in mm between wide and tele) isn't as important as how far from normal the focal lengths are.

So, why does a 24-70/2.8L cost about 1,800 Euro, while you can get a 24-85/3.5-4.5 USM for around 380 Euro?

The answer is that adding zoom capability costs brightness, too. Take an 85/1.8 lens, and add the zoom capability down to 24 mm, and if you want to keep the cost and bulk roughly the same, it'll cost you a couple of stops, and some optical quality to boot. If you want to make a similar zoom with a brightness of f/2.8, you're going to need to jump through similar hoops as making the 85/1.2L -- you'll still lose about two stops, *and* will have to fight every inch of the way to maintain optical quality. This adds up in the price tag, and the weight.

To summarize...

1. Near normal focal-length lenses are easiest to make. The further you go from 50 mm, the more expensive, darker, or worse lenses get.

2. Wide-angle is trickier than tele.

3. Lenses have a "natural" brightness: go darker, and you can buy better optical quality or zoom capability; go brighter, and you'll trade off either quality or you'll have a much more expensive lens.

4. Zoom capability has its cost: either in brightness (about one-two stops), or in dollars and bulk. (Cf. a

200/2.8L costs about as much as a 70-200/4L, but a 70-200/2.8L costs in the same ballpark as a 200/1.8L.)

5. Good optics generally cost more than mediocre optics.

6. Build quality usually, but not always, goes hand in hand with optical quality. The positive exceptions are usually near normal range.

All the primes between 28 and 135 mm (except the super-bright ones) are reasonably priced and optically superb. Zooms in the same range are usually (a) darker, (b) poorer optically, (c) bigger and more expensive, or (d) a combination of any of the above.

Sometimes you'll find a lens that's (positively) off the scale in some way -- it delivers more than you'd expect from these rules of thumb. These are the ones to look out for. For example, the Canon 80-200/4.5-5.6 is exceptionally good optically for an inexpensive consumer zoom.

So, to pick the right lens for you, consider your needs, where you're willing to compromise, and how much you're willing to pay. Then look for the lens(es) that'll deliver what you need at the lowest possible price. And don't forget shopping used!