

Problem Set 2: Back of the Envelope¹

Objective: The objective of this assignment is to introduce students to how developers and investors initially examine the financial feasibility of a deal². The intuition underlying this static approach is that an investor seeks solvency (breakeven) in the short run and profitability in the long run.³ It is also a useful method to (stress) test the initial cash flow assumptions that create the yield. This is important because if the initial cash flow in year one is faulty, by simply doing discounted cash flow analysis, an investor is first compounding the errors into the future and then discounting these errors back to the present.

The deal: One Renaissance Square, 2 N. Central Avenue, Phoenix, AZ 85004. Located in the heart of the Cooper Square district of downtown Phoenix on Washington Street between First Avenue and Central Avenue, the 26-floor (347 feet) Class A tower that Trammell Crow Commercial built in 1987 is situated on 0.95 acres (41,563 square feet) and has 491,623⁴ net rentable square feet. The typical floor plate is 19,500 square feet. The project architects were Pierce Goodwin Alexander & Linville and Emery Roth & Sons. Three years later in 1990, another tower consisting of 28 stories known as Two Renaissance Square was constructed on the next block at 40 N. Central Avenue.



Structurally, the building consists of reinforced concrete slab on grade beams and reinforced concrete piers supporting a rigid steel frame and trusses with lightweight concrete slab floors. The exterior of the building consists of carmine red granite with copper anodized windows. The building is equipped with a computerized energy management system. The HVAC (heating ventilation and air conditioning) system is comprised of two central air-handling units, one located in the penthouse and another in the basement. Each central air-handling unit contains two supply fans, filter bank, and cooling coil bank. There are two 450 ton chillers and one 200-ton chiller, all piped in parallel with automatic valves at each chiller. Fan powered VAV boxes and electric reheat provide heating throughout the building. The common and basement areas of each building and

¹Please do not reprint or reproduce in whole or part without written permission from the author. The author gratefully acknowledges the assistance of Charles A. Miscio and Pete Bolton of CBRE (CB Richard Ellis) Phoenix office in the preparation of this case study.

²This is known in the trade as the “back of the envelope” or the backdoor-frontdoor approach.

³This is the philosophy that used to be taught at the University of Wisconsin by the late Professor James A. Graaskamp, my mentor. Graaskamp coined the phrase backdoor-frontdoor.

⁴The 491,623 square feet is not consistent with BOMA’s (Building Owners and Management Association) definition of rentable square feet since some of the current leases do not reflect the current BOMA re-measurement. As leases roll on these spaces, the rentable square feet(RSF) will be converted to BOMA RSF. Total rentable square feet using BOMA’s definition is 483,852 square feet.

the garage are sprinklered. Halon gas cylinders are utilized in certain specific areas instead of water to avoid computer equipment damage. Twelve elevators service the building with four elevators serving floors 2 through 12 and five elevators service the high-rise portion of the tower (Floors 12 through 26). Two hydraulic elevators service lower level to second floor and one service elevator extends from the basement to the 26th floor. Two escalators service the lower level from the parking garage to the main lobby.

One Renaissance Square features five levels of underground parking for 605 cars (parking ratio of 1.2 cars per 1,000 square feet), a 20,000 square foot, state-of-the-art fitness facility with tennis, racquetball & basketball courts, a building conference center, and a 24-Hour on-site security service⁵. It also has premium access to the proposed light rail station. The property is well located in the Phoenix central business district, offering tenants immediate access to City Hall, the Federal Building, Phoenix's Superior Court, Symphony Hall, America West Arena (Phoenix Suns - NBA) and Bank One Ballpark (Arizona Diamondbacks - MLB) with convenient access to Interstate 10 and the Sky Harbor International Airport.

Only five downtown office properties are comparable to One Renaissance Square. These properties are Phelps Dodge Tower, Collier Center, One Arizona Center, Two Arizona Center, and Two Renaissance Square. These six buildings in aggregate have 2.2 million square feet and have historically tended to outperform the rest of the Downtown market in terms of higher occupancy rates and better economics.

On March 16, 2005, Maguire Properties (NYSE:MPG) acquired One Renaissance Square for \$120 million as part of a \$1.5 Billion office portfolio acquisition from Commonwealth's Fifth Street Properties. Since the Phoenix property was always considered a non-core asset, Maguire announced plans to sell it hiring Secured Capital Corp as their exclusive advisor and CB Richard Ellis (CBRE) as the local broker. Charles Miscio of CBRE was the broker in charge of the transaction. Property tours ended and offers were due by April 19, 2005. On June 29, 2005, MPG sold One Renaissance Square for \$128.8 million to a subsidiary of Pauls Core Plus Venture, L.P.⁶

⁵In addition to the 24 hour manned security desk, there are closed-circuit television and intrusion alarms, emergency communication systems, and after-hour electronic card entry control systems in the elevators, garage, and office areas.

⁶Pauls Core Plus Venture L.P., is a partnership between Pauls Realty Fund Advisor LLC (10%) and GE Pension Trust (90%). The Pauls Corp. was formed and managed by William Pauls and currently has nearly \$700 million of assets. The company currently owns nearly 5 million sq. ft. of office and retail properties in Denver, Kansas City, Las Vegas, and San Francisco. The GE Pension Trust currently has \$2.3 billion of real estate investments and is advised by GE Asset Management.

which also owns Two Renaissance Square⁷. When Pauls Core purchased the building, One Renaissance Square was offered for sale without an asking price on an “As Is, Where Is” condition. In connection with the sale of One Renaissance Square, the buyer assumed \$103.6 million of mortgage debt at an interest rate of 5.1325%⁸. The One Renaissance Square Mortgage Loan is interest only (IO) without principal amortization for the entire loan term with an annual debt service of \$5,388,000 and matures on April 1, 2012. The loan is structured with a hard lockbox⁹. As part of the loan provisions, future mezzanine or subordinate indebtedness is not allowed. The loan can be prepaid subject to Defeasance after the earlier of 1) two years after the start up of a REMIC or 2) March 16, 2008. Assumption of the loan is permitted with Lender’s approval and a written notice 30 days prior to the transfer date. Borrower will have to pay lender a non-refundable processing fee of \$25,000. There is no assumption fee for the initial assumption of the loan but there will be a 0.5% fee for each subsequent assumption. In connection with the sale, MPG entered into a lease obligation with the buyer to lease 37,220 rentable square feet of vacant space at \$25.10 per square foot through March 2007 to guarantee a 98% occupancy status for two years¹⁰. MPG has the option to terminate this lease in the event that they sublease the space to a tenant or tenants for an equal amount of rent.

The \$103.6 million loan is secured by a leasehold interest in the 25-story tower and includes a two-story annex building with a rooftop tennis court, a five-level subterranean parking garage, retail shops, an athletic club, and a restaurant. The parking garage is co-owned with the City of Phoenix in a condo structure. The collateral includes 322 owned parking spaces, and an additional 283 parking spaces are leased from the city for 50 years. The garage needs nearly \$4 million in repairs of which approximately \$3.1 million will come from the city’s March 14 bond election, and the rest is to come from the Pauls Company. A leasehold interest exists since the building sits on land leased from the city. The lease is renewed in five-year terms with the next renewal to occur in 2007. Ground lease payments to the City of Phoenix are equal to approximately 70% of traditional property taxes and are made in lieu of property tax payments. If the ground lease is not renewed, a fee simple interest in the land will be deeded to the borrower at no cost with traditional property taxes to be paid from that point on.

Also known as the Ernst & Young Tower¹¹, the property is currently 97.5% leased by 13 office and eight retail tenants paying a weighted average rent of \$22.80 per square foot with a weighted average lease term of approximately 7.9 years. The five

⁷Two Renaissance Square was purchased in September 2005 for approximately \$120 million after the purchase of One Renaissance Square with \$85.2 million in debt (65% LTV) at 5.14% (150 bps over 10 year Treasury) maturing April 1, 2012.

⁸Maguire Properties repaid \$24 million of the term loan prior to the assumption of the loan e.g. the original loan amount was \$127.6 million.

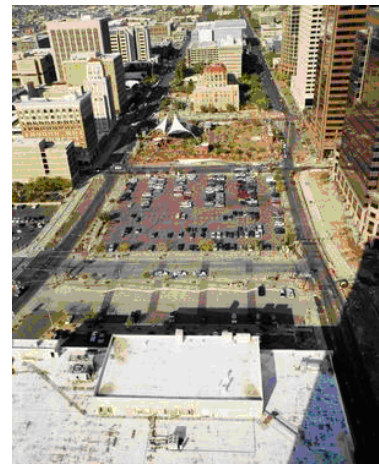
⁹The cash management “hard lock-box” requires that all cash receipts from the property be deposited into a lender-controlled account. In this way, the CMBS investors can be assured that cash will be devoted first to service the debt and pay taxes, insurance and the cost of property maintenance. Cash can be released to the borrower only after the debt service has been paid and all required accounts have been funded.

¹⁰The property was 98% occupied at the time of the current sale.

¹¹Ernst and Young leases space on the 23rd, 24th and 26th floors.

largest tenants occupy 380,744 rentable square feet or 77.4% of the total building. The largest tenant, Quarles & Brady occupies 161,300 square feet (32.8% of square feet, 33.2% of rental income) on floors 2-9 under ten leases of various terms, all of which expire on April 30, 2015. The current blended rental rate per square foot of \$23.07 increases to \$24.00 on January 1, 2010, \$25.00 on January 1, 2011 and the greater of \$31.00 or market on January 1, 2012. There are two five-year options to renew the leases at a rental rate per square foot at the then fair market rate. Quarles & Brady, a tenant since 1994, is one of the 100 largest law firms in the United States and employs more than 400 lawyers. Bryan Cave LLP, the second largest tenant, occupies 103,353 square feet (21.0% of square feet, 22.1% of rental income) under six leases of various terms, all of which expire on April 30, 2017. The current rental rate per square foot of \$24.00 increases to \$25.00 on May 1, 2006, \$26.00 on May 1, 2009, and \$33.50 on May 1, 2011. There is one five-year option to renew the leases at a rental rate per square foot at the greater of \$33.50 or the then fair market rate. Bryan Cave, a leading international law firm has been a tenant at the One Renaissance Square since 1998. Ernst & Young U.S., LLP occupies 50,203 square feet (10.2% of square feet, 12.5% of rental income) on floors 23, 24 and 26 under three ten-year leases, all of which expire on June 30, 2010. The current rental rate per square foot of \$27.85 increases to \$29.85 on July 1, 2008. There are two five-year options to renew the leases at a rental rate per square foot at 95% of the then fair market rate. Ernst & Young, a tenant since 2000, is one of the world's largest accounting firms. Maguire Properties, the seller, leases 37,220 sf (7.6% of square feet, 8.3% of rental income) under a two-year master lease which expires on March 1, 2007. The rental rate per square foot is \$25.10.

The area surrounding One Renaissance Square is currently undergoing revitalization. In October 2006, the Phoenix city council approved a \$900 million project known as CityScape¹² comprising 3 city blocks¹³ just south of Washington Street (One Renaissance Square), including the area known as Patriots Square Park. Anticipated to open in 2009, CityScape will consist of 4 towers, one office tower similar to One Renaissance Square, a mixed use office and residential tower, and two residential towers that will include a 150-room boutique hotel. The project will feature 250,000 square feet of retail space including AJ's Fine Foods store, the area's first grocery store in 25 years (located on the corner of Central Avenue and Washington Streets) along with dining such



as P.F. Chang's China Bistro, shopping and other entertainment. Inventory estimates suggest there is approximately 500,000 square feet of existing retail, food/beverage and entertainment functions in Downtown Phoenix. The majority of this inventory is situated within Arizona Center and Colliers Center. Currently, there is only one existing shopping mall in downtown, Arizona Center, which has about 150,000 square feet of leasable

¹²The developer of CityScape is Scottsdale-based RED Development who is partnering with Donald Cardon, a developer and former Phoenix deputy housing director, and Barron Collier Cos., another developer that owns the Collier Center in downtown Phoenix.

¹³The blocks are known as Block 22 and Block 23 in addition to the Patriot Square block

retail space. To make the deal work, the city will purchase the project's underground parking garage and pay for repairs to an existing parking garage at a cost of \$96.5 million. The city will also wave property taxes for eight years (a \$26 million financial incentive package) using a state law called the Government Property Lease Excise Tax on the development's key components. After that, the project would be taxed but at a lower rate. In addition to this, the city which owns the titles to the land, would sign a long-term lease with the developer.

Other large revitalization projects in the area include the expansions of the new Arizona State University campus and the Phoenix Convention Center and the construction of a \$1.4 billion light-rail system. The first phase of the Valley Metro Rail system will connect downtown Phoenix and downtown Tempe, with a station platform scheduled to be built directly in front of Two Renaissance Square. The CBD's competitive position has also been buttressed over the past few years by the completion of several high-profile projects, including America West Arena, Bank One Ballpark, and Phoenix Civic Plaza Convention Center.

The central business district (CBD) submarket delineated by Glendale Avenue to the north, Buckeye Road to the south, 7th Avenue to the west, and 7th Street to the east, contains approximately 6.9 million square feet of "Class A" office space and had a vacancy rate of 6.1% as of the second quarter of 2005, a significant decline from the 11.5% recorded as of mid- 2004. During the first half of 2005, the net absorption was 236,000 square feet. The average asking rent per square foot per year is \$24, a decline of -1.2% from year end 2004 (\$24.15).

Property Assumptions: (Please refer to the worksheet “Building Stats” for further details about the building)

Category	Description
Date of Analysis	April 16, 2005
Discount rate on leases	<p>A lease is a type of debt financing (pre-tax). Assume that the average tenant (office and retail) for One Renaissance Square has a Caa/CCC rating with an effective maturity of 7 years¹⁴.</p> <p>Pre-tax cost of debt = riskfree rate + default premium</p> <p>where riskfree rate is located in "Treasury Rates" worksheet and the default premium is located in the "BondMkt Rates" worksheet. The default premium is the premium over the applicable treasury rate. Since we assume a 7 year maturity, take the average of the 5-year and 10-year Treasury yield for the riskfree rate.</p> <p>Note: This pre-tax cost of debt is the borrowing cost if the borrower were to borrow money directly from the capital markets instead of using bank financing.</p> <p>Example: Suppose that the tenant is a AA tenant who signs a 10 year lease. Then the discount rate used to discount lease payments (pre-tax cost of debt) using the numbers in our spreadsheet is</p> <p>Riskfree rate: 4.54% (bcs its a 10-year lease) + Default premium: .84% (10-yr Treas bcs 10 yr lease) <u>Pre-tax Cost of Debt 5.38%</u></p>
Rentable SqFt (RSF)	491,623 square feet is the total net rentable square feet
psf	per square foot of net rentable area. (see above)
Expected Selling Price	All that is known was that Maguire Properties bought it for \$120 million (\$120,000,000) and that it was offered for sale without an asking price on an “As Is, Where Is” condition
Going-In Cap Rate	According to the "RealtyRates" worksheet, the current cap rate that participants are purchasing office properties at is 5.8% (Market Survey). However, investors surveyed indicate they will use a 9.57% cap rate. Point: expectations and reality differ.

¹⁴According to the 10-K for Maguire Properties, they note that the weighted average remaining lease term was 7.9 years for One Renaissance Square when they sold it.

Category	Description																				
Building Class	Class A ¹⁵ .																				
Potential Rental Revenue	Assumes 100% occupancy. Expected rent per occupied space on a per square foot rentable area basis is given in the "4. Calc ProForma" worksheet. For available space (vacant) and space that won't be renewed use 2006 market rents.																				
2005 Annual Market Rents psf psf = (per square foot of net rentable area)	<table> <tr> <td>Floors 1 – 22</td> <td>\$24 psf</td> </tr> <tr> <td>Floors 23 – 26</td> <td>\$26 psf</td> </tr> <tr> <td>Retail</td> <td>\$19.50 psf</td> </tr> <tr> <td>Health Club</td> <td>\$ 4 psf</td> </tr> <tr> <td>Storage</td> <td>\$18 psf</td> </tr> </table>	Floors 1 – 22	\$24 psf	Floors 23 – 26	\$26 psf	Retail	\$19.50 psf	Health Club	\$ 4 psf	Storage	\$18 psf										
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Annual growth rate in market rents	<table> <tr> <td></td> <td>Office</td> <td>Retail</td> <td>Health</td> <td>Storage</td> </tr> <tr> <td>Year 2006-2008</td> <td>7%</td> <td>7%</td> <td>7%</td> <td>7%</td> </tr> <tr> <td>Year 2009</td> <td>4%</td> <td>4%</td> <td>4%</td> <td>4%</td> </tr> <tr> <td>Thereafter</td> <td>3%</td> <td>3%</td> <td>3%</td> <td>3%</td> </tr> </table>		Office	Retail	Health	Storage	Year 2006-2008	7%	7%	7%	7%	Year 2009	4%	4%	4%	4%	Thereafter	3%	3%	3%	3%
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Rent increase over Term	Rent increases on signed leases in One Renaissance Square are 3% per year.																				
Term of New Lease	10 years																				
Parking Revenue	\$1.16 psf/year. Gross parking revenues represent monthly parking from in-place spaces. Garage expenses are included in non-reimbursable expenses.																				
Other Income	Other income is \$0.34 psf/year. Includes income from tenant services profit, storage income from non-rentable area from current tenants, conference room income, and telecom income on in-place agreements.																				
Vacancy	The market vacancy rate is 6%.																				
Free Rent (Months)	Tenant has four months of free rent on a 10 year lease ¹⁶ . Assume that free rent is 3.6% of Potential Rental Revenue. Example: if annual rent per sqft is \$26, then the free rent per year is \$.94 per sqft (\$26*3.6%)																				

¹⁵Building classifications in most markets refer to Class "A", "B", "C" and sometimes "D" properties. While the rating assigned to a particular building is very subjective, Class "A" properties are typically newer buildings with superior construction and finish in excellent locations with easy access, attractive to credit tenants, and which offer a multitude of amenities such as on-site management or covered parking. These buildings, of course, command the highest rental rates in their sub-market. As the "Class" of the building decreases (i.e. Class "B", "C" or "D") one component or another such as age, location or construction of the building becomes less desirable. Note that a Class "A" building in one sub-market might rank lower if it were located in a distinctly different sub-market just a few miles away containing a higher end product.

¹⁶This assumption is based on the lease terms for Beyond Juice whose contract began on January 1, 2005 and ends on December 31, 2014. Free rent months were January 2005 to April 2005.

Category	Description																								
Tenant Reimbursements (Revenue)	<p>Tenants pay Full Service Gross (FSG) + Base Year, paying their pro-rate share of reimbursable expenses over their base year amount. Tenant reimbursements also include management fees calculated as 3% of effective gross revenues (EGR) and non-cash expenses such as amortized capital costs and management office rent. Tenant reimbursements also include recoveries for amortized costs relating to lobby upgrades. These costs are amortized over their useful lives and charged back to tenants. The majority of the costs will be fully amortized in 2006.</p> <p>For purposes of calculating tenant reimbursements only, effective gross revenue is defined as</p> <p>Base Rental Revenue for Occupied Space¹⁷ - Base Rent Abatements - <u>TI, Leasing Costs & Capital Reserves</u> Landlord's Effective Gross Income (EGI)</p>																								
Operating Expense per sqft (rentable square feet)	<table border="0"> <tr> <td>Cleaning/Janitorial</td> <td>\$0.88</td> </tr> <tr> <td>Repair & Maintenance</td> <td>\$1.39</td> </tr> <tr> <td>Utilities</td> <td>\$1.13</td> </tr> <tr> <td>Security/Life Safety</td> <td>\$0.67</td> </tr> <tr> <td>Administration</td> <td>\$0.60</td> </tr> <tr> <td>Real Estate Taxes¹⁸</td> <td>\$2.23</td> </tr> <tr> <td><u>Insurance</u></td> <td><u>\$0.14</u></td> </tr> <tr> <td>Reimbursable Expenses¹⁹</td> <td>\$7.17</td> </tr> <tr> <td>+ <u>Management Fees</u>²⁰</td> <td>1.5%*EGI</td> </tr> <tr> <td>Total Reimbursable Expenses</td> <td>\$7.04+ 1.5%*EGI</td> </tr> <tr> <td>+ <u>Total Non-Reimbursable Expenses</u>²¹</td> <td>\$0.74</td> </tr> <tr> <td>Operating Expenses</td> <td>\$7.78 + 1.5%*EGI</td> </tr> </table> <p>where EGI is Landlord's Effective Gross Income as defined in Tenant Reimbursements above.</p>	Cleaning/Janitorial	\$0.88	Repair & Maintenance	\$1.39	Utilities	\$1.13	Security/Life Safety	\$0.67	Administration	\$0.60	Real Estate Taxes ¹⁸	\$2.23	<u>Insurance</u>	<u>\$0.14</u>	Reimbursable Expenses ¹⁹	\$7.17	+ <u>Management Fees</u> ²⁰	1.5%*EGI	Total Reimbursable Expenses	\$7.04+ 1.5%*EGI	+ <u>Total Non-Reimbursable Expenses</u> ²¹	\$0.74	Operating Expenses	\$7.78 + 1.5%*EGI
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¹⁷This is the total rent for all space excluding (subtracting out) space on Master Lease, space coming up for renewal in 2006, and currently vacant space

¹⁸Taxes include ground lease payment made to City of Phoenix, excise tax, real estate taxes on garage and special assessments.

¹⁹Excludes management fees

²⁰Management fees are in addition to salaries which is included in the Administration line item.

²¹Garage expenses also known as Parking Operation Costs are the only non-reimbursable expenses.

Category	Description									
Tenant Improvements psf (Lease concession). Also known as TI or Finish Out Allowance	TI (\$/psf) for new leases is \$10 psf and for the renewal of existing leases is \$5 psf. The landlord aka lessor pays for this cost (TI) and represents a concession that effectively lowers the rental rate. We assume that TI is amortized (depreciated) over the life of the lease e.g. assumes that the life of Tenant Improvements is equal to the length of the lease. Note: any cost in excess of the agreed amount is to be paid by the tenant. No excessive TI allowance is assumed for our property e.g., additional amount above standard TI.									
Capital Reserves	Capital Reserves are \$0.10 per square foot per year.									
Replacement Reserves	Already included in TI and capital reserves									
Leasing commissions	<table border="0"> <thead> <tr> <th></th> <th>Year 1 – 5</th> <th>Year 6+</th> </tr> </thead> <tbody> <tr> <td>New Leases</td> <td>5% per year</td> <td>2.5% per year</td> </tr> <tr> <td>Renewals</td> <td>2.5% per year</td> <td>1.25% per year</td> </tr> </tbody> </table>		Year 1 – 5	Year 6+	New Leases	5% per year	2.5% per year	Renewals	2.5% per year	1.25% per year
	Year 1 – 5	Year 6+								
New Leases	5% per year	2.5% per year								
Renewals	2.5% per year	1.25% per year								
Loan Balance	Existing loan balance is \$103,600,000									
Interest Rate on Commercial Mortgages	The interest rate on the existing loan is 5.1325%. Interest calculation is Actual/360 days ²² .									
Annual debt service	Annual debt service is \$5,388,000 on the existing loan									
Mortgage Constant	Annual mortgage constant is equal to the contract interest rate since loan is interest only. Interest rate is 5.1325%.									
Loan to Value (LTV)	80%									
Amortization Period or Term of Loan	The existing loan is an interest only loan (no amortization). The 7 year loan has a maturity date of April 2012 (4/01/12).									
Debt Coverage Ratio	1.45; This is the minimum for investing in office buildings located in the Central Business District (CBD).									
Before-tax Cash on Cash (Return on Equity)	11.58%; This is the average for investing in office buildings located in the Central Business District (CBD).									

²²Actual/360 (days per month, days per year): Each month is treated normally and the year is assumed to be 360 days e.g. in a period from February 1, 2005 to April 1, 2005 T is considered to be 59 days divided by 360 where $T = D_p/D_y$ and D_p is the number of days in the period, and D_y is the number of days in the year.

Assignment: Please prepare a spreadsheet to answer the following questions and highlight your answers in **yellow**. *This is an individual assignment.*

1. Rollover of Key Tenants (4 points): Using the information on tenants in the “Rent Roll (Tenant Stack)” worksheet, complete the “1. Major Tenant Expirations” worksheet by filling in the area highlighted in **yellow**. Discuss whether the new owner has to worry about any of the major tenants leases expiring in the short term e.g., the next 3 years? Assume that the date of your analysis is as of April 16, 2005. (Feel free to make a copy of the “Rent Roll (Tenant Stack)” worksheet by right clicking your mouse over a tab → select **Move or Copy...** → highlight Rent Roll (Tenant Stack) → click on box labeled **Create a copy** → click the OK button → double click on the copy of worksheet you just duplicated and type in whatever label you want to use e.g. Rent Roll (reformatted). You can now use the Sort command or other commands in Excel to group all of the space of a tenant together).
2. Maximum Vacancy Rate (1 point): What is the maximum vacancy rate for One Renaissance Square at end of year (EOY) 2005 assuming that no current vacant space is rented by year end 2005 and existing tenants whose lease will expire choose not to renew their leases? What is the vacancy rate if the Renaissance Athletic Club renews their lease?
3. Lease Rollover Analysis (10 points): Using the information on tenants in the “Rent Roll (Tenant Stack)” worksheet, complete the “3. Rollover” worksheet by filling in the area highlighted in **yellow**. In what year does at least 10% of the total net rentable square feet come up for renewal? What are the critical years with respect to leases potentially rolling over? Discuss why it is important to do a lease rollover analysis?
4. Tenant Improvements (TI) (5 points): Calculate the tenant improvements on a per square foot basis per year using the “4. PVCalc of TI” worksheet and assumptions about tenant improvements for new leases and renewals reported above. Essentially, you are converting the amount of tenant improvements (PV) into an equivalent annual annuity (EAA) that you should have learned about in your finance class. Appendix A of this handout discusses how to calculate EAA.
5. Rent Abatement or Free Rent (5 points): In the offering memorandum given to potential investors, the cash flows reported excluded contractual rent abatements and rent credits although the memorandum noted that a schedule of abatements and credits would be provided to investors at a later date. However, in the detailed rent per tenant in the report, for Suite 160 occupied by Beyond Juice, whose lease commenced on January 1, 2005 and expires on December 31, 2014, the report lists free rent months of January 2005 to April 2005. We will assume therefore that this situation holds for all new leases e.g. 4 months of free rent on a 10 year lease. Calculate the “haircut” or the percentage of free rent per year using the “5. Free Rent Calc” worksheet for Suite 700 that Quarles & Brady Streich Lang LLP rented starting

May 2005²³ and expiring on April 2015. Please note that we are using an approximation that is used in practice rather than the more theoretically correct method of converting the flows into an equivalent annual annuity (EAA) and then backing out the free rent per square foot. Appendix B gives an example of the free rent approximation.

6. Effective Gross Rent on New Space (10 points): Calculate the equivalent annuity for effective gross rent on new office, retail, and health club space using the “6. Calc EfcRent (New Space)” worksheet. Your textbook discusses the procedure used in the spreadsheet template which essentially involves converting the flows into an equivalent annual annuity (EAA). In doing your calculations, please refer to the Assumptions page(s) of this case.
7. Pro-Forma Rents and Expenses (15 points): Calculate the pro-forma rents and expenses for Year **2006** using the “7. Calc ProForma” worksheet in conjunction with the assumptions given above starting on page 6.
8. Present Value of Master Lease (5 points): Calculate the present value of the master lease using the “8. PV of Master Lease” worksheet. Since Maguire Properties (MPG) is not rated by S&P, Moody’s or Duff Phelps Fitch, assume a Caa/CCC credit rating. Recall that MPG entered into a lease obligation with the buyer to lease 37,220 rentable square feet of vacant space at \$25.10 per square foot through March 2007 to guarantee a 98% occupancy status for two years. From an accounting standpoint, Maguire views this lease as an operating lease which is an off-balance sheet item and is reported in the footnotes to their 10K. Following is an excerpt of this from their 10-K dated December 31, 2005:

Operating Leases

In connection with the sales of Austin Research Park I and II and One Renaissance Square in June 2005, we entered into leases with the respective buyers to lease vacant space through April 2007 and March 2007, respectively (see Note 15 for more information). We have the option to terminate these leases in the event that we sublease the space to a tenant or tenants for an equal amount of rent.

The minimum commitment under these leases as of December 31, 2005 was as follows (in thousands):

2006	\$ 1,506
2007	353
2008	-
2009	-
2010	-
Thereafter	-
Total	\$ 1,859

²³Even though the date of our analysis is April 16, 2005, information on this lease was reported in the offering memorandum.

Maguire Properties further goes on to say that “Our total potential obligation of approximately **\$1.6 million** under this lease was offset against the sales value recognized and is included in accounts payable and other liabilities in the accompanying consolidated balance sheet as of December 31, 2005”. Please discuss whether you agree with this statement e.g., is the present value of their potential obligation approximately \$1.6 million dollars? This was the incentive to make the deal work (the art of the deal) from the perspective of the Pauls Corp.

9. Cap Rate Frontdoor Approach (20 points):

- a. Required Rent: What is the required asking rent per square foot of **net rentable area** using the cap rate version of the front door approach given the expected selling price? Is the deal financially feasible? Please explain. Recall that the only information on value available at the time of sale was that Maguire Properties (NYSE:MPG) acquired One Renaissance Square for \$120 million on March 16, 2005 and then immediately announced plans to sell it with property tours ending and offers due by April 19, 2005 since the Phoenix property was always considered a non-core asset. Also recall that the space that Maguire agreed to lease from Paul Corp. was vacant at the time.
- b. Sensitivity Analysis via Data Table: In addition to calculating required rent, prepare a two way Data Table showing the required rent at varying levels of vacancy rates and going-in cap rates. To access the Data Table command in Excel click on **Data** submenu on the Excel toolbar → **Table ...**. Appendix F gives an illustration of how to use the Data Table function. What is the most probable cap rate that makes the deal work at various vacancy rate levels? What range of operating expense per square foot (excluding TI/LC) in combination with the cap rate(s) makes the deal feasible?
- c. Sensitivity Analysis via Solver: This is where we try to structure the deal to make it financially feasible by varying the terms of the deal. I have provided a “9.b Frontdoor Sensitivity” worksheet for you to put your final answers into.
 - What is the highest purchase price that an institutional investor should pay and still have the deal be financially feasible all other variables remaining constant?
 - What is the highest vacancy rate that the building can have and still have the investor remain solvent all other variables remaining constant including the purchase price? Is this vacancy rate lower than the direct market vacancy rate?
 - What would the going-in cap rate have to be for the deal to breakeven all other variables remaining constant? Note: Some developers such as the Reichmans use the interest rate in lieu of the going-in cap rate. This implicitly assumes that no equity is put into the deal e.g., 100% debt financing so the investor “mortgages-out”. (Please see Appendix E of this case study).

- What would the operating expenses per square foot have to be for the deal to breakeven all other variables remaining constant?

Please discuss whether these terms make financial sense or not. Recall that the purchasers required Maguire Properties to lease space in the building for two years. If we also assume that the buyers of the property expect to be able to renew all space that is coming up for renewal in 2006 so that only the existing vacant space remains, redo your analysis in terms of the preceding questions. Namely,

- What is the highest purchase price that an institutional investor should pay and still have the deal be financially feasible all other variables remaining constant?
- What is the highest vacancy rate that the building can have and still have the investor remain solvent all other variables remaining constant including the purchase price? Is this vacancy rate lower than the direct market vacancy rate?
- What would the going-in cap rate have to be for the deal to breakeven all other variables remaining constant?

Given this analysis, how important is it to the deal that Maguire leases back space in the building for two years?

Hint: Make a copy of your Frontdoor worksheet by right clicking on the mouse, selecting the **Move or Copy....** option, highlighting the Frontdoor worksheet, click on the box at the lower left hand corner **Create a copy** and then click the **OK** button. Next, use the **Solver...** subroutine located under the **Tools** submenu in Excel and set the justified rent equal to the asking rent. Appendix G of this case gives an example of how to use Solver.

10. Backdoor using Debt Coverage Ratio Approach (20 points): What is the justified price per square foot of gross building area for One Renaissance Square given the assumptions listed on page 6 through page 9 and the "10. Backdoor (DSCR)" worksheet? Is the deal financially feasible from a backdoor perspective? Please explain. Is the justified price also greater than the actual price per square foot that Pauls Corp paid? Please use the Data Table command in Excel to set up a two-way table showing the justified price per square foot of gross building area at i) various combinations of interest rate and vacancy rate, ii) various combinations of the debt coverage ratio and the vacancy rate, and iii) various combinations of the before tax cash on cash rate and the vacancy rate. Are there any scenarios for which the deal is financially feasible? What does your analysis suggest about their likely "implied" investment strategy?

Restatement of assignment. Please highlight your answers in **yellow** and turn in a hard copy of your results. ***This is an individual assignment.***

Appendix A: Equivalent Annual Annuity (EAA)

The Equivalent Annual Annuity method begins with the calculation of the NPV (or PV) of each project under consideration. This value is converted to an annuity given the number of years in the project's life span. That is, given the number of years and the discount rate, there is an amount which if paid at regular intervals for the same period would equal the NPV (or PV). The annuity can be calculated using the following formula:

$$\text{Annuity} = \frac{\text{Net Present Value or Present Value}}{\sum_{t=1}^T \left(\frac{1}{1+r} \right)^t}$$

Example: Suppose that our building has 100,000 square feet. Leases have 15 year terms and tenants in our building have BBB credit ratings. All of the leases are new. The treasury yield on a 10 year bond is 4.54% and on a 30 year bond is 4.81%. The default spread associated with a BBB bond at 10 years is 156 bps (basis points) and is 172 bps for a 30 year bond. Tenant improvements per square foot per year (psf/yr) are \$20.

Risk-free rate ²⁴	4.68%	((4.54%+4.81%)/2)
+ Default premium ²⁵	1.64%	((1.56%+1.72%)/2)
Pre-tax Cost of Debt	6.32%	(This is our discount rate (r))

Tenant Improvements: \$20 * 100,000 sqft = \$2,000,000 (this is our present value (PV))

Length of lease (T): 15 years

$$\text{PVIFA} = 1 / \sum_{t=1}^T \left(\frac{1}{1+r} \right)^t = 1 / \sum_{t=1}^T \left(\frac{1}{1+.0632} \right)^t = 9.51236281$$

EAA = Total Tenant Improvements/PVIFA = \$2,000,000/9.51236281 = \$210,253

TI psf/yr = EAA/Square Feet = \$210,253/100,000 sqft = \$2.10 psf/yr

^{24A}Use "15 year" treasury yield since leases are 15 yrs. Since there is no "15 year" treasury, we take the average of the yield on a 10 year and a 30 year Treasury bond

²⁵Averaged the default premium of a 10 year BBB bond and a 30 year BBB bond. Since 100 basis points (bps) = 1%, it follows that 156 bps = 1.56%.

Appendix B: Example of Simplistic Way of Calculating Effective Rent

Assume that

Square feet of tenant: 5,000 square foot

Term of lease: 36 months

Base rent: \$25 psf

Annual escalations: \$.50

Free rent: 1 month (first month)

	Formulas	Total Rent
Year 1 (11 months)	$\$25.00 * 5,000 \text{ sqft} * (11/12 \text{ months}) =$	\$114,583
Year 2 (12 months)	$\$25.50 * 5,000 \text{ sqft} =$	\$127,500
Year 3 (12 months)	$\$26.00 * 5,000 \text{ sqft} =$	\$130,000
Total Rent (all periods)		\$372,083

Effective Rent: $\$372,083 / 5,000 \text{ sqft} / 3 \text{ years} = \$24.81/\text{sf}/\text{year}$

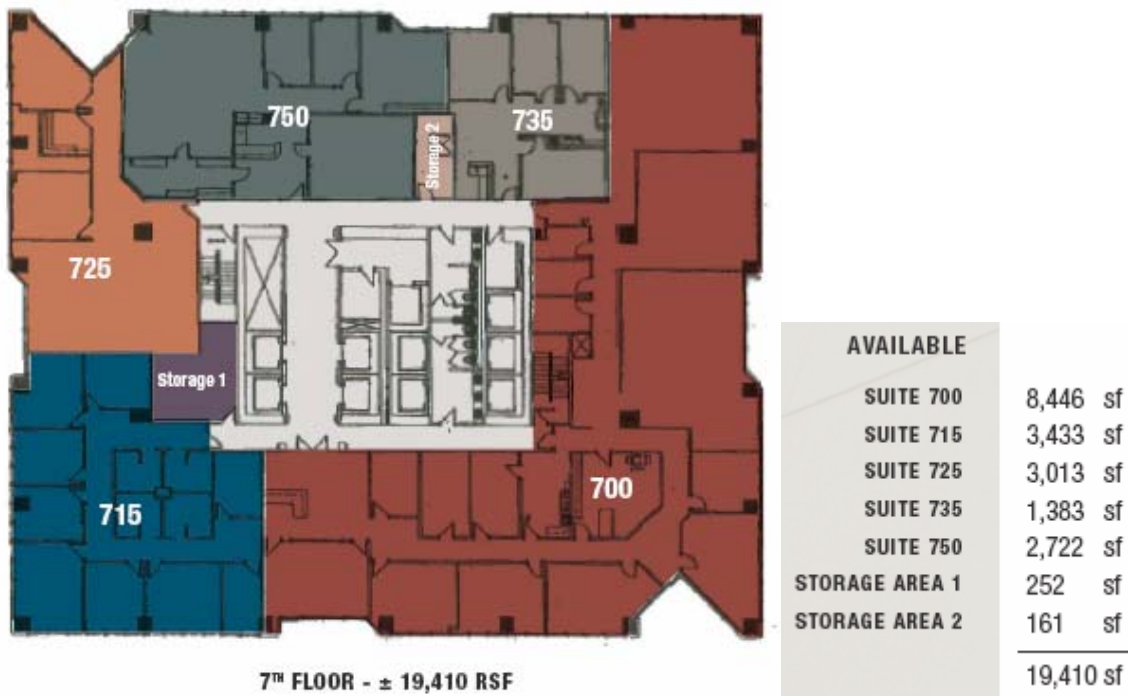
Rent Abatement (free rent): $\$25 * (1/12 \text{ months}) / 3 \text{ years} = \$0.69/\text{sf}/\text{year}$

÷ Average Rent: $\$382,500 / 5,000 \text{ sqft} / 3 \text{ years} = \$25.50/\text{sf}/\text{year}$

Haircut (percentage free rent) 2.7%

where $\$382,500 = \$125,000 + \$127,500 + \$130,000$ (if no free rent exists in yr 1)

Appendix C: Space Available at One Renaissance Square



Appendix D: Standard & Poor's Analysis of the Deal

Since the \$103.6 million mortgage was securitized as part of a \$1.977 Billion Commercial Mortgage Pass-Through (MPT) Certificates offering known as the Banc of America Commercial Mortgage Inc. Series 2005-C5, Standard and Poor's used the following underwriting assumptions with respect to the \$103.6 million loan²⁶ in the ratings process:

- Gross potential revenue (GPR) was based on leases in place as of the May 2005 rent roll;
- Expense reimbursements were based on the terms of the leases in place and the property's historical reimbursement income;
- An occupancy level of 93% was assumed because the subject's current 97.5% occupancy is above market levels;
- Operating expenses, other than property taxes and insurance premiums, were based on historical levels;
- Property taxes and insurance premiums were based on the property's current actual expenses;
- A management fee of 4.0% of effective gross income (EGI) was assumed;
- TI (tenant improvement) allowances were estimated at \$10.00 per sq. ft. for new leases and \$5.00 per sq. ft. for renewal leases;
- LCs (leasing commissions) were estimated at 4.0% for new leases and 2.0% for renewal leases;
- TI/LC assumptions were based on the in-place weighted average lease terms of 14.1 years;
- A 65.0% renewal probability was assumed;
- Replacement reserves were underwritten at \$0.30 per sq. ft.;

Based on these assumptions, Standard & Poor's overall net cash flow variance for the property was 5.0%; Standard & Poor's applied a 9.00% capitalization rate to the net cash flow and gave credit for a \$1.7 million up-front general leasing reserve account, yielding a value of \$71.49 million, or \$145 per square foot.

²⁶The loan for One Renaissance Square was the second-largest loan in the securitized commercial mortgage pool

Appendix E: The Brothers Reichmann

The Brothers Reichman and the Strategy of “More is More” (5 Points)²⁷: In an interview with Olympia and York’s executive vice president Edward Minskoff,

“Just how well the market adapts to rent increases is the determining factor in Olympia & York’s planning for new developments. The go-ahead is very much a function of projected income exceeding projected costs. ‘Before flashing the green light for a new project, the developer has to tally both hard and soft costs,’ Minskoff explains. ‘The former refers to expenses incurred on the actual construction work; the latter includes design, legal and accounting fees, marketing, expenses and so forth.

In New York today (1983), hard and soft costs to develop new properties range from \$150 to \$250 per square foot depending on the cost of the land. For argument’s sake, let’s figure \$150 as the average cost. With financing at 15 percent, interest would be \$22.50 per square foot, add another \$7 per square foot for taxes and \$7 for maintenance and you have a breakeven figure of \$36.50 per square foot. Projected market rent levels will have to be at a minimum \$38 to \$40 per square foot



Paul Reichmann

level to make the development economically feasible. We also figure our rent adjustments this way. They should reflect replacement costs to develop similar buildings in the current market.

The same kind of thinking applies to property purchases, as well. One of the reasons we bought the Uris buildings was that calculations showed the asking price to be about a third of replacement costs. We’d have had to spend three times as much to build comparable properties.’ ”

In 1964, the Reichmann brothers: Albert, Paul and Ralph, established Olympia and York Industrial Development Company, which, at its peak, constituted the greatest real estate empire the world had ever seen. Two sentences could express the Reichmann’s way of doing business: “Their edge was their integrity” and “Their word was their bond”. The Reichmanns were one of the ten wealthiest families in the world, ranking just below the British Royal family in the 1980s. Paul Reichmann has been at the same time one of the most resourceful and resilient entrepreneurs of the 20th century. Notable buildings that the Reichmanns have developed include the World Financial Center and Canary Wharf²⁸.



Canary Wharf, UK

²⁷from Mark Stevens, *Land Rush: The Secret World of Real Estate’s Super Brokers & Developers*, 1984, McGraw-Hill

²⁸www.shemayisrael.co.il/orgs/ozar/reichman.htm

Appendix F: How to Use the Data Table Function

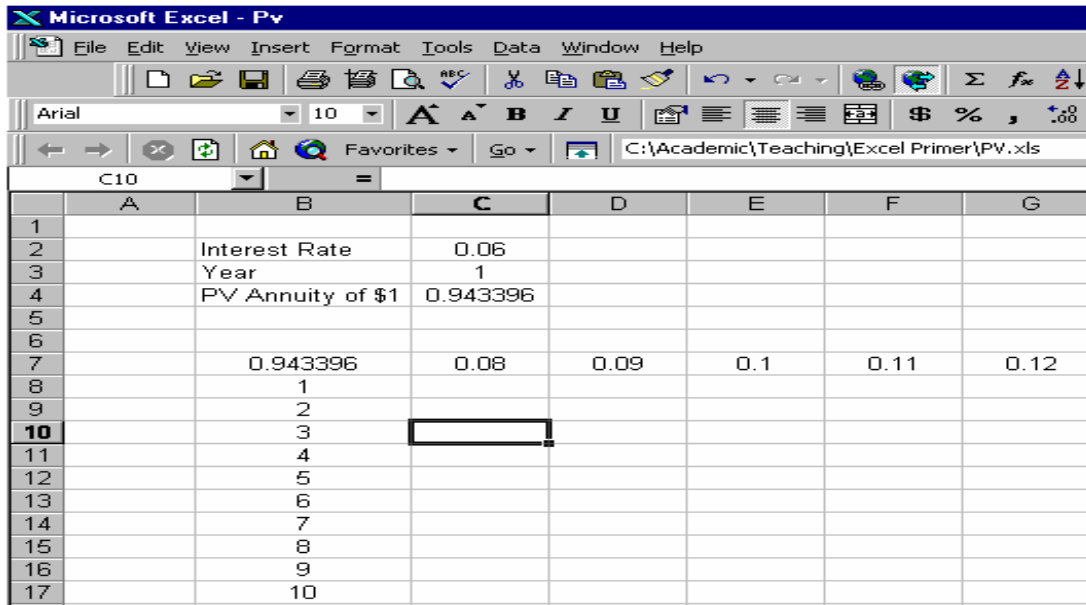
One method to do sensitivity analysis is by using the DATA TABLE command. This command allows the user to build a table in which only one variable is changed. Alternatively, the user can build a table in which two variables are changed. The nice feature of a DATA TABLE is that the table changes when the corresponding reference cells are changed.

Warning: One quirk of the Data Table command is that it can only be used on the same sheet that the formulas are on. As such, a Data Table cannot be constructed by linking together several worksheets (We will discuss how to link worksheets later on)

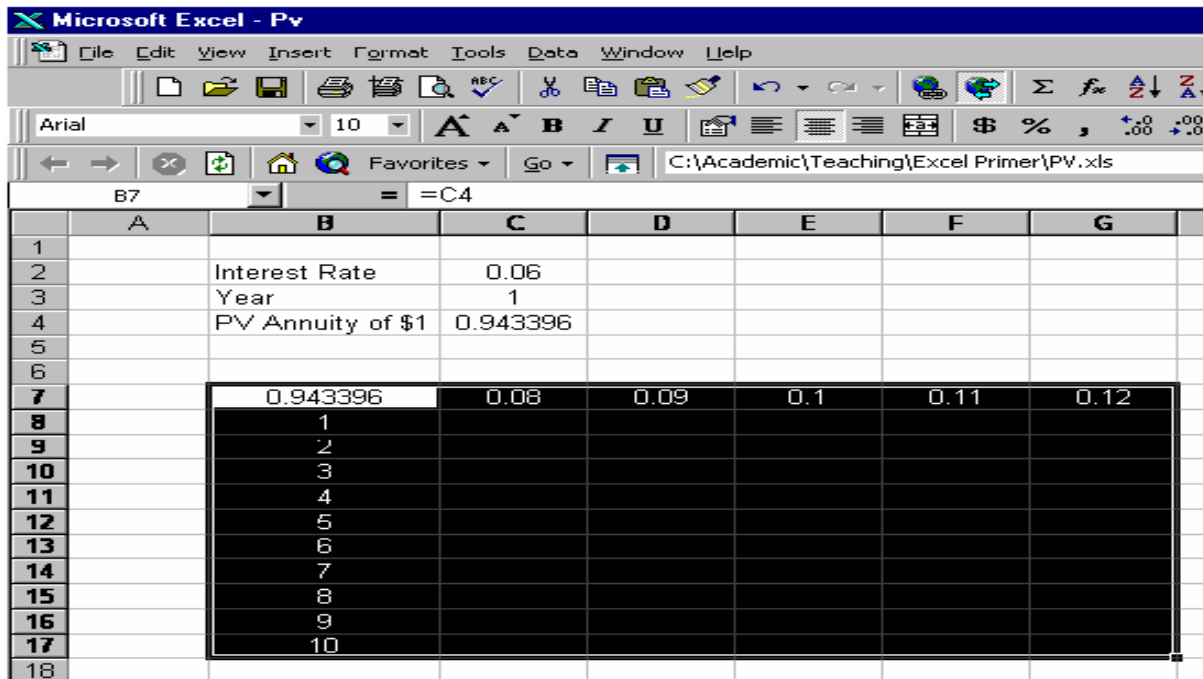
Example: Time value of money tables are frequently included at the back of most corporate finance textbooks. We will construct a present value of an annuity of \$1 per period table.

- ① We will use a new worksheet in our workbook. Go to the lower left hand corner of the worksheet and click on Sheet 2. Rename this sheet PV of an Annuity of \$1. Type the following words and numbers in the appropriate cells

Cell	What to Type in the Cell
B2	Interest Rate
C2	.06 (you can click on the % icon after you type this in)
B3	Year
C3	1
B4	PV Annuity of \$1
C4	$= (1 - (1 / (1 + \$C\$2)^{C3})) / \$C\2 or $=PV(\$C\$2, C3, -1, 0)$
B8 – B17	Type in the numbers 1 through 10 in sequential order
C7 – G7	Type in the numbers .08 to .12 in sequential order
B7	=C4 (This is the reference cell used to generate the Table)

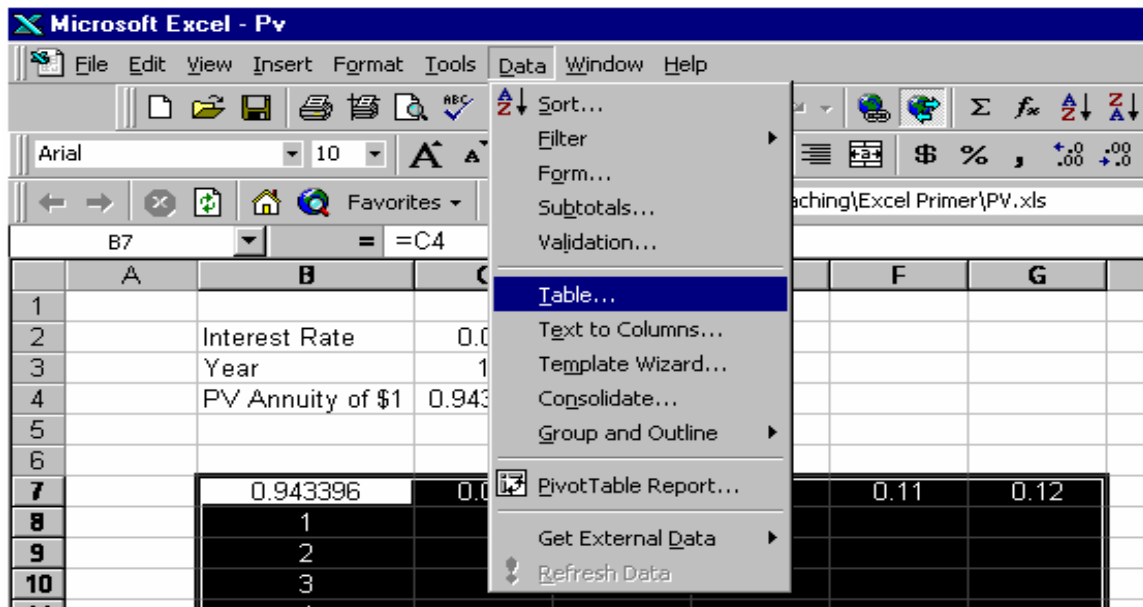


- 2 Click on cell B7. Hold down the Shift key and then click on cell G17. Column B through Column G should be highlighted in black from row 7 through row 17.



Alternatively, you can click on cell B7 and highlight the area by holding down the left button on your mouse and moving your cursor to cell G17.

- ③ From the **TITLE** toolbar, click on **Data** and then choose the **Table...** option.

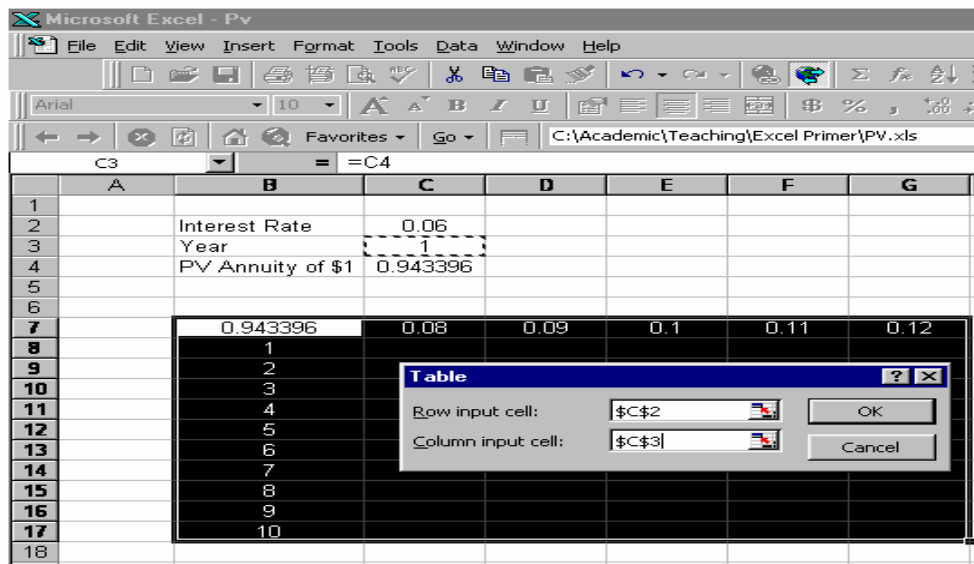


- ④ In the Table box which appears on your screen, there is a **Row Input Cell** and a **Column Input Cell**.

For the **Row Input Cell**, click on cell C2. The first box should now have \$C\$2 in it. Cell C2 (\$C\$2) is the Absolute Cell Reference for the initial discount rate. Notice that in the table we have constructed, all of our discount rates are in a ROW.

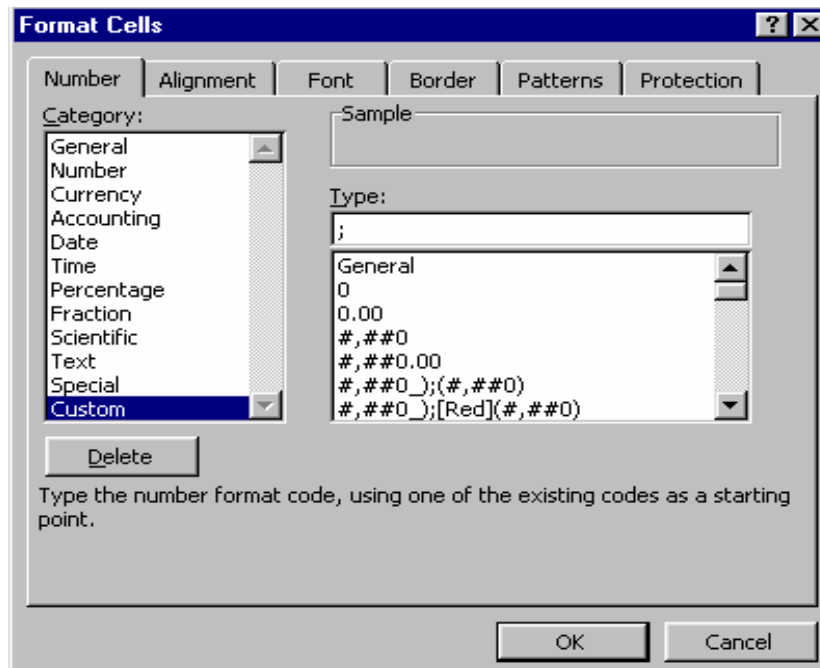
Next, for the **Column Input Cell**, click on cell C3. The second box should now have \$C\$3 in it. Cell C3 (\$C\$3) is the Absolute Cell Reference for the initial year (T). Observe that in the table we have constructed. All of our years are in a COLUMN.

Click the OK button.



	A	B	C	D	E	F	G
1							
2		Interest Rate	0.06				
3		Year	1				
4		PV Annuity of \$1	0.943396				
5							
6							
7		0.943396	0.08	0.09	0.1	0.11	0.12
8		1	0.925926	0.917431	0.909091	0.900901	0.892857
9		2	1.783265	1.759111	1.735537	1.712523	1.690051
10		3	2.577097	2.531295	2.486852	2.443715	2.401831
11		4	3.312127	3.23972	3.169865	3.102446	3.037349
12		5	3.992710	3.889651	3.790787	3.695897	3.604776
13		6	4.622880	4.485919	4.355261	4.230538	4.111407
14		7	5.206370	5.032953	4.868419	4.712196	4.563757
15		8	5.746639	5.534819	5.334926	5.146123	4.967640
16		9	6.246888	5.995247	5.759024	5.537048	5.328250
17		10	6.710081	6.417658	6.144567	5.889232	5.650223
18							

- ⑤ **Improving the Presentation of the Data Table:** We shall first convert the discount rates from decimals into percentages in cell C7 through cell G7 by clicking on the % icon in the MENU toolbar. Next, we will hide the cell B7. First, click on cell B7 and then click on the right button of the mouse. Select **Format Cells...** In the left window (denoted **Category:**) of the Format Cells box, click on **Custom**. In the right window (**Type:**) of the Format Cells box, insert a semicolon (;) in the box. Click the OK button.



	A	B	C	D	E	F	G
1							
2		Interest Rate	0.06				
3		Year	1				
4		PV Annuity of \$1	0.943396				
5							
6							
7			8%	9%	10%	11%	12%
8		1	0.925926	0.917431	0.909091	0.900901	0.892857
9		2	1.783265	1.759111	1.735537	1.712523	1.690051
10		3	2.577097	2.531295	2.486852	2.443715	2.401831
11		4	3.312127	3.23972	3.169865	3.102446	3.037349
12		5	3.992710	3.889651	3.790787	3.695897	3.604776
13		6	4.622880	4.485919	4.355261	4.230538	4.111407
14		7	5.206370	5.032953	4.868419	4.712196	4.563757
15		8	5.746639	5.534819	5.334926	5.146123	4.967640
16		9	6.246888	5.995247	5.759024	5.537048	5.328250
17		10	6.710081	6.417658	6.144567	5.889232	5.650223
18							

- ⑥ **Changing the discount rates and/or years in the Data Table:** Earlier, we stated that the Data Table changes when the related Relative cell references are changed. To see that this is the case, replace the percentages 8% - 12% in cells C7 through G7 with 14% - 18%. Observe that the present value of an annuity table is recalculated. This will not be the case however, if cell C2 or cell C3 are changed because these are Absolute cell references.

	A	B	C	D	E	F	G
1							
2		Interest Rate	0.06				
3		Year	1				
4		PV Annuity of \$1	0.943396				
5							
6							
7			14%	15%	16%	17%	18%
8		1	0.877193	0.869565	0.862069	0.854701	0.847458
9		2	1.646661	1.625709	1.605232	1.585214	1.565642
10		3	2.321632	2.283225	2.245890	2.209585	2.174273
11		4	2.913712	2.854978	2.798181	2.743235	2.690062
12		5	3.433081	3.352155	3.274294	3.199346	3.127171
13		6	3.888668	3.784483	3.684736	3.589185	3.497603
14		7	4.288305	4.16042	4.038565	3.922380	3.811528
15		8	4.638864	4.487322	4.343591	4.207163	4.077566
16		9	4.946372	4.771584	4.606544	4.450566	4.303022
17		10	5.216116	5.018769	4.833227	4.658604	4.494086
18							

The Solver subroutine in Excel is a useful tool to help decision makers explore what-if scenarios. Using Solver, you can find the minimum (**Min**), maximum (**Max**), or a specified (**Value of**) value for a single cell, by modifying other cells that are directly or indirectly related to the target formula. The minimum, maximum, or specified value that is found by modifying other cells is called a target cell and the target **formula** resides in this cell. Constraints can be applied to restrict the values of the target cell using constrained cells. Solver adjusts the values in the specified adjustment cells. Solver commands are in a group called what-if analysis tools. We will use the following example involving the calculation of the internal rate of return to show how Solver works.

Example: The investment syndicate known as Professors Capital is deciding whether to purchase a building that costs \$10 million with cash flows in the first year \$2.5 million. His weighted average borrowing cost²⁹ is 6.5%. Cash flows are expected to grow each year at 3% per annum. The net proceeds from the sale of the property at the end of a five year holding period is \$12.75 million. What is the internal rate of return on this property?

Initial set up of our spreadsheet with cash flow stated in 000s.

	A	B	C	D	E
1	Discount Rate	0.065			
2	Growth Rate	0.03			
3					
4		Time	Cash Flow	PVF	PV
5		0	-10000	=1/(1+\$B\$1)^B5	=C5*D5
6		1	2500	=1/(1+\$B\$1)^B6	=C6*D6
7		2	=C6*(1+\$B\$2)	=1/(1+\$B\$1)^B7	=C7*D7
8		3	=C7*(1+\$B\$2)	=1/(1+\$B\$1)^B8	=C8*D8
9		4	=C8*(1+\$B\$2)	=1/(1+\$B\$1)^B9	=C9*D9
10		5	=C9*(1+\$B\$2)+12750	=1/(1+\$B\$1)^B10	=C10*D10
11					
12				NPV	=SUM(E5:E10)

where PVF is the present value factor $(1/(1+r))^T$, r is the discount rate, and T is time.

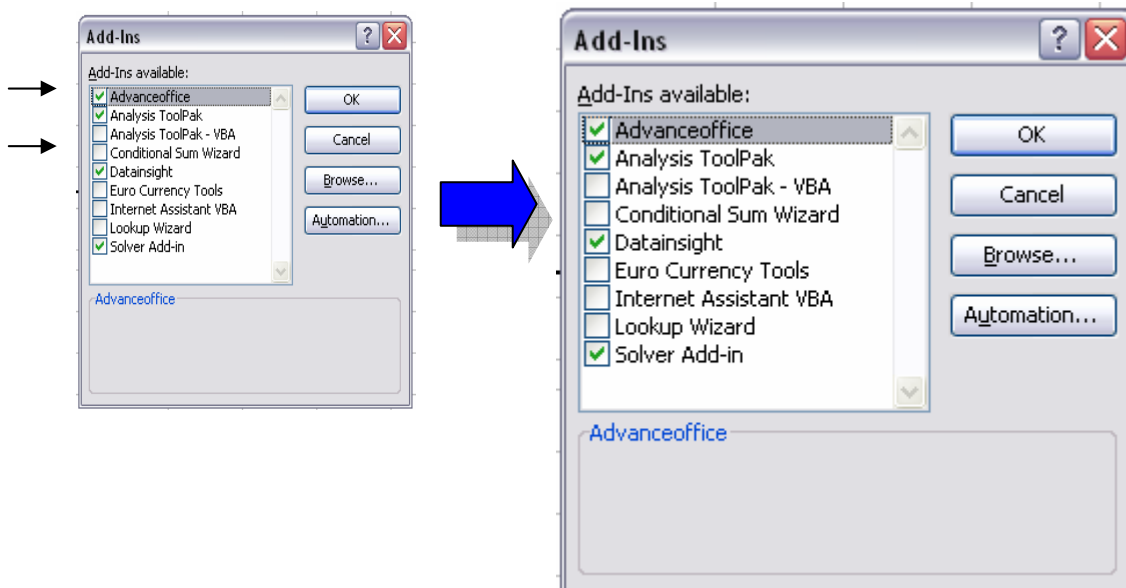
²⁹Cost of funds from using a mortgage (k_{Debt}) and cost of funds using the investment syndicate's own equity (k_{Equity}). For example, suppose that the syndicate borrows 80% from a bank at a cost of 5.5% (k_{Debt}) and they put in the rest of the funds (20%) expecting to earn a 12.5% (k_{Equity}) return on their investment. Then the weighted average borrowing cost from using both of these sources of capital to fund the deal is $((W_{Equity} * k_{Equity}) + (W_{Debt} * k_{Debt})) = 80% * 5.5% + 20% * 12.5% = 6.5%$.

Output (to see formulas in a spreadsheet type **Ctrl ~** and to get back to the regular mode type **Ctrl ~** again).

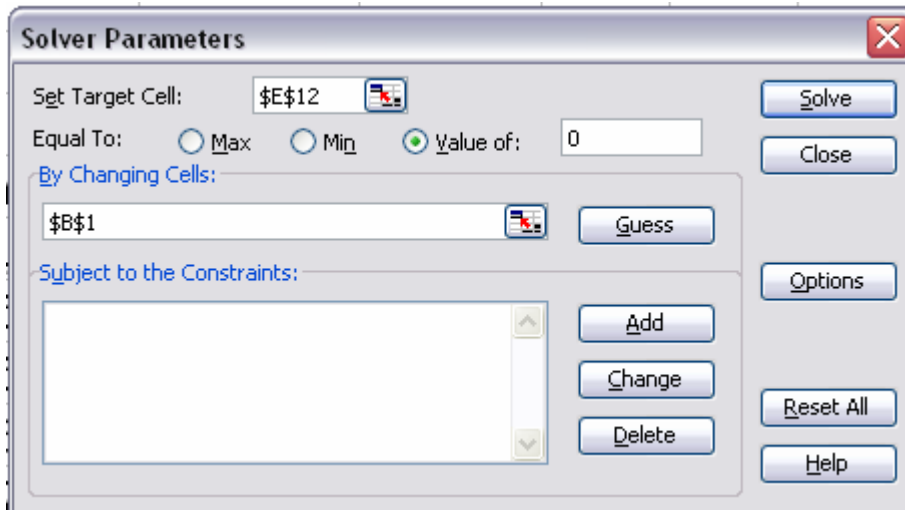
	A	B	C	D	E
1	Discount Rate	6.5%			
2	Growth Rate	3.0%			
3					
4		Time	Cash Flow	PVF	PV
5		0	-10,000	1.000000	-10,000
6		1	2,500	0.938967	2,347
7		2	2,575	0.881659	2,270
8		3	2,652	0.827849	2,196
9		4	2,732	0.777323	2,124
10		5	15,564	0.729881	11,360
11					
12				NPV	10,297

To calculate IRR, first recall from your finance class that IRR is the rate of return that makes the net present value equal to zero e.g., $NPV = 0$ or the present value of the benefits is equal to the present value of the cost of those benefits.

To use the Solver subroutine, select the **Tools** submenu and then choose the **Solver...** option. If you do not see the Solver option in the Tools submenu, go to the **Tools** submenu, select **Add-Ins...**, choose **Solver Add-Ins** and then click OK. You should now see the **Solver...** option in the **Tools** submenu.



This is the next screen you see when you select the Solver subroutine:

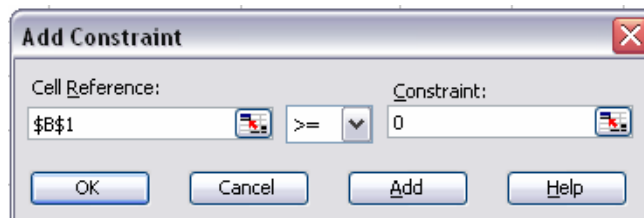


Target cell: Our NPV formula is located in cell E12 (row E, column 12). The target cell must contain a formula so it must have an = sign in it.

Value of the Target Cell: We are trying to change the value of the NPV from our current value of \$10,297 to a value of \$0. We do this by clicking on **Value of:** and inputting **0** as the value.

By Changing Cells: We will make $NPV = 0$ by changing the value of the discount rate which is located in cell B1. This is equivalent to us manually changing the discount rate until $NPV = 0$.

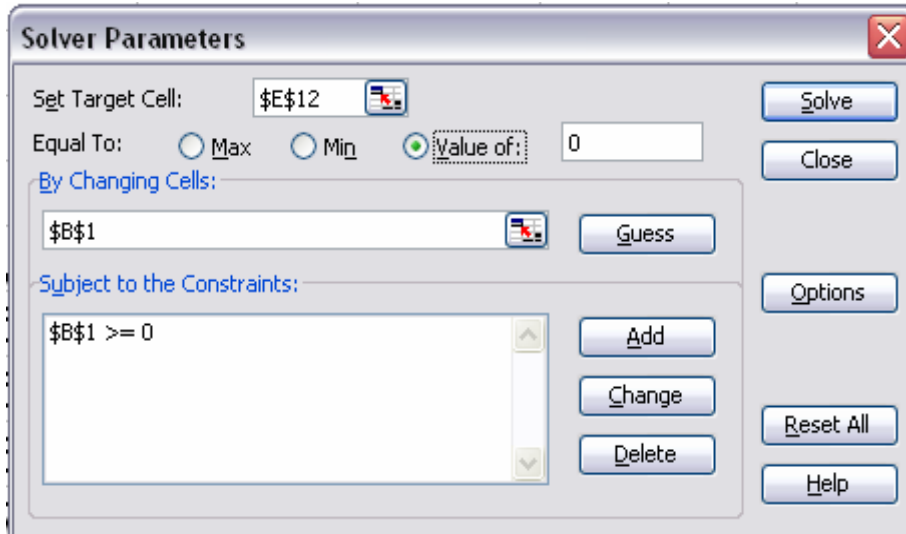
Since we wish to have a positive IRR (cell $B1 > 0$), we need to add a constraint. Click on the **Add** button to the right of the **Subject to the Constraints:** box. Next, we set cell B1 to be greater to or equal to 0 as follows:



Since this is the only constraint, we click the OK button. Note: we did not need to add this constraint in our current example since the sum of our cash flows is greater than our original investment which means that the IRR will be a positive number. I used this example to demonstrate how to add a constraint. This is important when there are multiple IRRs on a project. Multiple IRRs exist when there are both positive and

negative cash flows with one IRR for each change in sign from a positive to a negative or negative to a positive cash flow.

Our Solver box now shows our constraint that the IRR must be a positive number (>0)

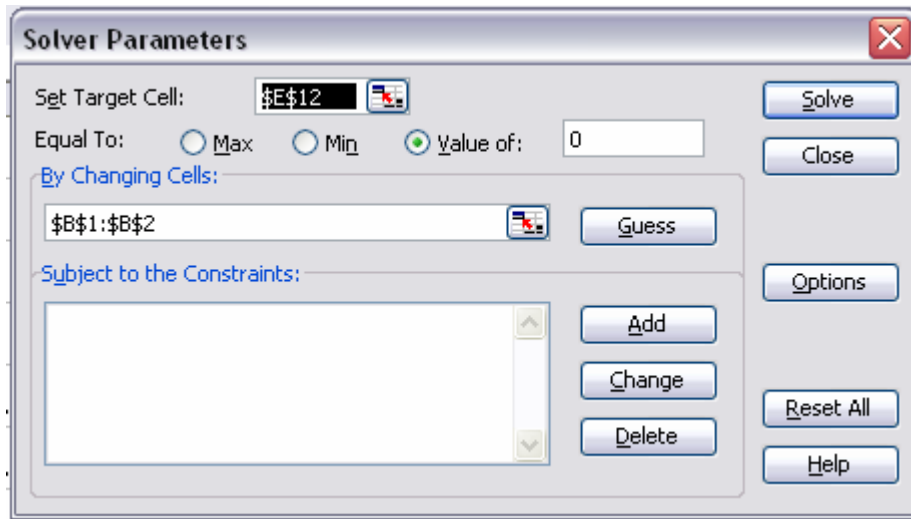


After clicking the **Solve** button, notice that our discount rate has changed. Our “new” discount rate of 29.2% is the IRR given a 3% growth rate in our cash flows.

	A	B	C	D	E
1	Discount Rate	29.2%			
2	Growth Rate	3.0%			
3					
4		Time	Cash Flow	PVF	PV
5		0	-10,000	1.000000	-10,000
6		1	2,500	0.773747	1,934
7		2	2,575	0.598684	1,542
8		3	2,652	0.463230	1,229
9		4	2,732	0.358423	979
10		5	15,564	0.277328	4,316
11					
12				NPV	0

What if we allow the growth rate to also change? We can solve for the IRR (NPV = 0) by simultaneously changing both the discount rate AND the growth rate in the **By Changing Cells:** box.

This is our input box. Notice that we have taken out our constraint.



Our output is as follows:

	A	B	C	D	E
1	Discount Rate	25.2%			
2	Growth Rate	-8.8%			
3					
4		Time	Cash Flow	PVF	PV
5		0	-10,000	1.000000	-10,000
6		1	2,500	0.799023	1,998
7		2	2,279	0.638437	1,455
8		3	2,078	0.510126	1,060
9		4	1,895	0.407602	772
10		5	14,477	0.325683	4,715
11					
12				NPV	0

The new IRR is 25.2% based on a -8.8% growth rate. For further examples of how to use Solver, Microsoft includes an Excel file named Solvsamp.xls with every hard installation of the application. The spreadsheet goes through a complete explanation of several interrelated examples using Microsoft Excel Solver. To search for this file on your computer, click on the **start** button on the lower left hand corner of your screen, on the right hand side of your screen, click on **Search** then type **Solvsamp.xls**.

